U.S. Department of Energy

ALASKA LNG PROJECT

Draft
Supplemental Environmental Impact Statement

July 2022

Volume II
Appendices

DOE/EIS-0512-S1

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Alaska LNG Project

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AGENCY AND ALASKA NATIVE COORDINATION

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ACHP	Advisory Council on Historic Preservation
BLM	Bureau of Land Management
DOE	Department of Energy
DOT	Department of Transportation
FECM	Office of Fossil Energy and Carbon Management
FERC	Federal Energy Regulatory Commission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
PHMSA	Pipeline and Hazardous Materials Safety Administration
SEIS	Supplemental Environmental Impact Statement
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

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APPENDIX A AGENCY AND ALASKA NATIVE COORDINATION

A.1 INTRODUCTION

During preparation of the Draft Supplemental Environmental Impact Statement (SEIS), the United States (U.S.) Department of Energy (DOE), Office of Fossil Energy and Carbon Management (FECM) actively maintained communication with Federal, State, and Alaska Native tribal governments. This appendix summarizes the records of formal consultation between the DOE and these government agencies and Alaska Native Tribes.

The DOE invited the following agencies to be Cooperating Agencies for this Draft SEIS as these agencies participated as cooperating agencies in the preparation of the Federal Energy Regulatory Commission's (FERC) 2020 EIS; however, no agencies accepted the invitation. This Appendix will be updated for the Final SEIS to include a sample agency notification letter for the Draft SEIS as well as any formal communication received. Refer to Chapter 8, Distribution List, for a detailed list of agencies and other entities contacted about this Draft SEIS.

- Advisory Council on Historic Preservation (ACHP)
- U.S. Air Force
- U.S. Army Corps of Engineers (USACE)
- U.S. Coast Guard (USCG)
- U.S. Department of Interior, Bureau of Land Management (BLM)
- U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Federal Energy Regulatory Commission (FERC)
- U.S. Fish and Wildlife Service (USFWS)
- National Oceanic and Atmospheric Administration (NOAA)
- National Marine Fisheries Service (NMFS)
- National Park Service (NPS)

DOE contacted each of the 78 Alaska Native Tribes (124 coordination letters hard-mailed on December 10, 2021) involved in the 2020 EIS process, notifying them of DOE's decision to prepare an SEIS and to inquire about their interest. Additionally, DOE requested the Alaska Natives provide any traditional knowledge regarding resources on the North Slope potentially affected by upstream development. To date, DOE has not received any responses from any Alaska Natives. This appendix contains a representative letter used for Alaska Native correspondence with the following Alaska Native Tribes.

- Athna, Inc.
- Alaska Eskimo Whaling Commission
- Alatna Village
- Alexander Creek Inc.
- Allakaket Village and Tribal Council
- Anderson Village

- Arctic Village Council
- Atqasuk Corporation
- Baan-O-Yeel-Kon Corporation
- Bean Ridge Corporation
- Beaver Village
- Bristol Bay Native Corporation
- Calista Corporation
- Central Council Tlingit & Haida Indian Tribes of Alaska
- Cheesh-Na Tribe
- Chenega Corporation
- Chickaloon Native Village
- Chilkat Tribal Court
- Chilkoot Indian Association
- Chugach Alaska Corporation
- Chugachmiut, Inc.
- Circle Native Community
- Cook Inlet Region, Inc.
- Cook Inlet Tribal Council
- Copper River Native Association
- Douglas Indian Association
- Doyon Limited
- Eklutna Inc.
- Eklutna Native Village
- Evansville Village and Tribal Council
- Denali Borough
- Gulkana Village
- Gwichyaa Zhee Gwichni'in Tribal Government
- Inupiat Community of the Arctic Slope
- Kaktovik Inupiat Corporation
- Kenai Natives Association, Inc.
- Kenaitze Indian Tribe
- Knik Tribal Council
- Knikatnu, Inc.
- K'oyitl'ots'ina, Limited
- Kuukpik Corporation
- Manley Hot Springs Village

- Mendas Cha-as Native Corporation
- Minto Village Council
- NANA Regional Corporation
- Native Village of Barrow Inupiat Traditional Government
- Native Village of Cantwell
- Native Village of Eyak
- Native Village of Fort Yukon
- Native Village of Gakona
- Native Village of Kaktovik
- Native Village of Kluti-Kaah
- Native Village of Nanwalek (English Bay)
- Native Village of Nuiqsut
- Native Village of Port Graham
- Native Village of Stevens
- Native Village of Tatitlek
- Native Village of Tyonek
- Nenana Native Association
- Ninilchik Traditional Council
- Nunamiut Inupiat Corporation
- Rampart Village Council
- Salamatof Native Association, Inc.
- Seldovia Village Tribe
- Seth-De-Ya-Ah Corporation
- Talkeetna
- Tanana Chiefs Conference
- Tanana Tribal Council
- The Tatitlek Corporation
- Toghotthele Corporation
- Tozitna, Limited
- Tyonek Native Corporation
- Ukpeagvik Inupiat Corporation
- Valdez Native Tribe
- Village of Anaktuvuk Pass
- Village of Salamatof
- Village of Venetie

A.2 ALASKA NATIVE COORDINATION

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY
Albany, OR • Morgantown, WV • Pittsburgh, PA

NATIONAL ENERGY TECHNOLOGY LABORATORY

December 10, 2021

NAME
TITLE
ORGANIZATION
ADDRESS
ADDRESS

SUBJECT: Advanced Notice Regarding the U.S. Department of Energy's Preparation of a Supplemental Environmental Impact Statement for the Proposed Alaska Liquified Natural Gas Project, and Request for Information

Dear NAME:

In August 2020, the U.S. Department of Energy (DOE) issued an order authorizing the export of liquefied natural gas (LNG) by Alaska LNG Project LLC (Alaska LNG) for a period of 30 years. The proposed Alaska LNG Project[1] would allow for the export of LNG to non-free trade agreement countries under the Natural Gas Act.[2] Sierra Club requested rehearing of that order, which DOE granted in part on April 15, 2021.

Previously in March 2020, the Federal Energy Regulatory Commission (FERC) published a Final Environmental Impact Statement (EIS) for the proposed Alaska LNG Project under the National Environmental Policy Act (NEPA).[3] DOE adopted the EIS in March 2020. In July 2021, DOE published a Notice of Intent (NOI) to Prepare a Supplemental EIS for the Alaska LNG Project in the *Federal Register* (refer to Attachment 1 of this letter).

The NOI explains that as part of DOE's rehearing process DOE is preparing a Supplemental EIS that will be comprised of two studies: (1) an assessment of potential environmental impacts associated with natural gas production on the North Slope of Alaska, and (2) a life cycle analysis calculating the greenhouse gas emissions for LNG exported from the proposed Alaska LNG Project.

In preparing the EIS, FERC collected traditional knowledge from Alaska Native communities concerning the characteristics of Alaskan natural resources and use or

[1] The Alaska LNG Project includes: (1) producing natural gas on the North Slope of Alaska, (2) transporting the natural gas on a proposed 800-mile long pipeline, and (3) liquefying the natural gas for export at a proposed liquefaction facility, to be built in the Nikiski area of the Kenai Peninsula in south central Alaska.

[2] *See Alaska LNG Project LLC*, DOE/FE Order No. 3643-A, FE Docket 14-96-LNG, Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations (Aug. 20, 2020), *available at*: https://www.energy.gov/sites/default/files/2020/08/f77/ord3643a.pdf.

[3] Federal Energy Regulatory Comm'n, Alaska LNG Project Final Environmental Impact Statement, Docket No. CP17-178-000 (Mar. 6, 2020), available at: https://www.ferc.gov/industries-data/natural-gas/final-environmentalimpact-statement-0.

3610 Collins Ferry Road, P.O. Box 880, Morgantown, WV 26507
mark.lusk@netl.doe.gov Phone (304) 285-4145 www.netl.doe.gov

management practices that are passed down from generation to generation and contribute to the cultural, social, and spiritual identity of Alaska Native communities. DOE will incorporate this information, as relevant, into the Supplemental EIS. In particular, DOE will focus on resources within the North Slope of Alaska that may be affected by the production and export of LNG from the proposed Alaska LNG Project.

DOE currently plans to issue the Draft Supplemental EIS for public review and comment on May 2, 2022.[4] If you have additional information related to Alaska North Slope resources and greenhouse gas emissions that was not previously considered as part of FERC's EIS, we request that you provide it to my office within 30 days from the receipt of this letter.

As a recipient of this letter, you will receive the Notice of Availability for the release of the Draft Supplemental EIS and will also have an opportunity to comment at that time. Based on DOE's findings from the Supplemental EIS and any comments received, DOE may decide to modify, set aside, or affirm the Alaska LNG order.[5]

If you have any questions, please do not hesitate to contact me.

Sincerely,

Mark W. Lusk
NEPA Compliance Officer

1 Attachment: Notice of Intent To Prepare a Supplemental Environmental Impact Statement for the Alaska LNG Project (Federal Register / Vol. 86, No. 125 / Friday, July 2, 2021)

cc:
NAME

[4] *See* U.S. Dep't of Energy, Notice of Schedule for Supplemental Environmental Impact Statement, Docket No. 14-96-LNG (Aug. 24, 2021), *available at*: https://www.energy.gov/sites/default/files/2021-08/Alaska%20LNG%20-%20Notice%20of%20Schedule%20for%20SEIS.pdf.
[5] DOE is planning to issue the Final Supplemental EIS on September 15, 2022, and the final order on December 14, 2022. *See id.*

2

Attachment 1

35280 Federal Register / Vol. 86, No. 125 / Friday, July 2, 2021 / Notices

Abstract: This is a request for a new information collection. The Rural, Insular, and Native Achievement Programs (RINAP) administers Section 1121 of Title I, Part A of the ESEA; Title II of Public Law 108–118 (Supplemental Education Grant (SEG)), CARES Act—Outlying Areas; Title III of CRRSA—Outlying Areas, Sections 2005 and 11006(2–3) of the ARP; Title V, Part B of the ESEA (Rural Education Achievement Program), Title VI, Part B of the ESEA (Native Hawaiian Education); and Title VI, Part C of the ESEA (Alaska Native Education). Periodic progress updates, phone, virtual, or in-person conversations during a fiscal year with authorized representatives and project directors help ensure grantees are making progress toward meeting program goals and objectives. The information shared with RINAP helps inform the selection and delivery of technical assistance to grantees and aligns structures, processes, and routines so RINAP can monitor the connection between grant administration and intended outcomes.

Dated: June 29, 2021.

Kate Mullan,

PRA Coordinator, Strategic Collections and Clearance Governance and Strategy Division, Office of Chief Data Officer, Office of Planning, Evaluation and Policy Development.

[FR Doc. 2021–14186 Filed 7–1–21; 8:45 am]

BILLING CODE 4000–01–P

DEPARTMENT OF ENERGY

Notice of Intent To Prepare a Supplemental Environmental Impact Statement for the Alaska LNG Project

AGENCY: Office of Fossil Energy, Department of Energy.

ACTION: Notice of intent.

SUMMARY: On April 15, 2021, the U.S. Department of Energy's Office of Fossil Energy (DOE/FE) granted a request for rehearing of a final order issued to Alaska LNG Project LLC (Alaska LNG) for the export of liquefied natural gas (LNG) produced from Alaskan sources to non-free trade agreement countries, pursuant to the Natural Gas Act (NGA). In the Rehearing Order, DOE stated that it was granting rehearing for the purpose of conducting two Alaska-specific environmental studies (collectively, the Alaska environmental study proceeding). To this end, DOE intends to prepare a supplemental environmental impact statement (SEIS) for the Alaska environmental study proceeding (DOE/EIS–0512–S1), consistent with the National Environmental Policy Act (NEPA). The SEIS will include analysis of potential environmental impacts associated with natural gas production on the North Slope of Alaska and a life cycle analysis (LCA) calculating the greenhouse gas (GHG) emissions for LNG exported from the proposed Alaska LNG Project.

ADDRESSES: Documents related to the SEIS process will be posted at: *https://energy.gov/nepa/doeeis-0512-s1-supplemental-environmental-impact-statement-alaska-lng-project.*

FOR FURTHER INFORMATION CONTACT: Questions concerning the SEIS or requests to be placed on the SEIS distribution list should be sent to: Brian Lavoie, U.S. Department of Energy (FE–34), Office of Regulation, Analysis, and Engagement, Office of Fossil Energy, Forrestal Building, Room 3E–042, 1000 Independence Avenue SW, Washington, DC 20585; (202) 586–2459; *brian.lavoie@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

Background

On August 20, 2020, DOE issued DOE/FE Order No. 3643–A (the Alaska LNG Order) [1] to Alaska LNG Project LLC (Alaska LNG) under section 3(a) of the NGA.[2] DOE/FE authorized Alaska LNG to export LNG produced from Alaskan sources to any country with which the United States has not entered into a free trade agreement (FTA) requiring national treatment for trade in natural gas, and with which trade is not prohibited by U.S. law or policy (non-FTA countries). Alaska LNG is authorized to export LNG in a volume equivalent to 929 billion cubic feet per year (Bcf/yr) of natural gas (2.55 Bcf per day), for a term of 30 years, with export operations required to commence within 12 years of the date that the Alaska LNG Order was issued. Exports will occur by vessel from a liquefaction facility to be constructed in the Nikiski area of the Kenai Peninsula in south central Alaska (Liquefaction Facility), which will be part of the proposed Alaska LNG Project.[3]

Alaska Gasline Development Corporation (AGDC), an independent, public corporation of the State of Alaska, applied to the Federal Energy Regulatory Commission (FERC) for authorization to site, construct, and operate the Alaska LNG Project. As approved by FERC on May 21, 2020,[4] the Alaska LNG Project includes the following three elements:

(i) Producing natural gas from stranded resources on the North Slope of Alaska at a proposed natural gas treatment plant to be located on the North Slope;

(ii) Transporting the natural gas on a proposed 800-mile long pipeline; and

(iii) Liquefying the natural gas for export from the proposed Liquefaction Facility, which has a planned liquefaction capacity of 20 million metric tons per year of LNG (equivalent to approximately 929 Bcf/yr of natural gas).[5]

In sum, AGDC holds the FERC authorization for the Alaska LNG Project, and Alaska LNG holds the DOE authorization to export LNG from the Alaska LNG Project. Both the DOE and FERC authorizations have been challenged in the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit).[6] Those lawsuits are ongoing and are currently subject to various pending procedural motions.

To fulfill its obligations under NEPA,[7] DOE/FE participated as a cooperating agency in FERC's review of the Alaska LNG Project.[8] FERC issued the final environmental impact statement (EIS) for the Alaska LNG Project on March 6, 2020,[9] and DOE/FE adopted the final EIS on March 16, 2020 (DOE/EIS–0512).[10] Subsequently, DOE/FE issued the Alaska LNG Order, conditioning it on Alaska LNG's compliance with the 165 environmental conditions adopted in the FERC Order (*see supra* note 4), among other requirements.[11]

[1] *Alaska LNG Project LLC,* DOE/FE Order No. 3643–A, FE Docket 14–96–LNG, Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations (Aug. 20, 2020), *available at: https://www.energy.gov/sites/default/files/2020/08/f77/ord3643a.pdf* [hereinafter Alaska LNG Order].

[2] 15 U.S.C. 717b(a). The authority to regulate the imports and exports of natural gas, including liquefied natural gas, under section 3 of the NGA (15 U.S.C. 717b) has been delegated to the Assistant Secretary for FE in Redelegation Order No. S4–DEL–FE1–2021, issued on March 25, 2021.

[3] *See Alaska LNG Project LLC,* DOE/FE Order No. 3643–B, FE Docket 14–96–LNG, Order on Rehearing (Apr. 15, 2021), *available at: https://www.energy.gov/sites/default/files/2021-04/ord3643b.pdf* [hereinafter Rehearing Order].

[4] *Alaska Gasline Dev. Corp.,* Order Granting Authorization Under Section 3 of the Natural Gas Act, 171 FERC ¶ 61,134, ¶¶ 1–2 (May 21, 2020) [hereinafter FERC Order].

[5] Rehearing Order at 3.

[6] *See Sierra Club* v. *U.S. Dep't of Energy,* Petition for Review, Case No. 20–1503 (D.C. Cir. Dec. 16, 2020); *Center for Biological Diversity, et al.,* v. *Federal Energy Regulatory Comm'n,* Petition for Review, Case No. 20–1379 (D.C. Cir. Sept. 21, 2020); *see also* Rehearing Order at 5–6.

[7] 42 U.S.C. 4321 *et seq.*

[8] *See* Alaska LNG Order at 23, 32.

[9] Federal Energy Regulatory Comm'n, *Alaska LNG Project Final Environmental Impact Statement,* Docket No. CP17–178–000 (Mar. 6, 2020), *available at: https://www.ferc.gov/industries-data/natural-gas/final-environmental-impact-statement-0* [hereinafter final EIS].

[10] Letter from Amy Sweeney, DOE/FE, to Julie Roemele, U.S. Envtl. Prot. Agency (Mar. 16, 2020) (adoption of final EIS), *available at: https://www.energy.gov/nepa/downloads/doeeis-0512-notice-adoption.*

[11] *See* Alaska LNG Order at 42 (Ordering Para. H).

Attachment 1

Sierra Club filed a Request for Rehearing of the Alaska LNG Order, and AGDC filed a Motion for Leave to Answer and Answer to Sierra Club's Request for Rehearing.[12] On April 15, 2021, DOE/FE issued the Rehearing Order in which DOE/FE: (i) Granted AGDC's Motion for Leave to Answer; (ii) granted Sierra Club's Rehearing Request for the purpose of conducting the Alaska environmental study proceeding; and (ii) denied Sierra Club's request for DOE/FE to withdraw the Alaska LNG Order, without prejudice to Sierra Club's ability to request relief in the future, should circumstances change.[13]

DOE/FE explained that, since the issuance of the Alaska LNG Order and while DOE/FE's action on Sierra Club's Rehearing Request was pending, the President had issued two Executive Orders (E.O.) relevant to the Alaska LNG proceeding: E.O. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,*[14] and E.O. 14008, *Tackling the Climate Crisis at Home and Abroad.*[15] Consistent with these Executive Orders and to address Sierra Club's arguments on rehearing, DOE stated that it was appropriate to further evaluate the environmental impacts of exporting LNG from the proposed Alaska LNG Project to non-FTA countries. Therefore, DOE/FE announced that it was commissioning the Alaska environmental study proceeding.[16]

Supplemental EIS (SEIS)

DOE/FE intends to prepare a SEIS for the Alaska environmental study proceeding. The SEIS will include an upstream analysis of potential environmental impacts associated with natural gas production on the North Slope of Alaska. This analysis will examine potential upstream impacts associated with incremental natural gas production on the North Slope of Alaska due to Alaska LNG's exports of LNG.

In addition, the SEIS will include a LCA calculating the GHG emissions for LNG exported from the proposed Alaska LNG Project, taking into account unique issues relating to production, pipeline transportation, and liquefaction in Alaska.[17] Specifically, the LCA will examine the life cycle GHG emissions for LNG exported from Alaska by vessel to import markets in Asia (the markets targeted for exports from Alaska) and potentially in other regions.

DOE/FE has commissioned DOE's National Energy Technology Laboratory (NETL) to conduct both studies.

Potential Areas of Environmental Analysis

For the upstream production study, DOE/FE has tentatively identified the following resource areas for analysis (although the following list is not intended to be comprehensive or to predetermine the potential impacts to be analyzed): Land use and visual resources; geology and soils; water resources; air quality and noise; ecological resources; cultural and paleontological resources; infrastructure; waste management; occupational and public health and safety; socioeconomics; transportation; and environmental justice. For the LCA, DOE/FE will examine the global nature of GHG emissions associated with exports of LNG from Alaska from a life cycle perspective, as stated previously.

NEPA Process and Public Participation in the SEIS

DOE/FE will prepare the SEIS in accordance with the Council on Environmental Quality (CEQ) regulations at 40 CFR parts 1500–1508 and DOE NEPA implementing procedures at 10 CFR part 1021. In accordance with 10 CFR 1021.311(f), a public scoping process is not required for a DOE-issued SEIS. DOE/FE will issue a notice in the **Federal Register** detailing the release of the draft SEIS, dates of one or more internet-based public hearings, and instructions for submitting public comments.

Signing Authority

This document of the Department of Energy was signed on June 28, 2021, by Jennifer Wilcox, Ph.D., Acting Assistant Secretary for Fossil Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE **Federal Register** Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on June 29, 2021.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

[FR Doc. 2021–14188 Filed 7–1–21; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. EL21–83–000]

PJM Interconnection, L.L.C.; Notice of Filing

Take notice that on June 10, 2021, pursuant to section 206 of the Federal Power Act, 16 U.S.C. 824e, and Rule 206 of the Federal Energy Regulatory Commission's (Commission) Rules of Practice and Procedure, 18 CFR 385.206, PJM Interconnection, L.L.C. (PJM), made a filing identifying an unjust and unreasonable aspect of the formula for determining the Regulation market performance-clearing price credit, as stated in PJM Open Access Transmission Tariff Attachment K-Appendix, section 3.2.2(g) and the Amended and Restated Operating Agreement of PJM Interconnection, L.L.C., Schedule 1, section 3.2.2(g). PJM submitted this filing to establish a refund effective date for the replacement calculation of the formula, which is currently under development in the PJM stakeholder process, as more fully explained in the filing.

Any person desiring to intervene or to protest this filing must file in accordance with Rules 211 and 214 of

[12] *See* Rehearing Order at 5–6 (providing additional background on DOE's rehearing proceeding). Sierra Club's and AGDC's arguments on rehearing are summarized in the Rehearing Order at 6–10.

[13] *See id.* at 2.

[14] Exec. Order 13990 of Jan. 20, 2021, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, 86 FR 7037 (Jan. 25, 2021), *available at: https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis.* E.O. 13990 directs agencies to "immediately review" all regulations, orders, and other actions issued after January 20, 2017, that may increase GHG emissions or have other impacts on climate change.

[15] Exec. Order No. 14008 of Jan. 27, 2021, Tackling the Climate Crisis at Home and Abroad, 86 FR 7619 (Feb. 1, 2021), *available at: https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad.* E.O. 14008 sets forth additional policies to address climate change—specifically to "organize and deploy the full capacity of [Federal] agencies to combat the climate crisis"—and requires the "Federal Government [to] drive assessment, disclosure, and mitigation of climate pollution and climate-related risks in every sector" of the U.S. economy.

[16] *See* Rehearing Order at 12–13.

[17] DOE/FE previously has explained that a LCA is a method of accounting for cradle-to-grave GHG emissions over a single common denominator. DOE considers GHG emissions from all processes in the LNG supply chains—from the "cradle" when natural gas is extracted from the ground, to the "grave" when electricity is used by the consumer. *See* U.S. Dep't of Energy, Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas From the United States: 2019 Update—Response to Comments, 85 FR 72, 76 (Jan. 2, 2020); *see also* Rehearing Order at 14 n.90.

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Alaska LNG Project

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APPENDIX B
NORTH SLOPE PRODUCTION STUDY

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APPENDIX B NORTH SLOPE PRODUCTION STUDY

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B.2 PRODUCTION REPORT 2 – ALASKA LNG UPSTREAM STUDY REPORT 2: IMPACTS OF PBU MAJOR GAS SALES ON OIL PRODUCTION AND CO_2 STORAGE POTENTIAL (MAY 20, 2022) B.2-1

B.3 PRODUCTION REPORT 3 – ALASKA LNG UPSTREAM STUDY REPORT 3: STORING BYPRODUCT CO2 FROM THE ALASKA LNG GAS TREATMENT PLANT AT THE PRUDHOE BAY UNIT (APRIL 5, 2022) B.3-1

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B.1 PRODUCTION REPORT 1: ALASKA LNG UPSTREAM STUDY REPORT 1: ESTABLISHING THE SOURCES OF NATURAL GAS SUPPLY FOR THE ALASKA LNG PROJECT (MAY 20, 2022)

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Alaska LNG Upstream Study Report 1: Establishing the Sources of Natural Gas Supply for the Alaska LNG Project

May 20, 2022
DOE/NETL-2022/3785

Disclaimer

This project was funded by the United States Department of Energy, National Energy Technology Laboratory, in part, through a site support contract. Neither the United States Government nor any agency thereof, nor any of their employees, nor the support contractor, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

All images in this report were created by NETL, unless otherwise noted.

Vello Kuuskraa[1]
Matt Wallace[1]
Donald Remson[2*]

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Tim Skone[2]
Alana Sheriff[3]
Timothy R. Carr, Ph.D.[4]

[1] Advanced Resources International
[2] National Energy Technology Laboratory (NETL)
[3] NETL support contractor
[4] Independent Reviewer, West Virginia University
*Corresponding contact: Donald Remson@netl.doe.gov, 412.386.5379

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ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Conservation
AGDC	Alaska Gasline Development Corporation
AOGCC	Alaska Oil and Gas Conservation Commission
APDES	Alaska Pollutant Discharge Elimination System
B, bbl	Barrel
B/D	Barrels per day
Bcf	Billion cubic feet
Bcfd	Billion cubic feet per day
cf	Cubic feet
cfd	Cubic feet per day
CCP	Central Compressor Plant
CGF	Central Gas Facility
CO_2	Carbon dioxide
cp	Centipoise
CWA	Clean Water Act
d, D	Day
DOE	U.S. Department of Energy
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Study
EOR	Enhanced oil recovery
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
ft	Foot
GCWI	Gas cap water injection
GPMA	Greater Point McIntyre Area
GTP	Gas Treatment Plant
H_2S	Hydrogen sulfide
IPA	Initial Participating Area
LNG	Liquified natural gas
m	Meter
M	Thousand
Mcf	Thousand cubic feet
Mcfd	Thousand cubic feet per day
mD	Millidarcy
MGSP	Major Gas Sales Project
MI	Miscible injectant
MIST	Miscible injectant sidetrack
MM	Million
MMBO	Million barrels oil
MMcfd	Million cubic feet per day
mol%	Mole percent
MW, MWe	Megawatt electric
n/a	Not available/applicable
NETL	National Energy Technology Laboratory
NGL	Natural gas liquid
OGIP	Original gas in-place
OOIP	Original oil in-place
PAVE	Pressure and Vaporization Program
PBU	Prudhoe Bay Unit
POD	Plan of Development
POP	Prudhoe Oil Pool
psi	Pounds per square inch
PTTL	Point Thomson Transmission Line
PTU	Point Thomson Unit
scf	Standard cubic feet
scf/B	Standard cubic feet per barrel
SPCC	Spill Prevention, Control, and Countermeasure
SWOP	Seawater Optimization Plan
TAPS	Trans Alaska Pipeline System
Tcf	Trillion cubic feet
tonne	Metric ton (1,000 kg)
U.S.	United States
UIC	Underground Injection Control
VSM	Vertical support member
WAG	Water-alternating-gas
°API	Degrees API (American Petroleum Institute)
°C	Degrees Celsius
°F	Degrees Fahrenheit

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EXECUTIVE SUMMARY

BACKGROUND

The Alaska LNG Project has received authorization to export 2.55 billion cubic feet per day (Bcfd) of natural gas for 30 years from its LNG facility in Nikiski to overseas markets.

In addition to the authorized volumes of natural gas exports, notable volumes of natural gas will need to be produced for lease fuel, local sales, gas reinjection fuel by the existing Central Compressor Plant (CCP) and the Central Gas Facility (CGF), extraction of natural gas liquids (NGLs), and other uses. Additional fuel will also be needed to operate the Gas Treatment Plant (GTP), the Mainline Pipeline, and the LNG facility associated with the Alaska LNG Project. Finally, the natural gas delivered to the GTP will need to be processed to remove carbon dioxide (CO_2) from the gas stream.

STUDY PURPOSE

This report is the first in a series of three reports assessing the energy and infrastructure resources available to support the development of the Alaska LNG Project. Together these three reports comprise the "Upstream Study" of oil and natural gas resources and CO_2 utilization and storage potential at the Prudhoe Bay Unit (PBU) and surrounding areas.

The purpose of this report, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," is to evaluate the capacity of natural gas supply from the PBU and the Point Thomson Unit (PTU) on the North Slope of Alaska to support the Alaska LNG Project for a 30-year period.

The second of the three Upstream Study reports, "Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential," examines the impacts of the Alaska LNG Project on oil production at the PBU and discusses options for utilizing the byproduct CO_2 stream from the Alaska LNG GTP for CO_2 enhanced oil recovery (EOR) operations on the North Slope.

The third of the three Upstream Study reports, "Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit," identifies and assesses the viability of storing byproduct CO_2 from the GTP facility in a deep saline reservoir at the PBU.

SOURCES OF NATURAL GAS SUPPLY

Exhibit ES-1 provides a location map for the primary North Slope of Alaska fields addressed by this study. The PBU, consisting of the Prudhoe Oil Pool (POP) and a series of satellite fields, is expected to provide 75 percent of the natural gas supply. The PTU, located 60 miles to the east of the PBU, is expected to provide approximately 25 percent of the natural gas supply.

Exhibit ES-1. North Slope field location map

Used with permission from Alaska Oil and Gas Conservation Commission (AOGCC) [1]

REQUIRED NATURAL GAS SUPPLY

To provide a baseline for establishing the volumes of natural gas needed for export and account for gas uses by the Alaska LNG Project, a variety of past studies were examined, notably the Appendices in the Alaska LNG Resource Report 9. [2] This information was used to establish a material balance assessment for required natural gas supplies for the Alaska LNG Project.

The material balance assessment starts with the natural gas supply input requirements at the GTP associated with the Alaska LNG Project and ends with natural gas exports from the LNG facility. As shown in Exhibit ES-2, a delivery of 3.36 Bcfd is required at the GTP to have 2.55 Bcfd of natural gas available for export. [2]

Exhibit ES-2. Natural gas supply material balance: from input to GTP to output from LNG facility

Primary Supply Delivery Nodes		Natural Gas Supply (Bcfd)	
1	**Delivery to Gas Treatment Plant**		**3.36**
	Less: Fuel Use	(0.21)	
	Extraction of CO_2/H_2S	(0.35)	
2	**Delivery to Mainline Pipeline**		**2.80**
	Less: Fuel Use	(0.07)	
	In-State Sales	n/a	
3	**Delivery to LNG Facility**		**2.73**
	Less: Fuel Use	(0.18)	
4	**Available for LNG Export**		**2.55**

To provide 30 years of gas supply to the GTP will require 34.2 trillion cubic feet (Tcf) of natural gas. This estimate of required gas supply accounts for reduced volumes of exports during the LNG facility start up (during years 1–4) and reduced volumes of exports during Year 30. This volume of natural gas will support 22.9 Tcf of gas exports, after deduction of fuel use and extraction of CO_2 from the produced gas stream. In addition, the study estimates the need for 2.9 Tcf of residual gas resources[a] to support the delivery of natural gas supply to the GTP in Year 30. As such, the total required natural gas resources for the Alaska LNG Project is 37.1 Tcf (Exhibit ES-3).

Exhibit ES-3. Required natural gas resources: 30 years of LNG exports

Time Period	Required Resources (Tcf)
Years 1–4	2.8
Years 5–29	30.6
Year 30	0.8
Total	**34.2**
Residual Gas Resources*	2.9
Total	**37.1**

*Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20% per year during years 31–40.

[a] Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20 percent per year during years 31–40.

AVAILABLE NATURAL GAS RESOURCES

Two fields are expected to be the primary sources of natural gas supply for the LNG facility—the PBU and the PTU. Other fields adjoining the PBU could also provide natural gas supply to the GTP, if needed.

The study's estimate of available natural gas resources draws on the U.S. Department of Energy (DOE)/National Energy Technology Laboratory (NETL) report entitled "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" The estimate adjusts the natural gas resources numbers in this report for reserve growth at PBU/PTU and for higher fuel consumption due to a later LNG export start date of 2029. With these adjustments, these two fields have estimated natural gas resources of 41.1 Tcf, with 30.7 Tcf from PBU and 10.4 Tcf from PTU. [3] A portion of this gas resource, estimated at 3.0 Tcf, would be consumed for fuel, local sales, NGL extraction, and other uses, leaving 38.1 Tcf available for delivery to the GTP (Exhibit ES-4). This volume of natural gas resources is sufficient to meet the gas supply requirements of 37.1 Tcf, shown previously in Exhibit ES-3.

Exhibit ES-4. Summary of available natural gas resources, PBU/PTU

	PBU (Tcf)	PTU (Tcf)	Total (Tcf)
Available Resources	28.7	9.1	37.8
Reserve Growth	2.0	1.3	3.3
Total	**30.7**	**10.4**	**41.1**
Less: Lease Fuel, Sales/Other	2.7	0.3	3.0
Total	**28.0**	**10.1**	**38.1**

POTENTIAL ACTIVITIES FOR MEETING REQUIRED NATURAL GAS SUPPLIES

Providing these volumes of natural gas supply and resources from the PBU and the PTU will entail some additional development, as discussed in the Federal Energy Regulatory Commission (FERC) Environmental Impact Study (EIS). [4] More specifically, the FERC EIS states that the activities set forth in its report for the PBU Major Gas Sales Project (MGSP) and the PTU Expansion would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project, as discussed below.

PBU MGS Project

The PBU MGS Project would expand and enhance the existing facilities at the site to produce natural gas for delivery to the Alaska LNG Project rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, including valve and metering modules and pipelines.

The PBU MGS Project would include a 5-acre expansion of the CGF pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering

module for feed gas at the CGF. Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline would be constructed from the PBU CGF to the new valve module on the CGF pad. A short, larger diameter pipeline would connect the new valve module with the new metering module on the same pad. After metering, the gas would be delivered to the PBU CGF metering module with the GTP. An additional 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date. The PBU MGS Project would also include construction of four new byproduct pipelines—measuring 25, 3, 8, and 8 miles in length (diameter to be determined)—to send GTP byproduct to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by vertical support members (VSMs), permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet). The construction footprint of the PBU MGS Project would total about 514 acres.

Construction of the PBU MGS Project facilities would occur during winter seasons over a four- to six-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project, with drilling beginning in Year 5 and completed in Year 9. If necessary to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill about 10 new production and injection wells to increase gas recovery at the PBU, which is consistent with the cumulative impacts portion of the FERC EIS for the project. [4] The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. In addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments). [4]

PTU Expansion Project

The PTU Expansion Project would require the incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Three new production wells would be drilled at the Central Pad, one existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost.

The PTU Expansion Project facilities would be fabricated off-site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed along the coast to the west of the PTU marine facilities. Minor screeding may take place in summer months immediately prior to the arrival of barges. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to the Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual ice road in the winter, and by barge or boat in the summer.

Construction of the PTU Expansion would occur over about two years, beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at PTU, as well as camps at PBU and Badami.

The Alaska Gasline Development Corporation (AGDC) indicates that the UIC Class I disposal well to be drilled at the Central Pad has received a permit from the U.S. Environmental Protection Agency (EPA) under the UIC program governing construction, operation, and closure requirements for injection wells. EPA would also require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the Clean Water Act (CWA). If the project anticipates discharge of any pollutants into waters of the United States, the Alaska Department of Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill a fourth (new) production well on an existing well pad. This activity would support the estimated volume of reserve growth at PTU and assure sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.

STUDY FINDINGS

The study, “Establishing the Sources of Natural Gas Supply for the Alaska LNG Project,” finds that sufficient volumes of natural gas resources are available from PBU and PTU to meet the expected volumes of natural gas exports by the Alaska LNG Project.

The PBU and PTU, with 38.1 Tcf of available resources, would meet the required 37.1 Tcf of natural gas for the Alaska LNG Project.

1 PRUDHOE BAY FIELD

1.1 BACKGROUND

The Prudhoe Bay oil field, also called the Prudhoe Bay Unit (PBU), covers an area of about 213,000 acres on the North Slope of Alaska along the coastline of the Beaufort Sea (Exhibit 1-1). The PBU contains the Prudhoe Oil Pool (POP) and a series of satellite oil fields, such as Aurora, Borealis, Midnight Sun, Lisburne, and Point McIntyre, among others. These satellite fields are located within the boundaries of the PBU and are being developed using PBU production and processing facilities.

Exhibit 1-1. Prudhoe Bay oil field location map

North Slope, Alaska

Used with permission from AOGCC [1]

1.2 DISCOVERY AND DEVELOPMENT

The PBU was discovered in 1968 with the Prudhoe Bay State No. 1 exploratory well. The discovery well added both the POP and the Lisburne Oil Pool. Subsequent exploratory drilling in the eastern portion of the PBU discovered the Point McIntyre Oil Pool in 1988, the Niakuk Oil

Pool in 1993, and the Raven Oil Pool in 2001. These four fields, along with currently inactive North Prudhoe Bay and West Beach Oil Pools, have been combined into the Greater Point McIntyre Area (GPMA), also called the Eastern Satellite fields. [1]

Exploratory drilling in the western portion of the PBU led to the discovery and development of the Midnight Sun and Polaris Oil pools in 1997, followed by the discovery and development of the Aurora Oil Pool in 2000 and the Borealis and Orion Oil pools in 2001. These five oil pools are combined into the Western Satellite Participating Areas, also called the Western Satellite fields. [1]

Large-scale oil production from the POP began in 1977 with the completion of the Trans Alaska Pipeline System (TAPS) from the North Slope to Valdez in southern Alaska. The POP has been developed with a host of technically innovative hydrocarbon recovery practices, as further discussed in this report.

Production from the Eastern Satellite fields (GPMA) started first at Lisburne in 1982, followed by Point McIntyre in 1993 and Niakuk in 1994. These oil fields are being developed using waterflooding, with gas injection/gravity drainage underway in Lisburne and Point McIntyre, and gas cap water injection also used in the Lisburne field. [5]

Production from the Western Satellite fields started at Midnight Sun in 1998, followed by Polaris in 1999, Aurora in 2000, and Borealis and Orion in 2001. These five oil fields are being produced with miscible injectant (MI) involving water-alternating-gas (WAG) technology. [6]

1.3 GEOLOGIC AND RESERVOIR SETTING

1.3.1 Prudhoe Oil Pool

The POP contains three deep Permian/Triassic-age sandstone formations—Sag River, Shublik, and Ivishak. The Ivishak, also called the Sadlerochit, is the major producing formation, as shown in the Generalized North Slope stratigraphic column (Exhibit 1-2). The reservoir is a combination structural and stratigraphic trap, bounded on the north by major faults and on the east by a Lower Cretaceous truncation (Exhibit 1-3). [1]

The high productivity of the reservoirs in the POP, with initial flows of 10,000 barrels per day (B/D) per well, is supported by a thick oil column of nearly 500 feet (ft), high permeability that averages nearly 300 millidarcy (mD), strong initial reservoir pressure of 4,335 pounds per square inch (psi), and a low oil viscosity of 0.8 centipoise (cp). [1]

Exhibit 1-2. Generalized North Slope stratigraphic column displaying oil and gas reservoirs and associated accumulations

Used with permission from AOGCC [1]

Exhibit 1-3. Prudhoe Bay oil field structure map

Used with permission from AOGCC [1]

A type-log for the POP, the ARCO Prudhoe Bay State No. 1 well, the field discovery well, is shown in Exhibit 1-4. [1]

The primary oil recovery mechanisms include gravity drainage (below the large gas cap), solution-gas drive, and a weak water drive. The primary oil recovery mechanisms have been augmented with reinjection of produced gas to maintain reservoir pressure and to produce a portion of the residual oil in the gas cap. More recently, the field operator has undertaken injection of water into the gas cap (gas cap water injection [GCWI]) using reinjection of produced water augmented by seawater injection (the Seawater Optimization Plan [SWOP]). In addition, the operator is continuing the world-scale miscible enhanced oil recovery (EOR) program at the POP. [7] [8] [9]

Exhibit 1-4. Generalized North Slope stratigraphic column displaying oil and gas reservoirs and associated accumulations

Used with permission from AOGCC [1]

1.3.2 Western Satellite Fields

The Western Satellite oil fields produce from the Early Cretaceous-age Kuparuk River Formation, a stratigraphically complex quartz-rich sandstone with interbedded siltstone and mudstone. The Kuparuk reservoir contains three to four stratigraphic intervals, with the "C" interval the primary oil formation. The oil gravity in these fields ranges from 24–27°API. The original reservoir pressure ranges from 4,450–4,480 psi, with reservoir temperatures of about 180°F. The original solution gas-oil ratios range from 500–800 standard cubic feet per barrel (scf/B). [1]

1.3.3 Eastern Satellite Fields

In the eastern portion of the PBU (the location of the Eastern Satellite oil fields), the Lisburne Oil Pool produces from the deeper Lisburne Group, a limestone and dolomite formation interbedded with shaly and silty beds. The Lisburne Oil Pool has a gas cap and solution gas in the reservoir with an original gas-oil ratio of 830 scf/B. The oil gravity is 27°API and the reservoir has an original pressure of 4,490 psi and a temperature of 183°F. The second notable Eastern Satellite oil field, the Point McIntyre Oil Pool, produces from the Cretaceous-age Kuparuk and Kalubik formations. Point McIntyre has an oil gravity of 27°API with an original reservoir pressure of about 4,380 psi and a reservoir temperature of 180°F. [1]

1.4 OIL AND GAS RESOURCES

1.4.1 Oil and Condensate Resources

The Prudhoe Bay Field, the largest oil field in North America, is estimated to contain about 25 billion barrels of original oil in-place (OOIP). The application of new technologies and improved understanding of the key oil displacement mechanisms have increased the initial estimated oil recovery factor of about 40 percent of OOIP to more than 60 percent of OOIP. The condensate recovery factor is estimated at 80 percent of original condensate in-place. This has raised the expected oil recovery at the Prudhoe Bay Field from an initial estimate of 9.6 billion barrels of oil to a range of 14–15 billion barrels of oil. [10]

As of the end of 2020, approximately 13 billion barrels of oil have been recovered from the PBU, with about 12 billion barrels from the POP and the remainder from Satellite fields. [1]

1.4.2 Natural Gas Resources

Total original gas in-place (OGIP) for the PBU is estimated at 47.4 trillion cubic feet (Tcf). [3] The oil field is overlain by a major gas cap and the reservoir oil contains gas in solution with an original solution gas-oil ratio of 735 scf/B.

1.4.2.1 Prudhoe Bay Unit

According to an earlier North Slope of Alaska resource study conducted by the U.S. Department of Energy/National Energy Technology Laboratory (U.S. DOE/NETL) [3], as well as adjustments made by this study, 28.7 Tcf of natural gas resources will be available from the PBU at the start of the Alaska LNG Project in 2029. This estimate is based on an initial recoverable natural gas

resource of 35.9 Tcf, less 7.2 Tcf consumed for fuel and other gas uses before the start of the Alaska LNG Project. Subtracting 2.7 Tcf for fuel and other uses (including gas shrinkage from extraction of natural gas liquids [NGLs]) at the field site during the 30-year Alaska LNG Project, 26.0 Tcf of natural gas resources is available from the PBU for delivery to the Gas Treatment Plant (GTP) (Exhibit 1-5).

Exhibit 1-5. Prudhoe Bay Unit natural gas resources

Area	Recoverable Resources (Tcf)	Lease Fuel/Other (Tcf)	Available Resources for GTP (Tcf)
Total	**28.7**	**(2.7)**	**26.0**
Prudhoe Oil Pool	24.8	(2.4)	22.4
PBU Satellite Fields	3.9	(0.3)	3.6

Modified with permission from U.S. DOE/NETL, 2007 [3] and BP Exploration (Alaska), 2015 [11] by Advanced Resources International, 2021

1.4.2.2 Prudhoe Oil Pool

Based on information provided by BP Exploration (Alaska) Inc. to the Alaska Oil and Gas Conservation Commission (AOGCC), the POP could produce 24.8 Tcf during 30 years of the Alaska LNG Project. Subtracting fuel and other uses of 2.4 Tcf, approximately 22.4 Tcf would be available for delivery to the GTP over a 30-year period. [11]

1.4.2.3 PBU Satellite Fields

Subtracting the recoverable natural gas resources at the POP (24.8 Tcf) from the total resources at PBU (28.7 Tcf) leaves 3.9 Tcf of natural gas resources available from PBU Satellite fields, notably Lisburne and Point McIntyre. Subtracting 0.3 Tcf of natural gas for fuel and other uses leaves a net volume of 3.6 Tcf available from PBU Satellite fields for delivery to the GTP (Exhibit 1-5).

1.4.2.4 Reserve Growth

Better understanding of reservoir geology and structure with use of seismic, improved characterization of reservoir properties with modern-day logs, and application of more effective recovery technologies such as horizontal wells have enabled the recoverable oil and gas reserves at the PBU to increase substantially, as shown in Exhibit 1-6. [3]

Exhibit 1-6. Change in recoverable reserves from discovery or onset of production to end of 2004

Producing Field		Original Reserve Estimate (MMBO)	Estimated Ultimate Recovery (MMBO)	Change (MMBO)
Prudhoe Bay Unit				
1.	Prudhoe Oil Pool	9,560	13,841	+4,251
2.	Point McIntyre	300	591	+291
3.	Lisburne	400	192	(208)

The changes in recoverable reserves (reserve growth) for the fields shown in Exhibit 1-6 are from discovery to end of Year 2004. Additional reserve growth in these fields since the publication of this data would be expected, particularly from the more recently discovered fields.

The initial recoverable natural gas resources estimate of 35.9 Tcf for PBU assumed 75.7 percent recovery of OGIP (47.4 Tcf * 0.757 = 35.9 Tcf). [3] This study estimates that with reserve growth, the ultimate natural gas recovery efficiency for PBU will be consistent with the 80 percent of OOIP recovery efficiency expected for condensate. [12] The technical literature discusses that high-permeability natural gas reservoirs will have recovery efficiencies of 80 percent or higher. [13] This would provide an estimated 2.0 Tcf of reserve growth from the PBU.

1.5 FIELD DEVELOPMENT

1.5.1 Current Status

Oil development at the POP involves large-scale (7.68 billion cubic feet per day [Bcfd]) reinjection of the produced gas, primarily into the gas cap for gravity drainage. [14] In addition, the POP is the site of one of the largest waterflood and EOR projects in the world. Currently, the field has more than 800 active oil-producing wells, along with about 220 gas, water, and MI wells. These wells have been drilled and produce from a series of central well pads (Exhibit 1-7).

Exhibit 1-7. Prudhoe Bay Unit Prudhoe Oil Pool location map

Used with permission from AOGCC [1]

1.5.2 Year 2020 and 2021 Development

Year 2020 and 2021 development at the PBU focused primarily on maintaining and increasing oil recovery, not the development of the natural gas resources. However, because so much of the oil production brings associated gas, the oil development activities underway in the PBU will also contribute to increased future natural gas supply.

The 2020 drilling program at the POP focused mainly on the development of the miscible injectant sidetrack (MIST) program at Drill Site 03, involving drilling three new sidetracked production wells and two new sidetracked injection wells in the waterflooded area to expand the MIST program. Additional sidetracked production and injection wells were drilled in the gravity drainage area. Drilling activity at the POP was halted in April 2020 due to the COVID-19 pandemic and was not scheduled to resume for the remainder of 2020. [14]

A two-well-workover effort was implemented in early 2020 at the POP and then placed on hold for the remainder of the year. For 2021, the field operator, Hilcorp North Slope LLC, had planned to conduct about 15 well workovers in the POP, enhancing productivity and returning idle wells to production.

Modifications to the SWOP were implemented in mid-2020. The existing seawater injection at Flow Station 1 (FS1, Drill Sites 01 and 12) was shut in and diverted to the GCWI project to improve the gas vaporization oil recovery process at the POP.

For the longer-term, Hilcorp plans to evaluate new drilling opportunities, examine the potential for undeveloped resources, and appraise and potentially expand the performance of their Pressure and Vaporization (PAVE) Program. [15]

Due to challenging conditions related to COVID-19, the PBU working interest owners did not approve a drilling or development program for the PBU Satellite fields for 2021.

1.5.3 Modified 2021 Development Plan

In June 2021, Hilcorp North Slope filed its new 2021 Plan of Development (POD) for the Eastern Satellite fields in the PBU. [15] The plan includes drilling four new oil and associated gas wells and completing up to three well workovers at Lisburne and Point McIntyre. Subsequently, in September 2021, Hilcorp North Slope also provided a revised POD for the Western Satellite fields in the PBU. This POD proposes the drilling of four new wells in 2021 and up to 10 new wells in 2022 at Orion, drilling up to five new wells at Polaris, drilling up to four new wells at Borealis, and drilling a new well and conducting a robust well workover program at Aurora. [16]

1.6 ANNUAL PRODUCTION

1.6.1 Crude Oil and Condensate

Prudhoe Oil Pool. The PBU Initial Participating Area (IPA) (also called the POP) provided 166,797 B/D of crude oil and condensate production in 2020, up from 164,715 B/D in 2019. The PBU Satellite fields (Aurora, Borealis, Orion, Midnight Sun, Polaris, and Point McIntyre, among others) and three small oil pools produced 48,411 B/D in 2020 and 44,562 B/D in 2019. As such,

the total 2020 oil/condensate production from the PBU was 215,208 B/D of crude oil and condensate, up from 209,277 B/D in 2019 (Exhibit 1-8). [1]

Exhibit 1-8. Crude oil/condensate and natural gas production, Prudhoe Oil Pool and Satellite fields*

		Oil/Liquids Production				Gross Gas Production			
		2019		2020		2019		2020	
		MB	B/D	MB	B/D	MMcf	Mcfd	MMcf	Mcfd
Western Satellites	Aurora	1,712	4,690	1,945	5,329	4,571	12,523	4,897	13,416
	Borealis	1,920	5,260	2,034	5,573	6,847	18,759	5,713	15,652
	Midnight Sun	408	1,118	356	975	3,226	8,838	2,433	6,666
	Orion	1,609	4,408	1,438	3,940	2,642	7,238	2,882	7,896
	Polaris	1,303	3,570	2,267	6,211	1,442	3,951	3,246	8,893
	Total	6,952	19,047	8,040	22,027	18,728	51,310	19,171	52,523
Eastern Satellites	Lisburne	3,494	9,573	3,701	10,140	81,028	221,995	77,887	213,389
	Niakuk	320	877	294	805	428	1,173	425	1,164
	Pt. McIntyre	4,857	13,307	5,152	14,115	58,145	159,301	65,059	178,244
	Raven	307	841	176	482	916	2,510	661	1,811
	Total	8,978	24,597	9,323	25,542	140,517	384,978	144,032	394,608
Other	Put River	99	271	53	145	672	1,841	493	1,351
	Sag River	220	603	220	603	1,042	2,855	826	2,263
	Put River U	16	44	34	93	236	647	1,723	4,721
	Total	335	918	307	841	1,950	5,342	3,042	8,334
Subtotal		**16,265**	**44,562**	**17,670**	**48,411**	**161,195**	**441,630**	**166,245**	**455,466**
Prudhoe Oil Pool		**60,121**	**164,715**	**60,881**	**166,797**	**2,565,775**	**7,029,521**	**2,726,025**	**7,468,562**
Total		**76,386**	**209,277**	**78,551**	**215,208**	**2,726,970**	**7,471,151**	**2,892,270**	**7,924,027**

*Please note that the oil and gas production volume derived from the AOGCC database is sometimes of variance with the oil and gas production data provided by field operators.

Based on information derived from the Annual Reservoir Surveillance Reports for 2020 and the 2021 POD for the IPA of the PBU, approximately 73,300 B/D of oil production in 2020 was from the Waterflood/MI area, with 93,500 B/D produced from the gravity drainage area.

As shown in Exhibit 1-9, oil production from the PBU IPA, after reaching a 10-year plateau of about 1.5 million B/D between the late 1970s and late 1980s, has been steadily declining for the

past 30 years. The field saw a relatively steep drop in the annual oil production during the initial years after the production plateau, declining to about 1.29 million B/D in 1990 and then to about 0.51 million B/D in 2000.

Exhibit 1-9. PBU IPA historical production

Used with permission from AOGCC [1]

However, during the past 20 years, from 2000–2020, the decline in oil production has steadily slowed, to about 7 percent per year between 2000–2005, about 5 percent per year between 2005–2010, about 4 percent per year between 2010–2015, and finally to about 3 percent per year between 2015–2020 (Exhibit 1-10).

Exhibit 1-10. PBU IPA oil production decline

Used with permission from AOGCC [1]

As shown in Exhibit 1-11, the historic pressure decline at the PBU POP has been stabilized and has moderately increased in the gravity drainage area due to GCWI. In addition, the reservoir pressure in the PBU POP Miscible Gas Project has also been stabilized and moderately increased in recent years. [17]

Exhibit 1-11. Prudhoe Bay Unit IPA—areal average pressure

Used with permission from Hilcorp [17]

1.6.2 Natural Gas

Along with oil and condensate production, the PBU produced 7.92 Bcfd of natural gas in 2020 (with 7.47 Bcfd from the PBU IPA), up from 7.47 Bcfd in 2019 (with 7.03 Bcfd from the PBU POP) when production was limited by constraints at the Central Gas Facility (CGF).

Prudhoe Oil Pool. In 2020, reinjection of the gas produced at PBU IPA was 6.93 Bcfd, equal to about 93 percent of the produced gas stream. Approximately 0.39 Bcfd of the produced gas was used for fuel, NGL extraction, and gas sales/other, with 0.15 Bcfd extracted and used for MI (Exhibit 1-12.). [17]

Exhibit 1-12. Gross gas production, gas use, and gas reinjection: PBU IPA

	2020 Daily Production (MMcfd)
Gas Production	**7,470**
Fuel Use (e)	(310)
▪ Gas Reinjection	(220)
▪ Other	(90)
Miscible Injectant	(150)
NGL Extraction *	(50)
Gas Sales/Other *	(30)
Subtotal	(540)
Reinjected Gas	**6,930**

*The volumes of gas shrinkage due to NGL extraction and Gas Sales/Other are extrapolated from data for 2019 with adjustments.

PBU Western Satellite Fields. The five Western Satellite fields provided 53 million cubic feet per day (MMcfd) of natural gas production in 2020, primarily from Aurora and Borealis fields, essentially the same as in 2019 (Exhibit 1-13). Approximately 64 MMcfd of gas (labeled as MI) was reinjected into these five satellite fields, enabling oil production to increase in 2020 (Exhibit 1-14). [5] [6] A portion of the MI was provided from other fields. Note the recent increase in natural gas production after a long prior period of decline for the Western Satellite fields.

Exhibit 1-13. Western Satellite gas production

Used with permission from AOGCC [1]

Exhibit 1-14. Gross gas production, gas use, and gas reinjection: satellite fields

	2020 Daily Production (MMcfd)	
	Western Satellites	Eastern Satellites (Lisburne & Pt McIntyre)
Gas Production	53	400
Gas/Miscible Injection	64	329

The current operator of Western Satellite fields has targeted returning idle wells to service, identifying portions of the fields that have been under-developed, and maximizing the use of MI. [6]

PBU Eastern Satellite Fields. The Eastern Satellite fields (also called GPMA) produced approximately 400 MMcfd of natural gas in 2020, primarily from Lisburne and Point McIntyre fields, up slightly from 2019 (Exhibit 1-15). Of this total gas production, approximately 329 MMcfd was reinjected into the Lisburne and Point McIntyre fields, shown previously in Exhibit 1-14.

Exhibit 1-15. Eastern Satellite gas production

Used with permission from AOGCC [1]

The current operator of the Eastern Satellite fields has focused on returning idle wells to service, optimizing surface facilities, targeting reservoirs that have been under-developed, improving reservoir voidage replacement, and improving operational efficiencies. [5]

1.6.3 Natural Gas Liquids: Prudhoe Oil Pool

The PBU IPA also produced 45,280 B/D of NGLs in 2020, up from 43,600 B/D in 2019. In 2019, approximately 10,400 B/D of NGLs were taken to the Kuparuk River Unit for their MI Program, with the 33,200 B/D delivered to the TAPS. [17] The NGL volumes are in addition to the oil production volumes reported previously in Exhibit 1-8 and Exhibit 1-10.

1.6.4 Water: Prudhoe Oil Pool

The PBU IPA averaged 1,149,000 B/D of water production in 2020 for a water cut of about 87 percent. Produced water of 667,000 B/D was reinjected into the oil formations. Approximately 632,000 B/D of seawater was injected into the waterflood, the WAG project, and the gas cap (GCWI). [17]

1.7 PRUDHOE BAY AND THE ALASKA LNG PROJECT

The PBU is expected to provide approximately 75 percent of the natural gas supply for the Alaska Gasline Development Corporation's (AGDC) Alaska LNG Project, requiring 2.5 Bcfd to be delivered to the GTP (Exhibit 1-16). [17] This means that the PBU would need to produce a gross natural gas volume ranging 2.67–2.81 Bcfd to account for gas reinjection fuel, other fuel, NGL extraction, and other uses, as shown in Exhibit 1-16. This would enable the PBU to deliver 2.5 Bcfd to the GTP for gas offtake and carbon dioxide (CO_2) extraction (Exhibit 1-17).

Exhibit 1-16. Gross natural gas production, Prudhoe Bay Unit

		2029–2038 (MMcfd)	2039–2048 (MMcfd)	2049–2058 (MMcfd)
1	**Gas Delivery to GTP**	**2,500**	**2,500**	**2,500**
	Plus: Gas Reinjection Fuel	150	60	40
	Other Fuel	90	90	90
	Extraction of NGLs	40	20	10
	Local Sales/Other	30	30	30
	Subtotal	310	200	170
2	**Gross Production**	**2,810**	**2,700**	**2,670**

Exhibit 1-17. Gas offtake and CO_2 handling

Used with permission from BPXA [11]

1.7.1 Available Natural Gas Resources

The study estimates that 30.7 Tcf of recoverable natural gas resources would be available from the POP and the PBU satellite fields at the start of the Alaska LNG Project in 2029. Of this, approximately 2.7 Tcf would be consumed for lease use, local sales, and gas shrinkage during the 30-year Alaska LNG Project.

As such, 28.0 Tcf of natural gas resources would be available from PBU for delivery to the GTP, as shown in Exhibit 1-18.

Exhibit 1-18. Available natural gas resources, Prudhoe Bay Unit

	(Tcf)
Available Resources	28.7
Reserve Growth	2.0
Total	**30.7**
Less: Lease Fuel, Sales/Other	(2.7)
Total	**28.0**

1.7.2 Meeting the Gas Supply Requirements: Prudhoe Bay Unit

Exhibit 1-19 illustrates the annual requirements for natural gas supplies at the GTP from the PBU. Exhibit 1-20 provides the tabulation of total natural gas supply requirements of 25.5 Tcf at the GTP from the PBU by period.

The 28.0 Tcf of available natural gas resources from the PBU, shown in Exhibit 1-18, are sufficient to meet the total 25.5 Tcf of gas supply requirements at the GTP, plus the need for residual gas resources at the end of 30 years of natural gas exports.

Exhibit 1-19. Annual required natural gas supply, Prudhoe Bay Unit

Exhibit 1-20. Total required natural gas supply, Prudhoe Bay Unit

Time Period	Required Resources (Tcf)
Years 1–4	2.1
Years 5–29	22.8
Year 30	0.6
Total	**25.5**

2 POINT THOMSON

2.1 BACKGROUND

The PBU, encompassing an area of about 93,000 acres, is located on the North Slope of Alaska, adjacent to the Arctic National Wildlife Refuge and approximately 60 miles east of Prudhoe Bay (Exhibit 2-1). Point Thomson is scheduled to be one of the two primary sources of natural gas for the Alaska LNG Project. The field is projected to provide about 25 percent of the 3.36 Bcfd of natural gas to arrive and be processed by the GTP, and then be transported by the 809-mile Mainline Pipeline from the North Slope to the LNG facility at Nikiski.

Exhibit 2-1. Point Thomson location

Used with permission from ExxonMobil [18]

2.2 DISCOVERY AND DEVELOPMENT

Point Thomson was discovered by Exxon Corp's Point Thompson Unit (PTU) No. 1 exploration well in 1977 and further defined by the PTU No. 2 and No. 3 wells in 1978 and 1979. [19] In 2010, ExxonMobil drilled two new delineation wells, PTUs No. 15 and No. 16, to test the production potential of the reservoir for a gas-cyclic and condensate recovery project (Exhibit 2-2).

Exhibit 2-2. Point Thomson adjacent wells

- DW-1: Class I UIC Disposal Well, drilled in 2015. Authorized by US EPA for injection of waste.
- PTU-1, PTU-3, AK State D-1: Exploration wells drilled in 1970s and 1980s. Permanently abandoned per Applications for Sundry Approvals by AOGCC.

Used with permission from ExxonMobil [18]

2.3 GEOLOGIC AND RESERVOIR SETTING

The Early Cretaceous-age Thomson Sand, at a depth of about 12,700 ft, is the primary hydrocarbon producing interval in the PTU (Exhibit 2-3). The Thomson Sand is abnormally pressured, with an average reservoir pressure of about 10,100 psi and a pressure gradient of about 0.8 psi/ft. The high reservoir pressure, along with other favorable reservoir properties (e.g., a net sand of 200–300 ft, porosity of 5–34 percent, and permeability that reaches more than 10 darcies in portions of the field), enable the one current production well, PTU No. 17, to flow at about 200 MMcfd (Exhibit 2-4). [18]

Exhibit 2-3. Point Thomson geologic description

- Primary Resource - gas cap in the Lower Cretaceous Thomson Sand:
  - Porosity < 0.05 – 0.34
  - Permeability < 0.01 mD to > 50,000 mD
- Hydrocarbon accumulation: ~500 ft gas column; thin 37' heavy oil rim (12-14° API)
- H2S 4–30 ppm; CO2 ~4.5%
- Abnormally pressured (~10,100 psi @-12,700' TVDSS)
- 22 wells in region, 16 penetrate Thomson Formation
- 1,776' of Thomson conventional core collected
- Recent wells: PTU-15 and PTU-16 drilled 2009-2010
- Full 3D seismic coverage, reprocessed in 2014

Used with permission from ExxonMobil [18]

Exhibit 2-4. Point Thomson injection zone

Both injection wells penetrate excellent to good reservoir quality in the proximal facies of the fan delta (conglomerate and sandstone).

Used with permission from ExxonMobil [18]

2.4 NATURAL GAS RESOURCES

2.4.1 Initial Resources

According to a previous North Slope of Alaska resource study conducted by DOE/NETL [3], as well as adjustments made by this study, 9.1 Tcf of natural gas resources is available from the PTU at the start of the Alaska LNG Project in 2029. This is based on an initial recoverable natural gas resources of 9.2 Tcf, less 0.1 Tcf consumed for fuel and other gas uses before the start of the Alaska LNG Project. Approximately 0.3 Tcf of the recoverable natural gas resources would be consumed at the field site for fuel and other uses during the 30-year Alaska LNG Project.

2.4.2 Reserve Growth

Additional resources of natural gas at Point Thomson would derive from reserve growth. The initial recoverable natural gas resources estimate of 9.2 Tcf for PTU assumed 70 percent recovery of OGIP (13.2 Tcf * 0.7 = 9.2 Tcf). [3] The PTU contains a highly over-pressured natural gas formation that typically has notably higher gas recovery efficiency. This study estimates that the ultimate natural gas recovery efficiency for PTU will reach 80 percent of OGIP, providing 1.3 Tcf of reserve growth. The technical literature discusses that high-pressure, high-permeability natural gas reservoirs will have recovery efficiencies of 80 percent or higher. [13]

As such, 10.1 Tcf of natural gas resources would be available from Point Thomson for delivery to the GTP associated with the Alaska LNG Project (Exhibit 2-5).

Exhibit 2-5. Point Thomson natural gas resources

Recoverable Resources (Tcf)	Reserve Growth (Tcf)	Lease Fuel/Other (Tcf)	Available Resources for GTP (Tcf)
9.1	1.3	(0.3)	10.1

Modified with permission from U.S. DOE/NETL [3] by Advanced Resources International, 2021

2.5 CURRENT AND ANTICIPATED PRODUCTION AND TRANSPORTATION

2.5.1 Current Gas-Cycling Project

At Point Thomson, the current gas-cycling project that started in 2016 consists of three wells, with PTU No. 17 serving as the gas producer and PTUs No. 15 and No. 16 serving as the gas injectors (Exhibit 2-4). A fourth well, PTU DW-1, serves as the produced water disposal well for the gas-cycling project.

The gas-cycling project is designed to produce 200 MMcfd of natural gas transported to ExxonMobil's gas treatment facilities, where approximately 10,000 B/D of condensate would be extracted from the gas production stream. After deduction for condensate and fuel gas, approximately 194 MMcfd would be reinjected into the Thomson Sand of the PTU to maintain reservoir pressure. The gas-cycling project is estimated to reduce the initial reservoir pressure by only approximately 4 percent over 30 years. [19] The recovered condensate is transported by pipeline to the TAPS (Exhibit 2-6 and Exhibit 2-7).

Exhibit 2-6. Point Thomson Project overview

- Establish key infrastructure
- Drill and complete four wells
  - **1 production well** (PTU-17, also known as West Pad Well)
  - **2 injection wells** (PTU-15 and PTU-16)
  - **1 disposal well** (PTU-DW1)
- Develop facilities designed to produce 10 KBD condensate and cycle 200 MCFD of gas

Used with permission from ExxonMobil [18]

Exhibit 2-7. Point Thomson operations—injection rates and pressures

- **Designed injection rate is 194 million standard cubic feet per day (MMSCFD)**
  - Injected gas is gas from produced fluid minus condensate, water, and fuel gas
  - Injected gas split between PTU-15 and PTU-16 at approximately equal rates
- **Injection pressures for PTU-15 and PTU-16 at the wellhead range from 9,800 psi to 10,000 psi**
  - Sandface pressure approximately 10,150 psi
  - Wells equipped with downhole gauges for reservoir pressure and temperature monitoring. Annulus pressure of injection wells PTU-15/16 will also be monitored
  - Sandface pressure gradient (~0.80 psi/ft) is less than the Thomson fracture gradient and confining zone fracture gradient (~0.91 psi/ft)

Central Pad Processing Facilities

Used with permission from ExxonMobil [18]

Several constraints, particularly involving high-pressure gas compression, have limited achieving the gas-cycling project's design of 200 MMcfd of natural gas production and 10,000 B/D of condensate production. During the first seven months of 2021, the project has averaged 155

MMcfd of natural gas and 8,630 B/D of condensate, with higher rates of 166 MMcfd of natural gas and 9,430 B/D of condensate produced during June/July 2021. [1]

2.5.2 Natural Gas Production and Transportation

Point Thomson produced about 159.5 MMcfd (55 billion cubic feet [Bcf]) of natural gas in 2020, up from 110 MMcfd (40 Bcf) in 2019, from the PTU No. 17 well drilled from the West Pad (Exhibit 2-8). Two additional pads, the Central Pad and the East Pad, provide the sites for the two injection wells—PTU No. 15 and PTU No. 16. [20]

Exhibit 2-8. Point Thomson field

Used with permission from AOGCC [1]

A new 62.5-mile, 32-inch diameter pipeline, the Point Thomson Transmission Line (PTTL), would transport the natural gas from Point Thomson to the GTP for further processing to remove CO_2 and natural gas liquids before delivering the processed pipeline quality gas to the Mainline Pipeline.

2.5.3 Natural Gas Composition

The composition of the reinjected gas, after removal of condensate, water, and fuel gas, is primarily methane (87.40 percent), ethane (4.22 percent), propane (1.64 percent), butane (0.86 percent), and CO_2 (4.46 percent) (Exhibit 2-9).

Given the above noted composition of the natural gas at Point Thomson, the study estimates that the GTP would extract approximately 40 MMcfd of CO_2 from the Point Thomson gas stream. The plan is for the extracted CO_2 (and trace components of hydrogen sulfide [H_2S]) to be used as MI for EOR. [18]

Exhibit 2-9. Point Thomson operations—fluid types and sources

- **Injected gas is the produced fluid with condensate, water, and fuel gas removed**
  - Contains mainly methane (C1), ethane (C2), and carbon dioxide (CO2)
  - Trace components such as H2S (<30ppm) also present
- **Injected gas originated in the reservoir and is compatible with the reservoir fluid and formation**

Estimated Composition of Injected Gas Stream

Component	Mole %
C1	87.397
C2	4.2190
C3	1.6440
IC4	0.3200
NC4	0.5450
IC5	0.1890
NC5	0.1920
C6	0.1860
C7	0.0960
C8	0.0430
C9	0.0160
C12	0.0050
C17	0
C27	0
C42	0
C65	0
C86+	0
H20	0
N2	0.6640
CO2	4.4600

Used with permission from ExxonMobil [18]

2.5.4 Condensate Production and Transportation

The condensate from the gas-cycling project is transported by a 22-mile, 12-inch diameter insulated pipeline to the existing Badami pipeline that connects to the TAPS. Once the higher natural gas production volumes of about 870 MMcfd are produced for the Alaska LNG Project, Point Thomson will produce about 40,000 B/D of condensate that will be transported using existing facilities to the TAPS. The liquids pipeline is designed to accommodate 70,000 B/D of condensate. [19]

2.6 POINT THOMSON AND THE ALASKA LNG PROJECT

Point Thomson is expected to provide approximately 25 percent of the gas supply for AGDC's Alaska LNG Project. This means that Point Thomson would need to produce about 0.89 Bcfd of natural gas. After extraction of condensate and fuel gas, approximately 0.86 Bcfd would be available for the GTP.

2.6.1 Available Natural Gas Resources

The study estimates that 10.4 Tcf of recoverable natural gas resources would be available from Point Thomson at the start of the Alaska LNG Project in 2029. Of this, approximately 0.3 Tcf would be consumed for lease use, local sales, gas shrinkage, and other uses during the 30-year Alaska LNG Project.

As such, 10.1 Tcf of natural gas resources would be available from PTU for delivery to the GTP, as shown in Exhibit 2-10.

Exhibit 2-10. Available natural gas resources, Point Thomson Unit

	(Tcf)
Recoverable Resources	9.1
Reserve Growth	1.3
Total	**10.4**
Less: Lease Fuel, Sales/Other	(0.3)
Total	**10.1**

2.6.2 Meeting the Gas Supply Requirements: Point Thomson

Exhibit 2-11 illustrates the annual natural gas supply requirements at the GTP from the PTU. Exhibit 2-12 shows that Point Thomson would need to deliver a total of 8.7 Tcf of natural gas to the GTP.

The 10.1 Tcf of available natural gas resources from the PTU, shown in Exhibit 2-10, are sufficient to meet the total 8.7 Tcf of gas supply requirements of the GTP, plus the need for residual gas resources.

Exhibit 2-11. Annual required natural gas supply, Point Thomson Unit

Exhibit 2-12. Total required natural gas resources, Point Thomson Unit

Time Period	Required Resources (Tcf)
Years 1–4	0.7
Years 5–29	7.8
Year 30	0.2
Total	**8.7**

3 MEETING THE NATURAL GAS SUPPLY REQUIREMENTS OF THE ALASKA LNG PROJECT: ALTERNATIVE #1 NATURAL GAS SUPPLY CASE

3.1 BACKGROUND AND PURPOSE

The Alaska LNG Project has received authorization to export 2.55 Bcfd of natural gas for 30 years from its LNG facility in Nikiski to overseas markets. (Alaska LNG Project, Application of Alaska Gasline Development Corporation (AGDC) for Authorization under Section 3 of the Natural Gas Act) [21] (Alaska LNG Resource Report 1 (Resource Report 1 (RR1)) (Alaska LNG Project, 2017b) [22]

In addition to the above authorized volumes of natural gas exports, additional volumes of natural gas will need to be produced for lease fuel, gas reinjection fuel by the existing Central Compressor Plant (CCP) and CGF, extraction of NGLs, and other uses. Additional fuel will also be needed to operate the GTP, the Mainline Pipeline, and the LNG facility associated with the Alaska LNG Project. Finally, the natural gas delivered to the GTP will need to be processed to remove CO_2 from the gas stream.

The purpose of this section of the report is to determine to what extent the natural gas production requirements set forth in the Alternative #1 Natural Gas Supply Case can be met by natural gas resources from the PBU and PTU.

3.2 ESTABLISHING REQUIRED NATURAL GAS SUPPLY AND RESOURCES

To provide a baseline for required volumes of natural gas supply and account for gas uses by the Alaska LNG Project, a variety of past studies were examined, notably the appendices included in the Alaska LNG Resource Report 1 [22] and Alaska LNG Resource Report 9. [2] This information was used to establish a material balance assessment for required natural gas supply, Exhibit 3-1. The material balance assessment starts with the natural gas supply input requirements at the GTP associated with the Alaska LNG Project and ends with natural gas exports from the LNG facility.

Exhibit 3-1. Material Balance assessment: from input to GTP to output from LNG facility

Primary Supply Delivery Nodes		Natural Gas Supply (Bcfd)	
1	**Delivery to Gas Treatment Plant**		**3.36**
	Less: Fuel Use	(0.21)	
	Extraction of CO_2/H_2S	(0.35)	
2	**Delivery to Mainline Pipeline**		**2.80**
	Less: Fuel Use	(0.07)	
	In-State Sales	n/a	
3	**Delivery to LNG Facility**		**2.73**
	Less: Fuel Use	(0.18)	
4	**Available for LNG Export**		**2.55**

Input and Output: GTP. Once all three of the LNG units are in full operation, the GTP would need to receive 3.36 Bcfd of natural gas supply, with about 2.5 Bcfd from the PBU [23] and about 0.86 Bcfd from Point Thomson. [24] These numbers are within the maximum allowable gas production volumes (3.9 Bcfd peak) set forth in the AOGCC Conservation Orders.

The GTP will use 0.21 Bcfd for fuel [2], Application of Alaska Gasline Development Corporation for Authorization Under Section 3 of the Natural Gas Act, Appendix F) Gas Treatment Plant Air Quality Modeling Report) and will process and remove approximately 0.35 Bcfd of CO_2 from the gas stream [23], Exhibit 3-2. The 0.35 Bcfd of CO_2 consists of 0.31 Bcfd from the Prudhoe Bay gas stream, and its 12 percent CO_2 content, and 0.04 Bcfd from the Point Thomson gas stream, and its 4.4 percent CO_2 content. [3] As such, 2.80 Bcfd of natural gas would exit the GTP as input to the Mainline Pipeline.

Input and Output: Mainline Pipeline. The Mainline Pipeline will consume 0.07 Bcfd of natural gas for fuel. [25] As such, 2.73 Bcfd of natural gas would exit the Mainline Pipeline as input to the LNG facility.

Exhibit 3-2. Gas offtake and CO_2 handling

Used with permission from BPXA [11]

Input and Output: LNG Facility. The LNG facility will consume 0.18 Bcfd of natural gas for fuel. [26] As such, 2.55 Bcfd of natural gas would be available for LNG export to overseas markets.

Required Natural Gas Supply at the GTP. To provide 30 years of gas supply to the GTP will require 34.2 Tcf of natural gas. This estimate of required gas supply accounts for reduced volumes of exports during the LNG facility start up (during years 1–4) and reduced volumes of exports during Year 30. In addition, the study estimates the need for 2.9 Tcf of residual gas resources[b] to support the delivery of natural gas supply to the GTP in Year 30. As such, the total required natural gas supply for the Alaska LNG Project is 37.1 Tcf at the GTP, tabulated in Exhibit 3-3 and illustrated in Exhibit 3-4.

Summary of LNG Exports. After subtraction of CO_2 extraction and fuel use by the GTP, the Mainline Pipeline and the LNG facility, a total of 26.0 Tcf of natural gas is exported during the 30 years of the Alaskan LNG Project, Exhibit 3-5.

[b] Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20 percent per year during Years 31–40.

Exhibit 3-3. Total required natural gas supply: 30 years of LNG exports

Time Period	Required Resources at the GTP (Tcf)
Years 1–4	2.8
Years 5–29	30.6
Year 30	0.8
Total	**34.2**
Residual Gas Resources*	2.9
Total	**37.1**

*Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 30-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20% per year during years 31–40.

Exhibit 3-4. Annual required natural gas supply: 30 years of LNG exports

*Residual Gas Resources represent the volume of gas resources left behind at the Prudhoe Bay Unit and at Point Thomson at the end of the 30-year LNG export project. This volume is estimated using resources equal to ten years of natural gas production that declines at 20% per year during Years 31 through 40.

Exhibit 3-5. Total LNG Exports: 30 years of LNG exports

Time Period	Required Resources at the LNG Facility (Tcf)
Years 1–4	2.1
Years 5–29	23.3
Year 30	0.6
Total	**26.0**

3.3 AVAILABLE NATURAL GAS RESOURCES

3.3.1 Prudhoe Bay and Point Thomson Units

As discussed in the previous chapters, two fields are expected to be the primary sources of natural gas supply for the LNG facility—the PBU and the PTU (Exhibit 3-6).

Exhibit 3-6. Location of PBU satellite and other fields

Used with permission from AOGCC [1]

As set forth in the DOE/NETL report entitled "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" and adjusted for reserve growth at PBU/PTU and higher fuel consumption due to a later LNG export start date of 2029, these two fields have estimated

natural gas resources of 41.1 Tcf, with 30.7 Tcf from PBU and 10.4 Tcf from PTU. [3] A portion of this gas resource, estimated at 3.0 Tcf, would be consumed for fuel, local sales, NGL extraction, and other uses, leaving 38.1 Tcf available for delivery to the GTP (Exhibit 3-7). This volume of resource is sufficient to meet the gas supply requirements at the GTP of 37.1 Tcf, shown previously in Exhibit 3-3.

Exhibit 3-7. Summary of available natural gas resources, PBU/PTU

	PBU (Tcf)	PTU (Tcf)	Total (Tcf)
Available Resources	28.7	9.1	37.8
Reserve Growth	2.0	1.3	3.3
Total	**30.7**	**10.4**	**41.1**
Less: Lease Fuel, Sales/Other	2.7	0.3	3.0
Total	**28.0**	**10.1**	**38.1**

3.4 POTENTIAL ACTIVITIES FOR MEETING REQUIRED NATURAL GAS SUPPLIES

Providing these volumes of natural gas supply and resources from the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU) will entail some additional development, as discussed in the FERC EIS. (FERC, 2020) [4] More Specifically, the FERC EIS states that the activities set forth in its report for the Prudhoe Bay Unit P and the Point Thomson Unit (PTU) Expansion would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project, as discussed below.

3.4.1 PBU MGS Project

The PBU MGS Project would expand and enhance the existing facilities at the site to produce natural gas for delivery to Alaska LNG rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, including valve and metering modules and pipelines.

The PBU MGS Project would include a 5-acre expansion of the CGF pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering module for feed gas at the CGF. Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline would be constructed from the PBU CGF to the new valve module on the CGF pad. A short, larger diameter pipeline would connect the new valve module with the new metering module on the same pad. After metering, the gas would be delivered to the PBU CGF metering module with the GTP. An additional 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date. The PBU MGS Project would also include construction of four new byproduct pipelines—measuring 25, 3, 8, and 8 miles in length (diameter to be determined)—to send GTP byproduct to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by

VSMs, permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet). The construction footprint of the PBU MGS Project would total about 514 acres.

Construction of the PBU MGS Project facilities would occur during winter seasons over a four- to six-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project, with drilling beginning in Year 5 and completed in Year 9. If necessary to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill about 10 new production and injection wells to increase gas recovery at the PBU, which is consistent with the cumulative impacts portion of the FERC EIS for the project. [4] The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. In addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments). [4]

3.4.2 PTU Expansion Project

The PTU Expansion Project would require the incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Three new production wells would be drilled at the Central Pad, one existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost.

The PTU Expansion Project facilities would be fabricated off-site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed along the coast to the west of the Point Thomson marine facilities. Minor screeding may take place in summer months immediately prior to the arrival of barges. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to Central Pad. Personnel, materials, and

equipment would be brought to the site by year-round air transportation, an annual ice road in the winter, and by barge or boat in the summer.

Construction of the PTU Expansion would occur over about two years, beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at Point Thomson, as well as camps at Prudhoe Bay and Badami.

AGDC indicates that the UIC Class I disposal well to be drilled at the Central Pad has received a permit from the U.S. Environmental Protection Agency (EPA) under the UIC Program governing construction, operation, and closure requirements for injection wells. EPA would also require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the Clear Water Act (CWA). If the project anticipates discharge of any pollutants into waters of the United States, the Alaska Department of Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill a fourth (new) production well on an existing well pad. This activity would support the estimated volume of reserve growth at PTU and assure sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.

3.5 STUDY FINDINGS: ALTERNATIVE #1 NATURAL GAS SUPPLY CASE

The study, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," finds that sufficient natural gas resources are available from PBU and PTU on the North Slope of Alaska to meet the expected volumes of natural gas exports by the Alaska LNG Project set forth for the Alternative #1 Natural Gas Supply Case.[c] The PBU and PTU, with 38.1 Tcf of available resources, would meet the required 37.1 Tcf of natural gas supply at the Gas Treatment Plant of the Alaska LNG Project. This would enable the LNG facility in the Alternative #1 Natural Gas Supply Case to export 26.0 Tcf of natural gas, after subtraction of fuel use by the GTP Plant, by the Mainline Pipeline and the LNG facility, and after the extraction of CO_2, as shown previously on Exhibit 3-5.

[c] The study entitled "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," is a comprehensive natural gas resource study that incorporates proved reserves, reserve growth, and undeveloped resources. In mid-January 2022, following FERC's approval of the Alaska LNG Project, the U.S. Energy Information Administration (EIA), in its publication "U.S. Crude Oil and Natural Gas Proved Reserves, Year-End 2020," (USEIA, 2020) [27] significantly increased its recognition of natural gas-proved reserves for Alaska, stating: "Approval of this project means that a large volume of previously stranded Alaskan natural gas resources now meets the definition of proved reserves. The annual total of natural gas proved reserves in Alaska increased in 2020 by 27 Tcf, quadrupling the state's total from 9 Tcf to 36 Tcf. Additional upstream production facilities will add more proved reserves in years to come."

4 MEETING THE NATURAL GAS SUPPLY REQUIREMENTS OF THE ALASKA LNG PROJECT: ALTERNATIVE #2 NATURAL GAS SUPPLY CASE

4.1 BACKGROUND AND PURPOSE

The Alaska LNG Project has received authorization to export 2.55 Bcfd of natural gas for 30 years from its LNG facility in Nikiski to overseas markets. (Alaska LNG Project, Application of Alaska Gasline Development Corporation (AGDC) for Authorization under Section 3 of the Natural Gas Act) [21] (Alaska LNG Resource Report 1 (Resource Report 1 (RR1)) (Alaska LNG Project, 2017b) [22] export for a total authorization of 27.87 Tcf of natural gas exports. To the extent the Alaska LNG Project has not fully meet its full export authorization during its initial 30 years of operation, the Alaska LNG Project has the option of adding three years to its initially authorized time schedule for catch-up with authorized volumes.

In addition to the above authorized volumes of natural gas exports, additional volumes of natural gas will need to be produced for lease fuel, gas reinjection fuel by the existing Central Compressor Plant (CCP) and CGF, extraction of NGLs, and other uses. Additional fuel will also be needed to operate the GTP, the Mainline Pipeline, and the LNG facility associated with the Alaska LNG Project. Finally, the natural gas delivered to the GTP will need to be processed to remove CO_2 from the gas stream.

The purpose of this section of the report is to determine to what extent the natural gas production requirements set forth in Alternative #2 Natural Gas Supply Case can be met by natural gas resources from the PBU and PTU for the initial 30 years of the project plus three years of catch-up with authorized LNG export volumes.

4.2 ESTABLISHING REQUIRED NATURAL GAS SUPPLY AND RESOURCES

To provide a baseline for required volumes of natural gas supply and account for gas uses by the Alaska LNG Project, a variety of past studies were examined, notably the appendices included in the Alaska LNG Resource Report 1 [22] and Alaska LNG Resource Report 9. [2] This information was used to establish a material balance assessment for required natural gas supply, Exhibit 4-1. The material balance assessment starts with the natural gas supply input requirements at the GTP associated with the Alaska LNG Project and ends with natural gas exports from the LNG facility.

Exhibit 4-1. Material Balance assessment: from input to GTP to output from LNG facility

Primary Supply Delivery Nodes		Natural Gas Supply (Bcfd)	
1	**Delivery to Gas Treatment Plant**		**3.36**
	Less: Fuel Use	(0.21)	
	Extraction of CO_2/H_2S	(0.35)	
2	**Delivery to Mainline Pipeline**		**2.80**
	Less: Fuel Use	(0.07)	
	In-State Sales	n/a	
3	**Delivery to LNG Facility**		**2.73**
	Less: Fuel Use	(0.18)	
4	**Available for LNG Export**		**2.55**

Input and Output: GTP. Once all three of the LNG units are in full operation, the GTP would need to receive 3.36 Bcfd of natural gas supply, with about 2.5 Bcfd from the PBU [23] and about 0.86 Bcfd from Point Thomson. [24] These numbers are within the maximum allowable gas production volumes (3.9 Bcfd peak) set forth in the AOGCC Conservation Orders.

The GTP will use 0.21 Bcfd for fuel [2], Application of Alaska Gasline Development Corporation for Authorization Under Section 3 of the Natural Gas Act, Appendix F) Gas Treatment Plant Air Quality Modeling Report) and will process and remove approximately 0.35 Bcfd of CO_2 from the gas stream [23] (Exhibit 4-2). The 0.35 Bcfd of CO_2 consists of 0.31 Bcfd from the Prudhoe Bay gas stream, and its 12 percent CO_2 content, and 0.04 Bcfd from the Point Thomson gas stream, and its 4.4 percent CO_2 content. [3] As such, 2.80 Bcfd of natural gas would exit the GTP as input to the Mainline Pipeline.

Input and Output: Mainline Pipeline. The Mainline Pipeline will consume 0.07 Bcfd of natural gas for fuel. [25] As such, 2.73 Bcfd of natural gas would exit the Mainline Pipeline as input to the LNG facility.

Exhibit 4-2. Gas offtake and CO_2 handling

Used with permission from BPXA [11]

Input and Output: LNG Facility. The LNG facility will consume 0.18 Bcfd of natural gas for fuel. [26] As such, 2.55 Bcfd of natural gas would be available for LNG export to overseas markets.

Required Natural Gas Supply at the GTP. To provide 33 years of gas supply to the GTP will require 38.4 Tcf of natural gas. This estimate of required gas supply accounts for reduced volumes of exports during the LNG facility start up (during years 1–4), reduced volumes of exports during Year 30, and three years of catch-up LNG exports to reach total authorized LNG export volumes. In addition, the study estimates the need for 1.7 Tcf of residual gas resources[d] to support the delivery of natural gas supply to the GTP in Years 31 through 33. As such, the total required natural gas supply for the Alaska LNG Project is 38.4 Tcf at the GTP, tabulated in Exhibit 4-3 and illustrated in Exhibit 4-4.

Summary of LNG Exports. After subtraction of CO_2 extraction and fuel use by the GTP, the Mainline Pipeline and the LNG facility, a total of 27.83 Tcf is available for export during the 33 years of the Alaska LNG Project, Exhibit 4-5.

[d] Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 33-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20 percent per year during Years 31–40.

Exhibit 4-3. Total required natural gas supply: 33 years of LNG exports

Time Period	Required Resources at the GTP (Tcf)
Years 1–4	2.8
Years 5–29	30.6
Year 30	1.1
Years 31-33	2.1
Total	**36.7**
Residual Gas Resources*	1.7
Total	**38.4**

*Residual gas resources represent the volume of gas resources left behind at the PBU and PTU at the end of the 33-year LNG export project. This volume is estimated using resources equal to 10 years of natural gas production that declines at 20% per year during years 31–40.

Exhibit 4-4. Annual required natural gas supply at the GTP: 33 years of LNG exports

*Residual Gas Resources represent the volume of gas resources left behind at the Prudhoe Bay Unit and at Point Thomson at the end of the 33-year LNG export project. This volume is estimated using resources equal to ten years of natural gas production that declines at 20% per year during Years 31 through 40.

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Exhibit 4-5. Total LNG Exports: 33 years of LNG exports

Time Period	Required Resources at the LNG Facility (Tcf)
Years 1–4	2.10
Years 5–29	23.27
Year 30	0.83
Years 31-33	1.63
Total	**27.83**

4.3 POTENTIAL ACTIVITIES FOR MEETING REQUIRED NATURAL GAS SUPPLIES

Providing these volumes of natural gas supply and resources from the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU) will entail some additional development, as discussed in the FERC EIS. (FERC, 2020) [4] More Specifically, the FERC EIS states that the activities set forth in its report for the Prudhoe Bay Unit P and the Point Thomson Unit (PTU) Expansion would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project, as discussed below.

4.3.1 PBU MGS Project

The PBU MGS Project would expand and enhance the existing facilities at the site to produce natural gas for delivery to Alaska LNG rather than reinjecting the gas back into the field. While most of the infrastructure necessary to gather and transport natural gas from existing wellheads is present at the PBU, some new infrastructure would be required, including valve and metering modules and pipelines.

The PBU MGS Project would include a 5-acre expansion of the CGF pad, requiring about 150,000 cubic yards of granular fill material to allow installation of a valve module and a metering module for feed gas at the CGF. Three new feed gas pipelines, currently designed as 48-inch-diameter lines, and a propane gas pipeline would be constructed from the PBU CGF to the new valve module on the CGF pad. A short, larger diameter pipeline would connect the new valve module with the new metering module on the same pad. After metering, the gas would be delivered to the PBU CGF metering module with the GTP. An additional 5-mile-long gas pipeline from the Lisburne Production Center to the PBU CGF may be installed at a future date. The PBU MGS Project would also include construction of four new byproduct pipelines—measuring 25, 3, 8, and 8 miles in length (diameter to be determined)—to send GTP byproduct to existing well pads for reinjection into the field. All of the pipelines would be aboveground, supported by VSMs, permanently affecting a total area of about 1.5 acres (based on an assumption of 2,500 dual-based VSMs, each with a footprint of 26 square feet). The construction footprint of the PBU MGS Project would total about 514 acres.

Construction of the PBU MGS Project facilities would occur during winter seasons over a four- to six-year period beginning in Year 1 and ending in Year 7 of the Alaska LNG Project, with drilling

beginning in Year 5 and completed in Year 9. If necessary to house the construction and drilling workforces, a 200-person camp would be established on one of the existing pads at the PBU. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill about 10 new production and injection wells to increase gas recovery at the PBU, which is consistent with the cumulative impacts portion of the FERC EIS for the project. [4] The number of new wells and the schedule for their completion would be based on expected gas recovery efficiencies and performance of existing wells. In addition to new wells, some existing wells would be shut in (i.e., removed from active service) and others worked over (i.e., subjected to major maintenance or remedial treatments). [4]

4.3.2 PTU Expansion Project

The PTU Expansion Project would require the incremental expansion of an existing well pad (Central Pad) by 7 acres to accommodate new facilities. An additional 7-acre multi-season ice pad adjacent to the Central Pad would be used over one summer for construction offices, warehousing, and equipment storage. Three new production wells would be drilled at the Central Pad, one existing gas injection well would be converted to a production well, and a new Underground Injection Control (UIC) Class I disposal well would be drilled on that same pad.

Granular material (e.g., gravel or crushed rock) for the pad would be obtained from an existing PTU stockpile; no new quarrying would be necessary. The pad expansions would be of sufficient thickness to protect the underlying permafrost from thawing. Other design considerations to protect the permafrost include installation of insulated conductors at production and disposal wells, which would minimize heat transfer between hydrocarbon fluids and permafrost. At new wells, installation of thermosiphons would prevent thawing of near-bore permafrost.

The PTU Expansion Project facilities would be fabricated off-site with modular components shipped to the project area for installation. Delivery of modular facilities would be accomplished by sealift, which would require dredging about 5,000 cubic yards of material to enable barges to reach the Central Pad for unloading. Dredging would take place in the winter months by cutting through the ice. Any excess material removed by dredging would be placed along the coast to the west of the Point Thomson marine facilities. Minor screeding may take place in summer months immediately prior to the arrival of barges. Maintenance dredging is not anticipated to be required. A barge bridge would be created by ballasting and grounding the oceangoing barges in series to enable module movement to Central Pad. Personnel, materials, and equipment would be brought to the site by year-round air transportation, an annual ice road in the winter, and by barge or boat in the summer.

Construction of the PTU Expansion would occur over about two years, beginning in Year 2 and concluding in Year 4 of the Alaska LNG Project. The construction and drilling workforces would be housed in temporary construction camps at Point Thomson, as well as camps at Prudhoe Bay and Badami.

AGDC indicates that the UIC Class I disposal well to be drilled at the Central Pad has received a permit from the U.S. Environmental Protection Agency (EPA) under the UIC Program governing construction, operation, and closure requirements for injection wells. EPA would also require Facility Response Plans to demonstrate preparedness in case of a worst-case oil discharge, and a Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent environmental damage from the discharge of oil, under Section 311 of the Clear Water Act (CWA). If the project anticipates discharge of any pollutants into waters of the United States, the Alaska Department of Conservation (ADEC) would determine whether to issue a general or individual Alaska Pollutant Discharge Elimination System (APDES) permit. [4]

These activities would provide sufficient natural gas supply for the initial 20-year time frame of the Alaska LNG Project.

To meet the natural gas supply requirements of the extended 30-year time frame of the Alaska LNG Project, the study estimates that there may be a need to drill a fourth (new) production well on an existing well pad. This activity would support the estimated volume of reserve growth at PTU and assure sustained natural gas deliverability from the PTU during the latter years of the Alaska LNG Project.

4.4 STUDY FINDINGS: ALTERATIVE #2 NATURAL GAS SUPPLY CASE

The study, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," finds that sufficient natural gas resources will be available from PBU and PTU on the North Slope of Alaska to meet the authorized volumes of natural gas exports by the Alaska LNG Project set forth in this report.[e]

Specifically, the PBU and PTU have available natural gas resources to provide essentially all - - 27.83 Tcf of the 27.87 Tcf - - of the natural gas resources authorized for export, Exhibit 4-5. Given the conservative nature of the natural gas resources portion of the study, the recently recognized improved operating practices at the PBU (not included in the natural gas resources study), and inherent uncertainties during the authorized export term, the study determines that sufficient natural gas resources will be available to meet the authorized volumes of LNG exports.

Attachment A: "Annual Volumes of Natural Gas Available for LNG Export by the Alaska LNG Project" to this report provides the annual volumes of gross gas production, fuel/other gas use, gas reinjection, and gas delivery to the GTP from PBU and PTU. It also provides annual data on extraction of CO_2 and fuel use by the GTP, the Mainline Pipeline and the LNG facility, ending with natural gas available for LNG export, as discussed above and shown previously on Exhibit 4-5.

[e] The study entitled "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," is a comprehensive natural gas resource study that incorporates proved reserves, reserve growth, and undeveloped resources. In mid-January 2022, following FERC's approval of the Alaska LNG Project, the U.S. Energy Information Administration (EIA), in its publication "U.S. Crude Oil and Natural Gas Proved Reserves, Year-End 2020," (USEIA, 2020) [27] significantly increased its recognition of natural gas-proved reserves for Alaska, stating: "Approval of this project means that a large volume of previously stranded Alaskan natural gas resources now meets the definition of proved reserves. The annual total of natural gas proved reserves in Alaska increased in 2020 by 27 Tcf, quadrupling the state's total from 9 Tcf to 36 Tcf. Additional upstream production facilities will add more proved reserves in years to come."

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ATTACHMENT A: ANNUAL VOLUMES OF NATURAL GAS AVAILABLE FOR LNG EXPORT BY THE ALASKA LNG PROJECT

		Gross Gas Gas Production			Fuel Use for Compression/Other Gas				Gas Delivery to GTP			Fuel Use/	Available Gas for	
		PBU	PTU	Total	PBU	PTU	Total	PBU	PBU	PTU	Total	Extraction of CO_2	LNG Export	
Year		(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcfd)	(Bcf)
1	2029	7.95	0.14	8.09	0.31	0.00	0.31	7.22	0.42	0.14	0.56	0.13	0.43	155
2	2030	7.81	0.36	8.17	0.31	0.01	0.32	6.45	1.05	0.35	1.40	0.34	1.06	388
3	2031	7.70	0.65	8.36	0.31	0.02	0.33	5.50	1.89	0.63	2.52	0.61	1.91	698
4	2032	7.50	0.80	8.29	0.31	0.03	0.34	4.88	2.31	0.77	3.08	0.74	2.34	853
5	2033	7.21	0.89	8.10	0.31	0.03	0.34	4.40	2.50	0.86	3.36	0.81	2.55	931
6	2034	6.92	0.89	7.81	0.31	0.03	0.34	4.11	2.50	0.86	3.36	0.81	2.55	931
7	2035	6.63	0.89	7.52	0.31	0.03	0.34	3.82	2.50	0.86	3.36	0.81	2.55	931
8	2036	6.34	0.89	7.23	0.31	0.03	0.34	3.53	2.50	0.86	3.36	0.81	2.55	931
9	2037	6.05	0.89	6.94	0.31	0.03	0.34	3.24	2.50	0.86	3.36	0.81	2.55	931
10	2038	5.76	0.89	6.65	0.31	0.03	0.34	2.95	2.50	0.86	3.36	0.81	2.55	931
11	2039	5.47	0.89	6.36	0.20	0.03	0.23	2.77	2.50	0.86	3.36	0.81	2.55	931
12	2040	5.19	0.89	6.08	0.20	0.03	0.23	2.49	2.50	0.86	3.36	0.81	2.55	931
13	2041	4.91	0.89	5.80	0.20	0.03	0.23	2.21	2.50	0.86	3.36	0.81	2.55	931
14	2042	4.63	0.89	5.52	0.20	0.03	0.23	1.93	2.50	0.86	3.36	0.81	2.55	931
15	2043	4.35	0.89	5.24	0.20	0.03	0.23	1.65	2.50	0.86	3.36	0.81	2.55	931
16	2044	4.07	0.89	4.96	0.20	0.03	0.23	1.37	2.50	0.86	3.36	0.81	2.55	931
17	2045	3.79	0.89	4.68	0.20	0.03	0.23	1.09	2.50	0.86	3.36	0.81	2.55	931
18	2046	3.52	0.89	4.41	0.20	0.03	0.23	0.82	2.50	0.86	3.36	0.81	2.55	931
19	2047	3.24	0.89	4.13	0.20	0.03	0.23	0.54	2.50	0.86	3.36	0.81	2.55	931
20	2048	2.96	0.89	3.85	0.20	0.03	0.23	0.26	2.50	0.86	3.36	0.81	2.55	931
21	2049	2.68	0.89	3.57	0.17	0.03	0.20	0.01	2.50	0.86	3.36	0.81	2.55	931
22	2050	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
23	2051	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
24	2052	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
25	2053	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
26	2054	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
27	2055	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
28	2056	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
29	2057	2.67	0.89	3.56	0.17	0.03	0.20	0.00	2.50	0.86	3.36	0.81	2.55	931
30	2058	2.39	0.80	3.19	0.15	0.03	0.18	0.00	2.24	0.77	3.01	0.73	2.28	834
31	2059	1.91	0.64	2.55	0.12	0.02	0.14	0.00	1.79	0.62	2.41	0.58	1.83	668
32	2060	1.53	0.51	2.04	0.10	0.02	0.11	0.00	1.44	0.49	1.93	0.47	1.46	535
33	2061	1.22	0.41	1.63	0.08	0.01	0.09	0.00	1.15	0.39	1.54	0.37	1.17	427
Total														**27,828**

		Gross Gas Gas Production			Fuel Use for Compression/Other Gas				Gas Delivery to GTP			Fuel Use/	Available Gas
		PBU	PTU	Total	PBU	PTU	Total	PBU	PBU	PTU	Total	Extraction of CO_2	for LNG Export
Year		(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)	(Bcf)
1	2029	2,902	53	2,955	113	2	115	2,635	153	51	204	49	155
2	2030	2,850	132	2,982	113	4	118	2,353	383	128	511	123	388
3	2031	2,812	238	3,050	113	8	121	2,009	690	230	920	222	698
4	2032	2,736	291	3,027	113	10	123	1,780	843	281	1,124	271	853
5	2033	2,631	325	2,956	113	11	124	1,605	913	314	1,226	296	931
6	2034	2,525	325	2,850	113	11	124	1,499	913	314	1,226	296	931
7	2035	2,419	325	2,744	113	11	124	1,393	913	314	1,226	296	931
8	2036	2,313	325	2,638	113	11	124	1,287	913	314	1,226	296	931
9	2037	2,207	325	2,532	113	11	124	1,182	913	314	1,226	296	931
10	2038	2,101	325	2,426	113	11	124	1,076	913	314	1,226	296	931
11	2039	1,995	325	2,320	73	11	84	1,010	913	314	1,226	296	931
12	2040	1,894	325	2,219	73	11	84	908	913	314	1,226	296	931
13	2041	1,792	325	2,117	73	11	84	806	913	314	1,226	296	931
14	2042	1,690	325	2,015	73	11	84	705	913	314	1,226	296	931
15	2043	1,588	325	1,913	73	11	84	603	913	314	1,226	296	931
16	2044	1,487	325	1,812	73	11	84	501	913	314	1,226	296	931
17	2045	1,385	325	1,710	73	11	84	399	913	314	1,226	296	931
18	2046	1,283	325	1,608	73	11	84	298	913	314	1,226	296	931
19	2047	1,181	325	1,506	73	11	84	196	913	314	1,226	296	931
20	2048	1,080	325	1,405	73	11	84	94	913	314	1,226	296	931
21	2049	978	325	1,303	62	11	73	3	913	314	1,226	296	931
22	2050	975	325	1,299	62	11	73	0	913	314	1,226	296	931
23	2051	975	325	1,299	62	11	73	0	913	314	1,226	296	931
24	2052	975	325	1,299	62	11	73	0	913	314	1,226	296	931
25	2053	975	325	1,299	62	11	73	0	913	314	1,226	296	931
26	2054	975	325	1,299	62	11	73	0	913	314	1,226	296	931
27	2055	975	325	1,299	62	11	73	0	913	314	1,226	296	931
28	2056	975	325	1,299	62	11	73	0	913	314	1,226	296	931
29	2057	975	325	1,299	62	11	73	0	913	314	1,226	296	931
30	2058	873	291	1,164	56	10	65	0	817	281	1,099	265	834
31	2059	699	233	932	45	8	52	0	654	225	880	212	668
32	2060	560	187	746	36	6	42	0	524	180	704	170	535
33	2061	447	149	596	28	5	33	0	418	144	562	135	427
Total		**52,224**	**9,695**	**61,919**	**2,584**	**327**	**2,911**	**22,344**	**27,296**	**9,368**	**36,664**	**8,836**	**27,828**

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B.2 PRODUCTION REPORT 2: ALASKA LNG UPSTREAM STUDY REPORT 2: IMPACTS OF PBU MAJOR GAS SALES ON OIL PRODUCTION AND CO_2 STORAGE POTENTIAL (MAY 20, 2022)

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Alaska LNG Upstream Study Report 2: Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential

May 20, 2022
DOE/NETL-2022/3784

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Matt Wallace[1]
Vello Kuuskraa[1]
Donald Remson[2*]

The authors wish to acknowledge the excellent guidance, contributions, and cooperation of:

Tim Skone[2]
Alana Sheriff[3]
Timothy R. Carr, Ph.D.[4]
Srijana Rai[3]

[1] Advanced Resources International
[2] National Energy Technology Laboratory (NETL)
[3] NETL support contractor
[4] Independent Reviewer, West Virginia University
*Corresponding contact: Donald Remson@netl.doe.gov, 412.386.5379

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ACRONYMS AND ABBREVIATIONS

AOGCC	Alaska Oil and Gas Conservation Commission
API	American Petroleum Institute
ARI	Advanced Resources International
B, bbl	Barrel
B/D	Barrels per day
BAU	Business as usual
Bcf	Billion cubic feet
Bcfd	Billion cubic feet per day
CCUS	Carbon capture, utilization, and storage
cf	Cubic feet
cfd	Cubic feet per day
CO_2	Carbon dioxide
DNR	Department of Natural Resources
DOE	U.S. Department of Energy
EOR	Enhanced oil recovery
EUR	Estimated ultimate recovery
FFM	Full-field model
ft	Foot
GTP	Gas treatment plant
HCPV	Hydrocarbon pore volume
KRU	Kuparuk River Unit
LNG	Liquified natural gas
M	Thousand
Mbbl	Thousand barrels
Mcf	Thousand cubic feet
Mcfd	Thousand cubic feet per day
mD	Millidarcies
MI	Miscible injectant
MGS	Major gas sales
MM	Million
MMbbl	Million barrels
MMcf	Million cubic feet
MMcfd	Million cubic feet per day
MMmt	Million metric tons
MMP	Minimum miscibility pressure
MWAG	Miscible water-alternating-gas
NETL	National Energy Technology Laboratory
NGL	Natural gas liquid
OOIP	Original oil in-place
PBU	Prudhoe Bay Unit
POD	Plan of Development
POP	Prudhoe Oil Pool
psi	Pounds per square inch
PTU	Point Thomson Unit
SEIS	Supplemental Environmental Impact Statement
Tcf	Trillion cubic feet
U.S.	United States
WAG	Water-alternating-gas
°API	Degrees API (American Petroleum Institute)

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1 INTRODUCTION

The U.S. Department of Energy (DOE) is preparing a Supplemental Environmental Impact Statement (SEIS) following the authorization to export 2.55 billion cubic feet per day (Bcfd) of natural gas from the North Slope of Alaska for the Alaska LNG Project. The natural gas to be exported is projected to come from the Prudhoe Bay Unit (PBU), consisting of the Prudhoe Bay Oil Pool (POP) and its Satellite fields (75 percent), and Point Thomson (25 percent). The project has been authorized for an oversight period of 30 years beginning in 2029, which is the first year gas exports are expected for the Alaska LNG Project. Additionally, the project may elect to operate an additional three years (for a total of 33 years) to reach the total authorized natural gas export volume, if needed.

The export of natural gas will mark a significant change in PBU field management, as oil production has, so far, been the primary objective. The demand for natural gas produced on the North Slope of Alaska is very limited, with only small quantities sold for in-state use. Currently, most of the produced gas is reinjected for pressure management or used for miscible gas injection (MI). The start of the Alaska LNG Project will lead to lower volumes of gas for reinjection, causing the reservoir pressure and the oil production to decline. Additionally, the processing of the natural gas at the new Gas Treatment Plant (GTP) associated with the Alaska LNG Project will create a byproduct stream of CO_2 of approximately 350 million cubic feet per day (MMcfd) that will need to be managed.

1.1 THREE STUDY CASES

Three study cases were developed to evaluate potential impacts of the Alaska LNG Project on oil production from the PBU, including:

1. **Case 1. "Business As Usual" (BAU) Gas Reinjection**—This case examines the remaining oil production potential from the PBU given no Alaska LNG Project and thus no major gas sales (MGS). In Case 1, the produced gas and its CO_2 content will continue to be reinjected into the PBU for pressure maintenance and MI.
2. **Case 2. Reduced Gas Reinjection**—This case examines the reduction in oil production from the PBU given the decreasing volumes of gas injection and the steady decline in reservoir pressure due to the Alaska LNG Project.
3. **Case 3. Use and Storage of Byproduct CO_2**—This case examines the potential for utilization and storage of the byproduct CO_2 using CO_2 enhanced oil recovery (EOR). Injection of the byproduct CO_2 into the nearby Kuparuk River Field is modeled to examine the capacity to store CO_2 and obtain incremental oil production.

2 STUDY PURPOSE

This report is the second in a series of three reports assessing the energy and infrastructure resources available to support the development of the Alaska LNG Project. Together, these three reports comprise the "Upstream Study" of oil and natural gas resources and CO_2 utilization and storage potential at the PBU and surrounding areas.

The purpose of this report, "Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential," is to examine the impacts of the Alaska LNG Project on oil production at the PBU and to discuss options for utilizing the byproduct CO_2 stream from the Alaska LNG GTP for CO_2 EOR operations on the North Slope. Injection of CO_2 into the POP will not be possible during MGS due to the need to reduce pressure to achieve optimum natural gas recovery from the POP. As such, this report examines the potential for CO_2 storage with CO_2 EOR in the Kuparuk River Unit (KRU) next to the PBU.

The first of the three Upstream Study reports, "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project," evaluates the capacity of natural gas supply from the PBU and Point Thomson Unit (PTU) on the North Slope of Alaska to support the Alaska LNG Project for a 30-year period.

The third of the three Upstream Study reports, "Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit," identifies and assesses the viability of storing byproduct CO_2 from the GTP facility in a deep saline reservoir at the PBU.

3 PRUDHOE BAY UNIT OIL PRODUCTION

The PBU is comprised of the large POP, plus its Eastern and Western Satellite fields. The Eastern Satellite fields include the Point McIntyre, Lisburne, Niakuk, and Raven oil pools. The Western Satellite fields include the Aurora, Borealis, Midnight Sun, Polaris, and Orion oil pools. These fields produce from four main reservoir intervals—Schrader Bluff, Kuparuk, Sadlerochit, and Lisburne (Exhibit 3-1).

Exhibit 3-1. Prudhoe Bay Unit reservoirs and participating area boundaries

Used with permission from Alaska DNR, 2012 [1]

Total original oil in-place (OOIP) for the PBU is estimated at 31.6 billion barrels. [2] The POP, the largest oil field in North America, is estimated to contain about 25 billion barrels of OOIP [3], leaving 6.6 billion barrels of OOIP for the Eastern and Western Satellite fields.

3.1 HISTORY OF IMPROVED OIL RECOVERY PRACTICES

Operation of the POP has included extensive improved oil recovery practices since 1981. These practices, which include waterflooding, MI, and water-alternating-gas injection (WAG), have helped maintain reservoir pressure and increase the efficiency of oil recovery.

The central portion of the POP field has been produced by gravity drainage enhanced by lean gas reinjection. Water injection into the gas cap has been used in recent years to assist with

pressure maintenance. The perimeter of the POP field is produced primarily by MI and WAG injection.

Waterflooding has been used for pressure maintenance and oil recovery at each of the 11 Eastern and Western Satellite fields. In most cases, waterflooding was initiated at the field within one to two years of first oil production to maintain reservoir pressure. MI has been used at the five Western Satellite fields, while WAG has been used at Lisburne and Point McIntyre in the Eastern Satellite fields (Exhibit 3-2).

Exhibit 3-2. PBU reservoir and well map

Used with permission from the Alaska Oil and Gas Conservation Commission (AOGCC), 2021 [4]

Enhanced recovery operations at the Eastern Satellite fields occurred intermittently between the late 1980s and early 1990s at Lisburne and Point McIntyre. The enhanced recovery efforts in the Western Satellite fields started between 2000–2010 (Exhibit 3-3).

Exhibit 3-3. PBU enhanced recovery start dates

PBU Area		Reservoir	First Prod	WI	MI/WAG
Prudhoe Oil Pool		Sadlerochit	1969	1981	1986
Western Satellites	Aurora	Kuparuk	2000	2001	2003
	Borealis	Kuparuk	2001	2002	2004
	Midnight Sun	Kuparuk	1998	2000	2016
	Polaris	Schraeder Bluff	1999	2003	2009
	Orion	Schraeder Bluff	2002	2003	2006
Eastern Satellites	Niakuk	Kuparuk	1994	1995	-
	Lisburne	Lisburne	1982	1987-1989	1987
	Pt. McIntyre	Kuparuk/Kalubik	1993	1994	2000
	Raven	Sadlerochit/Sag	2007	2007	-

3.2 FIELD DEVELOPMENT AND OIL PRODUCTION

The PBU has produced approximately 13 billion barrels of oil through the end of 2020. The majority of this production, approximately 12 billion barrels, has been from the POP. The Eastern Satellite fields have produced approximately 770 million barrels (MMbbl) of oil and the Western Satellite fields have produced approximately 230 MMbbl of oil.

Major development of the POP began in 1977, leading to an oil production peak of 572 MMbbl (1.57 MMbbl per day) in 1987. The latest oil production at the POP was approximately 61 MMbbl (167,000 barrels per day [B/D]) in 2020.

Development of the Eastern Satellite fields began in 1981 at the Lisburne Oil Pool, followed by the development of Point McIntyre in 1993. Production from the Eastern Satellite fields peaked in 1996 at 73.6 MMbbl (approximately 200,000 B/D). Oil production at the Eastern Satellite fields was approximately 9.5 MMbbl (26,000 B/D) in 2020.

The five Western Satellite fields were developed between 1998–2002, with oil production peaking in 2003 at 18.6 MMbbl (approximately 51,000 B/D). Oil production at the Western Satellite fields was approximately 8 MMbbl (22,000 B/D) in 2020 (Exhibit 3-4).

Exhibit 3-4. Annual oil production—POP and Satellite fields

Modified with permission from AOGCC, 2021 [5]

3.3 METHODOLOGY FOR ESTIMATING FUTURE OIL PRODUCTION

Advanced Resources International (ARI) used historical oil production data for the POP and the Satellite fields to conduct production decline analysis to assess future expected oil production at PBU. The historical production data shows that the oil production decline rate has decreased steadily in the past few years (Exhibit 3-5).

Exhibit 3-5. PBU oil production decline

Modified with permission from AOGCC, 2021 [5]

The oil production decline rate of approximately 3 percent per year for the POP was first carried out to 2029 (the first year of expected gas sales for the Alaska LNG Project) to provide a starting point for examining the impact of the MGS on future oil production. The decline analysis was then extended to the end of 2058 for Case 1 to establish the baseline for oil production without the Alaska LNG Project. A steeper oil production decline rate was used in Case 2 to estimate the loss of potential oil production from the POP and Satellite fields due to the Alaska LNG Project.

The decline analysis methodology was calibrated against a detailed full-field model (FFM) of the impact of MGS on oil production from the POP from 2025–2054, conducted by BP. [6]. The FFM evaluated potential oil production for both a "baseline" case (future oil production with no gas sales) and a "gas reference" case (starting the MGS project in 2025). The BP "baseline" case provided an oil production volume of 1.07 billion barrels for the POP over a 30-year period if no MGS project was initiated. The BP FFM study also showed a lower volume of 0.79 billion barrels of oil production under the "gas reference" case. The reduced oil production in the MGS case is due to declining reservoir pressure resulting from reduced gas reinjection.

The oil production decline curve models for Case 1 and Case 2 were then calibrated to the BP FFM models. The POP decline curve oil production from 2025–2054 was matched to the BP model production totals—1.07 billion barrels for the "baseline" case and 0.79 billion barrels for the "gas reference" case. The calibrated decline curve models were used to calculate the oil production decline at the POP and the Satellite fields, first from 2020–2029, and then to 2058. The results from these analyses are discussed in more detail in Section 3 and Section 4.

4 CASE 1—"BUSINESS AS USUAL"

Case 1 provides the BAU oil production case for the POP and Satellite fields within the PBU, assuming no MGS project. A decline curve-based assessment of oil production was projected out to 2058, which includes eight years of development leading up to the MGS project in 2029, and then for 30 years until the end of 2058.

4.1 CASE 1 OIL PRODUCTION

Case 1 started with oil production in 2020 of 61 MMbbl for the POP, 9.3 MMbbl for the Eastern Satellites, and 8.0 MMbbl for the Western Satellites. The POP was assumed to continue its current oil production decline of 3 percent per year to an estimated oil production of 47.8 MMbbl in 2028. The Satellite fields, using a 1 percent decline in oil production per year, resulted in estimated oil production of 8.6 MMbbl for the Eastern Satellite fields and 7.4 MMbbl for the Western Satellite fields in 2028.

Small adjustments were made to the incremental decline rates from 2029–2058 for Case 1 to match the "baseline" BP model. The overall oil production decline curve for the POP gradually flattens from 2.85 percent in year 2029 to 2.61 percent in year 2055. Similar decline rates were used to estimate future oil recovery from the Eastern and Western Satellite fields (Exhibit 4-1).

Exhibit 4-1. Case 1 annual decline rates

Project Years	Decline Rate		
	POP	Eastern Satellites	Western Sattelites
2020 to 2028	3%	1%	1%
2029	2.85%	2.85%	2.85%
2030 to 2034	2.81%	2.81%	2.81%
2035 to 2039	2.77%	2.77%	2.77%
2040 to 2044	2.73%	2.73%	2.73%
2045 to 2049	2.69%	2.69%	2.69%
2050 to 2054	2.65%	2.65%	2.65%
2055 to 2058	2.61%	2.61%	2.61%

Case 1 total oil production from the POP from 2029–2058 is 957 MMbbl (Exhibit 4-2).

Exhibit 4-2. Case 1 BAU oil production

4.2 CASE 1 IMPACTS

The sections below outline the oil production impacts for Case 1 for an operational period of both 30 years and 33 years.

Management of byproduct CO_2 is not required for Case 1 since the produced gas (including its CO_2 content) from the PBU is reinjected under the BAU scenario. A table of the PBU annual oil production, gross gas production, gas consumption, and gas reinjection for Case 1 is included in Exhibit A-1 of Appendix A.

4.2.1 30 Year Project Impacts

The results of the oil production decline analysis for Case 1 show that total oil production from 2029–2058 for the PBU is 1,277 MMbbl. This includes 957 MMbbl from the POP, 148 MMbbl from the Western Satellite fields, and 172 MMbbl from the Eastern Satellite fields (Exhibit 4-3).

Exhibit 4-3. Case 1 PBU estimated oil production (2029–2058)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	957
Western Satellites	148
Eastern Satellites	172
Prudhoe Bay Unit	1,277

4.2.2 33 Year Project Impacts

Assuming Alaska LNG elects to extend the project by three years, the results of the oil production decline analysis for Case 1 show that total oil production from 2029–2061 for the PBU is 1,355 MMbbl. This includes 1,016 MMbbl from the POP, 157 MMbbl from the Western Satellite fields, and 182 MMbbl from the Eastern Satellite fields (Exhibit 4-4).

Exhibit 4-4. Case 1 PBU estimated oil production (2029–2061)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	1,016
Western Satellites	157
Eastern Satellites	182
Prudhoe Bay Unit	1,355

5 CASE 2—REDUCED GAS REINJECTION

Case 2 analysis of oil production potential for the POP and Satellite fields assumes a steady decline in pressure in the PBU due to the start of the MGS project. It also assumes a switch in priority from production of oil to production of gas for export as part of the Alaska LNG Project. The volumes of natural gas and CO_2 that are currently reinjected would now be produced. The oil production estimates for Case 2 are calibrated against the oil production estimated by the detailed BP model for MGS. The same rates of oil production decline were used for both the POP and Satellite fields. Management and utilization of the byproduct CO_2 produced as part of MGS is addressed in Case 3 of this report and in Upstream Study Report 3.

5.1 CASE 2 OIL PRODUCTION

Case 2 provides a projection of oil production to 2058, which includes eight years of development leading up to MGS beginning in 2029 and 30 years of MGS operation until the end of 2058. Case 2 includes the same beginning oil production data points for 2029 and the same initial decline rates (3 percent and 1 percent, respectively) for the POP and Satellite fields as in Case 1.

Oil production for Case 2 has a steeper decline than Case 1 due to the reduction in reservoir pressure from reduced gas reinjection. The initial decline rates increase from 5 percent in 2029 to 6.5 percent in 2031 as the GTP trains are brought online and less gas is reinjected at the PBU. The decline rate then gradually decreases from 6.44 percent in 2035 to 6.2 percent in 2055. The oil production decline rates used for the Eastern and Western Satellite fields were the same as the decline rates for the POP (Exhibit 5-1).

Exhibit 5-1. Case 2 "pressure depletion" decline rates

Project Years	Decline Rate		
	POP	Eastern Satellites	Western Sattelites
2020 to 2028	3%	1%	1%
2029	5.00%	5.00%	5.00%
2030	6.00%	6.00%	6.00%
2030 to 2034	6.50%	6.50%	6.50%
2035 to 2039	6.44%	6.44%	6.44%
2040 to 2044	6.38%	6.38%	6.38%
2045 to 2049	6.32%	6.32%	6.32%
2050 to 2054	6.26%	6.26%	6.26%
2055 to 2058	6.20%	6.20%	6.20%

In Case 2, the total oil production for the POP from 2029–2058 is 620 MMbbl (Exhibit 5-2).

Exhibit 5-2. Case 2 "pressure depletion" oil production decline curve

5.2 CASE 2 IMPACTS

The sections below outline the oil production impacts for Case 2 for an operational period of both 30 years and 33 years.

A table of the PBU annual oil production, gross gas production, gas consumption, gas delivery to the GTP, gas reinjection, and gas-oil ratio for Case 2 is included in Exhibit A-2 of Appendix A.

5.2.1 30 Year Project Impacts

Applying the oil production decline methodology in Case 2 shows that total future oil production from 2029–2058 for the PBU is 825 MMbbl. This includes 620 MMbbl for the POP, 95 MMbbl for the Western Satellite fields, and 110 MMbbl for the Eastern Satellite fields (Exhibit 5-3).

Exhibit 5-3. Case 2 "pressure depletion" PBU EUR (2029-2058)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	620
Western Satellites	95
Eastern Satellites	110
Prudhoe Bay Unit	825

As such, given the BAU (Case 1) volume of oil production of 1,277 MMbbl and the MGS (Case 2) volume of oil production of 825 MMbbl, initiating the Alaska LNG Project in 2029 reduces total PBU oil production by 452 MMbbl (Exhibit 5-4).

Exhibit 5-4. Comparison of Case 1 and Case 2

Development Case	Oil Prod. (MMbbl)
Case 1 (BAU)	1,277
Case 2 (MGS)	825
Oil Production Impact	452

5.2.2 33 Year Project Impacts

Assuming Alaska LNG elects to extend the project by three years, applying the oil production decline methodology in Case 2 shows that total future oil production from 2029–2061 for the PBU is 849 MMbbl. This includes 638 MMbbl for the POP, 97 MMbbl for the Western Satellite fields, and 113 MMbbl for the Eastern Satellite fields (Exhibit 5-5).

Exhibit 5-5. Case 2 "pressure depletion" PBU EUR (2029-2061)

Prudhoe Bay Unit	Oil Prod. (MMbbl)
Prudhoe Oil Pool	638
Western Satellites	97
Eastern Satellites	113
Prudhoe Bay Unit	849

As such, given the BAU (Case 1) volume of oil production of 1,355 MMbbl and the MGS (Case 2) volume of oil production of 849 MMbbl, extending the Alaska LNG Project to 2061 reduces total PBU oil production by 506 MMbbl (Exhibit 5-6).

Exhibit 5-6. Comparison of Case 1 and Case 2

Development Case	Oil Prod. (MMbbl)
Case 1 (BAU)	1,355
Case 2 (MGS)	849
Oil Production Impact	506

6 CASE 3—STORAGE AND USE OF BYPRODUCT CO_2

Case 3 investigates the option of storing byproduct CO_2 captured at the GTP during the 30-year Alaska LNG Project using CO_2 EOR. This scenario is one of several likely options for storing CO_2 with CO_2 EOR on the North Slope of Alaska.

The large Kuparuk River oil field, adjacent to the PBU, is the subject of the CO_2 Storage and EOR Project for Case 3. The field was selected for Case 3 due to its proximity to the PBU and its reservoir capacity for utilizing the byproduct CO_2 from the Alaska LNG project. Approximately 350 MMcfd of CO_2 from the GTP associated with the Alaska LNG Project would be injected for CO_2 storage and EOR.

Extensive studies of the operation of miscible gas injection have been performed at the Kuparuk River oil field, providing a precedent for evaluating the viability of a CO_2 flood at Kuparuk. In addition, existing pipeline corridors exist between Kuparuk River and the PBU.

6.1 KUPARUK RIVER UNIT

The KRU oil field is located approximately 30 miles west of the PBU's central facilities on Alaska's North Slope. It is the second largest oil field in Alaska after Prudhoe Bay (Exhibit 6-1). Oil production at Kuparuk River began in 1981 and increased until reaching a peak of nearly 120 MMbbl per year (330,000 B/D) in 1992. Oil production has declined steadily to a current total of 23 MMbbl in 2020 (63,000 B/D). Total oil production from the KRU is approximately 2.5 billion barrels as of the end of 2020 (Exhibit 6-2).

Exhibit 6-1. Kuparuk oil field location

Used with permission from AOGCC, 2021 [5]

Exhibit 6-2. KRU oil production to 2020

The Kuparuk River oil field produces primarily from two major sandstone reservoirs—the A Sand and C Sand. The previous evaluation of the Kuparuk River oil field established an OOIP of approximately 3.95 billion barrels for the A Sand and 2.31 billion barrels for the C Sand. The C Sand, located above the A Sand, has a slightly smaller areal extent than the A Sand (Exhibit 6-3).

The KRU has field-wide average permeability of 150 millidarcies (mD) and an average porosity of 22 percent, with an average API oil gravity of 24°.

Exhibit 6-3. KRU C Sand and A Sand orientation

Used with permission from BP Alaska, 1990 [7]

6.2 KRU OPERATIONS

Significant EOR activities, in the form of miscible water-alternating-gas (MWAG), have been underway at Kuparuk for several decades. The first MWAG pilot was performed at two drill sites in 1988, and a third pilot was undertaken in 1993. Following the pilots, large-scale implementation of MWAG was started in 1996.

The broader application of MWAG at Kuparuk River has been constrained by the limited supply of miscible injectant (natural gas liquids [NGLs]). The miscible injectant is limited by what is produced at Kuparuk and what can be supplied for the project from the PBU. The KRU received an average of 65.8 MMcfd of miscible injectant in 2020, which was utilized at 71 injection wells on 24 drill pads. [8] Overall, the KRU currently has approximately 740 active wells, including 406 production wells and 334 injection wells.

Exhibit 6-4 shows the water injection, MI, and WAG injection well locations at the KRU.

Exhibit 6-4. KRU well locations

Used with permission from AOGCC, 2021 [5]

While injection of CO_2 as a miscible injectant has not been used at the KRU, a number of pilot studies and modeling of EOR potential have been performed for the field. Detailed geocellular modeling of the KRU A Sand and C Sand was performed to evaluate the options for improving MI injectivity and throughput in these reservoirs. [9] Additional studies, including slim tube experiments, showed a high correlation between the estimated minimum miscibility pressure (MMP) value and the observed MMP value of the oil in the Kuparuk River reservoir. [10] The calculations used by this study suggest that the oil reservoirs at the KRU should meet the technical criteria for miscible CO_2 injection, as discussed in Section 6.3 of this report.

6.3 KRU TYPE PATTERNS

Representative "type" patterns for the C Sand and the A Sand were developed for modeling CO_2EOR at the KRU. These type patterns included average reservoir properties for the C Sand and A Sand, as well as CO_2 EOR project parameters, such as:

1. <u>CO_2 Flood Pattern Size</u>—Each project is developed using a pattern size of 320 acres, which is consistent with the pattern development at the KRU.
2. <u>Fluid Injection Rate</u>— CO_2 and water injection rates are calculated for the C Sand and A Sand based on the pattern size, fluid properties, and reservoir characteristics. The

project is modeled using stacked injection intervals, with each injection well completed into both the C Sand and A Sand.

3. CO_2 Flood Design—A total of 1.5 hydrocarbon pore volume (HCPV) of CO_2 is injected into the KRU using WAG injection. The pattern is oriented as a line-drive configuration using one injection well and one production well per pattern, similar to the pattern configuration used at the KRU.

6.3.1 Reservoir Properties

Reservoir property data for the C Sand and A Sand were obtained from the AOGCC pool statistic reports, as well as technical research papers on the KRU. [11] [10]

The C Sand OOIP was calculated to be approximately 2.24 billion barrels based on an estimated area of 107,400 acres and an average net pay of 23.4 feet. The OOIP for the A Sand was calculated to be 3.66 billion barrels based on an estimated area of approximately 150,000 acres and an average net pay of 25 feet.

Exhibit 6-5 includes additional reservoir property data for the type patterns.

Exhibit 6-5. KRU type pattern reservoir properties

Reservoir Data		C Sand	A Sand
Volumetric Data	OOIP (MMbbl)	2,242	3,658
	Area (ac)	107,400	149,700
	Net Pay (ft)	23.4	25.0
	Porosity (%)	21%	23%
	Soi (%)	69%	69%
	Boi	1.26	1.26
Reservoir Properties	Permeability (md)	130	100
	Depth (ft)	6,000	6,250
	Temperature (F)	158	162
	API Gravity	24	24
	Oil Viscosity (cp)	1.62	1.57
	Initial Pressure (psi)	3,135	3,135

6.3.2 CO_2 Miscibility

MMP at Kuparuk was studied using a range of miscible injectants from low to high molecular weights. [10] The study showed that most of the low to mid molecular weight injectants had MMP of about 3,000 pounds per square inch (psi). In general, the MMP for CO_2 is typically lower than for low molecular weight hydrocarbon injectants, such as methane.

The following equation was used in this study to estimate the MMP for the C Sand and A Sand reservoirs [12]:

$$C5+\ MW\ =\ 4{,}247.98641\ *\ (API\ Gravity\hat{}-0.87022)$$

The MMP was calculated to be 3,083 psi for the C Sand and 3,164 psi for the A Sand, both of which satisfy criteria for MMP based on the reservoir depths.

6.3.3 Injectivity

The fluid injection rate was calculated for each reservoir to determine the maximum allowable rate of injection into the reservoir. The following equation was used to estimate the rate of water injection for the type patterns:

$$q = 3.541 *\ kh\Delta P\ /\ \mu[\ln\left(\frac{a}{r_w}\right) - 0.619]$$

Where:

- k is the average permeability of the reservoir, in mD.
- h is the average net pay of the reservoir, in ft.
- ΔP is the difference between the estimated maximum allowable injection pressure (equal to depth * 0.6 psi/ft) and the reservoir pressure at the production well (equal to 1,000 psi).
- μ is the reservoir water viscosity, in centipoise.
- a is the distance between the injection well and production well, in ft.
- r_w is injection wellbore radius, in ft.

A water injection rate of 2,971 B/D was calculated for the C Sand and 2,644 B/D was calculated for the A Sand. A rate of 2,644 B/D was used for both type patterns.

To estimate the equivalent CO_2 injection rate, the water injection rate was converted to a CO_2 injection rate using a CO_2 conversion factor of 2.3 thousand cubic feet per barrel. Therefore, a CO_2 injection rate of 6.081 MMcfd was used in each type pattern.

6.3.4 Reservoir Heterogeneity

The Dykstra-Parsons coefficient was used to assess the heterogeneity of the Kuparuk River oil reservoir. ARI estimated the Dykstra-Parsons value based on the correlation between reservoir sweep efficiency and mobility ratio, which is used to calculate the Dykstra-Parsons for oil fields that have experienced waterflooding, as described by Hirasaki, et al (SPE 13415). [13]

The ARI model calculated Dykstra-Parsons values of 0.77 for the C Sand and 0.79 for the A Sand type patterns.

6.4 CO_2 PROPHET MODEL

Reservoir modeling of the CO_2 EOR project at the KRU was performed using the CO_2 Prophet model. The CO_2 Prophet model is a finite difference stream-tube model that identifies how key reservoir variables influence CO_2 storage effectiveness and oil recovery with CO_2 EOR. The model performs three essential functions:

1. First, the model generates streamlines for fluid flow between injection and production wells.
2. Next, the model performs oil displacement and recovery calculations using fluid injectivity and reservoir property data.
3. Then, the model calculates the volume of CO_2 stored in the reservoirs.

The model generates a set of annual output data for oil, CO_2, and water production from the reservoir. These data are used to assess the technically viable CO_2 storage and incremental oil production for the project.

6.4.1 CO_2 Prophet Input Data

The exhibits below include the input data used to model the C Sand and A Sand type patterns with the CO_2 Prophet model. The input data includes relative permeability data, reservoir property data, fluid injection data, and CO_2 flood parameters (Exhibit 6-6 and Exhibit 6-7).

Exhibit 6-6. C Sand CO_2 Prophet input sheet

```
'AK Kuparuk C Sand CO2 PROPHET INPUT |'
'********** 'WELL AND PATTERN DATA ********'
'PATTERN'
'LD'
'NWELLS       NOINJ'
2,             1
'WELLS        WELLY         WELLQ'
0,            0,             1
1,            1,            -1
'NBNDPT'
 5
'BOUNDX       BOUNDY'
0,             0
0,             1
1,             1
1,             0
0,             0
'*************  PROGRAM CONTROLS  ********'
'LWGEN        OUTTIM'
'N',           1
'**** RELATIVE PERMEABILITY PARAMETERS ***'
'SORW         SORG          SORM'
0.335,         0.3,         0.08
'SGR          SSR'
0.3,          0.3
'SWC          SWIR'
0.3,           0.3
'KROCW        KWRO          KRSMAX        KRGCW'
0.8,          0.2,          0.4,           0.45
'EXPOW        EXPW          EXPS          EXPG          EXPOG'
2,            2,            2,            2,            2
'KRMSEL       W'
1,             0.999
'***************  FLUID DATA  ************'
'VISO         VISW'         CO2SOL 0 REDFAC 0.15 CO2INJ
2.5,          0.43
'BO           RS            API           SALN          GSG'
1.1,          465,           24,          30000,        0.75
'************** RESERVOIR DATA ***********'
'TRES         P             MMP'
158,          3607,         3083
'DPCOEF       PERMAV        THICK         POROS         NLAYERS'
0.77,         130,          23.4,          0.21,         10
'SOINIT       SGINIT        SWINIT'
0.335,        0,            0.665
'AREA         XKVH'
13939200,      1
'********** INJECTION PARAMETERS *********'
'NTIMES       WAGTAG'
3,            'T'
'HCPVI        WTRRAT        SOLRAT        TMORVL'
0.375,         2644,         6.081,        0.35
0.525,         2644,         6.081,        0.45
0.6,           2644,         6.081,        0.5
```

Exhibit 6-7. A Sand CO_2 Prophet input sheet

```
'AK Kuparuk A Sand CO2 PROPHET INPUT '
'********** 'WELL AND PATTERN DATA ********'
'PATTERN'
'LD'
'NWELLS       NOINJ'
2,             1
'WELLS        WELLY         WELLQ'
0,            0,             1
1,            1,            -1
'NBNDPT'
 5
'BOUNDX       BOUNDY'
0,             0
0,             1
1,             1
1,             0
0,             0
'*************  PROGRAM CONTROLS  ********'
'LWGEN        OUTTIM'
'N',           1
'**** RELATIVE PERMEABILITY PARAMETERS ***'
'SORW         SORG          SORM'
0.335,         0.3,         0.08
'SGR          SSR'
0.3,          0.3
'SWC          SWIR'
0.3,           0.3
'KROCW        KWRO          KRSMAX        KRGCW'
0.8,          0.2,          0.4,           0.45
'EXPOW        EXPW          EXPS          EXPG          EXPOG'
2,            2,            2,            2,            2
'KRMSEL       W'
1,             0.999
'***************  FLUID DATA  ************'
'VISO         VISW'         CO2SOL 0 REDFAC 0.15 CO2INJ
2.5,          0.43
'BO           RS            API           SALN          GSG'
1.1,          465,           24,          30000,        0.75
'************** RESERVOIR DATA ***********'
'TRES         P             MMP'
162,          3758,         3164
'DPCOEF       PERMAV        THICK         POROS         NLAYERS'
0.79,         100,          25.0,         0.23,         10
'SOINIT       SGINIT        SWINIT'
0.335,        0,            0.665
'AREA         XKVH'
13939200,      1
'********** INJECTION PARAMETERS *********'
'NTIMES       WAGTAG'
3,            'T'
'HCPVI        WTRRAT        SOLRAT        TMORVL'
0.375,         2644,         6.081,         0.35
0.525,         2644,         6.081,         0.45
0.6,           2644,         6.081,         0.5
```

6.4.2 Pattern Results

The results of the CO_2 Prophet model simulation showed that a total of 11.1 billion cubic feet (Bcf) of CO_2 could be stored in the C Sand over 25 years of injection and a total of 12.9 Bcf of CO_2 could be stored in the A Sand over 28 years of injection per 320-acre pattern in the KRU.

Total CO_2 storage potential per pattern is approximately 24.0 Bcf (1.25 million metric tons [MMmt]) of CO_2.

Exhibit 6-8 shows the annual rate of CO_2 storage for the 320-acre type pattern at the KRU EOR project.

Exhibit 6-8. CO_2 Prophet pattern level CO_2 storage

Oil production from the type pattern is approximately 1.5 MMbbl for the C Sand over 25 years and 1.7 MMbbl for the A Sand over 28 years. Total incremental oil production potential is approximately 3.2 MMbbl per 320-acre pattern (Exhibit 6-9).

Exhibit 6-9. CO_2 Prophet pattern level oil production

6.5 KRU CO_2 EOR DEVELOPMENT

The CO_2 Prophet type pattern results were used to develop a full-field CO_2 storage model at the KRU for the 30-year CO_2 storage and oil recovery project. The rate of pattern development was calculated such that the total annual CO_2 storage was equal to the volume of CO_2 byproduct offtake from the Alaska LNG GTP. This volume of CO_2 byproduct increases in the initial years as the GTP trains come online. This volume equals 58 MMcfd in Year 1, 175 MMcfd day in Year 2, 283 MMcfd in Year 3, and 350 MMcfd in Years 4–29. CO_2 supply decreases in Year 30 to 233 MMcfd. Based on a review of the current development of the KRU, it is assumed that an adequate number of injection wells exist to develop a CO_2 EOR project at the KRU, without the need to drill any additional new injection wells. Existing wells would undergo retrofitting, as needed, in order to inject both CO_2 and water into the reservoirs. Additionally, a new CO_2 distribution system would be constructed at the KRU to deliver CO_2 to the injection wells in the field. This would require construction of approximately 19 miles of small volume CO_2 distribution pipelines to be installed in the field. Exact configuration and specifications of the CO_2 EOR project would be determined by the project operator.

6.5.1 CO_2 Storage

The CO_2 storage model for the KRU includes 188 patterns developed over the 30-year MGS project time frame. New patterns are brought online for the first 29 of the 30 years of MGS to meet the demand for storing the CO_2 byproduct.

A total of 3.62 trillion cubic feet (Tcf) (190 MMmt) of CO_2 is stored in the C Sand and A Sand of the KRU over the 30-year MGS period (Exhibit 6-10).

Exhibit 6-10. KRU field-wide CO_2 storage development

The 188 patterns developed for CO_2 storage encompass a total field area of just over 60,000 acres, or about 60 percent of the C Sand area and about 40 percent of the A Sand area. With more than 300 active injection wells currently in the field, the operator could be selective in pattern development to identify the optimal pattern configuration and existing wells to use for CO_2 EOR.

6.5.2 Incremental Oil Production

The CO_2 Prophet model shows that potential incremental oil production increases steadily in the first 10 years of the project to an average of about 18 MMbbl per year (50,000 BPD). Production declines slowly over the last five years of the project, to about 16 MMbbl per year (44,000 BPD).

Total incremental oil production potential for the CO_2 EOR project at the KRU is 473 MMbbl over the 30-year project period (Exhibit 6-11). Given the steady decline in oil production from the PBU between now and the start of the MGS, and the even steeper oil production decline once the MGS comes online, this study shows that the existing oil processing infrastructure at the PBU would easily accommodate the increased oil production from the KRU.

Exhibit 6-11. KRU field-wide incremental oil production potential

6.6 CASE 3 IMPACTS

The sections below outline the oil production and CO2 storage impacts for Case 3 for an operational period of both 30 years and 33 years.

A table of the KRU annual oil production, CO_2 injection, CO_2 production, and CO_2 storage for Case 3 is included in Exhibit A-3 of Appendix A.

6.6.1 30 Year Project Impacts

The results of the Case 3 study show that utilizing the byproduct CO_2 from the Alaska LNG Project for CO_2 EOR for 30 years on the Alaska North Slope could provide incremental oil production of 473 MMbbl. The project would also store approximately 3.62 Tcf (190 MMmt) of byproduct CO_2, or an annual average of 120 Bcf (6.3 MMmt) over the 30-year life of the project (Exhibit 6-12).

Exhibit 6-12. Case 3 impacts (2029-2058)

Development Case	Oil Production (MMbbl)	CO2 Storage (Tcf)	CO2 Storage (MMmt)
Case 3 Use and Storage of By-Product CO2	473	3.62	190

6.6.2 33 Year Project Impacts

The results of the Case 3 study show that utilizing the byproduct CO_2 from the Alaska LNG Project for CO_2 EOR for 33 years on the Alaska North Slope could provide incremental oil production of 512 MMbbl. The project would also store approximately 3.87 Tcf (205 MMmt) of byproduct CO_2, or an annual average of 117 Bcf (6.2 MMmt) over the 33-year life of the project (Exhibit 6-13).

Exhibit 6-13. Case 3 impacts (2029-2061)

Development Case	Oil Production (MMbbl)	CO2 Storage (Tcf)	CO2 Storage (MMmt)
Case 3 Use and Storage of By-Product CO2	512	3.87	205

7 OBSERVATIONS AND NEXT STEPS

7.1 MAINTAINING OIL PRODUCTION ON THE ALASKA NORTH SLOPE

The sections below outline the impacts of the MGS project (Case 2) and the CO-EOR project at Kuparuk (Case 3) to North Slope oil production for both a 30 year project and a 33 year project.

7.1.1 30 Year Project Impacts

Case 2 shows that initiation of the MGS project will lead to a significant reduction in oil production from the PBU. Total oil production for Case 2 is 825 MMbbl compared to 1,277 MMbbl for Case 1 (BAU), for a net loss of 452 MMbbl of oil due to the Alaska LNG Project.

However, utilizing the byproduct CO_2 as part of a carbon capture, utilization, and storage (CCUS) operation could offset the loss in oil production while also effectively managing the CO_2. The results of Case 3 show potential incremental oil production of 473 MMbbl, which provides a total oil production potential of 1,298 MMbbl for Case 3 compared to 1,277 MMbbl for Case 1.

The potential geologic storage of byproduct CO_2 was determined to be 3.62 Tcf for Case 3 (Exhibit 7-1). The geologic storage of the CO_2 by-product produced as part of Case 2 is further investigated in Alaska LNG Upstream Study Report 3: Storing By-Product CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit.

Exhibit 7-1. Comparison of oil production and CO_2 storage impacts (2029-2058)

Development Case	Oil Production (MMbbl)	KRU CO2 Storage (Tcf)	PBU CO2 Storage (Tcf)
Case 1 Business As Usual	1,277	NA	NA
Case 2 Reduced Gas Injection	825	NA	3.62
Loss Due to Alaska LNG	(452)	NA	NA
Gain from CO2 EOR at KRU	473	3.62	NA
Impact of Alaska LNG Project	1,298	3.62	3.62

7.1.2 33 Year Project Impacts

Over 33 years, the total oil production for Case 2 is 849 MMbbl compared to 1,355 MMbbl for Case 1 (BAU), for a net loss of 506 MMbbl of oil due to the Alaska LNG Project.

The results of Case 3 show potential incremental oil production of 512 MMbbl over 33 years, which provides a total oil production potential of 1,361 MMbbl for Case 3 compared to 1,361 MMbbl for Case 1.

The potential geologic storage of byproduct CO_2 over 33 years was determined to be 3.87 Tcf for Case 3 (Exhibit 7-1).

Exhibit 7-2. Comparison of oil production and CO_2 storage impacts (2029-2061)

Development Case	Oil Production (MMbbl)	KRU CO2 Storage (Tcf)	PBU CO2 Storage (Tcf)
Case 1 Business As Usual	1,355	NA	NA
Case 2 Reduced Gas Injection	849	NA	3.87
Loss Due to Alaska LNG	(506)	NA	NA
Gain from CO2 EOR at KRU	512	3.87	NA
Impact of Alaska LNG Project	1,361	3.87	3.87

7.2 FURTHER MODELING OF CO_2 STORAGE POTENTIAL USING CO_2 EOR

The Case 3 study for the KRU is one example of utilizing the byproduct CO_2 for CO_2 EOR and CO_2 storage on the Alaska North Slope. It is likely that CCUS is viable in other nearby oil fields, as well as the KRU. This study represents a “high-level” evaluation of CO_2 EOR potential, whereas operators will utilize more in-depth compositional modeling simulations to determine the potential for CO_2 storage and incremental oil production in this region.

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APPENDIX A

CASE 1 ANNUAL DATA

Exhibit A-1. Case 1 annual PBU oil production, gross gas production, gas consumption, gas reinjection, and gas-oil ratio (33 years)

		PBU Oil Production	Gross PBU Gas Production	PBU Gas Consumption	PBU Gas Reinjection	Gas-Oil Ratio
Year		(MMbbl)	(Tcf)	(Tcf)	(Tcf)	(Mcf/bbl)
1	2029	62.0	2.89	0.23	2.66	47
2	2030	60.2	2.87	0.22	2.64	48
3	2031	58.5	2.84	0.22	2.62	49
4	2032	56.9	2.82	0.22	2.60	50
5	2033	55.3	2.80	0.22	2.58	51
6	2034	53.7	2.78	0.22	2.56	52
7	2035	52.2	2.75	0.22	2.54	53
8	2036	50.8	2.73	0.21	2.52	54
9	2037	49.4	2.71	0.21	2.50	55
10	2038	48.0	2.69	0.21	2.48	56
11	2039	46.7	2.67	0.21	2.46	57
12	2040	45.4	2.64	0.21	2.44	58
13	2041	44.2	2.62	0.21	2.42	59
14	2042	43.0	2.60	0.20	2.40	61
15	2043	41.8	2.58	0.20	2.38	62
16	2044	40.7	2.56	0.20	2.36	63
17	2045	39.6	2.54	0.20	2.34	64
18	2046	38.5	2.52	0.20	2.32	65
19	2047	37.5	2.50	0.20	2.30	67
20	2048	36.5	2.48	0.19	2.28	68
21	2049	35.5	2.46	0.19	2.27	69
22	2050	34.5	2.44	0.19	2.25	71
23	2051	33.6	2.42	0.19	2.23	72
24	2052	32.7	2.40	0.19	2.21	73
25	2053	31.9	2.38	0.19	2.19	75
26	2054	31.0	2.36	0.18	2.18	76
27	2055	30.2	2.34	0.18	2.16	78
28	2056	29.4	2.32	0.18	2.14	79
29	2057	28.7	2.30	0.18	2.12	80
30	2058	27.9	2.28	0.18	2.11	82
31	2059	27.2	2.27	0.18	2.09	83
32	2060	26.5	2.25	0.18	2.07	85
33	2061	25.8	2.23	0.17	2.06	87
Total		**1,355.4**	**84.03**	**6.58**	**77.45**	**62**

CASE 2 ANNUAL DATA

Exhibit A-2. Case 2 annual PBU oil production, gross gas production, gas consumption, gas delivery to the GTP, gas reinjection, and gas-oil ratio (33 years)

		PBU Oil Production	Gross PBU Gas Production	PBU Gas Consumption	PBU Gas Delivery to GTP	PBU Gas Reinjection	Gas-Oil Ratio
Year		(MMbbl)	(Tcf)	(Tcf)	(Tcf)	(Tcf)	(Mcf/bbl)
1	2029	60.6	2.90	0.11	0.15	2.6	48
2	2030	56.9	2.85	0.11	0.38	2.4	50
3	2031	53.3	2.81	0.11	0.69	2.0	53
4	2032	50.0	2.74	0.11	0.84	1.8	55
5	2033	46.9	2.63	0.11	0.91	1.6	56
6	2034	44.1	2.52	0.11	0.91	1.5	57
7	2035	41.2	2.42	0.11	0.91	1.4	59
8	2036	38.6	2.31	0.11	0.91	1.3	60
9	2037	36.1	2.21	0.11	0.91	1.2	61
10	2038	33.8	2.10	0.11	0.91	1.1	62
11	2039	31.6	2.00	0.07	0.91	1.0	63
12	2040	29.6	1.89	0.07	0.91	0.9	64
13	2041	27.7	1.79	0.07	0.91	0.8	65
14	2042	25.9	1.69	0.07	0.91	0.7	65
15	2043	24.3	1.59	0.07	0.91	0.6	65
16	2044	22.7	1.49	0.07	0.91	0.5	65
17	2045	21.3	1.38	0.07	0.91	0.4	65
18	2046	19.9	1.28	0.07	0.91	0.3	64
19	2047	18.7	1.18	0.07	0.91	0.2	63
20	2048	17.5	1.08	0.07	0.91	0.1	62
21	2049	16.4	0.98	0.06	0.91	0.0	60
22	2050	15.4	0.97	0.06	0.91	-	63
23	2051	14.4	0.97	0.06	0.91	-	68
24	2052	13.5	0.97	0.06	0.91	-	72
25	2053	12.7	0.97	0.06	0.91	-	77
26	2054	11.9	0.97	0.06	0.91	-	82
27	2055	11.1	0.97	0.06	0.91	-	88
28	2056	10.4	0.97	0.06	0.91	-	93
29	2057	9.8	0.97	0.06	0.91	-	100
30	2058	9.2	0.87	0.06	0.82	-	95
31	2059	8.53	0.70	0.04	0.65	-	82
32	2060	7.9	0.56	0.04	0.52	-	71
33	2061	7.27	0.45	0.03	0.42	-	61
Total		**848.8**	**52.22**	**2.58**	**27.30**	**22.34**	**62**

CASE 3 ANNUAL DATA

Exhibit A-3. Case 3 annual KRU oil production, CO_2 injection, CO_2 production, and CO_2 storage (33 years)

		Oil Production	CO_2 Injection	CO_2 Production	CO_2 Storage
Year		(MMbbl)	(Bcf)	(Bcf)	(Bcf)
1	2029	0.5	21.7	0.3	21.4
2	2030	3.1	69.3	5.4	63.9
3	2031	7.4	122.7	19.2	103.5
4	2032	11.9	167.5	40.1	127.3
5	2033	15.0	191.8	63.7	128.2
6	2034	16.3	212.7	84.3	128.3
7	2035	16.9	228.4	100.9	127.5
8	2036	17.2	240.8	113.7	127.2
9	2037	17.5	252.4	124.3	128.0
10	2038	17.9	261.9	134.7	127.2
11	2039	18.0	272.7	145.1	127.6
12	2040	18.1	282.3	155.3	127.0
13	2041	18.0	292.1	164.9	127.2
14	2042	17.9	301.3	174.0	127.3
15	2043	17.9	310.0	182.4	127.7
16	2044	17.9	318.1	190.3	127.8
17	2045	17.9	325.7	197.9	127.8
18	2046	18.0	333.8	205.6	128.2
19	2047	18.0	340.6	213.3	127.3
20	2048	17.9	348.2	220.9	127.3
21	2049	17.8	356.1	228.5	127.6
22	2050	17.7	364.1	235.9	128.2
23	2051	17.7	370.8	243.3	127.6
24	2052	17.4	372.6	245.1	127.4
25	2053	17.0	367.8	239.7	128.1
26	2054	16.8	359.3	232.0	127.3
27	2055	16.6	354.5	226.5	128.0
28	2056	16.6	350.1	221.7	128.4
29	2057	16.5	339.4	211.4	128.0
30	2058	15.9	307.8	198.8	109.0
31	2059	14.2	278.8	184.8	94.0
32	2060	12.8	257.2	174.1	83.1
33	2061	11.4	238.9	164.4	74.5
Total		**511.7**	**9,211.3**	**5,342.5**	**3,868.8**

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B.3 PRODUCTION REPORT 3: ALASKA LNG UPSTREAM STUDY REPORT 3: STORING BYPRODUCT CO_2 FROM THE ALASKA LNG GAS TREATMENT PLANT AT THE PRUDHOE BAY UNIT (APRIL 5, 2022)

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Alaska LNG Upstream Study Report 3: Storing Byproduct CO_2 from the Alaska LNG

April 5, 2022

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Vello Kuuskraa[1]
Matt Wallace[1]
Donald Remson[2*]

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Tim Skone[2]
Alana Sheriff[3]
Srijana Rai[3]
Timothy R. Carr, PhD[4]

[1] Advanced Resources International
[2] National Energy Technology Laboratory (NETL)
[3] NETL support contractor
[4] Independent Reviewer, West Virginia University
*Corresponding contact: Donald Remson@netl.doe.gov, 412.386.5379

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ACRONYMS AND ABBREVIATIONS

AGDC	Alaska Gasline Development Corporation
AOGCC	Alaska Oil and Gas Conservation Commission
B, bbl	Barrel
Bcf	Billion cubic feet
CO_2	Carbon dioxide
cp	Centipoise
cu ft	cubic foot
EOR	Enhanced Oil Recovery
ft	Foot
GTP	Gas Treatment Plant
In	Inches
Lb, lbs	pound(s)
LNG	Liquified Natural Gas
mD	Millidarcy
Mcf	Thousand cubic feet
MM	Million
MMcf	Million cubic feet
MMcfd	Million cubic feet per day
MMmt	million metric tons
NETL	National Energy Technology Laboratory
NGL	Natural gas liquid
PBU	Prudhoe Bay Unit
POP	Prudhoe Oil Pool
ppm	Parts per million
psi	Pounds per square inch
PTU	Point Thomson Unit
Sq mi	square mile
U.S.	United States
USGS	United States Geological Survey
°API	Degrees API (American Petroleum Institute)
°F	Degrees Fahrenheit

1 BACKGROUND

The natural gas resources in the Prudhoe Bay Unit (PBU) and the Point Thomson Unit (PTU), the two sources of natural supplies for the Alaska LNG Project, contain notable volumes of carbon dioxide (CO_2). These volumes of CO_2 are planned to be removed from the natural gas production stream by a newly constructed Gas Treatment Plant (GTP) to meet pipeline specifications before entering the 800-mile Mainline Pipeline connecting the sources of natural gas supplies on the North Slope with the liquified natural gas (LNG) export facility at Nikiski on the Kenai Peninsula (Exhibit 1-1). [1]

Exhibit 1-1: Alaska LNG Pipeline route from Prudhoe Bay to Nikiski

Used with permission from Alaska Gasline Development Corporation (AGDC), 2022 [1]

The volume of byproduct CO_2 projected to be separated by the GTP Facility from the gross natural gas production stream from PBU and PTU is estimated at 350 million cubic feet per day (MMcfd). This volume of CO_2 would need to be placed into a deep underground storage setting to reduce the greenhouse gas emissions impact of the Alaska LNG Project.

2 PURPOSE OF REPORT

This report is the third in a series of three reports assessing the energy and infrastructure resources available to support the development of the Alaska LNG Project. Together these three reports comprise the "Upstream Study" of oil and natural gas resources and CO_2 utilization and storage potential at the PBU and surrounding areas.

The purpose of this report, "Storing Byproduct CO_2 from the Alaska LNG Gas Treatment Plant at the Prudhoe Bay Unit", is to identify and assess the viability of storing byproduct CO_2 from the GTP Facility in a deep saline reservoir at the PBU.

The first of the three Upstream Study reports "Establishing the Sources of Natural Gas Supply for the Alaska LNG Project" is to evaluate the capacity of natural gas supply from the PBU and the PTU on the North Slope of Alaska to support the Alaska LNG Project for a 30-year period.

The second of the three Upstream Study reports "Impacts of PBU Major Gas Sales on Oil Production and CO_2 Storage Potential" examines the impacts of the Alaska LNG Project on oil production at the PBU, and discusses options for utilizing the byproduct CO_2 stream from the Alaska LNG GTP as part of CO_2 enhanced oil recovery (EOR) operations on the North Slope.

3 STUDY METHODOLOGY

Only a limited amount of rigorous geologic and reservoir information exists in the published technical literature on the viability of storing CO_2 in deep saline formations on the North Slope of Alaska. Fortunately, some fundamental geological information has been published in the technical literature following past oil and gas exploration and resource studies. [2][3][4][5] In addition, the US Geological Survey (USGS) has conducted a geologic framework study that identified and characterized, at a regional level, some of the geologic formations that could provide carbon dioxide storage options in Alaska. [6]

To develop more site-specific information on alternative underground storage options for the byproduct CO_2 from the GTP Facility associated with the proposed Alaska LNG Project, the study obtained and analyzed a series of deep well logs at the PBU. These included well logs from the PBU Western Satellite oil fields and from the Prudhoe Oil Pool (POP). Based on these log analyses, the Staines Tongue of the Sagavanirktok Formation at the POP emerged as the preferred saline formation option for storing CO_2.

To further define and quantify this CO_2 storage option, the study constructed a regional geological cross-section across the PBU for the Staines Tongue of the Sagavanirktok Formation and its overlying reservoir seal, the Mikkelsen Tongue of the Canning Formation.

Based on the geological cross-section and other information, the potential CO_2 storage site was located near the existing PBU gas processing plant. The geological model for the Staines Tongue interval at the potential CO_2 storage site was populated with key geological and reservoir properties from analyzed well logs and from other sources. Using this data, a static CO_2 storage capacity estimate was then prepared for the potential storage site.

Next, a more detailed geologic and reservoir model (sector model) was constructed and populated for the potential storage site. This sector model was placed into a full-scale reservoir simulator (GEM) to assess CO_2 injectivity per well, to establish dynamic CO_2 storage capacity, and to establish the areal extent of the CO_2 plume. This enabled the study to estimate the size of the CO_2 storage site, the number of CO_2 storage wells that would need to be drilled, and the spatial location of these CO_2 injection wells.

The sector model also enabled the study to assess the viability of the Staines Tongue saline formation at the PBU to serve as a long-term option for storing about 6.2 million metric tons of CO_2 per year for thirty years.

The construction of the geologic model and the results of the reservoir simulation performed by the study for storing CO_2 in the saline waters of the Staines Tongue of the Sagavanirktok Formation at the PBU are discussed in the following sections of the report.

4 THE PRUDHOE BAY OIL FIELD

4.1 PRUDHOE BAY FIELD

The Prudhoe Bay oil field, also called the Prudhoe Bay Unit (PBU), covers an area of about 213,000 acres on the North Slope of Alaska along the coastline of the Beaufort Sea (Exhibit 4-1). [7] The PBU contains the POP and a series of Satellite oil fields, such as Aurora, Borealis, Midnight Sun, Lisburne, and Point McIntyre, among others. These Satellite oil fields are located within the boundaries of the PBU and are being developed using PBU production and processing facilities.

Exhibit 4-1: Prudhoe Bay oil field location map

North Slope, Alaska

Used with permission from Alaska Oil and Gas Conservation Commission (AOGCC) [6]

4.2 PRUDHOE OIL POOL

The POP contains three deep Permian/Triassic-age sandstone formations—Sag River, Shublik, and Ivishak. The Ivishak, also called the Sadlerochit, is the major producing formation, as shown on the Generalized North Slope Stratigraphic Column (Exhibit 4-2). [7]

Exhibit 4-2: Generalized North Slope stratigraphic column displaying oil and gas reservoirs and associated accumulations

Used with permission from AOGCC, 2021 [7]

The favorable productivity of the reservoirs in the POP, with high initial flows of oil and associated natural gas, is supported by a thick oil column of nearly 500 ft., high permeability that averages nearly 300 millidarcy (mD), strong initial reservoir pressure of 4,335 pounds per square inch (psi), and a low oil viscosity of 0.8 centipoise (cp).

A type-log for the POP, the ARCO Prudhoe Bay State No.1 well, the field discovery well, is shown on Exhibit 4-3. [7]

The primary oil recovery mechanisms at the POP include gravity drainage (below the large gas cap), solution-gas drive, and a weak water drive. These primary oil recovery mechanisms have been augmented with reinjection of the produced associated natural gas to maintain reservoir pressure and to recover a portion of the residual oil in the gas cap. In addition, water is being injected along the periphery of the oil field for secondary recovery of oil and associated natural gas.

Exhibit 4-3: Type-log for the POP, the ARCO Prudhoe Bay State No.1 well

Used with permission from AOGCC, 2021 [7]

4.3 FIELD DEVELOPMENT

Oil development at the POP involves large-scale production of associated natural gas that contains CO_2. The associated gas produced at the POP is processed for extraction of natural gas liquids (NGLs), and is used for fuel for operations and for local gas sales. The bulk of the produced associated natural gas, approximately 7.68 billion cubic feet per day including its CO_2 content, is reinjected into the gas cap for enhancing oil recovery with gravity drainage. [8] Currently, the field has more than 800 active oil-producing wells along with about 220 gas, water, and miscible gas injection wells. These wells have been drilled and produce from a series of central drill sites (Exhibit 4-4). [7]

Exhibit 4-4: Prudhoe Bay Unit Prudhoe Oil Pool location map

Used with permission from AOGCC, 2021 [7]

5 GEOLOGIC SETTING FOR STORING CO_2 AT THE PBU

5.1 STAINES TONGUE CO_2 STORAGE HORIZON

The primary geologic horizon identified by this study for storing the byproduct CO_2 from the GTP Facility is the Tertiary-age Sagavanirktok Formation within the Brookian Sequence and its Staines Tongue and Mikkelsen Tongue members (Exhibit 5-1). [6]

A more detailed look at the proposed storage horizon, the Staines Tongue interval, and the overlying Mikkelsen Tongue interval that would serve as the reservoir seal, is shown on Exhibit 5-2. [4]

The Staines Tongue of the Sagavanirktok Formation overlies the Prince Creek Formation and underlies the Mikkelsen Tongue of the Canning Formation. The Staines Tongue contains sediments that were deposited on a marine shelf in associated deltaic and fluvial environments. [2] The overlying Mikkelsen Tongue is a major transgressive deposit consisting of a massive shale section and minor sandstone units that serves as the regional seal for the Staines Tongue saline reservoir. [9]

Exhibit 5-1: Generalized stratigraphic column of geologic units of the Alaska North Slope

Used with permission from USGS, 2012 [6]

Exhibit 5-2: Wireline Log Mobil West Kadleroshilik Unit #1 Well

Used with permission from USGS/ADNR, 2003 [4]

5.2 AREAL EXTENT OF STAINES TONGUE CO_2 STORAGE HORIZON

The areal extent of the Staines Tongue interval at the Prudhoe Bay Unit was defined by the USGS (Exhibit 5-3). [6] An overburden contour map establishing the depth of the Staines Tongue interval was also generated from a borehole-penetrations database of the Brookian sequence. [6]

Exhibit 5-3: Areal extent of the Staines Tongue assessment unit in the Alaska North Slope study area

Used with permission from USGS, 2012 [6]

6 CHARACTERIZING THE STAINES TONGUE SALINE FORMATION

6.1 BACKGROUND

Only limited, regional level information on the geologic setting and reservoir properties exists for the Staines Tongue of the Sagavanirktok Formation in the technical literature, as discussed above.

As such, the study obtained a series of well logs within and beyond the PBU area. These well logs were analyzed to develop more site-specific information for the Staines Tongue at the PBU, including information on its depth, gross and net pay, porosity, and other reservoir properties.

These data were used to assess the potential CO_2 storage capacity offered by the Staines Tongue saline formation. The log analysis also included defining and characterizing the important reservoir seal, the overlying Mikkelsen Tongue of the Canning Formation.

6.2 REGIONAL CROSS-SECTION

A three well regional cross-section was constructed to identify the depth and areal extent of the Staines Tongue saline reservoir at the PBU. The three wells used for the cross-section included:

- The PBU 18-1 well in the center of the PBU,
- The GWYDYR State 1 well on the northwestern border of the PBU, and
- The Kadler State 15-09-16 well on the southeastern border of the PBU.

The Kadler State 15-09-16 well ties to the major regional east to west cross-section prepared for the Brookian Sequence of the Alaska Norths Slope by Decker (Exhibit 6-1). [2]

Exhibit 6-1: Staines Tongue cross-section map

Modified with permission from Decker, 2010 [2] by Advanced Resources International

The three well cross-section bisects the eastern portion of the PBU and covers a total of 27 miles. The distance from the GWYDYR State 1 well to the PBU 18-1 well is 12 miles, and the distance from the PBU 18-1 well to the Kadler State 15-09-16 well is 15 miles (Exhibit 6-2).

Exhibit 6-2: Staines Tongue cross-section map

The well logs and the cross-section confirm the presence of the Staines Tongue saline reservoir at the PBU. The top of the Staines Tongue reservoir exists between 4,200 ft and 4,800 ft for the area covered by the GWYDYR State 1, PBU 18-1, and Kadler State 15-09-16 wells. This provides a favorable depth with sufficient pressure for storing CO_2 in a dense phase (Exhibit 6-3).

Exhibit 6-3: Staines Tongue well log cross-section

6.3 STAINES TONGUE WELL LOG ANALYSIS

The PBU 18-1 well log was used as the type well to determine the Staines Tongue reservoir characteristics for the CO_2 storage area (Exhibit 6-4).

Exhibit 6-4: PBU 18-1 well log

The Staines Tongue reservoir consists of interbedded sandstone and mud/siltstone. Analysis of the gamma ray log data using pay cut-off values above 60° API were used to determine the gross and net pay of the Staines Tongue reservoir. The gamma ray log showed the top of the Staines Tongue at approximately 4,590 ft and the bottom of the formation at 6,035 ft for a gross interval of 1,445 ft. The net pay was determined by combining continuous sandstone intervals of at least 20 ft or greater within this interval. The total net pay for the Staines Tongue was calculated to be 660 ft.

The PBU 18-1 log also shows a gross interval of 1,250 ft for the Mikkelsen Tongue between 3,340 and 4,590 ft above the Staines Tongue. More detailed log analysis established a minimum net shale thickness between 500 and 900 feet for this area, which provides a significant seal overlying the CO_2 storage formation

This CO_2 storage study focused on the bottom portion of the Staines Tongue interval that contained a series of thick sandstone units. This provided a net pay of 295 ft between 5,540 and 5,990 ft of depth. The selection of this net pay offered a relatively compact interval for well perforations and subsequent CO_2 injection (Exhibit 6-5).

Exhibit 6-5: PBU 18-1 Staines Tongue CO_2 storage interval

Porosity values were determined by taking an average of the density and neutron porosity curves in the sandstone units. The porosity log analysis showed an average porosity of 34 percent for the net pay portion of the Staines Tongue reservoir.

7 CO_2 STORAGE POTENTIAL IN THE STAINES TONGUE FORMATION

7.1 STORAGE DESIGN AND LOCATION

A potential CO_2 storage area is located adjacent to the existing PBU gas processing plant and is near the future site of the proposed GTP Facility. This location would reduce the need for new pipeline construction and infrastructure for the CO_2 storage operation (Exhibit 7-1).

Exhibit 7-1: Staines Tongue CO_2 storage project location

Modified with permission from AGDC, 2017 [10] and AOGCC, 2021 [7] by Advanced Resources international

To evaluate the Staines Tongue CO_2 storage site, a design of seven patterns that encompass six square miles each (a total of six sections) for a total storage area of 42 square miles was considered. This includes location of a CO_2 injection well at the center of each pattern. Each well would inject up to 50 million cubic feet of CO_2 per day, for a combined total daily injection volume of 350 MMcfd. This volume matches the estimated volume of byproduct CO_2 that will be produced by the Alaska LNG GTP Facility.

The study assumed the seven CO_2 injection wells will be drilled from the existing Drill Site 18. Laterally drilled injection wells #1 and #7 would extend up to 2.5 miles from Drill Site 18. CO_2 captured from the GTP would first be sent to the existing Central Gas Facility (CGF) via pipeline.

From there a 3-mile CO_2 delivery pipeline would deliver CO_2 to the CO_2 injection wells at Drill Site 18 (Exhibit 7-2).

Exhibit 7-2: Staines Tongue CO_2 storage project field design

Modified with permission from AOGCC, 2021 [7] by Advanced Resources International

7.2 INJECTIVITY CALCULATION

The injectivity rate for the Staines Tongue formation was calculated to establish the number of CO_2 injection wells required for the CO_2 storage project.

The following equation was used to estimate the rate of water injection per well into the Staines Tongue reservoir, where q is the water injection rate per well:

$$q = 3.541 * \ kh\Delta P \ / \ \mu[\ln\left(\frac{a}{r_w}\right) - 0.619].$$

Where:

- k is the average permeability (150 md),
- h is the average net pay of the reservoir (295 ft),
- ΔP is the difference between the estimated maximum allowable injection pressure (3,700 psi -- equal to mid-depth * 0.65 psi/ft) and the hydrostatic reservoir pressure (equal to 2,410 psi),
- μ is the reservoir water viscosity (0.46 cp),
- a is the distance between the injection well and production well (3,840 ft), and
- r_w is injection wellbore radius (2.4 in, or 0.2 ft).

The equation calculated an injection rate of approximately 18,900 barrels of water per day.

To estimate the equivalent CO_2 injection rate a conversion factor of 2.65 mcf/bbl was used based on the reservoir temperature and pressure. This provided a CO_2 injection rate of approximately 50 million cubic feet of CO_2 per day.

7.3 STATIC STORAGE CAPACITY CALCULATION

A static CO_2 storage capacity model was used to estimate the volume of CO_2 that could be stored in the Staines Tongue formation at the PBU.

The static storage capacity model was populated with reservoir properties for one section (one square mile) of the Staines Tongue formation. These properties included a net pay of 295 ft, a porosity of 34 percent, and a storage efficiency of 14 percent. The CO_2 density of 42 lbs/cu ft was calculated based on a reservoir pressure of 2,844 psi and a reservoir temperature of 145°F. Using this data, the static storage capacity model calculated that one section of the Staines Tongue formation could store 7.7 million metric tons (MMmt) of CO_2 (Exhibit 7-3).

Exhibit 7-3: Staines Tongue static CO_2 storage calculation

1 Section (MM sq ft)	27.9
Net Pay (ft)	295
Porosity (%)	34
Res. Capactiy (MM cu ft)	2,798
Storage Efficiency (%)	14
Storage Capacity (MM cu ft)	392
CO2 Density (lb/cu ft)	43.4
CO2 Storage Vol. (MM lbs)	17000
CO2 Storage Vol. (MM mt)	7.7
Field Area (sq mi)	42
Total CO2 Storage Vol. (MM mt)	325

Based on the static storage capacity model, the study established a CO_2 storage field area of 42 square miles that would have a total CO_2 storage volume of 325 million metric tons. As such, this storage site would provide approximately 75 percent more CO_2 storage capacity than the 190 MMmt of byproduct CO_2 that will need to be stored by the Alaska LNG Project.

8 DYNAMIC STAINES TONGUE STORAGE CAPACITY MODEL

8.1 BACKGROUND

The "static CO_2 storage capacity model" for the Staines Tongue, discussed above, provides an initial estimate for the extent of the CO_2 plume, the area required for storing CO_2, and other information for designing the CO_2 storage facility. However, a "dynamic CO_2 storage capacity model" is needed for establishing more rigorous values for the required storage area, for understanding the evolution of the CO_2 plume with time, and for making a more rigorous estimate for the number of CO_2 injection wells required for disposing the byproduct CO_2 from the GTP Facility associated with the Alaska LNG Project.

This section of the report discusses the construction of the "dynamic CO_2 storage capacity model" and its application at the Staines Tongue CO_2 storage site at the PBU.

8.2 SECTOR MODEL DESIGN

The first step for establishing dynamic CO_2 storage capacity for the Staines Tongue storage site at the PBU was to characterize and model one representative sector (type area) of the storage site. As such, a sector model was constructed to represent one of the seven CO_2 storage patterns. The sector model encompasses an area of 6 square miles and a gross vertical interval of 450 ft (see Exhibit 7-3). The three-dimensional model included 7,326 individual reservoir blocks (18 x 37 x 11). The storage reservoir in the sector model was placed at a depth between 5,550 ft and 6,000 ft and the reservoir horizon was assumed to be flat (Exhibit 8-1).

8.3 SECTOR MODEL REPRESENTATION OF THE STAINES TONGUE CO_2 STORAGE RESERVOIR

The vertical interval of 450 ft in the sector model was divided into nine different layers, five sandstone storage layers totaling 295 feet alternated with four shale layers totaling 155 feet (Exhibit 8-2). This sector model design enabled the Staines Tongue CO_2 storage site to properly capture the benefits of "reservoir architecture" that would limit the vertical override of the CO_2 as it flowed through the storage reservoir.

Exhibit 8-1: Staines Tongue sector model dimensions and reservoir depth

Exhibit 8-2: Staines Tongue sector model layers

Reservoir Layer	Lithology	Pay
1	Sandstone	70
2	Shale	40
3	Sandstone	25
4	Shale	20
5	Sandstone	40
6	Shale	35
7	Sandstone	35
8	Shale	60
9	Sandstone	125
	Total Sandstone Pay	**295**
	Total Shale Pay	**155**
	Total	**450**

The sector model assumed a porosity of 34 percent and an average permeability of 150 mD for each block in the sandstone layers, and a porosity of 5 percent and an average permeability of

50e-5 mD for each block in the shale layers. The vertical to horizontal permeability ratio was assumed to be 0.1 (Exhibit 8-3).

Exhibit 8-3: Staines Tongue sector model porosity and permeability

8.4 GEM CO_2 INJECTION SIMULATION

The Computer Modeling Group's GEM compositional simulator was used to run the Staines Tongue sector model. The initial conditions of the sector model assumed for the GEM simulator were:

- Initial reservoir pressure gradient of 0.435 psi/ft,
- Initial reservoir temperature of 145°F,
- Reservoir water salinity of 12,000 parts per million (ppm), and
- Rock compressibility of 2.9e-6 psi^{-1}.

The sector model was designed to inject a maximum of 50 million cubic feet of CO_2 per day per injection well with a maximum bottom-hole pressure limit in the model of 3,900 psi. The sector model assumed 30 years of continuous CO_2 injection.

The sector model represented an interior type-pattern of the Staines Tongue CO_2 storage field at the PBU. Pressure boundaries were established on the northern and southern portions of the type-pattern to represent pressure confinement barriers from the adjoining patterns. The

eastern and western boundaries of the sector model were open to allow the injection pressure and the CO_2 plume in the sector model to be unconfined in these two directions.

8.4.1 GEM Model Relative Permeability

The relative permeability curves used for the GEM model were based on history-matched CO_2 injection pressure and breakthrough response data for the Paluxy saline formation in Alabama. These curves were then adjusted for the higher porosity values seen in Staines Tongue formation.

Based on literature research regarding drainage and imbibition CO_2/brine relative permeability curves, the maximum relative permeability to gas was set to 0.65. Sequestration through relative permeability hysteresis was modeled with a maximum residual gas saturation of 0.3. The irreducible water saturation in the reservoir was set to 0.25, a typical value for sandstone (Exhibit 8-4).

Exhibit 8-4: GEM model relative permeability curves

9 STAINES TONGUE GEM MODEL RESULTS

9.1 CO_2 INJECTION PROFILE

The results of incorporating the Staines Tongue CO_2 storage sector model into the GEM reservoir simulator showed that the CO_2 injection well in the Staines Tongue saline formation is able to inject 50 MMcfd for 30 years without reaching the 3,900-psi bottom-hole pressure limitation.

The Gem reservoir simulation also showed that a single interior pattern in the sector model is able to accommodate cumulative CO_2 injection over 30 years of 548 billion cubic feet (Bcf) (29 MMmt).

9.2 AREAL EXTENT OF THE CO_2 PLUME

The results of the GEM sector model show that CO_2 concentration is highest near the injection well for each of the five net-pay intervals after 30 years of injection. CO_2 saturation approaches 70 percent at the center of the CO_2 plume and decreases to between 10 percent and 40 percent around the edges of the CO_2 plume.

After 30 years of injection, the CO_2 plume covers an area of 1.8 square miles in the top layer of the Staines Tongue formation (Exhibit 9-1). This is the maximum areal extent of the CO_2 plume after 30 years of injection.

The sector model also shows that at the end of CO_2 injection, about 14 percent of the injected CO_2 is dissolved in the formation water and about 11 percent of the injected CO_2 is trapped in the pore space. The remainder of the injected CO_2 is trapped by buoyancy in five distinct reservoir layers (Exhibit 9-2).

Exhibit 9-1: GEM model 30-Year CO_2 plume extent

Exhibit 9-2: GEM model 30-Year CO_2 plume extent by reservoir layer

10 CO_2 STORAGE STUDY CONCLUSIONS

10.1 VIABILITY OF STAINES TONGUE FORMATION CO_2 STORAGE

The export of natural gas for the Alaska LNG project will generate a considerable volume of byproduct CO_2 that must be managed effectively over the 30-year life of the project. This report addresses the option of using a deep saline reservoir at the PBU for storing the byproduct CO_2 from the GTP Facility associated with the Alaska LNG Project.

Evaluation of well logs by this study identified the Staines Tongue reservoir at the PBU as a viable option for CO_2 storage. The reservoir has significant pay zones for CO_2 injection with favorable porosity and permeability characteristics. Log analysis for this study also showed that the Mikkelson Tongue overlying the Staines Tongue reservoir would provide a favorable seal for the CO_2 injected into the Staines Tongue saline reservoir.

A geologic model was built and populated using detailed well log analysis and reservoir characterization of the Staines Tongue formation at the PBU. The geologic model was then placed into the GEM reservoir simulator to establish the “dynamic storage capacity“ of the Staines Tongue saline formation. This work showed that it is technically viable to store 350 MMcfd of byproduct CO_2 from the GTP Facility within the Staines Tongue CO_2 storage site at the PBU.

The results of the GEM model showed the CO_2 plume is well contained within the 42 square mile project area after 30 years of injection. Once the injection wells are shut-in the pressure in the saline formation would decline and the CO_2 concentration within the CO_2 plume would reach equilibrium.

Importantly, the study shows that the storage of byproduct CO_2 from the Alaska LNG Project in the saline formations below the PBU is technically feasible.

This option of storing CO_2 within the Staines Tongue saline formation underlying the PBU is one of several options for managing the byproduct CO_2 that would result from the sale of natural gas from PBU and PTU for the Alaska LNG Project. The final selection of CO_2 storage and

management options will be made by the operators of the PBU and PTU and the Alaska LNG Project.

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Supplemental Environmental Impact Statement

APPENDIX C
LIFE CYCLE ANALYSIS STUDY

Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project

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APPENDIX C LIFE CYCLE GREENHOUSE GAS EMISSIONS FROM THE ALASKA LNG PROJECT (MAY 27, 2022)

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APPENDIX C LIFE CYCLE GREENHOUSE GAS EMISSIONS FROM THE ALASKA LNG PROJECT (MAY 27, 2022)

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Life Cycle Greenhouse Gas Emissions from the Alaska LNG Project

May 27, 2022
DOE/NETL-2022/3791

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Author(s)

Timothy J. Skone, P.E.[2], Mackenzie R. Pias[1], Harshvardhan Khutal[1], Matthew B. Jamieson[2], Srijana Rai[1], Krista Kirchner-Ortiz[1], H. Scott Matthews[1], Gabrielle Yanai[1], Katherine Mumm[1], Michelle M. Krynock[2], and Donald Remson[2]

[1] National Energy Technology Laboratory (NETL) support contractor
[2] NETL
*Corresponding contact: Timothy.Skone@netl.doe.gov, 412.386.4495

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ACRONYMS AND ABBREVIATIONS

AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
BAU	Business-as-usual
Bbl	Barrel
Bcf	Billion cubic feet
Bcfd	Billion cubic feet per day
CELiC	Carbon Dioxide Enhance Oil Recovery Life Cycle
cf	Cubic feet
cfd	Cubic feet per day
CCS	Carbon capture and sequestration
CCUS	Carbon Capture, Utilization, and Storage
CH_4	Methane
CO_2	Carbon dioxide
d, D	Day
DAC	Direct air capture
EIA	Energy Information Administration
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
ft	Foot
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Reporting Program
GOR	Gas-to-Oil Ratio
GTP	Gas Treatment Plant
GWP	Global Warming Potential
H_2S	Hydrogen sulfide
hp	Horsepower
IPCC	Intergovernmental Panel on Climate Change
LCA	Life cycle analysis
LNG	Liquified Natural Gas
m	Meter
M	Thousand
Mbbl	Thousand barrels
MMbbl	Million barrels
Mcf	Thousand cubic feet
Mcfd	Thousand cubic feet per day
MM	Million
Mmt	Million metric tons
MMcfd	Million Cubic Feet per Day
MW, MWe	Megawatt electric
N_2O	Nitrous Oxide (Dinitrogen Monoxide)
n/a	Not available/applicable
NETL	National Energy Technology Laboratory
NG	Natural Gas
NGCC	Natural gas combined cycle
OPGEE 2.0	Oil Production Greenhouse gas Emissions Estimator 2.0
PBTL	Prudhoe Bay Transmission Line
PBU	Prudhoe Bay Unit
POP	Prudhoe Oil Pool
ppm	Parts per million
psi	Pounds per square inch
psig	Pound per square inch gauge
PTTL	Point Thomson Transmission Line
PTU	Point Thomson Unit
scf	Standard cubic feet
SF_6	Sulfur Hexafluoride
TAPS	Trans Alaska Pipeline System
Tcf	Trillion cubic feet
TPES	Total primary energy supply
tonne	Metric ton (1,000 kg)
US	United States

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1 INTRODUCTION

The goal of the Alaska Liquefied Natural Gas (LNG) project is to export up to 2.55 billion cubic feet per day (Bcfd) of LNG over a period of more than 30 years from the North Slope of Alaska. The majority of this gas (75%) is expected to be sourced from the Prudhoe Bay Unit (PBU), which consists of the Prudhoe Bay Oil Pool (POP) and its satellite fields. The remaining 25% of gas is expected to come from the Point Thomson Unit (PTU).

Current operations in the PBU have primarily been focused on oil production. The associated natural gas produced from this region has been reinjected to maintain reservoir pressure to increase oil productivity. With the proposed LNG project this associated gas will be diverted for sales in international markets (modeled as Asian markets within this report) rather than reinjected on site, thus decreasing the oil production over time.

To produce 2.55 Bcfd of gas, the Alaska LNG project requires the construction of a gas treatment plant (GTP) near PBU. The GTP is projected to produce a by-product of approximately 350 million cubic feet of carbon dioxide (CO_2) per day. An approximately 800-mile-long pipeline is also necessary to transport the processed gas from the GTP to a liquefaction facility.

The Alaska LNG Upstream Study is a series of three reports (Kuuskraa, et al., 2022a) (Wallace, et al., 2022) (Kuuskraa, et al., 2022b) that defines a business-as-usual (BAU) scenario of no action and two proposed scenarios for LNG export. In this document this series of reports will be referred to as the Upstream Study. The purpose of this life cycle assessment (LCA) is to quantify the life cycle greenhouse gas (GHG) emissions associated with the Alaska LNG project across the BAU and two proposed scenarios. The first of the two proposed scenarios sequesters CO_2 from the GTP in a reservoir, and the other uses it for enhanced oil recovery (EOR) in the Kuparuk River Unit (KRU) oil field on the North Slope of Alaska.

For each of the proposed scenarios in the Upstream Study, this study evaluates the life cycle global warming potential (GWP) of delivering LNG from Alaska to four destination countries: Japan, South Korea, China, and India. Results from this study are presented on both a multiproduct and single-product functional unit basis. The functional unit for the multiproduct basis is 1 MWh of electricity generated at a power plant in the respective LNG receiving country plus a standard amount of crude oil delivered and consumed in the Lower 48 United States. This amount of crude oil is set by the amount that is produced in Scenario 3 for each country and matched by the first two scenarios using an LCA technique known as system expansion which seeks to create equivalent analysis scenarios. The functional unit for the single-product system is 1 MWh of electricity generated at the power plant in the respective LNG receiving country. This study also considers GWP effects of generating the electricity with and without use of carbon capture and sequestration.

Additionally, this study produces speciated results that break down the life cycle GHG emissions for Scenario 3 into individual emission sources. Supplementary results estimate a time series

GHG emissions inventory from the implementation of this project in the year 2029 to the end of this project in 2061. The inventory is based on the production flow volumes for all co-products (Kuuskraa, et al., 2022a). A final set of results included in this study contain cumulative emission profiles that estimate emissions for each scenario over the entire timespan of the project. The Alaska LNG project is expected to produce the equivalent of 30 years of gas at 2.55 Bcfd. This study analyzes a 33-year timespan of the project in which it produces this 30-year equivalent amount of gas. For the purpose of the cumulative emissions profile, construction-related emissions are levelized across the study period.

In the following sections, this report defines the scenarios, data sources, and modeling approach for the LCA, and discusses results and findings from the study.

2 Scenario Descriptions and Qualitative Discussion

The Upstream Study considers three scenarios including BAU (1) and the two proposed scenarios (2 and 3), which are evaluated by this LCA to quantify their respective life cycle GHG emissions. **Sections 2.1**, **2.2**, and **2.3** describe the three scenarios in more detail. To aid in explanation, they are described in reverse order. **Sections 2.4** and **2.5** contain oil and gas production data, as well as the functional equivalency method used throughout this study (Kuuskraa, et al., 2022a), and **Section 2.6** describes sub-scenarios within Scenarios 2 and 3. **Section 2.7** provides a qualitative discussion related to the study.

2.1 Scenario 3: Use and Storage of By-Product CO_2

Scenario 3 serves as the foundation for this LCA study. It assesses the changes that occur when associated gas from oil production is used for sales. Although some gas is still reinjected in this scenario for the first 20 years of the project, most gas is produced and sold, leading to a decline in reservoir pressure and oil production over the 30 years of the Alaska LNG project. Gas volumes available for reinjection are projected to decline from 7.9 Bcf per day (see **Exhibit 2-8**) to near zero after approximately 20 years of production, further reducing annual oil production from the PBU. However, this scenario does generate additional oil from the EOR process. Given that both oil and gas are produced, the life cycle analysis of this scenario represents a multiproduct system boundary.

The upstream processes include oil and associated gas production and gathering and boosting. Some gas is reinjected, while the rest continues downstream to processing, mainline pipeline, liquefaction, storage and loading, ocean transport, regasification, and end use at a power plant in the destination country. Gas processing will take place at the new GTP where both acid gas removal and compression will occur. The CO_2 removed from the natural gas stream at the GTP is captured and used for EOR Injection. Approximately 350 million cubic feet per day of CO_2 injection is expected to occur in the Kuparuk River oil field to produce additional oil. As a result, Scenario 3 exhibits the highest 33-year average oil production volume as compared to the other two scenarios. In the multiproduct system boundary results, all oil produced in Scenario 3 is modeled to be transported, refined, and used at its destination.

Exhibit 2-1 shows the flow diagram for this scenario.

Exhibit 2-1. Process Flow Diagram, Scenario 3 – Use and Storage of By-Product CO_2

2.2 Scenario 2: Reduced Gas Injection

Scenario 2 is modeled similarly to Scenario 3 with respect to associated gas production with some gas still being reinjected in this scenario for enhanced oil production, but the CO_2 removed from the natural gas stream at the GTP is captured and travels about 3 miles to where it is sequestered in saline aquifers. **Exhibit 2-2** shows the process flow diagram of this scenario. For the multiproduct system boundary analysis, US average crude oil is added to Scenario 2 to compensate for the difference in oil production between Scenarios 2 and 3, ensuring their functional equivalence. **Exhibit 2-3** displays the process flow diagram of US average crude oil production and end use. Similar to Scenario 3, oil produced under the Alaska LNG Project is also modeled to be transported, refined, and used at its final destination in the multiproduct system.

Exhibit 2-2. Process Flow Diagram, Scenario 2 – Reduced Gas Injection

Exhibit 2-3. Process Flow Diagram - US Average Crude Oil

2.3 Scenario 1: "Business as Usual"

Scenario 1 represents the current operations of oil production with no major gas sales. All associated gas produced during oil production, 6.93 Bcfd, is assumed to be reinjected. Therefore, the major flows for this scenario are the production of oil and associated gas and the reinjection of that gas. This scenario is used to explain the expected BAU operations in Alaska, involving oil production from PBU over the 33-year timeframe of this analysis. **Exhibit 2-4** shows the process flow diagram for the BAU scenario. For the multiproduct system boundary analysis, US average crude oil and US average natural gas, shown in **Exhibit 2-5** and **Exhibit 2-6** respectively are added to Scenario 1 to compensate for the difference in oil and natural gas production between Scenarios 1 and 3, ensuring their functional equivalence.

Exhibit 2-4. Process Flow Diagram for Scenario 1 – Business as Usual (BAU)

Exhibit 2-5. Process Flow Diagram - US Average Lower 48 Natural Gas

Exhibit 2-6. Process Flow Diagram - US Average Crude Oil

2.4 Annual Quantities of Crude Oil and Natural Gas

Exhibit 2-7 displays the annual quantities of crude oil that are produced and delivered over the timespan of the project. **Exhibit 2-8**, **Exhibit 2-9**, and **Exhibit 2-10** display the annual quantities of natural gas that are delivered to the GTP, exported for sales, and reinjected for oil production, respectively, over the same time period. The periods seen in these tables are determined by changes in natural gas production for sales in Scenarios 2 and 3. In the first four years of the project, natural gas production steadily rises. By the year 2033, natural gas production in these two scenarios will peak, as all three trains at the liquefaction facility are fully functional. In the final year, natural gas production is expected to slightly decrease.

Besides being exported for sales and reinjected to maintain reservoir pressure, small quantities of natural gas are also used as fuel during operations. In Scenario 1, it is projected that 0.5-0.6

Bcfd of gas is used for fuel throughout the timespan of this project. In Scenarios 2 and 3, 0.2-0.3 Bcfd of gas is projected to be used as fuel over the same thirty years.

Exhibit 2-7. Annual Quantities of Crude Oil Produced and Exported (MMBbl/year) from North Slope for Each Scenario (Wallace, et al., 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5 (2033-2057)	Period 6 (2058-2061)
1	61.96	60.21	58.51	56.87	40.42 (average)	26.80 (average)
2	60.58	56.94	53.25	49.98	23.81 (average)	8.22 (average)
3	61.11	60.02	60.67	61.84	41.84 (average)	23.63 (average)

Exhibit 2-8. Annual Quantities of Natural Gas Delivered to GTP (Bcfd) from North Slope for Each Scenario (Wallace, et al., 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5 (2033-2057)	Period 6 (2058-2061)
1	0	0	0	0	0	0
2	0.56	1.40	2.52	3.08	3.36	2.23 (average)
3	0.56	1.40	2.52	3.08	3.36	2.23 (average)

Exhibit 2-9. Annual Quantities of Natural Gas Exported for Sales (Bcfd) from North Slope for Each Scenario (Wallace, et al., 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5 (2033-2057)	Period 6 (2058-2061)
1	-	-	-	-	-	-
2	0.43	1.06	1.91	2.34	2.55	1.69 (average)
3	0.43	1.06	1.91	2.34	2.55	1.69 (average)

Exhibit 2-10. Annual Quantities of Natural Gas Reinjected (Bcfd) from North Slope for Each Scenario (Wallace, et al., 2022)

Scenario	Period 1 (2029)	Period 2 (2030)	Period 3 (2031)	Period 4 (2032)	Period 5-Scenario 1 (2033-2057)	Period 5 – Scenarios 2 and 3		Period 5 (2058-2061)
						2033-2048	2049-2057	
1	7.3	7.2	7.2	7.1	6.4 (average)	-	-	5.7 (average)
2	7.2	6.4	5.5	4.9	-	2.3 (average)	0	0
3	7.9	7.8	7.7	7.5	-	2.3 (average)	0	0

2.5 Maintaining Functional Equivalence

For the multiproduct system analysis, all three scenarios analyzed in this study were made functionally equivalent to generate 1 MWh of electricity at the destination country and consume a standard amount of crude oil (40 kg).

As observed in **Exhibit 2-7** the average oil production declines over the 33-year duration of the project for all scenarios, however, it is the highest for Scenario 3, followed by Scenario 1 and Scenario 2. Therefore, Scenario 3, modeled with a natural gas combined cycle (NGCC) power plant using CCS, served as the foundational case for this analysis. All other scenarios with or without CCS are adjusted to produce 1 MWh of electricity in the destination country using regasified natural gas and the same quantity of oil (40 kg) as this foundational case. The quantity of crude oil produced and consumed for Scenarios 1 and 2 is matched to Scenario 3 by expanding the life cycle system boundary to include the US average for crude oil production, refining, and consumption.

In addition, the volume of natural gas produced and exported for sale is zero for Scenario 1. The life cycle analysis system boundary is expanded to include the life cycle emissions profile of LNG shipped from the United States Lower 48 region, for generating 1 MWh of electricity in the destination country. This was done to ensure Scenario 1 provides an equivalent service to society as Scenario 3.

Exhibit 2-11 explains these adjustments in more detail. For each scenario modeled with and without CCS, the amount of US average crude that was added from system expansion to match the foundational case production of 40 kg can be seen in the third column. Ranges exist within this column as the four destination countries require slightly varying quantities of crude oil to be added through system expansion in order to match 40 kg of crude oil consumption.

Exhibit 2-11. Modeling Functional Equivalence for Scenarios 1, 2, and 3, using NGCC Power Plant with or without CCS

Scenario	Case	US Avg Crude Makeup	US Avg Lower 48 LNG Export and End Use Makeup	Final Multi-Product Functional Unit
Scenario 3	NGCC With CCS	+ 0.00 - 0.48 kg crude oil	-	1 MWh electricity using regasified LNG + 40 kg of crude oil
	NGCC without CCS	+ 4.45 – 4.87 kg crude oil	-	1 MWh electricity using regasified LNG + 40 kg of crude oil
Scenario 2	NGCC with CCS	+ 19.58 – 19.82 kg crude oil	-	1 MWh electricity using regasified LNG + 40 kg of crude oil
	NGCC without CCS	+ 21.84 – 22.06 kg crude oil	-	1 MWh electricity using regasified LNG + 40 kg of crude oil
Scenario 1	NGCC with CCS	+ 0.60 - 1.07 kg crude oil	+1 MWh electricity generated in power plant at destination country using LNG shipped from US Lower 48	1 MWh electricity using regasified LNG + 40 kg of crude oil
	NGCC without CCS	+ 4.99 – 5.41 kg crude oil	+1 MWh electricity generated in power plant at destination country using LNG shipped from US Lower 48	1 MWh electricity using regasified LNG + 40 kg of crude oil

2.6 SUB-SCENARIOS

Within each proposed scenario of LNG export from Alaska, four Asian countries are considered as destinations: Japan, China, South Korea, and India. The only difference in the parameters within these sub-scenarios is the ocean transport distance, which affects the life cycle of fuel consumed to transport the shipment.

In Scenarios 2 and 3, results are shown with and without use of carbon capture and sequestration technologies at a power plant in each of the destination countries.

Finally, in the main report, global warming potential (GWP) results are estimated via the use of the IPCC Fourth Assessment Report (AR4) characterization factors over both 20 and 100-year time horizons (IPCC, 2007). The Appendix shows GWP results using both AR5 and AR6 methods.

2.7 QUALITATIVE DISCUSSION

Uncertainty about future technological and market developments limits DOE's ability to analyze LCA GHG emissions profiles for competing sources of energy for baseload power generation in the selected destination countries (Japan, South Korea, China, and India) at the same level of detail as LNG delivered from the Alaska LNG Project. Sources of uncertainty include competing energy alternatives for baseload power production (current and future technologies) and the role of energy services provided by imported natural gas as a result of changing emissions reduction strategies and targets.

Nevertheless, DOE believes it is important to evaluate potential sources of energy that might be able to provide similar energy services in the destination countries in the future. Accordingly, DOE is providing a qualitative assessment of alternative energy supplies.

All four destination countries are Asian economies with profiles that could be impacted as a result of additional supply from the Alaska North Slope. These countries also have different national energy and decarbonization goals. In this section, we seek to summarize the factors that may affect, or be affected by, the life cycle GWP profiles estimated in the quantitative section of this report.

2.7.1 Expected Trends in Global Energy Supply

The Energy Information Administration (EIA) International Energy Outlook 2021 modeled and graphically summarized its estimates of total energy supply through 2050 (US EIA, 2021). **Exhibit 2-12** shows that in its Reference Case, EIA expects global supply of renewables (most of the 'Other' category in the graph) to increase by a factor of five in the next 30 years. The energy supplied by renewables is expected to be comparable to that of liquid fuels by 2050. The increased use of renewables will lead to reduction in the carbon intensity of the global energy supply.

Exhibit 2-12. Estimated Total World Energy Supply Through 2050 (US EIA, 2021)

Note: quad = quadrillion Btu

While renewables receive much of the attention in discussions of future global energy and decarbonization policy, other sources are projected to continue to play a key role as well. With respect to baseload electricity generation specifically, various fuels and technologies are expected to compete in the global market. Use of coal and nuclear are expected to be relatively flat, while liquid fuels (mostly oil) and natural gas are expected to increase, with gas supply expected to nearly double by 2050. Coal has higher GWP impacts than natural gas, while nuclear and renewables have very low GWP impacts. Thus, there is significant uncertainty in what future global GHG emissions might be in the energy sector, and we have not tried to assess that in this report.

While it is acknowledged that there will be tremendous growth in renewables, even for baseload power, there is expected to be a continued role for natural gas, and thus from where it is sourced is of interest.

In terms of decarbonization, the International Energy Agency (IEA) report “Net Zero by 2050” (IEA, 2021b) estimates that in the energy production sector, almost all future fossil-based generation will come by pairing natural gas with carbon capture technologies and in power generation will be largely coal and natural gas plants with CCS (as shown in **Exhibit 2-13**).

Exhibit 2-13. Estimated Fossil Fuel Use and Share by Sector in 2050 (IEA, 2021b)

Notes: Non-combustion includes use for non-emitting, non-energy purposes such as petrochemical feedstocks, lubricants and asphalt. Energy production includes fuel use for direct air capture.

Overall, natural gas is projected to continue to be a significant source of energy around the world, and for electricity generation, it is likely to be paired with carbon capture technology to help countries meet decarbonization goals. LNG is a key part of a strategy to help to supply countries that do not have local or regional access to gas via pipelines.

2.7.2 Energy and Climate Transitions in the Export Countries

The four Asian countries modeled as LNG export markets in this study have varying energy mixes and decarbonization plans, as further described below. This subsection seeks to frame the general energy landscape in each country in support of further qualitative assessment.

2.7.2.1 Japan

In the last decade, Japan has reduced its reliance on nuclear energy from 15% in 2010 to 3% in 2020 and has also reduced its overall dependence on oil. This shift can be attributed to the 2011 earthquake and the subsequent nuclear accident at Fukushima. While much of the nuclear energy was replaced by fossil and renewable sources, nuclear generation is expected to increase again in the future as relicensing processes complete and decarbonization is re-prioritized. Such processes could be accelerated if costs of renewables or natural gas costs are higher. This is significant because Japan imports almost 90% of energy needed.

Japan was the world's largest importer of LNG in 2020, accounting for 21% of the global LNG market (International Trade Administration, 2022). With minimal in-country production, and no domestic or international gas pipelines, Japan relies entirely on LNG tanker shipments to meet their import demands. 24% of Japan’s energy demands were met with natural gas, almost all of it from imported gas. In 2020, the majority of Japan’s LNG imports came from Australia (39%),

followed by Malaysia (14%), Qatar (12%), Russia (8%) and the United States (6%) (International Trade Administration, 2022). Between 2017 and 2020, Japan increased its import shares from the United States from 1% to 6%, all of it from the Gulf Coast projects following long-term contracts that entered service in 2018 and 2019.

In 2020, Japan declared that it would aim to achieve net-zero GHG emissions and realize a decarbonized society by 2050 (IEA, 2021a). In 2019, 88% of Japan's total primary energy supply (TPES) was met by fossil fuels, so to achieve their 2050 vision the energy supply profile for Japan needs to change drastically. Japan has announced various strategies and policies to move onward with their ambitious goals. Japan also aims to increase its renewable shares from 8% in 2019 to 13% in 2030 and also restart its nuclear plants and increase their share from 4% in 2019 to 15% in 2030. As Japan shifts its energy profile, it is expected that the need for LNG will increase in the next decade because there is a lack of other viable energy sources.

2.7.2.2 South Korea

South Korea has insufficient domestic fossil fuel resources and relies almost entirely on imports to meet its energy demands (e.g., it produced 9 Bcf of natural gas and consumed 19 Tcf in 2019). South Korea relies largely on LNG imports for natural gas and does not have international pipeline infrastructure for importing gas. In 2019, South Korea received 27% of its LNG from Qatar, 19% from Australia, and 14% from the United States (IEA, 2020). However, over the last few years the trend has shifted to increased LNG imports from the United States and reduced imports from Qatar after multiple long-term contracts were signed with U.S. exporters. South Korea was the number one importer of U.S. LNG in 2021 (IEA, 2020). In addition, a long-term contract will come into effect in 2025 to purchase LNG from the US Freeport LNG terminal. Therefore, LNG imports from the US gulf coast region to South Korea are expected to increase in the near-term due to existing contracts.

The South Korean government aims to increase the share of renewable electricity to 20% by 2030 and 30-35% by 2040 (IEA, 2020). To meet ambitious climate goals as a part of the Paris Agreement, South Korea committed to phase-out coal. Natural gas will play an important role as a bridge fuel. South Korea also has ambitious goals of creating a strong hydrogen economy, especially in the transportation sector, and LNG is a potential source to enable that transition.

2.7.2.3 China

In 2019, the largest share of China's total energy demands was met by coal (58%), followed by petroleum and other liquids (20%). Only 8% of its demands were met by natural gas. However, the EIA anticipates that China's natural gas share will increase to about 14% by 2030, making it one of the fastest growing markets for natural gas in the world. Over the last decade, China's natural gas consumption has increased by about 13% every year. (U.S. EIA, 2020a)

Domestic production of gas in China is modest but increasing. As a result, China relies heavily on imported gas to satisfy the widening gap between domestic production and demand. Since 2021, China has become the largest importer of LNG in the world. Sixty percent of the imports were from LNG and 40% were from pipeline imports, mostly from Turkmenistan (about 1 Tcf), but starting in 2020, China also began importing natural gas from Russia via the Power of Siberia

pipeline, which will eventually grow to deliver 1 Tcf to eastern China. Australia has historically been the largest supplier of LNG to China accounting for 29% of the total supply followed by Qatar (9%). Disagreement on foreign policy led China to decrease Australian imports. China's LNG imports from the United States fluctuated in 2019 declined overall due to increased LNG tariffs. However, in early 2020 China offered tariff exemptions on LNG imports from the United States which is expected to boost the LNG supply from the United States, and several subsequent long-term contracts with U.S. LNG exports have since been signed. Turkmenistan is the second largest gas supplier for China but in the form of long-distance pipeline imports, it contributes 25% of total gas imports (LNG and pipeline). China plans to further increase natural gas pipeline capacity from Turkmenistan and is discussing a new pipeline from Western Siberia. While detailed demand and import projections were not available, pipeline gas supplies will compete with LNG supplies from other countries.

China expects to account for 40% of the global growth of renewable capacity between 2019 and 2024. However, China's high dependence on coal and future commitments to increase gas imports will mean that LNG and pipeline gas imports will also continue to rise in the near-term.

2.7.2.4 India

In 2020, 6% of India's energy demand was met with natural gas, 45% with coal, 25% with oil, and 20% with biofuels and waste (IEA, 2021c). However, India plans to increase the share of natural gas to 15% by 2030 (International Trade Association, 2018). India's natural gas demand exceeds its domestic production, and the country is expected to increase its LNG imports to meet the growing demand. In 2019, Qatar was the primary source of LNG imports for India with a 41% share. However, this share has decreased from 83% in 2014 as India diversifies its sources. The United States provides 8% of the LNG imports (U.S. EIA, 2020b). The regasification capacity for the country has increased over the years as more investments are made in natural gas infrastructure.

India is also investing heavily in pipeline infrastructure, having more than doubled its onshore gas pipeline network since 2008, and continues to construct pipelines in remote corners of the country. There are no plans for pipelines from other countries.

India plans to reach net zero emissions by 2070 and to meet 50% of its electricity requirements from renewable energy sources by 2030. This is occurring in the backdrop of a country with rapidly growing energy use, adding electricity access to about 50 million people per year. India has recently set a target of installing 500 gigawatts of renewable energy capacity by 2030, reducing the emissions intensity of its economy by 45%, and reducing a billion tonnes of CO_2.

2.7.3 Role of Carbon Capture and Storage in a Decarbonized Energy Sector

The four export destination country markets above have a diverse set of carbon management strategies in place for the future. Globally, one strategy with significant attention has been carbon capture and storage (CCS). While this study did not evaluate destination country geologic storage potential, CCS is a potentially pivotal technology that a country can take to start its march towards carbon-neutrality in support of large-scale power generation projects.

There are movements within each of the countries to pursue the technology, including in offshore locations. CCS can reduce the impacts from existing infrastructure by retrofitting the existing fossil based power and industrial plants, or in the integrated design of new fossil plants, to capture the CO_2 emissions from these large point source emitters.

Carbon emissions from fossil power plant operations dominate the life cycle GHG profile of electricity. Capturing power plant emissions will drastically reduce the life cycle GHG impacts from power generation using fossil fuels. As this happens, demand for LNG stands to further increase for the changing energy economies of the destinations being considered in this work due to parasitic loads associated with the carbon capture units at facilities to produce the same amount of power.

2.7.4 Alternative Technologies for Baseload Electricity Generation

2.7.4.1 Other sources of LNG

As the United States has been the world's largest natural gas producer since 2009 (EIA 2018), the increased production of natural gas has created the opportunity for exports, leading to growing investments in new LNG facilities. The United States has keen competition in the global LNG export market from other suppliers, including Australia, Qatar, and Russia. Projections show the United States will have the largest LNG export capacity in the world by the end of 2022 (U.S. EIA, 2021), but the other main exporters are also planning capacity increases. Moreover, the Asian countries evaluated as the destinations for this work have diversified their LNG sources to increase energy supply reliability. This transition has worked in favor of US LNG, as its share in all the destination countries has seen growth in the last few years and is expected to increase in the future as all the countries aim to achieve ambitious decarbonization goals while maintaining energy reliability of service. The GHG impacts from any source depend on varied factors, but the biggest differentiators are the impacts of upstream natural gas and ocean transport of the LNG. While the United States is centrally located between potential demands around the world, there are various potential LNG importers that would have shorter ocean transport distance from LNG suppliers in other countries, making them potentially preferable on a life cycle GHG emissions basis.

2.7.4.1.1 US Gulf Coast

LNG from the US Gulf Coast to Asian markets is expected to have a larger GHG emissions impact as compared to LNG imported from Alaska because of two major reasons:

1. The ocean transport route from the Gulf Coast to Asia is longer compared to the route from Alaska to the Asian markets. The shortest distance between the Gulf Coast and China is 140% longer than the route from Alaska to China, so the impact of transporting LNG by ocean tanker is expected to be greater when moving from the Gulf Coast to Asia. In addition to the longer distances, the vessel will also need to pass through either the Panama or Suez Canals, but this comes with restrictions on vessel size, delays, and additional costs to pass thorough the canals.

2. Associated gas is produced alongside oil production. Other natural gas production is not co-produced with oil. For associated gas (and in our study), the GHG emissions from the production wells and initial oil and gas separation activities are shared across products on an energy basis, resulting in relatively lower GHG emissions on a per unit of natural gas product produced basis (compared to non-associated production). About 75% of the proposed Alaskan North Slope gas for LNG export is associated gas (Kuuskraa, et al., 2022a). However, in the five major onshore oil production regions, including the Gulf Coast, only about 40% of gas produced is associated gas (U.S. EIA, 2021). Thus, the GHG intensity of natural gas from the Gulf Coast region would be expected to be higher.

2.7.4.1.2 Qatar

Qatar is the largest supplier of LNG for South Korea and India, and the second largest supplier for Japan and China. Qatar supplying LNG for India is ideal based on geographical proximity. However, for the other countries, the ocean transport distance from Alaska is shorter than the distance from Qatar, which implies lower GHG emissions in the ocean transport stage but as noted above, we have not attempted to quantify the GHG impacts of any of the foreign sources of natural gas.

2.7.4.1.3 Australia

Australia is the largest supplier of LNG for Japan and China and the second largest supplier for South Korea and India. Depending on which coast the LNG supplier is located on, Australia has the advantage of being geographically closer to all the Asian countries compared to Alaska, which would reduce the ocean shipping component of the life cycle emissions. However, as noted above, we have not attempted to quantify the GHG impacts of any of the foreign sources of natural gas.

2.7.4.2 Non-LNG sources of natural gas (e.g., regional and domestic pipeline gas supply)

Transporting natural gas via pipeline is a simpler and less GHG-intensive process than LNG. However, many Asian countries do not have existing pipeline infrastructure to receive international gas and to distribute it within the country; therefore, they would have to invest heavily into infrastructure expansion. That said, constructing pipelines results in GHG emissions, so power plants co-located to coastal LNG terminals would result in electricity with lower life cycle emissions than if significant domestic pipeline distribution was needed. Similarly, long cross-continental pipeline transport distance can result in higher GHG emissions that equal or exceed liquefaction, transportation and regasification operations. Existing active or planned regional pipelines, such as those delivering gas westward into Europe, or planned from Turkmenistan through Afghanistan and Pakistan to India, may be at risk of disruption due to conflict or policy changes, and could eventually lead to further demand for LNG to maintain energy security.

2.7.4.3 Domestic or regional coal

In general, coal as an energy source emits more GHGs than natural gas or LNG due to differences in the carbon ratio of the fuels, and in the relative efficiency of combustion and generation. NETL's 2019 LNG report (Roman-White, et al., 2019) estimated that importing LNG from the US gulf coast to China emits 37% and 28% less carbon dioxide equivalents than regional coal on a 100-yr and 20-yr timeline, respectively. And while coal is currently the largest source of energy for many Asian countries, these countries are trying to move away from coal to be able to meet their climate goals.

2.7.4.4 Nuclear energy

While nuclear energy is a low GHG source of energy, with zero GHG emissions during operations and very low life cycle emissions, it has seen a lot of social challenges resulting from major nuclear power plant incidents over the past several decades. For example, Japan relied heavily on nuclear energy but quickly moved away following the Fukushima nuclear incident. Nuclear energy has been ramping back up in Japan as plants have been re-starting. South Korea has the highest density of nuclear plants in the world and had previously intended a decrease in nuclear energy after Fukushima but continues to have plants under construction and may be renewing nuclear targets. China continues to refine nuclear technology and hopes to export technology in the future. India is also demonstrating plants fully designed and developed using its own technologies and continues to build and announce new plants. Overall, IEA expects nuclear electricity production to double by 2050 in support of decarbonization goals (IEA, 2021b).

2.7.5 Other Relevant Technologies for Electricity Generation

2.7.5.1 Renewable energy

Hydro, wind, and solar are main sources of renewable electricity. While it is true that these sources have lower GHG impacts when compared to fossil sources, the technologies have limitations, making these sources less reliable over medium to long time durations. Limitations include the intermittency of generation when the resource is available and misalignment of when renewable electricity is able to be supplied versus when it is in demand - which then requires energy to be stored. Storage technologies are generally some form of battery, which adds cost and additional technology challenges. Use of traditional batteries on the grid currently is limited to about 6-8 hours of storage which limits its utility, but the storage technology field is rapidly growing. All countries that have signed the Paris Agreement have ambitious goals to transform their electricity grids to rely heavily on these renewable sources. However, most Asian economies have political, social, and technological hurdles that will make the goal of carbon neutrality challenging to achieve solely based on making their electricity grid renewable. Adding renewable generation will also require additional grid infrastructure to transport the new supply to the increasing demand. Most countries will require bridge fuels before they become 100% renewable over the coming decades.

2.7.5.2 Hydrogen

Hydrogen has gained a lot of attention as an alternative fuel to meet energy demands. However, most hydrogen that is being produced in the market today is sourced from steam methane reforming of natural gas or coal gasification which does not necessarily make it a low-carbon alternative without capturing and permanently storing the carbon dioxide produced during the hydrogen production process. Hydrogen can also be produced from electrolysis of water using renewable electricity, but the technology is not utilized at a large enough scale yet to meet energy demand. Electrolysis of hydrogen with renewable electricity has significantly lower carbon footprint than that of existing fossil-based technologies (but will consume significant volumes of water).

2.7.5.3 Ammonia

The world is already producing large quantities of ammonia to be used as fertilizers, and the advent of technology to produce ammonia and combust it directly as fuel in power plants and engines or as a hydrogen carrier for applications like transportation make it a very attractive option. However, this technology is very new, and it will take a long time to scale up making ammonia a reliable energy source capable of replacing other existing options. There are thus substantial uncertainties and unknowns about its role in the future. So, although ammonia might become a competitor for other fuels in the future, studies on this topic are relatively recent and there is not enough research to predict its growth in the energy sector.

3 MODELING APPROACH AND KEY PARAMETERS

This section describes the approach taken when modeling each stage in Scenarios 1, 2 and 3, as well as the key parameters used. This LCA utilized existing models (described in Sections 3.1 through 3.9) to inform the creation of a model to represent the Alaska LNG supply chain. This LCA follows ISO 14040 and ISO 14044 international standards (ISO, 2006a) (ISO, 2006b).

3.1 PRODUCTION

This analysis combines two different processes to model the production stage in order to represent production from both PBU and PTU. It is important to note that approximately 75% of gas for the Alaska LNG Project is expected to be sourced from the PBU, while the remaining 25% is expected to come from the PTU. Together, these fields are expected to have about 41.1 Tcf of natural gas reserves, which is a sufficient volume for the needs of the project (Kuuskraa, et al., 2022a). All oil production for the project is expected to come from the PBU (with the exception of Scenario 3, which produces additional oil from CO_2-EOR in the Kuparuk River Unit (KRU) oil field on the North Slope of Alaska).

To model the production stage in PBU, the Oil Production Greenhouse gas Emissions Estimator (OPGEE) 2.0 model (El-Houjeiri, et al., 2018) was used to estimate the GHG emissions. The parameters in the model were updated based on technical performance data sourced from the ARI Upstream Study (Kuuskraa, et al., 2022a). This data includes the estimated oil and gas production from the North Slope over the 33-year timespan of the project. From this data, a gas-to-oil ratio (GOR) was calculated based on a weighted average over the 30 years of production. The producing well count and API Gravity was sourced from the Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP). These parameters (number of wells and API gravity) were taken from 2020 production facility data in the North Slope and assumed to be consistent throughout the duration of the project unless noted otherwise in the report (U.S. EPA, 2020).

The OPGEE 2.0 model provides life cycle GHG emissions in terms of CO_2e. These emissions are speciated into CO_2, CH_4, and N_2O, and incorporated into the total life cycle analysis to model the production stage. This stage includes emissions from drilling and development of wells, production and extraction, and surface processing of oil and associated gas. The production stage also includes the transportation of oil produced from the wells through a crude oil pipeline, which was modeled based on the oil pipeline unit process from NETL's Carbon Dioxide Enhance Oil Recovery Life Cycle (CELiC) model . The length of the Trans-Alaska Pipeline System (TAPS), the main pipeline network for oil transport in Alaska, is 800 miles. This pipeline is used to transport oil from PBU as well as oil produced via CO_2-EOR operations on the North Slope. Within OPGEE, the natural gas reinjection ratios were changed to reflect a 33-year weighted average for each of the three scenarios (Wallace, et al., 2022). These ratios determine the volume of natural gas that is compressed for reinjection. On account of the lower fraction of reinjected natural gas in Scenarios 2 and 3, the reinjection energy requirements are lower than those of Scenario 1.

To model the production stage in PTU, parameters from the 2020 NETL One Future report (Rai, et al., 2020) were used. These parameters represent the US average of CO_2, CH_4, and N_2O emission factors in the production stage of natural gas. The OPGEE 2.0 model was not used in modeling PTU because of the lack of oil production occurring at this site. Therefore, PTU production is only modeled for Scenarios 2 and 3, given that Scenario 1 only produces oil and not natural gas. Gas coming from PBU and PTU was modeled to be mixed in a ratio of 75:25 to represent the combination of the two gas streams.

For Scenario 1, there is no natural gas production for export from the North Slope. In order to compare Scenario 1 to Scenarios 2 and 3, it must provide the equivalent service or function to society with respect to the amount of crude oil derived services and natural gas derived services to society. The system boundary for Scenario 1 is expanded to include the production and delivery of natural gas from the Lower 48 United States to each of the receiving countries. Production and delivery of natural gas exports from the Lower 48 was modeled based on US average data from the 2020 NETL One Future report (Rai, et al., 2020). Additionally, the transport distance was adjusted to represent the distance to each receiving country in this study and the GWP values were changed from IPCC AR5 to IPCC AR4 values, the default GWP for this report. This was done in order to ensure that each of the three scenarios are functionally equivalent with respect to the amount of services provided by the crude oil derived products and the use of the imported natural gas for power generation (Wallace, et al., 2022).

Exhibit 3-1 summarizes the key parameters for the production stage in PBU. **Exhibit 3-2** summarizes the key parameters for the production stage in PTU.

Exhibit 3-1. Key Parameters for Production Stage of LCA - PBU

Parameter	Units	Value		Source
		Scenario 1	Scenarios 2 and 3	
Oil Production Volume	Mbbl/d	117	75	(Wallace, et al., 2022)
Gas Production Volume	Bcf/d	7.73	4.95	
Number of Gas Producing Wells	count	1,734		(U.S. EPA, 2020)
API Gravity	deg. API	26		
Gas-to-Oil Ratio (GOR), 33-yr weighted average	scf/bbl	66,064		(Wallace, et al., 2022)
Natural Gas Reinjection Fraction, 33-year weighted average	scf reinjected /scf	Scenario 1	0.5	
		Scenarios 2 and 3	0.3	

Exhibit 3-2. Key Parameters for Production Stage of LCA - PTU

Parameter	Units	Value	Source
CO_2 Emission Factor	kg/kg gas	1.98E-01	(Rai, et al., 2020)
CH_4 Emission Factor	kg/kg gas	1.08E-06	
N_2O Emission Factor	kg/kg gas	6.13E-03	

3.2 Prudhoe Bay Transport Line (PBTL) and Point Thomson Transport Line (PTTL)

The gas from PBU and PTU travel through small sections of pipeline to reach the GTP. These transmission pipelines are small enough to not require compression stations, so they were modeled using the NETL baseline natural gas model's (Littlefield et al., 2019) pipeline stage unit processes with updated distance parameters. This stage includes emissions from emergency shutdowns, fugitives, integrity and maintenance work, repairs, cautionary work, venting, and other sources.

Exhibit 3-3 summarizes the key parameters for the transmission line stage.

Exhibit 3-3. Key Parameters for Transmission Life Stage of LCA

Parameter		Units	Value		Source
			PBTL	PTTL	
Pipeline Length		miles	1	62.5	(FERC, 2020)
Pipeline Fugitive Emission Factor		kg CH_4/mile	1,120		(Littlefield, et al., 2019)
Pipeline venting emissions	Cautionary work emissions	tonnes CH_4	Min: 2.53E+01; Exp: 9.02E+01; Max: 1.81E+02		(U.S. EPA, 2020)
	New pipeline construction or modification emissions	tonnes CH_4	Min: 4.29E+02; Exp: 9.66E+02; Max: 1.73E+03		(U.S. EPA, 2020)
	Emergency Shutdown emissions	tonnes CH_4	Min: 1.52E-02; Exp: 4.95E+01; Max: 1.71E+02		(U.S. EPA, 2020)
	Pipeline Integrity work emissions	tonnes CH_4	Min: 2.89E+01; Exp: 5.46E+01; Max: 9.28E+01		(U.S. EPA, 2020)
	Maintenance work emissions	tonnes CH_4	Min: 5.32E+02; Exp: 1.46E+03; Max: 4.56E+03		(U.S. EPA, 2020)

Parameter		Units	Value		Source
			PBTL	PTTL	
	Repair work emissions	tonnes CH_4	Min: 3.14E+02; Exp: 1.43E+03; Max: 3.28E+03		(U.S. EPA, 2020)
	All other emissions	tonnes CH_4	Min: 1.84E+02; Exp: 3.31E+02; Max: 5.09E+02		(U.S. EPA, 2020)

3.3 Processing or Gas Treatment Plant (GTP)

The Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement (FEIS) (FERC, 2020) on this LNG project and EPA's GHGRP data were the primary data sources for the parameters in the processing stage for Scenarios 2 and 3. The FEIS provided specification of the new GTP that will be constructed as a part of this project. These specifications were used to model the processing stage. This stage includes emissions from acid gas removal unit, reciprocating compressors, blowdowns, dehydrators, equipment leaks, pneumatic devices, flaring, venting, and combustion operations.

The reciprocating compression energy was modeled using the methodology followed by (Roman-White, et al., 2021) , which involves developing a US average HPh per Mcf factor. The transmission compression HPh per Mcf factor was used as a proxy for estimating reciprocating compression energy for the processing stage. **Section 3.7** provides the detailed methodology for developing the US average HPh per Mcf factor. The factor is multiplied with the processing facility throughput to obtain the required reciprocating compression energy output.

Scenario 1 gas processing was modeled based on the 2020 NETL One Future report (Rai, et al., 2020).

Exhibit 3-4 summarizes the key parameters for the GTP stage for Scenarios 2 and 3.

Exhibit 3-4. Key Parameters for GTP Stage of LCA

Parameter	Units	Value	Source
Natural Gas Throughput	Mcf/yr	1.02E+09	(Kuuskraa, et al., 2022a)
Avg Volume of CO_2 Reinjected/Removed	Mmcf	1.26E+05	(Kuuskraa, et al., 2022a)
Dehydrator Venting	tonnes CH_4/facility-yr	6.47E+00	(US EPA GHGRP, 2020)
Reciprocating Compressor Energy	HPh per Mcf factor	Min: 2.04E-01; Exp: 2.96E-01; Max: 4.66E-01	(Roman-White, et al., 2021)
	Reciprocating engine thermal efficiency	44%	(Littlefield, et al., 2019)

Parameter	Units	Value	Source
Reciprocating Compressor Venting	tonnes CH_4/facility-yr	Min: 7.36E+01; Exp: 9.69E+01; Max: 1.26E+02	(U.S. EPA, 2020)
Blowdowns	tonnes CH_4/facility-yr	6.23E+01	(U.S. EPA, 2020)
Equipment Leaks	tonnes CH_4/facility-yr	Min: 7.16E+01 Exp: 8.73E+01 Max: 1.06E+02	(U.S. EPA, 2020)
Flared Volume	scf	1.41E+08	(U.S. EPA, 2020)
Pneumatic Device Venting	kg CH_4/facility-yr	3.17E+03	(U.S. EPA, 2020)

3.4 Management of CO_2 from GTP

The CO_2 that is captured from the natural gas stream at the GTP has been modeled in two different ways in this study, as described in the following subsections.

3.5 CO_2 Sequestration in Saline Aquifer (only in Scenario 2)

Scenario 2 in this LCA study evaluated the emissions from sequestration of the CO_2 captured from the natural gas stream at the GTP in saline aquifers. This stage includes the transport of CO_2 from the GTP to saline aquifers 3 miles away. The sequestration emissions were estimated based on the NETL gate-to-grave life cycle analysis model of saline aquifer sequestration of CO_2 (Littlefield et al. 2019). The CO_2 pipeline transport was modeled based on the unit process from NETL's CELiC model. **Exhibit 3-5** below summarizes the key parameters for the CO_2 sequestration stage.

Exhibit 3-5. Key Parameters for CO_2 Sequestration of LCA

Parameter	Units	Value	Source
CO_2 Sequestration (Scenario 2 only)			
CO_2 Pipeline Distance	miles	3	(Kuuskraa, et al., 2022b)
Average CO_2 Injected (33-year average)	MMcf/year	126,126	
CO_2 Pipeline - CH_4	kg/kg CO_2 injected	1.54E-08	(Jamieson & Skone, 2019)
CO_2 Pipeline - CO_2	kg/kg CO_2 injected	5.14E-05	
CO_2 Pipeline – N_2O	kg/kg CO_2 injected	8.06E-10	
Sequestration CH_4 Emissions	kg CH_4/ton of CO_2 sequestered	3.15E-02	(Littlefield, et al., 2019)
Sequestration CO_2 Emissions	kg CO_2/ton of CO_2 sequestered	1.39E+01	
Sequestration N_2O Emissions	kg N_2O/ton of CO_2 sequestered	1.10E-04	

Parameter	Units	Value	Source
Sequestration SF_6 Emissions	kg SF_6/ton of CO_2 sequestered	1.93E-06	

3.6 Transport and Use for EOR (only in Scenario 3)

Scenario 3 in this LCA evaluated the emissions from enhanced oil recovery (EOR) using the CO_2 captured from the natural gas stream from the GTP. This stage includes the transport of CO_2 from the GTP to Kuparuk reservoir for EOR. The CO_2 pipeline transport and EOR emissions were estimated based on NETL's CELiC model (Jamieson & Skone, 2019). This stage also includes the transportation of the oil produced from EOR practices through the 800-mile TAPS.

A model process was constructed to model the CO_2 profile for the 33-year average of the results from CELiC. The CELiC model was run for parameters from each year as reported by the ARI upstream study. The CELiC model outputs are averaged over the 33 years to provide the CO_2 injected, average crude produced, and emissions from EOR.

Exhibit 3-6 summarizes the key parameters for the CO_2 transport and use stage.

Exhibit 3-6. Key Parameters for CO_2 EOR Stage of LCA

Parameter	Units	Value	Source
CO_2 EOR (Scenario 3 only)			
CO_2 Pipeline Distance	miles	50	(Kuuskraa, et al., 2022b)
Average New CO_2 Injected	MMcf/year	126,126	
CO_2 Pipeline - CH_4	kg/kg CO_2 injected	2.56E-07	(Jamieson & Skone, 2019)
CO_2 Pipeline - CO_2	kg/kg CO_2 injected	8.57E-04	
CO_2 Pipeline – N_2O	kg/kg CO_2 injected	1.34E-08	
Average Oil Production	kg oil produced/kg new CO_2 injected	3.65E-01	
EOR CH_4 Emissions	kg/kg new CO_2 injected	2.86E-04	
EOR CO_2 Emissions	kg/kg new CO_2 injected	1.18E-01	
EOR N_2O Emissions	kg/kg new CO_2 injected	1.38E-06	
EOR SF_6 Emissions	kg/kg new CO_2 injected	2.51E-08	

3.7 Natural Gas - Transmission Compression and Mainline Pipeline

The Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement (FEIS) (FERC 2020) on this LNG project, EPA's GHGRP data, and Roman-White et al, 2021 were the

primary data sources for the parameters in the transmission compression stage for Scenarios 2 and 3. This stage includes emissions from reciprocating compressors, blowdowns, dehydrators, equipment leaks, pneumatic devices, transmission storage, flaring, venting, and combustion operations.

The reciprocating compression energy was modeled using the methodology followed by (Roman-White, et al., 2021), which involves developing a US average HPh per Mcf factor. The developed factor is multiplied with the facility throughput to obtain the required reciprocating compression energy output.

In 2019, total natural gas delivered in the United States to consumers = 28,291,006 MMcf (U.S. EIA, 2022)

Total HPh of transmission compression = 76,893 million HPh (U.S. EPA, 2021)

Using an average total transmission pipeline distance of 600 miles, and an average distance of 59 miles between transmission stations (Littlefield, et al., 2019), results in 9.2 compressor stations traveled by a unit of gas.

$$HPh\ per\ Mcf\ factor = \frac{76{,}893 \times 10^6\ HPh}{28{,}291{,}006\ \times 10^3\ Mcf} \times \frac{1}{9.2\ comp.stations}$$

$$HPh\ per\ Mcf\ factor = 0.296$$

The factor is multiplied with the ARI reported mainline pipeline throughput to obtain the required reciprocating compression energy output.

In addition, similar to the PBTL and PTTL, the mainline pipeline was also modeled for Scenarios 2 and 3 using NETL's baseline natural gas model's (Littlefield et al. 2019) pipeline stage unit processes with an updated distance parameter to represent the 806.9 miles of new pipeline that will be constructed for this project. This stage includes emissions from, emergency shutdowns, fugitives, integrity and maintenance work, repairs, cautionary work, venting and other sources.

Scenario 1 transmission compression and pipeline transport were modeled based on the 2020 NETL One Future report (Rai, et al., 2020).

Exhibit 3-7 summarizes the key parameters for the transmission compression and mainline pipeline stages for Scenarios 2 and 3.

Exhibit 3-7. Key Parameters for Transmission Compression Stage of LCA

Parameter	Units	Value	Source
Transmission Compression			
Number of Compression Stations	count	8	(FERC, 2020), (Roman-White, et al., 2021)
HPh per Mcf factor	HPh per Mcf	2.96E-01	

Parameter		Units	Value	Source
Natural Gas Throughput		Mcf/facility-yr	hp1.00E+09	(Kuuskraa, et al., 2022a)
Blowdowns		tonnes CH_4/yr	1.29E+02	(U.S. EPA, 2020)
Dehydrators	Emission factor	kg CH_4/Mmcf	1.80E+00	(U.S. EPA, 2020)
	Throughput volume for dehydrator vents	Mmcf/yr	1.19E+06	(U.S. EPA, 2020)
Equipment Leaks		tonnes CH_4/yr	2.39E+01	(U.S. EPA, 2020)
Flaring		tonnes CH_4/yr	1.10E-01	(U.S. EPA, 2020)
Pneumatic Devices	High bleed	count	1.53E+00	(U.S. EPA, 2020)
		kg/controller-yr	8.41E+02	(Littlefield, et al., 2019)
	Intermittent bleed	count	2.48E+01	(U.S. EPA, 2020)
		kg/controller-yr	2.27E+02	(Littlefield, et al., 2019)
	Low bleed	count	1.75E+00	(U.S. EPA, 2020)
		kg/controller-yr	6.60E+01	(Littlefield, et al., 2019)
Mainline Pipeline				
Pipeline Length		miles	806.9	(FERC, 2020)
Pipeline Fugitive Emission Factor		kg CH_4/mile	1,120	(Littlefield, et al., 2019)
Pipeline Venting Emissions	Cautionary work emissions	tonnes CH_4	Min: 2.53E+01; Exp: 9.02E+01; Max: 1.81E+02	(U.S. EPA, 2020)
	New pipeline construction emissions	tonnes CH_4	Min: 4.29E+02; Exp: 9.66E+02; Max: 1.73E+03	(U.S. EPA, 2020)
	Emergency Shutdown emissions	tonnes CH_4	Min: 1.52E-02; Exp: 4.95E+01; Max: 1.71E+02	(U.S. EPA, 2020)

Parameter		Units	Value	Source
	Pipeline Integrity work emissions	tonnes CH_4	Min: 2.89E+01; Exp: 5.46E+01; Max: 9.28E+01	(U.S. EPA, 2020)
	Maintenance work emissions	tonnes CH_4	Min: 5.32E+02; Exp: 1.46E+03; Max: 4.56E+03	(U.S. EPA, 2020)
	Repair work emissions	tonnes CH_4	Min: 3.14E+02; Exp: 1.43E+03; Max: 3.28E+03	(U.S. EPA, 2020)
	All other emissions	tonnes CH_4	Min: 1.84E+02; Exp: 3.31E+02; Max: 5.09E+02	(U.S. EPA, 2020)

3.8 Liquefaction and Loading/Unloading

Liquefaction and loading/unloading were modeled for all three scenarios as per the 2019 NETL LNG report (Roman-White, et al., 2019). The liquefaction stage was updated in Scenarios 2 and 3 to only represent the Propane Precooled Mixed Refrigerant (AP-C3MR™) process with cryogenic distillation and heat recovery steam generator (HRSG). All of the liquefaction processes include emissions from construction, energy consumption and fuel combustion for operation, venting, flaring, and fugitives.

Exhibit 3-8 and **Exhibit 3-9** show the key parameters used for liquefaction and loading/unloading stages, respectively.

Exhibit 3-8. Key Parameters for Liquefaction Stage of LCA

Model Parameter		Low	Expected	High	Distribution	Units	Source
Energy Requirement	Adsorption Based HHC* Removal, with HRSG*	-	2.86	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
	Adsorption Based HHC, without HRSG	-	3.08	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
	Cryogenic Distillation Based HHC removal, with HRSG	-	2.78	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
	Cryogenic Distillation Based HHC removal, without HRSG	-	3.35	-	Point Estimate	MJ/kg NG liquefied	(Mallapragada, et al., 2018)
Boil-off Rate (temporary storage)		0.02%	-	0.1%	Uniform	percent volume/day	(Dobrota, et al., 2013)
Storage Time		1.33	-	1.60	Uniform	days	(U.S. Energy Information Administration, 2017) (International Gas Union, 2017)
Power Consumption for BOG Recondenser		-	4,450	-	Point Estimate	kW/kg BOG condensed	(Li & Wen, 2016)
Handling Capacity of BOG Recondenser		-	13.38	-	Point Estimate	tonnes/hour	(Kinder Morgan, n.d.) (Li & Wen, 2016)

* HHC stands for heavy hydrocarbon removal and HRSG stands for heat recovery steam generator.

Exhibit 3-9. Key Parameters for Loading/Unloading Stages of LCA

Model Parameter	Low	Expected	High	Distribution	Units	References
Standard Loading/Unloading Rate	10,000		12,000	Uniform	m^3/hour	(Dobrota, et al., 2013)
Boil-off Rate		20,000		Point Estimate	kg/hour	(Dobrota, et al., 2013)

3.9 Ocean Transport and Crude Ocean Transport

Emissions associated with both transporting LNG to foreign markets and crude oil to the US west coast were included in this study. The model includes ocean transport of LNG from the liquefaction facility to four different overseas destinations: Japan, South Korea, China, and India. Scenario 1 natural gas was modeled as departing from the US Lower 48 and being delivered to the same four destinations. Ocean transport of crude oil was modeled from the southern coast of Alaska to a port in Washington state.

Exhibit 3-10 and **Exhibit 3-11** summarize the key parameters for the LNG ocean transport and crude ocean transport stages, respectively.

Exhibit 3-10. Key Parameters for LNG Ocean Transport Stage of LCA

Parameter	Units	Value				Source
Ocean Transport						
Vessel Capacity	m^3	176,000; Ranging from (150,000 to 180,000)				(FERC, 2020)
Distance [Source (Port) ↓ ; Destination (Port) →]	-	**Japan (Futtsu)**	**South Korea (Incheon)**	**China (Shanghai)**	**India (Mumbai)**	
Alaska, US (Petersburgh)	miles	4,456	5,443	5,489	10,614	(Searoutes, 2022)
US Lower 48 (Corpus Christi)	miles	10,575	11,625	11,671	11,266	
Parameter	**Units**	**Value**			**Distribution Type**	**Source**
Ship Speed, Laden	knots	-	19.5	-	Point Estimate	(Pace Global, 2015)
Ship Speed, Ballast	knots	-	20.9	-	Point Estimate	(Pace Global, 2015)
Ship Capacity	m^3	150,000	-	180,000	Uniform	(International Gas Union, 2017)
Available Volume	percent	-	98%	-	Point Estimate	(Hasan, 2009)
Percent Heel	percent	-	2.5%	-	Point Estimate	(Roman-White, et al., 2019)
Boil-Off Rate	percent volume/ day*	-	0.1%	-	Point Estimate	(International Gas Union, 2017)

Parameter	Units	Value			Distribution Type	Source
Engine Power	kW	-	31,400	-	Point Estimate	(MAN Diesel and Turbo, 2013)
Gas Consumption, 100% Load	kJ/kWh	-	7,318	-	Point Estimate	(Wärtsilä Corporation, 2018)
Oil Consumption, 50% Load	kg/kWh	-	0.1904	-	Point Estimate	(Wärtsilä Corporation, 2018)
Oil Consumption, 75% Load	kg/kWh	-	0.1844	-	Point Estimate	(Wärtsilä Corporation, 2018)
Oil Consumption, 100% Load	kg/kWh	-	0.1896	-	Point Estimate	(Wärtsilä Corporation, 2018)

Exhibit 3-11. Key Parameters for Crude Ocean Transport Stage of LCA

Parameter		Units	Value	Source
Crude Ocean Transport				
Vessel Capacity		m^3	176,000; Ranging from (150,000 to 180,000)	(FERC, 2020)
Distance [Alaska, US (Petersburgh) to Washington State, US]		miles	1,675	(Searoutes, 2022)
Fuel use proportions	Diesel	dimensionless	0.32	(NETL, 2010)
	Fuel oil	dimensionless	0.68	
Energy intensity of crude oil transportation		MJ/kg-km	1.00E-04	(NETL, 2010)

3.10 REGASIFICATION

Once the gas is delivered to the importing country, it is regasified in order to use it to produce electricity, a process that produces GHG emissions. **Exhibit 3-12** summarizes the key parameters for the gasification stage.

Exhibit 3-12. Key Parameters for Gasification Stage of LCA

Parameter	Units	Value	Source
Energy Requirement	MJ/kg LNG regasified	2.14E-01	(Pace Global, 2015)
Electricity Consumption	MWh/kg LNG regasified	1.21E-05	(Papadopoulo, et al., 2011)

Parameter	Units	Value	Source
Boil-Off Rate	Percent volume/day	0.06%	(Dobrota, et al., 2013)
Storage Time	days	1.46E+00	(EIA, 2017)
Fugitive Emission Rate	kg/kg LNG regasified	0.009%	(Papadopoulo, et al., 2011)

3.11 Power Generation

Two possible end uses of the delivered natural gas were modeled at the destination facility-power generation from a natural gas combined cycle (NGCC) power plant with and without carbon capture and sequestration (CCS). The power generation stage is modeled using the NETL baseline fossil energy plant report (James, 2019), and the modeling parameters do not vary across the four LNG receiving countries analyzed in this study.

Exhibit 3-13 summarizes the key parameters for the Power Generation stage.

Exhibit 3-13. Key Parameters for Power Generation Stage of LCA

Parameter	Units	Value	Source
NGCC without CCS			(James, 2019)
NOx Emissions, without CCS	kg/MWh_{net}	0.012	
CO_2 Emissions, without CCS	kg/MWh_{net}	342.46	
Natural Gas Flowrate, without CCS	kg/MWh_{net}	128.30	
NGCC with CCS			
NOx Emissions, with CCS	kg/MWh_{net}	0.010	
CO_2 Emissions, with CCS	kg/MWh_{net}	38.56	
Natural Gas Flowrate, with CCS	kg/MWh_{net}	144.38	

3.12 Construction

The impacts of constructing new facilities for the Alaska LNG project have been modeled based on estimated materials and data from the Alaska LNG Resource Report (Alaska LNG Project, 2017). Emissions from the construction of new wells were also estimated based on information provided by the ARI report on gas supply (Kuuskraa, et al., 2022a). The new facilities considered in construction emissions include the GTP, mainline pipeline, PBTL and PTTL, eleven new wells, and the liquefaction facility.

The Alaska LNG Resource Report (Alaska LNG Project, 2017) provides estimated annual emissions of construction-related operations for the GTP, mainline pipeline, PBTL and PTTL, and the liquefaction facility. This includes the emissions from onroad vehicles, nonroad equipment, generators, marine and rail logistics, and fugitives. These annual emissions were combined and added to estimates of material emissions for each new facility. Emissions from materials were

estimated based on steel and concrete makeup. Components of the GTP that were included in these estimates include six natural gas compressor turbines, six CO_2 compressor turbines, six power generation turbines, two building heaters, three emergency generators, four CO_2 flares, and two gas bath heaters. Materials for the mainline pipeline and the PBTL and PTTL pipelines were estimated based on pipeline lengths (see **Exhibit 3-7** and **Exhibit 3-3**, respectively) and diameters. Furthermore, materials for the PBU Miscible Gas Sales Project and the PTU Expansion Project, two development projects required in order to meet gas demand, were also estimated. These emissions are based on data provided by (Kuuskraa, et al., 2022a). These projects would include the construction of four new pipelines that are 25, 3, 8, and 8 miles in length. Emissions from the dredging of 5,000 yd^3 of materials that is required for the PTU Expansion Project are also included, using data from (Bianchini, et al., 2019). Furthermore, given the possible addition of eleven new well drilling sites, material emissions were estimated based on (Prusinski, et al., 2004) and (World Steel, 2011). Material emissions from the liquefaction facility were estimated based on the NETL 2019 LNG LCA report (Roman-White, et al., 2019). **Exhibit 3-15** displays the total emissions estimated for each new construction required for the project. These values combine the emissions associated with construction operations and materials. **Exhibit 3-15** displays these parameters on a normalized basis of per kilogram of natural gas produced for sales over the entire 33-year timespan of the project.

Exhibit 3-14. Summary of Parameters Used for Construction Stage of LCA

GTP Construction	kg CO_2e*	4.55E6	(Alaska LNG Project, 2017)
Mainline Pipeline Construction	kg CO_2e*	1.52E9	
PBTL and PTTL Construction	kg CO_2e*	3.37E7	
Liquefaction Facility Construction	kg CO_2e*	5.46E5	
Well Sites Construction	kg CO_2e*	4.25E6	(Kuuskraa, et al., 2022a)
PBU Miscible Gas Sales Project	kg CO_2e*	1.85E7	
PTU Expansion Project	kg CO_2e*	2.6E5	

*Reported in AR4 100-year values

Exhibit 3-15. Summary of Normalized Parameters Used for Construction Stage of LCA

Parameter	Units	Value	Source
GTP Construction	kg CO_2e/kg gas*	7.23E-06	(Alaska LNG Project, 2017)
Mainline Pipeline Construction	kg CO_2e/kg gas*	0.002	
PBTL and PTTL Construction	kg CO_2e/kg gas*	10.7E-04	
Liquefaction Facility Construction	kg CO_2e/kg gas*	9.3E-04	
Well Sites Construction	kg CO_2e/kg gas*	5.64E-07	(Bianchini, et al., 2019)
PBU Miscible Gas Sales Project	kg CO_2e/kg gas*	9.86E-05	
PTU Expansion Project	kg CO_2e*	2.65E-07	

*Reported in AR4 100-year values

3.13 US Average Crude Oil

In order to keep all three scenarios functionally equivalent for the multiproduct functional unit, US average crude oil data was used from the Crude Oil Baseline Report (Cooney et al., 2016). For all three scenarios, US average data for refinery and end use was added to oil produced in Alaska to cover the entire life cycle of crude oil. The entire life cycle includes production, transportation, refining, and end use. For Scenarios 1 and 2, US average crude oil data for all stages of the life cycle were used to match the production values in Scenario 3. **Exhibit 3-16** shows the key parameters used in this stage.

Exhibit 3-16. Summary of Parameters Used for US Average Stage of LCA

Parameter	Units	Value	Source
US Average Crude Refinery and End Use	kg CO_2e/kg crude*	3.30	(Cooney, et al., 2017)
US Average Crude Entire Life Cycle	kg CO_2e/kg crude*	3.70	

*Reported in AR4 100-year values

3.14 US Lower 48 Average Natural Gas

In order to make Scenario 1 functionally equivalent to Scenarios 2 and 3, US Lower 48 average natural gas supply data was used to model natural gas delivery to the four destination countries. Parameters from the NETL 2020 One Future report (Rai, et al., 2020) were used to model this data. The only processes that changed from this report were the processes related to power generation and ocean transport. The same power generation parameters that are seen in **Exhibit 3-13** were used to model power generation for the US Lower 48 average natural gas. The ocean transport process was only varied to represent the distances between Corpus Christi, Texas and each of the four destination countries, as shown in **Exhibit 3-17. Exhibit 3-18** and **Exhibit 3-19** show the cradle-to-gate and cradle-to-grave emission factors used for the US Lower 48 LNG process of the model.

Exhibit 3-17. Summary of Parameters Used for Ocean Distances in US Lower 48 Average Gas Model

Parameter	Units	Japan (Futtsu)	South Korea (Incheon)	China (Shanghai)	India (Mumbai)	Source
Distance from Corpus Christi, US	miles	10,575	11,625	11,671	11,266	(Cooney, et al., 2017)

Exhibit 3-18. Summary of Parameters Used for US Lower 48 LNG Export and End Use Stage of LCA – Without CCS*

Parameter	Units	Country	Value	Source
Cradle to Liquefaction				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg LNG liquefied	Japan	8.99E-01	(Littlefield, et al., 2019)
		South Korea	8.99E-01	
		China	8.99E-01	
		India	9.00E-01	
Cradle to Delivered				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg NG regasified	Japan	1.28E+00	(Littlefield, et al., 2019)
		South Korea	1.31E+00	
		China	1.31E+00	
		India	1.31E+00	
Cradle to Grave				
US Lower 48 LNG Export and End Use	kg CO_2e/ MWh	Japan	5.07E+02	(Littlefield, et al., 2019)
		South Korea	5.10E+02	
		China	5.10E+02	
		India	5.10E+02	

*Reported in AR4 100-year values

Exhibit 3-19. Summary of Parameters Used for US Lower 48 LNG Export and End Use Stage of LCA – With CCS*

Parameter	Units	Country	Value	Source
Cradle to Liquefaction				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg LNG liquefied	Japan	5.10E-01	(Littlefield, et al., 2019)
		South Korea	5.35E-01	
		China	5.36E-01	
		India	5.26E-01	

Parameter	Units	Country	Value	Source
Cradle to Delivered				
US Lower 48 LNG Export and End Use	kg CO_2e/ kg NG regasified	Japan	8.27E-01	(Littlefield, et al., 2019)
		South Korea	8.55E-01	
		China	8.56E-01	
		India	8.45E-01	
Cradle to Grave				
US Lower 48 LNG Export and End Use	kg CO_2e/ MWh	Japan	2.23E+02	(Littlefield, et al., 2019)
		South Korea	2.27E+02	
		China	2.28E+02	
		India	2.26E+02	

*Reported in AR4 100-year values

3.15 Reporting Units

This LCA by default presents the GWP results using the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (IPCC 2013a) 100-yr impact factors for CO_2, CH_4, N_2O, and SF_6. The appendix of this report also presents the results using the Fifth and Sixth Assessment Report (AR5) (IPCC 2013b) and AR6 (IPCC 2021)) 100-yr impact factors. **Exhibit 3-20** shows the impact factors for the GHGs based on the three IPCC reports.

Exhibit 3-20. GWP Factors from AR4, AR5, and AR6 (kg CO_2-equivalent per kg of GHG emitted)

GHG	AR4 (20-yr)	AR4 (100-yr)	AR5 (20-yr)	AR5 (100-yr)	AR6 (20-yr)	AR6 (100 yr)
CO_2	1	1	1	1	1	1
CH_4	72	25	86	36	82.5	30
N_2O	289	298	268	298	273	273
SF_6	16,300	22,800	17,783	26,087	18,300	25,200

4 RESULTS

When comparing the GHG emissions results of Alaskan LNG production across the three scenarios, it is important to recognize that extracting the natural gas for export instead of using it for reservoir pressure management to produce oil (BAU, Scenario 1) has a direct effect on the quantity of oil produced in the North Slope. Therefore, to assess and compare how GHG emissions may change if natural gas is diverted to LNG exports, the change in the GHG emissions from oil production must also be considered. The multiproduct functional unit results provide the total GHG emissions per unit of service provided to society. As noted in **Section 2.5** above, the multiproduct functional unit is 1 MWh of electricity production from natural gas and 40 kg of crude oil-derived products consumed. Multiproduct functional results are provided in **Section 4.1** below.

Alternatively, results are presented in this study on a single product functional unit basis in **Section 4.2** to achieve comparability on a per unit of electricity production from use of imported natural gas in each receiving country. These results are comparatively the same as the multiproduct functional unit results, but only show the GHG contributions related to the natural gas product.

LCA results for all scenarios modeled from Alaska to the four destination countries (Japan, India, Korea, and China) are shown in this section. The main report shows results using the AR4 GWP values. Multiproduct and single-product functional unit results are shown over 20 and 100-year time horizons for each of the three scenarios with and without CCS for power generation at a NGCC power plant. Sensitivity analysis results are also shown over 20 and 100-year time horizons for Scenario 3 without CCS for power generation at a NGCC power plant. Speciated emissions results, as well as annual and lifetime profile results, are shown over 100-year time horizons. Additional results using AR5 and AR6 GWP values are located within the Appendix.

4.1 MULTIPRODUCT FUNCTIONAL UNIT RESULTS

The following section discusses multiproduct functional unit results. The results are available on a per 1 MWh of electricity generated and consumed in the destination country, and production and consumption of 40 kg of crude oil-derived products consumed basis across all the three scenarios. Transmission of electricity was not considered due to the highly variable and unknown transmission and distribution losses that occur within each destination country.

Scenario 3 serves as the foundation for generating multiproduct system boundary results. The other two scenarios are made functionally equivalent to Scenario 3 by compensating for the difference in oil and gas production through the addition of US average crude and natural gas. In addition, US average emissions from crude refining and end use have been added to all three scenarios to ensure both the natural gas and oil supply chain life cycle GHG emissions from extraction to end use are accounted for in the study.

While the LCA results generated presume combustion of the natural gas in an NGCC plant in the destination country, combustion of the natural gas in other ways would have GWP profiles similar to that of NGCC without CCS. While there could be slight variations in end use efficiency

and thus the quantitative results, we would expect directionally comparable differences between the three Scenarios.

4.1.1 Multiproduct Functional Unit Results (AR4 – 100-year)

Results in this section are shown using AR4 GWP values on a 100-year time scale. **Exhibit 4-1** shows Scenarios 1, 2, and 3 with delivery to Japan. An NGCC power plant both with and without CCS is considered. **Exhibit 4-2**, **Exhibit 4-3,** and **Exhibit 4-4** display the same results, but with LNG delivery to South Korea, China, and India, respectively.

Exhibit 4-1. Multiproduct Functional Unit – Japan (AR4 – 100-yr)

Exhibit 4-2. Multiproduct Functional Unit – South Korea (AR4 – 100-yr)

Exhibit 4-3. Multiproduct Functional Unit – China (AR4 – 100-yr)

Exhibit 4-4. Multiproduct Functional Unit – India (AR4 – 100-yr)

The results show that for each of the four destination countries, expected life cycle emissions from Scenarios 2 and 3 are not higher than those from Scenario 1 when considering an NGCC power plant both with and without CCS and commensurate crude oil derived products consumption. The mean expected emissions from Scenarios 2 and 3 are lower than the mean expected emissions from Scenario 1. However, upon accounting for the uncertainty in the results, we observe overlap between Scenarios 2 and 3 and Scenario 1.

The mean expected Scenario 1 BAU results are higher on a per unit of service provided basis for the life cycle because oil production in the PBU currently produces, separates, and compresses the associated gas produced and then reinjects it into the oil reservoir to assist in oil production. All GHG burdens are assigned to the only current product – crude oil. In Scenarios 2 and 3, where the gas is now a product, the GHG burdens associated with oil extraction and initial separation of liquid and gaseous products output from the production wells are allocated on an energy basis to both products – crude oil and exported natural gas. Natural gas liquids are separated at the GTP and then combined with the oil product for export. A small portion is used to support local operations, although no adjustment has been made in this study for local natural gas liquids use; the consumption is minor compared to total energy export volumes and

do not impact the results interpretation. Natural gas liquids production is assigned to the oil product consistent with current operations.

In Scenario 2, the carbon dioxide separation, compression, and sequestration are shared by the oil and natural gas products on a product energy ratio. CO_2 under Scenario 3 used for CO_2-EOR production is assigned only to the oil product. In both Scenarios 2 and 3, a portion of the natural gas produced is still used to support oil production across the study period. The proportion varies across the 33-year study period, with nearly 90% in the initial years and then a steady decline to 0% by year 22 of the project. GHG emissions associated with the natural gas that is separated and compressed to a high pressure for reinjection into the oil field is assigned to the oil product. Oil production declines because of the reduction in natural gas availability for reservoir pressure management, in comparison to Scenario 1 BAU. The natural gas supply portion of the Upstream Study (Kuuskraa, et al., 2022a) finds that for optimum long-term production of the natural gas reserves of the Prudhoe Bay Unit (PBU), the CO_2 from the Gas Treatment Plant needs to be reinjected into a geologic setting other than the oil and natural gas reservoir at the PBU. Avoiding reinjection of CO_2 into the PBU will enable the reservoir pressure in the PBU to be reduced, helping increase the ultimate recovery of natural gas reserves from the PBU. Similarly, this will preclude increasing the CO_2 concentration of the natural gas produced from the PBU, thus avoiding the steadily higher energy requirements for gas treatment and compression at the Gas Treatment Plant.

These are the primary reasons why CO_2 produced with the crude oil and associated natural gas must be managed through geologic sequestration (Scenario 2) or used for CO_2-EOR in the Kuparuk Oil Field (Scenario 3).

The power plant operation and system expansion addition of US average crude refining and end use dominate the life cycle results for Scenarios 2 and 3. Scenario 1 emissions are largely from the system expansion addition of US Lower 48 natural gas. Other notable sources of emissions for all scenarios are natural gas extraction, liquefaction, and ocean transport.

On comparing results for Scenarios 2 and 3, we estimate slightly lower mean GWP values for Scenario 3 on account of the higher emissions intensity of US average crude used for system expansion of Scenario 2, to ensure its functional equivalence to Scenario 3. However, the significant overlap between uncertainty ranges for the two scenarios makes it difficult to suggest one option over the other from a life cycle GHG emissions perspective. Over the four destination countries, the relative differences among the scenarios are small. This is because most of the stagewise emissions throughout the life cycle are similar for the four countries, except for ocean transport distances. The ocean distances for Japan, Korea, and China are very similar, but India is much further away, and this leads to distinctly larger GWP effects.

4.1.2 Multiproduct Functional Unit Results (AR4 – 20-year)

Results in this section are shown using AR4 20-year GWP factors. These results follow the same format as those in Section 4.1.1, using a multiproduct functional unit for each of the three scenarios to the four destination countries. Again, an NGCC power plant in the receiving country both with and without CCS is considered.

Similar to the AR4 100-year results, Scenarios 2 and 3 do not show an increase in expected emissions over Scenario 1. Again, the mean expected emissions for Scenario 1 is higher than those of Scenarios 2 and 3, but we again observe overlap in the uncertainties among the three scenarios. These results also display the same dominating life cycle stages, with the system expansion of US Lower 48 natural gas being the largest emitter in Scenario 1, and power plant operations being the largest emitter in Scenarios 2 and 3. The results for the AR4 20-year scenarios are consistently higher due to the higher GWP values used in the shorter time horizon, most notably for methane which has a GWP roughly three times higher than in the AR4 100-year method.

Exhibit 4-5. Multiproduct Functional Unit – Japan (AR4 – 20-yr)

Exhibit 4-6. Multiproduct Functional Unit – South Korea (AR4 – 20-yr)

Exhibit 4-7. Multiproduct Functional Unit – China (AR4 – 20-yr)

Exhibit 4-8. Multiproduct Functional Unit – India (AR4 – 20-yr)

4.2 Single Product Functional Unit Results

This section shows results using a single functional unit of 1 MWh of electricity generated in the destination countries (by combusting natural gas sourced from Alaska). These results differ from the multiproduct functional unit results as they do not include crude oil produced on the Alaskan North Slope, refining and end use of the crude oil over its life cycle, or the expanded system boundary contributions for US average crude oil production and end use. In short, these results are the same as the multiproduct functional unit results with the oil related product systems removed. These results are useful when comparing results on a natural gas power generation basis only but *should not be used to assess the comparative GHG difference between the three Scenarios* as they do not represent an equivalent service to society. These results are shown using 20 and 100-year time horizons and the IPCC AR4 GWP values, with and without CCS.

4.2.1 Single Product Functional Unit Results (AR4 – 100-yr)

These results are shown using AR4 100-year GWP factors. **Exhibit 4-9** displays results for Scenarios 1, 2, and 3 delivering to Japan, using an NGCC power plant both with and without CCS. **Exhibit 4-10**, **Exhibit 4-11**, and **Exhibit 4-12** show the same results, except for delivery to South Korea, China, and India, respectively.

Exhibit 4-9. Single Product Functional Unit – Japan (AR4 – 100-yr)

Exhibit 4-10. Single Product Functional Unit – South Korea (AR4 – 100-yr)

Exhibit 4-11. Single Product Functional Unit – China (AR4 – 100-yr)

Exhibit 4-12. Single Product Functional Unit – India (AR4 – 100-yr)

These results show that both Scenarios 2 and 3 are not expected to produce an increase in emissions over Scenario 1. Like the multiproduct functional unit results, the mean expected emissions for Scenario 1 is higher than the other two scenarios, but there is an overlap among all three scenarios' uncertainties. It is important to note that, for both multiproduct and single product results, the overlap between scenarios grows as the ocean transport distance between Alaska and the destination country grows due to an increase in emissions in the ocean transport stage in Scenarios 2 and 3. Therefore, the difference in expected emissions between Scenarios 2 and 3 and Scenario 1 for India is less than that for Japan.

Scenario 2 and Scenario 3 have very similar results because while sequestration offers some emission savings, it does not make a notable difference when compared to Scenario 3. Furthermore, because the system expansion of crude oil has been taken out of the single functional unit results, there is less variability in the sources of emissions between Scenario 2 and Scenario 3, leading to more similar total emissions between them. In addition, the most variable component across countries is the ocean transport distance.

System expansion of US Lower 48 LNG Export and End Use is the only stage in Scenario 1 across each of the four destination countries. Power plant operations is by far the largest contributor

to emissions in Scenarios 2 and 3. Other significant contributions come from ocean transport, natural gas extraction, and liquefaction.

4.2.2 Single Product Functional Unit Results (AR4 – 20-year)

Results were generated using AR4 20-year GWP factors. Similar to the results shown in Section 4.2.1, results are based on a single product functional unit for each of the three scenarios to each of the four destination countries. An NGCC power plant, both with and without CCS, is considered.

This section produces very similar results to those of the previous section. Once again, Scenario 1 is observed to generate higher mean emissions than both Scenarios 2 and 3 for all destination countries, yet there exists an overlap in scenario uncertainties. The dominant life cycle stages also remain the same from the previous section, with system expansion of US Lower 48 LNG Export and End Use contributing the most to Scenario 1, and power plant operations contributing the most to Scenarios 2 and 3.

The main reason for the difference in results for this section are again the significantly higher GWP values for methane in the shorter 20-year time horizon.

Exhibit 4-13. Single Product Functional Unit – Japan (AR4 – 20-yr)

Exhibit 4-14. Single Product Functional Unit – South Korea (AR4 – 20-yr)

Exhibit 4-15. Single Product Functional Unit – China (AR4 – 20-yr)

Exhibit 4-16. Single Product Functional Unit – India (AR4 – 20-yr)

4.3 Case 3: Speciated GHG Emissions

4.3.1 Speciated GHG Emissions (AR4 100-yr)

The following section shows speciated results (i.e., broken out by greenhouse gas) of Scenario 3 to China, on a AR4 100-year GWP basis. The results are shown on the same multiproduct functional unit basis used in **Section 4.1**. These results assume that natural gas is delivered to an NGCC power plant without CCS in China. The speciated results data tables for all destination countries are provided in the Appendix.

The resulting emissions are grouped into categories similar to those presented on the multiproduct functional unit basis above. **Exhibit 4-17** displays speciated results for LNG delivery to China, using NGCC plant without CCS.

Exhibit 4-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 100-yr)

The results above show that similar to the single product and multiproduct functional unit results shown in prior sections, the Power Plant stage contributes most to overall emissions. The next largest stage contributor is crude oil refining and end use. These results also show that CO_2 emissions contribute the most to the GHG emissions in each category. Some of the stages, such as "Natural Gas Pipelines to GTP", "Natural Gas Alaskan Pipeline Transport", "Natural Gas Extraction, Associated", "Crude Oil Extraction, Associated", and "Natural Gas Processing at GTP", have high shares of CH_4 emissions for each of the four destination countries. Emissions of N_2O and SF_6 can be considered negligible in this study.

4.4 CUMULATIVE EMISSIONS PROFILES

The following section provides the cumulative emissions totals for the three scenarios over the 33-year lifetime of the project. **Exhibit 4-18** reports ARI provided data on annual quantities of crude and gas production for the three scenarios from the Alaskan North Slope. The exhibit also reports the quantities of makeup crude oil and natural gas required by Scenarios 1 and 2 in order to be functionally equivalent to Scenario 3 by means of system expansion. The yearly data are provided on both a primary and alternative unit basis (kg and Tcf for natural gas; kg and MMbbl for oil).

The fuel quantities provided in **Exhibit 4-18** are multiplied with the corresponding emission factors estimated by this analysis to obtain the annual GHG emission totals over the project lifetime, as reported in **Exhibit 4-20.** As an example, the estimated emission factors and emissions totals for the case of China without CCS are depicted in this section. **Exhibit 4-19** displays the emission factors used to calculate cumulative emissions for each country, both without and with CCS.

Exhibit 4-18. Annual Quantities of Oil and Gas Produced in Each Scenario (Wallace, et al., 2022)*

	Scenario 1			Scenario 2			Scenario 3		
Year	*Oil Production, kg (MMbbl)*	*System Expansion: Gas Production, kg (Tcf)*	*System Expansion: Oil Production, kg (MMbbl)*	*Gas Production, kg (Tcf)*	*Oil Production, kg (MMbbl)*	*System Expansion: Oil Production, kg (MMbbl)*	*Gas Production, kg (Tcf)*	*Oil Production, kg (MMbbl)*	*CO2-EOR Oil Production, kg (MMbbl)*
2029	8.97E+09 (6.20E+01)	3.88E+09 (1.55E-01)	-1.23E+08 (-8.48E-01)	3.88E+09 (1.55E-01)	8.77E+09 (6.06E+01)	7.71E+07 (5.33E-01)	3.88E+09 (1.55E-01)	8.77E+09 (6.06E+01)	7.71E+07 (5.33E-01)
2030	8.71E+09 (6.02E+01)	9.70E+09 (3.88E-01)	-2.69E+07 (-1.86E-01)	9.70E+09 (3.88E-01)	8.24E+09 (5.69E+01)	4.46E+08 (3.08E+00)	9.70E+09 (3.88E-01)	8.24E+09 (5.69E+01)	4.46E+08 (3.08E+00)
2031	8.47E+09 (5.85E+01)	1.75E+10 (6.98E-01)	3.12E+08 (2.16E+00)	1.75E+10 (6.98E-01)	7.71E+09 (5.33E+01)	1.07E+09 (7.42E+00)	1.75E+10 (6.98E-01)	7.71E+09 (5.33E+01)	1.07E+09 (7.42E+00)
2032	8.23E+09 (5.69E+01)	2.13E+10 (8.53E-01)	7.19E+08 (4.97E+00)	2.13E+10 (8.53E-01)	7.23E+09 (5.00E+01)	1.72E+09 (1.19E+01)	2.13E+10 (8.53E-01)	7.23E+09 (5.00E+01)	1.72E+09 (1.19E+01)
2033	8.00E+09 (5.53E+01)	2.33E+10 (9.31E-01)	9.63E+08 (6.66E+00)	2.33E+10 (9.31E-01)	6.79E+09 (4.69E+01)	2.17E+09 (1.50E+01)	2.33E+10 (9.31E-01)	6.79E+09 (4.69E+01)	2.17E+09 (1.50E+01)
2034	7.77E+09 (5.37E+01)	2.33E+10 (9.31E-01)	9.63E+08 (6.65E+00)	2.33E+10 (9.31E-01)	6.38E+09 (4.41E+01)	2.36E+09 (1.63E+01)	2.33E+10 (9.31E-01)	6.38E+09 (4.41E+01)	2.36E+09 (1.63E+01)
2035	7.56E+09 (5.22E+01)	2.33E+10 (9.31E-01)	8.56E+08 (5.91E+00)	2.33E+10 (9.31E-01)	5.96E+09 (4.12E+01)	2.45E+09 (1.69E+01)	2.33E+10 (9.31E-01)	5.96E+09 (4.12E+01)	2.45E+09 (1.69E+01)
2036	7.35E+09 (5.08E+01)	2.33E+10 (9.31E-01)	7.19E+08 (4.97E+00)	2.33E+10 (9.31E-01)	5.58E+09 (3.86E+01)	2.49E+09 (1.72E+01)	2.33E+10 (9.31E-01)	5.58E+09 (3.86E+01)	2.49E+09 (1.72E+01)
2037	7.15E+09 (4.94E+01)	2.33E+10 (9.31E-01)	6.07E+08 (4.20E+00)	2.33E+10 (9.31E-01)	5.22E+09 (3.61E+01)	2.53E+09 (1.75E+01)	2.33E+10 (9.31E-01)	5.22E+09 (3.61E+01)	2.53E+09 (1.75E+01)
2038	6.95E+09 (4.80E+01)	2.33E+10 (9.31E-01)	5.20E+08 (3.60E+00)	2.33E+10 (9.31E-01)	4.88E+09 (3.38E+01)	2.59E+09 (1.79E+01)	2.33E+10 (9.31E-01)	4.88E+09 (3.38E+01)	2.59E+09 (1.79E+01)
2039	6.75E+09 (4.67E+01)	2.33E+10 (9.31E-01)	4.21E+08 (2.91E+00)	2.33E+10 (9.31E-01)	4.57E+09 (3.16E+01)	2.61E+09 (1.80E+01)	2.33E+10 (9.31E-01)	4.57E+09 (3.16E+01)	2.61E+09 (1.80E+01)
2040	6.57E+09 (4.54E+01)	2.33E+10 (9.31E-01)	3.21E+08 (2.22E+00)	2.33E+10 (9.31E-01)	4.28E+09 (2.96E+01)	2.61E+09 (1.81E+01)	2.33E+10 (9.31E-01)	4.28E+09 (2.96E+01)	2.61E+09 (1.81E+01)
2041	6.39E+09 (4.42E+01)	2.33E+10 (9.31E-01)	2.14E+08 (1.48E+00)	2.33E+10 (9.31E-01)	4.01E+09 (2.77E+01)	2.60E+09 (1.80E+01)	2.33E+10 (9.31E-01)	4.01E+09 (2.77E+01)	2.60E+09 (1.80E+01)
2042	6.22E+09 (4.30E+01)	2.33E+10 (9.31E-01)	1.22E+08 (8.46E-01)	2.33E+10 (9.31E-01)	3.75E+09 (2.59E+01)	2.59E+09 (1.79E+01)	2.33E+10 (9.31E-01)	3.75E+09 (2.59E+01)	2.59E+09 (1.79E+01)
2043	6.05E+09 (4.18E+01)	2.33E+10 (9.31E-01)	4.86E+07 (3.36E-01)	2.33E+10 (9.31E-01)	3.51E+09 (2.43E+01)	2.59E+09 (1.79E+01)	2.33E+10 (9.31E-01)	3.51E+09 (2.43E+01)	2.59E+09 (1.79E+01)
2044	5.88E+09 (4.07E+01)	2.33E+10 (9.31E-01)	-1.02E+07 (-7.05E-02)	2.33E+10 (9.31E-01)	3.29E+09 (2.27E+01)	2.59E+09 (1.79E+01)	2.33E+10 (9.31E-01)	3.29E+09 (2.27E+01)	2.59E+09 (1.79E+01)
2045	5.72E+09 (3.96E+01)	2.33E+10 (9.31E-01)	-5.11E+07 (-3.53E-01)	2.33E+10 (9.31E-01)	3.08E+09 (2.13E+01)	2.60E+09 (1.79E+01)	2.33E+10 (9.31E-01)	3.08E+09 (2.13E+01)	2.60E+09 (1.79E+01)
2046	5.57E+09 (3.85E+01)	2.33E+10 (9.31E-01)	-8.56E+07 (-5.91E-01)	2.33E+10 (9.31E-01)	2.88E+09 (1.99E+01)	2.60E+09 (1.80E+01)	2.33E+10 (9.31E-01)	2.88E+09 (1.99E+01)	2.60E+09 (1.80E+01)

	Scenario 1			Scenario 2			Scenario 3		
Year	*Oil Production, kg (MMbbl)*	*System Expansion: Gas Production, kg (Tcf)*	*System Expansion: Oil Production, kg (MMbbl)*	*Gas Production, kg (Tcf)*	*Oil Production, kg (MMbbl)*	*System Expansion: Oil Production, kg (MMbbl)*	*Gas Production, kg (Tcf)*	*Oil Production, kg (MMbbl)*	*CO2-EOR Oil Production, kg (MMbbl)*
2047	5.42E+09 (3.75E+01)	2.33E+10 (9.31E-01)	-1.17E+08 (-8.07E-01)	2.33E+10 (9.31E-01)	2.70E+09 (1.87E+01)	2.60E+09 (1.80E+01)	2.33E+10 (9.31E-01)	2.70E+09 (1.87E+01)	2.60E+09 (1.80E+01)
2048	5.28E+09 (3.65E+01)	2.33E+10 (9.31E-01)	-1.57E+08 (-1.08E+00)	2.33E+10 (9.31E-01)	2.53E+09 (1.75E+01)	2.59E+09 (1.79E+01)	2.33E+10 (9.31E-01)	2.53E+09 (1.75E+01)	2.59E+09 (1.79E+01)
2049	5.13E+09 (3.55E+01)	2.33E+10 (9.31E-01)	-1.88E+08 (-1.30E+00)	2.33E+10 (9.31E-01)	2.37E+09 (1.64E+01)	2.57E+09 (1.78E+01)	2.33E+10 (9.31E-01)	2.37E+09 (1.64E+01)	2.57E+09 (1.78E+01)
2050	5.00E+09 (3.45E+01)	2.33E+10 (9.31E-01)	-2.09E+08 (-1.44E+00)	2.33E+10 (9.31E-01)	2.22E+09 (1.54E+01)	2.57E+09 (1.77E+01)	2.33E+10 (9.31E-01)	2.22E+09 (1.54E+01)	2.57E+09 (1.77E+01)
2051	4.86E+09 (3.36E+01)	2.33E+10 (9.31E-01)	-2.21E+08 (-1.53E+00)	2.33E+10 (9.31E-01)	2.08E+09 (1.44E+01)	2.56E+09 (1.77E+01)	2.33E+10 (9.31E-01)	2.08E+09 (1.44E+01)	2.56E+09 (1.77E+01)
2052	4.73E+09 (3.27E+01)	2.33E+10 (9.31E-01)	-2.63E+08 (-1.82E+00)	2.33E+10 (9.31E-01)	1.95E+09 (1.35E+01)	2.52E+09 (1.74E+01)	2.33E+10 (9.31E-01)	1.95E+09 (1.35E+01)	2.52E+09 (1.74E+01)
2053	4.61E+09 (3.19E+01)	2.33E+10 (9.31E-01)	-3.13E+08 (-2.16E+00)	2.33E+10 (9.31E-01)	1.83E+09 (1.27E+01)	2.47E+09 (1.70E+01)	2.33E+10 (9.31E-01)	1.83E+09 (1.27E+01)	2.47E+09 (1.70E+01)
2054	4.49E+09 (3.10E+01)	2.33E+10 (9.31E-01)	-3.42E+08 (-2.36E+00)	2.33E+10 (9.31E-01)	1.72E+09 (1.19E+01)	2.43E+09 (1.68E+01)	2.33E+10 (9.31E-01)	1.72E+09 (1.19E+01)	2.43E+09 (1.68E+01)
2055	4.37E+09 (3.02E+01)	2.33E+10 (9.31E-01)	-3.55E+08 (-2.45E+00)	2.33E+10 (9.31E-01)	1.61E+09 (1.11E+01)	2.41E+09 (1.66E+01)	2.33E+10 (9.31E-01)	1.61E+09 (1.11E+01)	2.41E+09 (1.66E+01)
2056	4.26E+09 (2.94E+01)	2.33E+10 (9.31E-01)	-3.41E+08 (-2.36E+00)	2.33E+10 (9.31E-01)	1.51E+09 (1.04E+01)	2.41E+09 (1.66E+01)	2.33E+10 (9.31E-01)	1.51E+09 (1.04E+01)	2.41E+09 (1.66E+01)
2057	4.15E+09 (2.87E+01)	2.33E+10 (9.31E-01)	-3.47E+08 (-2.40E+00)	2.33E+10 (9.31E-01)	1.42E+09 (9.79E+00)	2.38E+09 (1.65E+01)	2.33E+10 (9.31E-01)	1.42E+09 (9.79E+00)	2.38E+09 (1.65E+01)
2058	4.04E+09 (2.79E+01)	2.08E+10 (8.34E-01)	-4.13E+08 (-2.58E+00)	2.08E+10 (8.34E-01)	1.33E+09 (9.18E+00)	2.30E+09 (1.59E+01)	2.08E+10 (8.34E-01)	1.33E+09 (9.18E+00)	2.30E+09 (1.59E+01)
2059	3.93E+09 (2.71E+01)	1.67E+10 (6.68E-01)	-4.33E+08 (-2.99E+00)	1.67E+10 (6.68E-01)	1.23E+09 (8.53E+00)	2.26E+09 (1.56E+01)	1.67E+10 (6.68E-01)	1.23E+09 (8.53E+00)	2.26E+09 (1.56E+01)
2060	3.82E+09 (2.64E+01)	1.34E+10 (5.35E-01)	-4.63E+08 (-3.20E+00)	1.34E+10 (5.35E-01)	1.14E+09 (7.90E+00)	2.21E+09 (1.53E+01)	1.34E+10 (5.35E-01)	1.14E+09 (7.90E+00)	2.21E+09 (1.53E+01)
2061	3.71E+09 (2.56E+01)	1.07E+10 (4.27E-01)	-5.02E+08 (-3.47E+00)	1.07E+10 (4.27E-01)	1.05E+09 (7.27E+00)	2.15E+09 (1.49E+01)	1.07E+10 (4.27E-01)	1.05E+09 (7.27E+00)	2.15E+09 (1.49E+01)
Total (kg)	1.96E+11	6.96E+11	1.83E+09	6.96E+11	1.23E+11	7.51E+10	6.96E+11	1.23E+11	7.51E+10
Total (MMbbl)	1.36E+03	n/a	1.26E+01	n/a	8.49E+02	5.19E+02	n/a	8.49E+02	5.19E+02
Total (Tcf)	n/a	2.78E+01	n/a	2.78E+01	n/a	n/a	2.78E+01	n/a	n/a

*[Note: A conversion factor of 0.025 kg/scf was used for natural gas, and 144.7 kg/bbl for crude oil]

Exhibit 4-19. Estimated Emission Factors for Scenarios 1, 2, and 3 by Category for Each Country (AR4 – 100-yr)

	Japan Emission Factors						*South Korea Emission Factors*						*China Emission Factors*						*India Emission Factors*					
	Without CCS			*With CCS*			*Without CCS*			*With CCS*			*Without CCS*			*With CCS*			*Without CCS*			*With CCS*		
Emissions Category	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*	*Scen. 1*	*Scen. 2*	*Scen. 3*
Natural Gas Production, Transport and Liquefaction (kg CO_2e/kg NG liquefied)	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01	-	7.10E-01	7.05E-01
Natural Gas Ocean Transport, Regasification, and Power Plant (kg CO_2e/kg NG liquefied)	-	2.74E+00	2.74E+00	-	4.56E-01	4.56E-01	-	2.76E+00	2.76E+00	-	4.77E-01	4.77E-01	-	2.76E+00	2.76E+00	-	4.78E-01	4.78E-01	-	2.85E+00	2.85E+00	-	5.90E-01	5.90E-01
Crude Oil Production and Transport to Lower 48 (kg CO_2e/kg crude oil)	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01	1.43E-01	2.05E-01	3.10E-01
Crude Oil CO_2-EOR Production and Transport to Lower 48 (kg CO_2e/kg crude oil)	-	-	4.19E-01	-	-	4.19E-01	-	-	4.19E-01	-	-	4.19E-01	-	-	4.19E-01	-	-	4.19E-01	-	-	4.19E-01	-	-	4.19E-01
Crude Oil Refining and End use (kg CO_2e/kg crude oil)	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00	3.30E+00
System Expansion: US Lower 48 LNG Export and End Use (kg CO_2e/kg NG liquefied)	3.77E+00	-	-	1.48E+00	-	-	3.79E+00	-	-	1.50E+00	-	-	3.79E+00	-	-	1.50E+00	-	-	3.79E+00	-	-	1.49E+00	-	-
System Expansion: US Average Crude Oil Production and End Use (kg CO_2e/kg crude oil)	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-	3.70E+00	3.70E+00	-

Exhibit 4-20. Estimated Cumulative Emissions Totals for Scenarios 1, 2, and 3 by Category, China without CCS case (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	1.50E+01	-4.54E-01	4.54E+01	2.80E+00	1.09E+01	1.80E+00	2.89E+01	-	2.85E-01	4.47E+01	2.78E+00	1.09E+01	1.83E+00	2.92E+01	-	-	4.47E+01
2030	-	-	2.52E+00	5.83E+01	5.23E+01	-5.53E-01	1.13E+02	9.80E+00	3.81E+01	3.49E+00	5.61E+01	-	1.94E+00	1.09E+02	9.72E+00	3.81E+01	3.71E+00	5.78E+01	-	-	1.09E+02
2031	-	-	3.73E+00	8.63E+01	1.20E+02	6.02E-01	2.10E+02	2.24E+01	8.71E+01	5.07E+00	8.15E+01	-	5.91E+00	2.02E+02	2.22E+01	8.71E+01	5.74E+00	8.68E+01	-	-	2.02E+02
2032	-	-	4.91E+00	1.13E+02	2.02E+02	3.26E+00	3.23E+02	3.78E+01	1.47E+02	6.55E+00	1.05E+02	-	1.23E+01	3.09E+02	3.75E+01	1.47E+02	7.94E+00	1.16E+02	-	-	3.09E+02
2033	-	-	6.05E+00	1.40E+02	2.92E+02	6.83E+00	4.44E+02	5.46E+01	2.12E+02	7.94E+00	1.28E+02	-	2.03E+01	4.23E+02	5.42E+01	2.12E+02	1.02E+01	1.46E+02	-	-	4.23E+02
2034	-	-	7.16E+00	1.65E+02	3.81E+02	1.04E+01	5.64E+02	7.14E+01	2.78E+02	9.25E+00	1.49E+02	-	2.90E+01	5.36E+02	7.08E+01	2.78E+02	1.25E+01	1.75E+02	-	-	5.36E+02
2035	-	-	8.24E+00	1.90E+02	4.71E+02	1.36E+01	6.83E+02	8.82E+01	3.43E+02	1.05E+01	1.69E+02	-	3.81E+01	6.48E+02	8.75E+01	3.43E+02	1.48E+01	2.03E+02	-	-	6.48E+02
2036	-	-	9.28E+00	2.15E+02	5.61E+02	1.62E+01	8.01E+02	1.05E+02	4.08E+02	1.16E+01	1.87E+02	-	4.73E+01	7.59E+02	1.04E+02	4.08E+02	1.70E+01	2.29E+02	-	-	7.59E+02
2037	-	-	1.03E+01	2.38E+02	6.50E+02	1.85E+01	9.17E+02	1.22E+02	4.74E+02	1.27E+01	2.04E+02	-	5.67E+01	8.69E+02	1.21E+02	4.74E+02	1.91E+01	2.55E+02	-	-	8.68E+02
2038	-	-	1.13E+01	2.61E+02	7.40E+02	2.04E+01	1.03E+03	1.39E+02	5.39E+02	1.37E+01	2.20E+02	-	6.62E+01	9.78E+02	1.38E+02	5.39E+02	2.12E+01	2.79E+02	-	-	9.77E+02
2039	-	-	1.23E+01	2.84E+02	8.30E+02	2.19E+01	1.15E+03	1.55E+02	6.04E+02	1.46E+01	2.35E+02	-	7.59E+01	1.09E+03	1.54E+02	6.04E+02	2.32E+01	3.03E+02	-	-	1.08E+03
2040	-	-	1.32E+01	3.05E+02	9.19E+02	2.31E+01	1.26E+03	1.72E+02	6.70E+02	1.55E+01	2.49E+02	-	8.56E+01	1.19E+03	1.71E+02	6.70E+02	2.52E+01	3.26E+02	-	-	1.19E+03
2041	-	-	1.41E+01	3.26E+02	1.01E+03	2.39E+01	1.37E+03	1.89E+02	7.35E+02	1.63E+01	2.63E+02	-	9.52E+01	1.30E+03	1.88E+02	7.35E+02	2.71E+01	3.48E+02	-	-	1.30E+03
2042	-	-	1.50E+01	3.47E+02	1.10E+03	2.44E+01	1.49E+03	2.06E+02	8.00E+02	1.71E+01	2.75E+02	-	1.05E+02	1.40E+03	2.04E+02	8.00E+02	2.89E+01	3.69E+02	-	-	1.40E+03
2043	-	-	1.59E+01	3.67E+02	1.19E+03	2.46E+01	1.60E+03	2.23E+02	8.66E+02	1.78E+01	2.87E+02	-	1.14E+02	1.51E+03	2.21E+02	8.66E+02	3.07E+01	3.89E+02	-	-	1.51E+03
2044	-	-	1.67E+01	3.86E+02	1.28E+03	2.45E+01	1.71E+03	2.39E+02	9.31E+02	1.85E+01	2.98E+02	-	1.24E+02	1.61E+03	2.38E+02	9.31E+02	3.25E+01	4.08E+02	-	-	1.61E+03
2045	-	-	1.75E+01	4.05E+02	1.37E+03	2.43E+01	1.81E+03	2.56E+02	9.96E+02	1.91E+01	3.08E+02	-	1.33E+02	1.71E+03	2.54E+02	9.96E+02	3.42E+01	4.27E+02	-	-	1.71E+03
2046	-	-	1.83E+01	4.23E+02	1.46E+03	2.40E+01	1.92E+03	2.73E+02	1.06E+03	1.97E+01	3.17E+02	-	1.43E+02	1.81E+03	2.71E+02	1.06E+03	3.59E+01	4.45E+02	-	-	1.81E+03
2047	-	-	1.91E+01	4.41E+02	1.55E+03	2.36E+01	2.03E+03	2.90E+02	1.13E+03	2.03E+01	3.26E+02	-	1.53E+02	1.92E+03	2.88E+02	1.13E+03	3.75E+01	4.62E+02	-	-	1.91E+03
2048	-	-	1.98E+01	4.59E+02	1.64E+03	2.30E+01	2.14E+03	3.06E+02	1.19E+03	2.08E+01	3.34E+02	-	1.62E+02	2.02E+03	3.04E+02	1.19E+03	3.91E+01	4.79E+02	-	-	2.01E+03
2049	-	-	2.06E+01	4.76E+02	1.73E+03	2.23E+01	2.25E+03	3.23E+02	1.26E+03	2.13E+01	3.42E+02	-	1.72E+02	2.12E+03	3.21E+02	1.26E+03	4.07E+01	4.96E+02	-	-	2.11E+03
2050	-	-	2.13E+01	4.92E+02	1.82E+03	2.15E+01	2.35E+03	3.40E+02	1.32E+03	2.17E+01	3.50E+02	-	1.81E+02	2.22E+03	3.38E+02	1.32E+03	4.22E+01	5.11E+02	-	-	2.21E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	1.91E+03	2.07E+01	2.46E+03	3.57E+02	1.39E+03	2.22E+01	3.56E+02	-	1.91E+02	2.31E+03	3.54E+02	1.39E+03	4.37E+01	5.27E+02	-	-	2.31E+03
2052	-	-	2.27E+01	5.24E+02	2.00E+03	1.97E+01	2.56E+03	3.74E+02	1.45E+03	2.26E+01	3.63E+02	-	2.00E+02	2.41E+03	3.71E+02	1.45E+03	4.52E+01	5.41E+02	-	-	2.41E+03
2053	-	-	2.33E+01	5.39E+02	2.09E+03	1.86E+01	2.67E+03	3.90E+02	1.52E+03	2.29E+01	3.69E+02	-	2.09E+02	2.51E+03	3.88E+02	1.52E+03	4.66E+01	5.56E+02	-	-	2.51E+03
2054	-	-	2.40E+01	5.54E+02	2.18E+03	1.73E+01	2.77E+03	4.07E+02	1.58E+03	2.33E+01	3.75E+02	-	2.18E+02	2.61E+03	4.04E+02	1.58E+03	4.80E+01	5.69E+02	-	-	2.61E+03
2055	-	-	2.46E+01	5.68E+02	2.27E+03	1.60E+01	2.87E+03	4.24E+02	1.65E+03	2.36E+01	3.80E+02	-	2.27E+02	2.70E+03	4.21E+02	1.65E+03	4.93E+01	5.83E+02	-	-	2.70E+03
2056	-	-	2.52E+01	5.82E+02	2.35E+03	1.47E+01	2.98E+03	4.41E+02	1.71E+03	2.39E+01	3.85E+02	-	2.36E+02	2.80E+03	4.38E+02	1.71E+03	5.06E+01	5.95E+02	-	-	2.80E+03
2057	-	-	2.58E+01	5.96E+02	2.44E+03	1.35E+01	3.08E+03	4.58E+02	1.78E+03	2.42E+01	3.90E+02	-	2.45E+02	2.90E+03	4.54E+02	1.78E+03	5.19E+01	6.08E+02	-	-	2.89E+03
2058	-	-	2.64E+01	6.09E+02	2.52E+03	1.19E+01	3.17E+03	4.73E+02	1.84E+03	2.45E+01	3.94E+02	-	2.53E+02	2.98E+03	4.69E+02	1.84E+03	5.31E+01	6.20E+02	-	-	2.98E+03
2059	-	-	2.69E+01	6.22E+02	2.59E+03	1.03E+01	3.25E+03	4.85E+02	1.89E+03	2.47E+01	3.98E+02	-	2.62E+02	3.05E+03	4.81E+02	1.89E+03	5.43E+01	6.32E+02	-	-	3.05E+03
2060	-	-	2.75E+01	6.35E+02	2.64E+03	8.62E+00	3.31E+03	4.94E+02	1.92E+03	2.50E+01	4.02E+02	-	2.70E+02	3.11E+03	4.91E+02	1.92E+03	5.55E+01	6.43E+02	-	-	3.11E+03
2061	-	-	2.80E+01	6.47E+02	2.68E+03	6.76E+00	3.36E+03	5.02E+02	1.95E+03	2.52E+01	4.05E+02	-	2.78E+02	3.16E+03	4.98E+02	1.95E+03	5.66E+01	6.53E+02	-	-	3.16E+03

Exhibit 4-21. Total Electricity Generated in Each Destination Country, NGCC without CCS

Scenario	Japan	South Korea	China	India
Scenario 1, Electricity (MWh)	5.34E+09	5.33E+09	5.25E+09	5.33E+09
Scenario 2, Electricity (MWh)	5.41E+09	5.40E+09	5.32E+09	5.34E+09
Scenario 3, Electricity (MWh)	5.41E+09	5.40E+09	5.32E+09	5.34E+09

The estimated results (see **Exhibit 4-20**) depict that the BAU scenario (Scenario 1) would have the highest cumulative emissions over the 33-year project lifetime, followed by Scenario 2 and Scenario 3, respectively. The high cumulative emissions for Scenario 1 are due to the high carbon intensity of US Lower 48 LNG export and end use as compared to PBU associated gas production. In addition to this, lower quantities of LNG need to be shipped from Alaska to the destination countries to generate a MWh of electricity (as compared to LNG shipped from US Lower 48), due to the shorter shipping distances. As a result, for the same quantity of LNG shipped from Alaska (for Scenarios 2 and 3) and US Lower 48 (for Scenario 1), the total amount of electricity generated in the destination countries for Scenario 1 is lower (see **Exhibit 4-21**). In summary, the total quantity of service (in this case, electricity generated) is not consistent because these results reflect a GHG inventory approach representative of the quantity of natural gas exported from the Alaskan liquefaction facility and the quantity of crude oil produced from Scenario 3 over the 33-year LNG authorization time period. The quantity of crude oil exported was aligned using system expansion for Scenarios 1 and 2 to match Scenario 3. Scenario 1 was also expanded to include natural gas production to match the quantity of natural gas exported in Scenario 3. These results are consistent in the quantity of natural gas and crude oil exported from Alaska to each receiving country.

The 33-year cumulative emissions for Scenarios 2 and 3 are close, however on account of the higher carbon intensity of US average crude oil (used for system expansion of Scenario 2 to be functionally equivalent to Scenario 3) as compared to PBU associated crude oil production, lifetime emissions for Scenario 2 are slightly higher. **Exhibit 4-22**, **Exhibit 4-23**, and **Exhibit 4-24** depict the cumulative emissions profile for the China without CCS case, across Scenarios 1, 2, and 3, respectively.

Exhibit 4-22. Cumulative Emissions Profile for Scenario 1 – NGCC without CCS to China

Exhibit 4-23. Cumulative Emissions Profile for Scenario 2 – NGCC without CCS to China

Exhibit 4-24. Cumulative Emissions Profile for Scenario 3 – NGCC without CCS to China

4.5 SENSITIVITY ANALYSIS

Various sensitivity analyses were performed on Scenario 3 using a multiproduct functional unit with delivery to a NGCC power plant without CCS in each of the four destination countries.

4.5.1 Gas-to-Oil Ratio Sensitivity

The first sensitivity analysis was based on changing a key parameter, the gas-to-oil ratio (GOR), within the model to produce different results. Because prior results utilize a 33-yr weighted average for the GOR in the project timespan, varying this ratio in a sensitivity analysis provides clarity into how it affects overall emissions. For this analysis, the GOR was varied and run at 5% higher (69,368 scf/bbl) and 5% lower (62,763 scf/bbl) than its original value (66,064 scf/bbl). Scenario 3 without CCS was selected as the base case for understanding the effect of GOR on the overall results.

Exhibit 4-25 displays the sensitivity analysis results using AR4 100-yr GWP factors and **Exhibit 4-26** displays them using AR4 20-yr GWP factors. The main bars for each country in these exhibits show the multiproduct functional unit results previously seen in **Section 4.1.1** and **Section 4.1.2**. Error bars represent the total life cycle GHG emissions produced using the higher and lower gas-to-oil ratios.

This sensitivity analysis shows that varying the GOR by ± 5% has a modest impact on life cycle GHG emissions. For each of the countries in both exhibits, the total GHG emissions varies about 1-2 kg CO_2e/MWh electricity produced in either direction. This difference is relatively small, only representative of about 0.1 - 0.2% of total life cycle GHG emissions.

Exhibit 4-25. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 – 100-yr)

Exhibit 4-26. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 - 20-yr)

4.5.2 Methane Leakage Sensitivity

The second sensitivity analysis was based on estimating the effects of variation in CH_4 leakage. For this analysis, ± 5% variation in CH_4 emissions was modeled, while taking CH_4 emissions from all life cycle stages into account.

Exhibit 4-27 displays the sensitivity analysis results using AR4 100-yr GWP factors and **Exhibit 4-28** displays results using AR4 20-yr GWP factors.

As expected, the sensitivity is higher for the AR4 20-yr values because of the higher GWP values of CH_4 in the shorter time horizon.

As above, the main bars for each country in these exhibits show the multiproduct functional unit results previously seen in **Sections 4.1.1** and **4.1.2**. Error bars represent the total life cycle GHG emissions on account of a ±5% variation in CH_4 emissions.

This sensitivity analysis shows that varying the CH_4 leakage has a modest impact on life cycle GHG emissions. For each of the countries in both exhibits, the total GHG emissions vary about 1 to 3 kg CO_2e/MWh electricity produced in either direction. This difference is representative of about 0.1 – 0.4% of total life cycle GHG emissions.

Exhibit 4-27. Methane Leakage Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 100-yr)

Exhibit 4-28. Methane Leakage Sensitivity Analysis – Scenario 3 NGCC without CCS (AR4 - 20-yr)

5 CONCLUSIONS

This analysis has determined that expected life cycle emissions for the two proposed Scenarios 2 and 3 of the Alaska LNG Project would not increase GHG emissions compared to the BAU Scenario 1. Additionally, this study has found that there is not a substantial difference between the life cycle GHG emissions of Scenarios 2 and 3.

For both proposed scenarios, life cycle GHG emissions are very similar for each stage except ocean transport, which varies due to different distances between ports. The ocean transport stage results in very similar emissions for Japan, Korea and China since they are in relatively close proximity of each other. As India is slightly further away, it has distinctly higher emissions from the ocean transport stage and thus, overall. When CCS is not used, power generation consistently produces the most emissions of any life cycle stage. When CCS is utilized, the largest emissions contributing stage varies among scenarios.

The AR4 100-yr GWP expected emissions of exporting LNG from Alaska to Asia for Scenario 3's multiproduct functional unit varies from 602 to 622 kg CO_2e/ MWh electricity generated from NGCC power plant without CCS and 40 kg of crude oil consumed, and 318 to 340 kg CO_2e/MWh electricity generated from NGCC power plant with CCS and 40 kg of crude oil consumed. For Scenario 2, the GWP ranges from 602 to 622 kg CO_2e/MWh electricity generated from NGCC power plant without CCS and 40 kg of crude oil consumed, and 318 to 341 kg CO_2e/MWh electricity generated from NGCC power plant with CCS and 40 kg of crude oil consumed. Both of these scenarios produce lower emissions than Scenario 1, which varies from 645 to 648 kg CO_2e/MWh electricity generated from NGCC power plant without CCS and 40 kg of crude oil consumed, and 360 to 364 kg CO_2e/MWh electricity generated from NGCC power plant with CCS and 40 kg of crude oil consumed. However, accounting for uncertainty shows overlap between the lower end of Scenario 1 and the upper end of Scenarios 2 and 3 results.

The LCA study concludes that life cycle GHG emissions from production of natural gas on the North Slope of Alaska and subsequent liquefaction and export of LNG from Alaska, along with related oil production changes, would not increase GHG emissions on a life cycle basis for both carbon management scenarios considered in the study when compared to providing an equivalent service to society from existing Alaska North Slope oil production and US Lower 48 natural gas production and export. The total expected (mean) life cycle GHG results show a small reduction (4 to 11 percent) compared with the no action alternative (Scenario 1: Business as Usual), while the upper uncertainty ranges of Scenarios 2 and 3 overlap with the lower uncertainty range of Scenario 1, indicating no material difference among the three scenarios modeled. In conclusion, exporting LNG from the North Slope of Alaska would not increase GHG emissions when providing the same services to society (through production of natural gas and oil) as the no action alternative.

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Appendix A: AR4 100-yr Results

Six appendices have been prepared to supplement the main body of the report to show tabular results for alternative GWP methods and time horizons.

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR4 – 100-yr)
- Multiproduct Functional Unit – South Korea (AR4 – 100-yr)
- Multiproduct Functional Unit – China (AR4 – 100-yr)
- Multiproduct Functional Unit – India (AR4 – 100-yr)
- Single Product Functional Unit in kg CO2e – Japan (AR4 – 100-yr)
- Single Product Functional Unit in kg CO2e – South Korea (AR4 – 100-yr)
- Single Product Functional Unit in kg CO2e – China (AR4 – 100-yr)
- Single Product Functional Unit in kg CO2e – India (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR4 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR4 – 100-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR4 – 100-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR4 – 100-yr)

Exhibit A-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.19E+01	3.19E+01	-	3.59E+01	3.59E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.22E+01	2.22E+01	-	2.50E+01	2.50E+01
CO2 Compression and Sequestration	-	6.97E-01	-	-	7.84E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.61E+00	8.61E+00	-	9.69E+00	9.69E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.18E+01	3.18E+01
Ocean Transport	-	1.82E+01	1.82E+01	-	2.05E+01	2.05E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.50E+00	2.39E+00	2.39E+00	2.82E+00	2.69E+00	2.69E+00
Crude Oil Extraction, CO2-EOR	-	-	5.97E+00	-	-	6.72E+00
CO2-EOR Crude Oil Transport	-	-	7.86E-01	-	-	8.84E-01
Crude Oil Alaskan Pipeline Transport	1.58E+00	8.15E-01	8.15E-01	1.78E+00	9.18E-01	9.18E-01
Crude Oil Ocean Transport	8.44E-01	4.57E-01	8.97E-01	9.50E-01	5.14E-01	1.01E+00
Crude Oil Refining and End Use	1.14E+02	5.89E+01	1.16E+02	1.28E+02	6.63E+01	1.30E+02
Construction	-	4.81E-01	4.81E-01	-	5.41E-01	5.41E-01
System Expansion: US Average Crude Oil Production and End Use	2.00E+01	8.16E+01	1.80E+01	3.97E+00	7.33E+01	1.78E+00
System Expansion: US Lower 48 LNG Export and End Use	5.07E+02	-	-	2.23E+02	-	-
Total	6.45E+02	6.03E+02	6.03E+02	3.61E+02	3.18E+02	3.18E+02
Upper	2.28E+01	4.33E+01	3.97E+01	2.46E+01	4.38E+01	4.67E+01
Lower	1.24E+01	9.69E+00	9.40E+00	1.42E+01	1.09E+01	1.08E+01

Exhibit A-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.19E+01	3.19E+01	-	3.60E+01	3.60E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.22E+01	2.22E+01	-	2.50E+01	2.50E+01
CO2 Compression and Sequestration	-	6.98E-01	-	-	7.86E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.12E+01	2.12E+01	-	2.38E+01	2.38E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.51E+00	2.39E+00	2.39E+00	2.82E+00	2.69E+00	2.69E+00
Crude Oil Extraction, CO2-EOR	-	-	5.98E+00	-	-	6.73E+00
CO2-EOR Crude Oil Transport	-	-	7.87E-01	-	-	8.86E-01
Crude Oil Alaskan Pipeline Transport	1.58E+00	8.17E-01	8.17E-01	1.78E+00	9.20E-01	9.20E-01
Crude Oil Ocean Transport	8.46E-01	4.58E-01	8.99E-01	9.52E-01	5.15E-01	1.01E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.82E-01	4.82E-01	-	5.42E-01	5.42E-01
System Expansion: US Average Crude Oil Production and End Use	1.97E+01	8.15E+01	1.78E+01	3.69E+00	7.32E+01	1.50E+00
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.27E+02	-	-
Total	6.49E+02	6.06E+02	6.06E+02	3.65E+02	3.22E+02	3.21E+02
Upper	2.25E+01	3.90E+01	4.02E+01	2.57E+01	4.83E+01	4.12E+01
Lower	1.37E+01	1.01E+01	9.24E+00	1.49E+01	1.12E+01	1.06E+01

Exhibit A-3. Multiproduct Functional Unit in kg CO_2e – China (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.19E+01	3.19E+01	-	3.60E+01	3.60E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.22E+01	2.22E+01	-	2.50E+01	2.50E+01
CO2 Compression and Sequestration	-	6.98E-01	-	-	7.86E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.13E+01	2.13E+01	-	2.40E+01	2.40E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.51E+00	2.39E+00	2.39E+00	2.82E+00	2.69E+00	2.69E+00
Crude Oil Extraction, CO2-EOR	-	-	5.98E+00	-	-	6.73E+00
CO2-EOR Crude Oil Transport	-	-	7.87E-01	-	-	8.86E-01
Crude Oil Alaskan Pipeline Transport	1.58E+00	8.17E-01	8.17E-01	1.78E+00	9.20E-01	9.20E-01
Crude Oil Ocean Transport	8.46E-01	4.58E-01	8.99E-01	9.52E-01	5.15E-01	1.01E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.82E-01	4.82E-01	-	5.42E-01	5.42E-01
System Expansion: US Average Crude Oil Production and End Use	1.97E+01	8.15E+01	1.78E+01	3.72E+00	7.32E+01	1.49E+00
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.28E+02	-	-
Total	6.49E+02	6.06E+02	6.06E+02	3.65E+02	3.22E+02	3.22E+02
Upper	2.25E+01	3.98E+01	4.29E+01	2.56E+01	4.27E+01	4.18E+01
Lower	1.36E+01	9.67E+00	9.53E+00	1.49E+01	1.00E+01	1.12E+01

Exhibit A-4. Multiproduct Functional Unit in kg CO_2e – India (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.23E+01	3.23E+01	-	3.63E+01	3.63E+01
Natural Gas Pipelines to GTP	-	2.60E+00	2.60E+00	-	2.92E+00	2.92E+00
Natural Gas Processing at GTP	-	2.25E+01	2.25E+01	-	2.53E+01	2.53E+01
CO2 Compression and Sequestration	-	7.06E-01	-	-	7.94E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.72E+00	8.72E+00	-	9.81E+00	9.81E+00
Liquefaction	-	2.86E+01	2.86E+01	-	3.22E+01	3.22E+01
Ocean Transport	-	3.70E+01	3.70E+01	-	4.17E+01	4.17E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.53E+00	2.42E+00	2.42E+00	2.85E+00	2.72E+00	2.72E+00
Crude Oil Extraction, CO2-EOR	-	-	6.04E+00	-	-	6.80E+00
CO2-EOR Crude Oil Transport	-	-	7.95E-01	-	-	8.95E-01
Crude Oil Alaskan Pipeline Transport	1.60E+00	8.25E-01	8.25E-01	1.80E+00	9.29E-01	9.29E-01
Crude Oil Ocean Transport	8.55E-01	4.62E-01	9.08E-01	9.62E-01	5.20E-01	1.02E+00
Crude Oil Refining and End Use	1.15E+02	5.96E+01	1.17E+02	1.30E+02	6.71E+01	1.32E+02
Construction	-	4.87E-01	4.87E-01	-	5.48E-01	5.48E-01
System Expansion: US Average Crude Oil Production and End Use	1.85E+01	8.08E+01	1.64E+01	2.21E+00	7.24E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.09E+02	-	-	2.26E+02	-	-
Total	6.48E+02	6.23E+02	6.22E+02	3.64E+02	3.41E+02	3.40E+02
Upper	2.13E+01	4.56E+01	3.71E+01	2.55E+01	4.89E+01	4.44E+01
Lower	1.30E+01	9.34E+00	9.36E+00	1.47E+01	1.10E+01	1.06E+01

Exhibit A-5. Single Product Functional Unit in kg CO_2e – Japan (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.19E+01	3.19E+01	-	3.59E+01	3.59E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.22E+01	2.22E+01	-	2.50E+01	2.50E+01
CO2 Compression and Sequestration	-	5.99E-01	-	-	6.75E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.61E+00	8.61E+00	-	9.69E+00	9.69E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.18E+01	3.18E+01
Ocean Transport	-	1.82E+01	1.82E+01	-	2.05E+01	2.05E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.81E-01	4.81E-01	-	5.41E-01	5.41E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.07E+02	-	-	2.23E+02	-	-
Total	5.07E+02	4.59E+02	4.58E+02	2.23E+02	1.74E+02	1.74E+02
Upper	1.68E+01	3.29E+01	3.02E+01	1.89E+01	2.40E+01	2.55E+01
Lower	1.08E+01	7.37E+00	7.14E+00	1.23E+01	5.96E+00	5.93E+00

Exhibit A-6. Single Product Functional Unit in kg CO_2e – South Korea (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.19E+01	3.19E+01	-	3.60E+01	3.60E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.22E+01	2.22E+01	-	2.50E+01	2.50E+01
CO2 Compression and Sequestration	-	6.01E-01	-	-	6.76E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.12E+01	2.12E+01	-	2.38E+01	2.38E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.82E-01	4.82E-01	-	5.42E-01	5.42E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.27E+02	-	-
Total	5.10E+02	4.62E+02	4.61E+02	2.27E+02	1.78E+02	1.77E+02
Upper	1.70E+01	2.97E+01	3.06E+01	1.88E+01	2.67E+01	2.27E+01
Lower	1.21E+01	7.70E+00	7.03E+00	1.31E+01	6.19E+00	5.86E+00

Exhibit A-7. Single Product Functional Unit in kg CO_2e – China (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.19E+01	3.19E+01	-	3.60E+01	3.60E+01
Natural Gas Pipelines to GTP	-	2.57E+00	2.57E+00	-	2.89E+00	2.89E+00
Natural Gas Processing at GTP	-	2.22E+01	2.22E+01	-	2.50E+01	2.50E+01
CO2 Compression and Sequestration	-	6.01E-01	-	-	6.76E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.63E+00	8.63E+00	-	9.71E+00	9.71E+00
Liquefaction	-	2.83E+01	2.83E+01	-	3.19E+01	3.19E+01
Ocean Transport	-	2.13E+01	2.13E+01	-	2.40E+01	2.40E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.82E-01	4.82E-01	-	5.42E-01	5.42E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.10E+02	-	-	2.28E+02	-	-
Total	5.10E+02	4.62E+02	4.61E+02	2.28E+02	1.78E+02	1.78E+02
Upper	1.69E+01	3.03E+01	3.26E+01	1.94E+01	2.36E+01	2.31E+01
Lower	1.19E+01	7.37E+00	7.26E+00	1.31E+01	5.56E+00	6.20E+00

Exhibit A-8. Single Product Functional Unit in kg CO_2e – India (AR4 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.23E+01	3.23E+01	-	3.63E+01	3.63E+01
Natural Gas Pipelines to GTP	-	2.60E+00	2.60E+00	-	2.92E+00	2.92E+00
Natural Gas Processing at GTP	-	2.25E+01	2.25E+01	-	2.53E+01	2.53E+01
CO2 Compression and Sequestration	-	6.07E-01	-	-	6.83E-01	-
Natural Gas Alaskan Pipeline Transport	-	8.72E+00	8.72E+00	-	9.81E+00	9.81E+00
Liquefaction	-	2.86E+01	2.86E+01	-	3.22E+01	3.22E+01
Ocean Transport	-	3.70E+01	3.70E+01	-	4.17E+01	4.17E+01
LNG Regasification	-	3.42E+00	3.42E+00	-	3.85E+00	3.85E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.87E-01	4.87E-01	-	5.48E-01	5.48E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.09E+02	-	-	2.26E+02	-	-
Total	5.09E+02	4.79E+02	4.78E+02	2.26E+02	1.97E+02	1.96E+02
Upper	1.60E+01	3.50E+01	2.85E+01	1.95E+01	2.82E+01	2.56E+01
Lower	1.14E+01	7.18E+00	7.19E+00	1.28E+01	6.37E+00	6.13E+00

Exhibit A-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	4.50E-02	-	-	2.50E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	5.74E-02	8.09E-03	5.58E-09	1.58E+00
Crude Oil Ocean Transport	8.24E-01	2.00E-02	-	8.29E-07	8.44E-01
Crude Oil Refining and End Use	1.14E+02	1.61E-01	5.68E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.96E+01	3.83E-01	1.28E-02	-	2.00E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	4.24E+01	3.37E-01	1.84E-07	5.07E+02
Construction	-	-	-	-	-
Total	6.02E+02	4.31E+01	3.64E-01	1.02E-06	6.45E+02

Exhibit A-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	4.51E-02	-	-	2.51E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	5.75E-02	8.11E-03	5.59E-09	1.58E+00
Crude Oil Ocean Transport	8.26E-01	2.00E-02	-	8.31E-07	8.46E-01
Crude Oil Refining and End Use	1.14E+02	1.61E-01	5.69E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	3.78E-01	1.26E-02	-	1.97E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	4.28E+01	3.47E-01	1.84E-07	5.10E+02
Construction	-	-	-	-	-
Total	6.05E+02	4.35E+01	3.74E-01	1.02E-06	6.49E+02

Exhibit A-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	4.51E-02	-	-	2.51E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	5.75E-02	8.11E-03	5.59E-09	1.58E+00
Crude Oil Ocean Transport	8.26E-01	2.00E-02	-	8.30E-07	8.46E-01
Crude Oil Refining and End Use	1.14E+02	1.61E-01	5.69E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.94E+01	3.78E-01	1.26E-02	-	1.97E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	4.28E+01	3.48E-01	1.84E-07	5.10E+02
Construction	-	-	-	-	-
Total	6.05E+02	4.35E+01	3.74E-01	1.02E-06	6.49E+02

Exhibit A-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.49E+00	4.55E-02	-	-	2.53E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.53E+00	5.81E-02	8.19E-03	5.65E-09	1.60E+00
Crude Oil Ocean Transport	8.34E-01	2.02E-02	-	8.39E-07	8.55E-01
Crude Oil Refining and End Use	1.15E+02	1.63E-01	5.75E-03	-	1.15E+02
System Expansion: US Average Crude Oil Production and End Use	1.81E+01	3.53E-01	1.18E-02	-	1.85E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	4.27E+01	3.44E-01	1.84E-07	5.09E+02
Construction	-	-	-	-	-
Total	6.04E+02	4.33E+01	3.70E-01	1.03E-06	6.48E+02

Exhibit A-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.33E+01	-	-	3.19E+01
Natural Gas Pipelines to GTP	2.14E-03	2.56E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.18E+01	3.90E-01	2.71E-05	-	2.22E+01
CO2 Compression and Sequestration	6.56E-01	3.71E-02	1.55E-03	2.07E-03	6.97E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	3.44E+00	5.65E-07	-	8.61E+00
Liquefaction	2.25E+01	5.81E+00	-	1.33E-07	2.83E+01
Ocean Transport	1.68E+01	1.42E+00	-	-	1.82E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	9.44E-01	-	-	2.39E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.82E-01	2.97E-02	4.18E-03	2.89E-09	8.15E-01
Crude Oil Ocean Transport	4.42E-01	1.47E-02	-	6.13E-07	4.57E-01
Crude Oil Refining and End Use	5.88E+01	8.33E-02	2.94E-03	-	5.89E+01
System Expansion: US Average Crude Oil Production and End Use	8.00E+01	1.56E+00	5.21E-02	-	8.16E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	7.34E-03	2.63E-03	-	4.81E-01
Total	5.73E+02	3.00E+01	6.34E-02	2.16E-03	6.03E+02

Exhibit A-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.33E+01	-	-	3.19E+01
Natural Gas Pipelines to GTP	2.15E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.18E+01	3.91E-01	2.71E-05	-	2.22E+01
CO2 Compression and Sequestration	6.58E-01	3.71E-02	1.56E-03	2.07E-03	6.98E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	-	1.33E-07	2.83E+01
Ocean Transport	1.95E+01	1.69E+00	-	-	2.12E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	9.46E-01	-	-	2.39E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	2.97E-02	4.19E-03	2.89E-09	8.17E-01
Crude Oil Ocean Transport	4.43E-01	1.47E-02	-	6.14E-07	4.58E-01
Crude Oil Refining and End Use	5.89E+01	8.35E-02	2.94E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	1.56E+00	5.20E-02	-	8.15E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	7.35E-03	2.63E-03	-	4.82E-01
Total	5.76E+02	3.03E+01	6.34E-02	2.16E-03	6.06E+02

Exhibit A-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.33E+01	-	-	3.19E+01
Natural Gas Pipelines to GTP	2.15E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.18E+01	3.91E-01	2.71E-05	-	2.22E+01
CO2 Compression and Sequestration	6.58E-01	3.71E-02	1.56E-03	2.07E-03	6.98E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	-	1.33E-07	2.83E+01
Ocean Transport	1.96E+01	1.71E+00	-	-	2.13E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	9.46E-01	-	-	2.39E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	2.97E-02	4.19E-03	2.89E-09	8.17E-01
Crude Oil Ocean Transport	4.43E-01	1.47E-02	-	6.14E-07	4.58E-01
Crude Oil Refining and End Use	5.89E+01	8.35E-02	2.94E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	1.56E+00	5.20E-02	-	8.15E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	7.35E-03	2.63E-03	-	4.82E-01
Total	5.76E+02	3.03E+01	6.34E-02	2.16E-03	6.06E+02

Exhibit A-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	1.35E+01	-	-	3.23E+01
Natural Gas Pipelines to GTP	2.17E-03	2.60E+00	-	-	2.60E+00
Natural Gas Processing at GTP	2.21E+01	3.95E-01	2.74E-05	-	2.25E+01
CO2 Compression and Sequestration	6.64E-01	3.75E-02	1.57E-03	2.10E-03	7.06E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	3.48E+00	5.72E-07	-	8.72E+00
Liquefaction	2.27E+01	5.88E+00	-	1.35E-07	2.86E+01
Ocean Transport	3.39E+01	3.14E+00	-	-	3.70E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	9.55E-01	-	-	2.42E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.91E-01	3.00E-02	4.24E-03	2.92E-09	8.25E-01
Crude Oil Ocean Transport	4.48E-01	1.48E-02	-	6.21E-07	4.62E-01
Crude Oil Refining and End Use	5.95E+01	8.43E-02	2.97E-03	-	5.96E+01
System Expansion: US Average Crude Oil Production and End Use	7.92E+01	1.55E+00	5.16E-02	-	8.08E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	7.43E-03	2.66E-03	-	4.87E-01
Total	5.91E+02	3.20E+01	6.31E-02	2.19E-03	6.23E+02

Exhibit A-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.33E+01	-	-	3.19E+01
Natural Gas Pipelines to GTP	2.14E-03	2.56E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.18E+01	3.90E-01	2.71E-05	-	2.22E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	3.44E+00	5.65E-07	-	8.61E+00
Liquefaction	2.25E+01	5.81E+00	-	1.33E-07	2.83E+01
Ocean Transport	1.68E+01	1.42E+00	-	-	1.82E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	9.44E-01	-	-	2.39E+00
Crude Oil Extraction, CO2-EOR	5.58E+00	3.37E-01	1.95E-02	2.69E-02	5.97E+00
CO2-EOR Crude Oil Transport	7.53E-01	2.86E-02	4.03E-03	2.78E-09	7.86E-01
Crude Oil Alaskan Pipeline Transport	7.82E-01	2.97E-02	4.18E-03	2.89E-09	8.15E-01
Crude Oil Ocean Transport	8.68E-01	2.88E-02	-	1.20E-06	8.97E-01
Crude Oil Refining and End Use	1.15E+02	1.64E-01	5.77E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.77E+01	3.45E-01	1.15E-02	-	1.80E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	7.34E-03	2.63E-03	-	4.81E-01
Total	5.73E+02	2.92E+01	4.76E-02	2.70E-02	6.03E+02

Exhibit A-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.33E+01	-	-	3.19E+01
Natural Gas Pipelines to GTP	2.15E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.18E+01	3.91E-01	2.71E-05	-	2.22E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	-	1.33E-07	2.83E+01
Ocean Transport	1.95E+01	1.69E+00	-	-	2.12E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	9.46E-01	-	-	2.39E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	3.37E-01	1.95E-02	2.69E-02	5.98E+00
CO2-EOR Crude Oil Transport	7.55E-01	2.87E-02	4.04E-03	2.79E-09	7.87E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	2.97E-02	4.19E-03	2.89E-09	8.17E-01
Crude Oil Ocean Transport	8.70E-01	2.88E-02	-	1.21E-06	8.99E-01
Crude Oil Refining and End Use	1.16E+02	1.64E-01	5.78E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	3.40E-01	1.14E-02	-	1.78E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	7.35E-03	2.63E-03	-	4.82E-01
Total	5.76E+02	2.95E+01	4.75E-02	2.70E-02	6.06E+02

Exhibit A-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.33E+01	-	-	3.19E+01
Natural Gas Pipelines to GTP	2.15E-03	2.57E+00	-	-	2.57E+00
Natural Gas Processing at GTP	2.18E+01	3.91E-01	2.71E-05	-	2.22E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	3.44E+00	5.66E-07	-	8.63E+00
Liquefaction	2.25E+01	5.82E+00	-	1.33E-07	2.83E+01
Ocean Transport	1.96E+01	1.71E+00	-	-	2.13E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	9.46E-01	-	-	2.39E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	3.37E-01	1.95E-02	2.69E-02	5.98E+00
CO2-EOR Crude Oil Transport	7.55E-01	2.87E-02	4.04E-03	2.79E-09	7.87E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	2.97E-02	4.19E-03	2.89E-09	8.17E-01
Crude Oil Ocean Transport	8.70E-01	2.88E-02	-	1.21E-06	8.99E-01
Crude Oil Refining and End Use	1.16E+02	1.64E-01	5.78E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	3.40E-01	1.13E-02	-	1.78E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	7.35E-03	2.63E-03	-	4.82E-01
Total	5.76E+02	2.95E+01	4.75E-02	2.70E-02	6.06E+02

Exhibit A-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	1.35E+01	-	-	3.23E+01
Natural Gas Pipelines to GTP	2.17E-03	2.60E+00	-	-	2.60E+00
Natural Gas Processing at GTP	2.21E+01	3.95E-01	2.74E-05	-	2.25E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	3.48E+00	5.72E-07	-	8.72E+00
Liquefaction	2.27E+01	5.88E+00	-	1.35E-07	2.86E+01
Ocean Transport	3.39E+01	3.14E+00	-	-	3.70E+01
LNG Regasification	3.02E+00	4.00E-01	-	8.93E-05	3.42E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	9.55E-01	-	-	2.42E+00
Crude Oil Extraction, CO2-EOR	5.65E+00	3.41E-01	1.97E-02	2.72E-02	6.04E+00
CO2-EOR Crude Oil Transport	7.62E-01	2.89E-02	4.08E-03	2.81E-09	7.95E-01
Crude Oil Alaskan Pipeline Transport	7.91E-01	3.00E-02	4.24E-03	2.92E-09	8.25E-01
Crude Oil Ocean Transport	8.79E-01	2.91E-02	-	1.22E-06	9.08E-01
Crude Oil Refining and End Use	1.17E+02	1.66E-01	5.84E-03	-	1.17E+02
System Expansion: US Average Crude Oil Production and End Use	1.61E+01	3.15E-01	1.05E-02	-	1.64E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	7.43E-03	2.66E-03	-	4.87E-01
Total	5.91E+02	3.12E+01	4.71E-02	2.73E-02	6.22E+02

Exhibit A-21. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	1.49E+01	-4.54E-01	4.53E+01	2.80E+00	1.08E+01	1.80E+00	2.89E+01	-	2.85E-01	4.46E+01	2.78E+00	1.08E+01	1.83E+00	2.92E+01	-	-	4.46E+01
2030	-	-	2.52E+00	5.83E+01	5.20E+01	-5.53E-01	1.12E+02	9.80E+00	3.79E+01	3.49E+00	5.61E+01	-	1.94E+00	1.09E+02	9.72E+00	3.79E+01	3.71E+00	5.78E+01	-	-	1.09E+02
2031	-	-	3.73E+00	8.63E+01	1.19E+02	6.02E-01	2.10E+02	2.24E+01	8.65E+01	5.07E+00	8.15E+01	-	5.91E+00	2.01E+02	2.22E+01	8.65E+01	5.74E+00	8.68E+01	-	-	2.01E+02
2032	-	-	4.91E+00	1.13E+02	2.01E+02	3.26E+00	3.22E+02	3.78E+01	1.46E+02	6.55E+00	1.05E+02	-	1.23E+01	3.08E+02	3.75E+01	1.46E+02	7.94E+00	1.16E+02	-	-	3.08E+02
2033	-	-	6.05E+00	1.40E+02	2.90E+02	6.83E+00	4.43E+02	5.46E+01	2.11E+02	7.94E+00	1.28E+02	-	2.03E+01	4.22E+02	5.42E+01	2.11E+02	1.02E+01	1.46E+02	-	-	4.21E+02
2034	-	-	7.16E+00	1.65E+02	3.79E+02	1.04E+01	5.62E+02	7.14E+01	2.76E+02	9.25E+00	1.49E+02	-	2.90E+01	5.34E+02	7.08E+01	2.76E+02	1.25E+01	1.75E+02	-	-	5.34E+02
2035	-	-	8.24E+00	1.90E+02	4.68E+02	1.36E+01	6.81E+02	8.82E+01	3.41E+02	1.05E+01	1.69E+02	-	3.81E+01	6.46E+02	8.75E+01	3.41E+02	1.48E+01	2.03E+02	-	-	6.46E+02
2036	-	-	9.28E+00	2.15E+02	5.58E+02	1.62E+01	7.98E+02	1.05E+02	4.06E+02	1.16E+01	1.87E+02	-	4.73E+01	7.56E+02	1.04E+02	4.06E+02	1.70E+01	2.29E+02	-	-	7.56E+02
2037	-	-	1.03E+01	2.38E+02	6.47E+02	1.85E+01	9.14E+02	1.22E+02	4.71E+02	1.27E+01	2.04E+02	-	5.67E+01	8.66E+02	1.21E+02	4.71E+02	1.91E+01	2.55E+02	-	-	8.65E+02
2038	-	-	1.13E+01	2.61E+02	7.36E+02	2.04E+01	1.03E+03	1.39E+02	5.35E+02	1.37E+01	2.20E+02	-	6.62E+01	9.74E+02	1.38E+02	5.35E+02	2.12E+01	2.79E+02	-	-	9.73E+02
2039	-	-	1.23E+01	2.84E+02	8.25E+02	2.19E+01	1.14E+03	1.55E+02	6.00E+02	1.46E+01	2.35E+02	-	7.59E+01	1.08E+03	1.54E+02	6.00E+02	2.32E+01	3.03E+02	-	-	1.08E+03
2040	-	-	1.32E+01	3.05E+02	9.14E+02	2.31E+01	1.26E+03	1.72E+02	6.65E+02	1.55E+01	2.49E+02	-	8.56E+01	1.19E+03	1.71E+02	6.65E+02	2.52E+01	3.26E+02	-	-	1.19E+03
2041	-	-	1.41E+01	3.26E+02	1.00E+03	2.39E+01	1.37E+03	1.89E+02	7.30E+02	1.63E+01	2.63E+02	-	9.52E+01	1.29E+03	1.88E+02	7.30E+02	2.71E+01	3.48E+02	-	-	1.29E+03
2042	-	-	1.50E+01	3.47E+02	1.09E+03	2.44E+01	1.48E+03	2.06E+02	7.95E+02	1.71E+01	2.75E+02	-	1.05E+02	1.40E+03	2.04E+02	7.95E+02	2.89E+01	3.69E+02	-	-	1.40E+03
2043	-	-	1.59E+01	3.67E+02	1.18E+03	2.46E+01	1.59E+03	2.23E+02	8.60E+02	1.78E+01	2.87E+02	-	1.14E+02	1.50E+03	2.21E+02	8.60E+02	3.07E+01	3.89E+02	-	-	1.50E+03
2044	-	-	1.67E+01	3.86E+02	1.27E+03	2.45E+01	1.70E+03	2.39E+02	9.25E+02	1.85E+01	2.98E+02	-	1.24E+02	1.60E+03	2.38E+02	9.25E+02	3.25E+01	4.08E+02	-	-	1.60E+03
2045	-	-	1.75E+01	4.05E+02	1.36E+03	2.43E+01	1.81E+03	2.56E+02	9.90E+02	1.91E+01	3.08E+02	-	1.33E+02	1.71E+03	2.54E+02	9.90E+02	3.42E+01	4.27E+02	-	-	1.70E+03
2046	-	-	1.83E+01	4.23E+02	1.45E+03	2.40E+01	1.92E+03	2.73E+02	1.05E+03	1.97E+01	3.17E+02	-	1.43E+02	1.81E+03	2.71E+02	1.05E+03	3.59E+01	4.45E+02	-	-	1.81E+03
2047	-	-	1.91E+01	4.41E+02	1.54E+03	2.36E+01	2.02E+03	2.90E+02	1.12E+03	2.03E+01	3.26E+02	-	1.53E+02	1.91E+03	2.88E+02	1.12E+03	3.75E+01	4.62E+02	-	-	1.91E+03
2048	-	-	1.98E+01	4.59E+02	1.63E+03	2.30E+01	2.13E+03	3.06E+02	1.18E+03	2.08E+01	3.34E+02	-	1.62E+02	2.01E+03	3.04E+02	1.18E+03	3.91E+01	4.79E+02	-	-	2.01E+03
2049	-	-	2.06E+01	4.76E+02	1.72E+03	2.23E+01	2.24E+03	3.23E+02	1.25E+03	2.13E+01	3.42E+02	-	1.72E+02	2.11E+03	3.21E+02	1.25E+03	4.07E+01	4.96E+02	-	-	2.11E+03
2050	-	-	2.13E+01	4.92E+02	1.81E+03	2.15E+01	2.34E+03	3.40E+02	1.31E+03	2.17E+01	3.50E+02	-	1.81E+02	2.21E+03	3.38E+02	1.31E+03	4.22E+01	5.11E+02	-	-	2.21E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	1.90E+03	2.07E+01	2.45E+03	3.57E+02	1.38E+03	2.22E+01	3.56E+02	-	1.91E+02	2.31E+03	3.54E+02	1.38E+03	4.37E+01	5.27E+02	-	-	2.30E+03
2052	-	-	2.27E+01	5.24E+02	1.98E+03	1.97E+01	2.55E+03	3.74E+02	1.44E+03	2.26E+01	3.63E+02	-	2.00E+02	2.40E+03	3.71E+02	1.44E+03	4.52E+01	5.41E+02	-	-	2.40E+03
2053	-	-	2.33E+01	5.39E+02	2.07E+03	1.86E+01	2.66E+03	3.90E+02	1.51E+03	2.29E+01	3.69E+02	-	2.09E+02	2.50E+03	3.88E+02	1.51E+03	4.66E+01	5.56E+02	-	-	2.50E+03
2054	-	-	2.40E+01	5.54E+02	2.16E+03	1.73E+01	2.76E+03	4.07E+02	1.57E+03	2.33E+01	3.75E+02	-	2.18E+02	2.60E+03	4.04E+02	1.57E+03	4.80E+01	5.69E+02	-	-	2.60E+03
2055	-	-	2.46E+01	5.68E+02	2.25E+03	1.60E+01	2.86E+03	4.24E+02	1.64E+03	2.36E+01	3.80E+02	-	2.27E+02	2.69E+03	4.21E+02	1.64E+03	4.93E+01	5.83E+02	-	-	2.69E+03
2056	-	-	2.52E+01	5.82E+02	2.34E+03	1.47E+01	2.96E+03	4.41E+02	1.70E+03	2.39E+01	3.85E+02	-	2.36E+02	2.79E+03	4.38E+02	1.70E+03	5.06E+01	5.95E+02	-	-	2.79E+03
2057	-	-	2.58E+01	5.96E+02	2.43E+03	1.35E+01	3.07E+03	4.58E+02	1.77E+03	2.42E+01	3.90E+02	-	2.45E+02	2.88E+03	4.54E+02	1.77E+03	5.19E+01	6.08E+02	-	-	2.88E+03
2058	-	-	2.64E+01	6.09E+02	2.51E+03	1.19E+01	3.16E+03	4.73E+02	1.83E+03	2.45E+01	3.94E+02	-	2.53E+02	2.97E+03	4.69E+02	1.83E+03	5.31E+01	6.20E+02	-	-	2.97E+03
2059	-	-	2.69E+01	6.22E+02	2.57E+03	1.03E+01	3.23E+03	4.85E+02	1.87E+03	2.47E+01	3.98E+02	-	2.62E+02	3.04E+03	4.81E+02	1.87E+03	5.43E+01	6.32E+02	-	-	3.04E+03
2060	-	-	2.75E+01	6.35E+02	2.63E+03	8.62E+00	3.30E+03	4.94E+02	1.91E+03	2.50E+01	4.02E+02	-	2.70E+02	3.10E+03	4.91E+02	1.91E+03	5.55E+01	6.43E+02	-	-	3.10E+03
2061	-	-	2.80E+01	6.47E+02	2.67E+03	6.76E+00	3.35E+03	5.02E+02	1.94E+03	2.52E+01	4.05E+02	-	2.78E+02	3.15E+03	4.98E+02	1.94E+03	5.66E+01	6.53E+02	-	-	3.15E+03

Exhibit A-22. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	1.49E+01	-4.54E-01	4.54E+01	2.80E+00	1.09E+01	1.80E+00	2.89E+01	-	2.85E-01	4.47E+01	2.78E+00	1.09E+01	1.83E+00	2.92E+01	-	-	4.47E+01
2030	-	-	2.52E+00	5.83E+01	5.23E+01	-5.53E-01	1.13E+02	9.80E+00	3.81E+01	3.49E+00	5.61E+01	-	1.94E+00	1.09E+02	9.72E+00	3.81E+01	3.71E+00	5.78E+01	-	-	1.09E+02
2031	-	-	3.73E+00	8.63E+01	1.20E+02	6.02E-01	2.10E+02	2.24E+01	8.71E+01	5.07E+00	8.15E+01	-	5.91E+00	2.02E+02	2.22E+01	8.71E+01	5.74E+00	8.68E+01	-	-	2.02E+02
2032	-	-	4.91E+00	1.13E+02	2.02E+02	3.26E+00	3.23E+02	3.78E+01	1.47E+02	6.55E+00	1.05E+02	-	1.23E+01	3.09E+02	3.75E+01	1.47E+02	7.94E+00	1.16E+02	-	-	3.09E+02
2033	-	-	6.05E+00	1.40E+02	2.91E+02	6.83E+00	4.44E+02	5.46E+01	2.12E+02	7.94E+00	1.28E+02	-	2.03E+01	4.23E+02	5.42E+01	2.12E+02	1.02E+01	1.46E+02	-	-	4.23E+02
2034	-	-	7.16E+00	1.65E+02	3.81E+02	1.04E+01	5.64E+02	7.14E+01	2.78E+02	9.25E+00	1.49E+02	-	2.90E+01	5.36E+02	7.08E+01	2.78E+02	1.25E+01	1.75E+02	-	-	5.36E+02
2035	-	-	8.24E+00	1.90E+02	4.71E+02	1.36E+01	6.83E+02	8.82E+01	3.43E+02	1.05E+01	1.69E+02	-	3.81E+01	6.48E+02	8.75E+01	3.43E+02	1.48E+01	2.03E+02	-	-	6.48E+02
2036	-	-	9.28E+00	2.15E+02	5.61E+02	1.62E+01	8.01E+02	1.05E+02	4.08E+02	1.16E+01	1.87E+02	-	4.73E+01	7.59E+02	1.04E+02	4.08E+02	1.70E+01	2.29E+02	-	-	7.58E+02
2037	-	-	1.03E+01	2.38E+02	6.50E+02	1.85E+01	9.17E+02	1.22E+02	4.73E+02	1.27E+01	2.04E+02	-	5.67E+01	8.69E+02	1.21E+02	4.73E+02	1.91E+01	2.55E+02	-	-	8.68E+02
2038	-	-	1.13E+01	2.61E+02	7.40E+02	2.04E+01	1.03E+03	1.39E+02	5.39E+02	1.37E+01	2.20E+02	-	6.62E+01	9.78E+02	1.38E+02	5.39E+02	2.12E+01	2.79E+02	-	-	9.77E+02
2039	-	-	1.23E+01	2.84E+02	8.30E+02	2.19E+01	1.15E+03	1.55E+02	6.04E+02	1.46E+01	2.35E+02	-	7.59E+01	1.09E+03	1.54E+02	6.04E+02	2.32E+01	3.03E+02	-	-	1.08E+03
2040	-	-	1.32E+01	3.05E+02	9.19E+02	2.31E+01	1.26E+03	1.72E+02	6.69E+02	1.55E+01	2.49E+02	-	8.56E+01	1.19E+03	1.71E+02	6.69E+02	2.52E+01	3.26E+02	-	-	1.19E+03
2041	-	-	1.41E+01	3.26E+02	1.01E+03	2.39E+01	1.37E+03	1.89E+02	7.35E+02	1.63E+01	2.63E+02	-	9.52E+01	1.30E+03	1.88E+02	7.35E+02	2.71E+01	3.48E+02	-	-	1.30E+03
2042	-	-	1.50E+01	3.47E+02	1.10E+03	2.44E+01	1.48E+03	2.06E+02	8.00E+02	1.71E+01	2.75E+02	-	1.05E+02	1.40E+03	2.04E+02	8.00E+02	2.89E+01	3.69E+02	-	-	1.40E+03
2043	-	-	1.59E+01	3.67E+02	1.19E+03	2.46E+01	1.60E+03	2.23E+02	8.65E+02	1.78E+01	2.87E+02	-	1.14E+02	1.51E+03	2.21E+02	8.65E+02	3.07E+01	3.89E+02	-	-	1.51E+03
2044	-	-	1.67E+01	3.86E+02	1.28E+03	2.45E+01	1.71E+03	2.39E+02	9.31E+02	1.85E+01	2.98E+02	-	1.24E+02	1.61E+03	2.38E+02	9.31E+02	3.25E+01	4.08E+02	-	-	1.61E+03
2045	-	-	1.75E+01	4.05E+02	1.37E+03	2.43E+01	1.81E+03	2.56E+02	9.96E+02	1.91E+01	3.08E+02	-	1.33E+02	1.71E+03	2.54E+02	9.96E+02	3.42E+01	4.27E+02	-	-	1.71E+03
2046	-	-	1.83E+01	4.23E+02	1.46E+03	2.40E+01	1.92E+03	2.73E+02	1.06E+03	1.97E+01	3.17E+02	-	1.43E+02	1.81E+03	2.71E+02	1.06E+03	3.59E+01	4.45E+02	-	-	1.81E+03
2047	-	-	1.91E+01	4.41E+02	1.55E+03	2.36E+01	2.03E+03	2.90E+02	1.13E+03	2.03E+01	3.26E+02	-	1.53E+02	1.92E+03	2.88E+02	1.13E+03	3.75E+01	4.62E+02	-	-	1.91E+03
2048	-	-	1.98E+01	4.59E+02	1.64E+03	2.30E+01	2.14E+03	3.06E+02	1.19E+03	2.08E+01	3.34E+02	-	1.62E+02	2.02E+03	3.04E+02	1.19E+03	3.91E+01	4.79E+02	-	-	2.01E+03
2049	-	-	2.06E+01	4.76E+02	1.73E+03	2.23E+01	2.25E+03	3.23E+02	1.26E+03	2.13E+01	3.42E+02	-	1.72E+02	2.12E+03	3.21E+02	1.26E+03	4.07E+01	4.96E+02	-	-	2.11E+03
2050	-	-	2.13E+01	4.92E+02	1.82E+03	2.15E+01	2.35E+03	3.40E+02	1.32E+03	2.17E+01	3.50E+02	-	1.81E+02	2.22E+03	3.38E+02	1.32E+03	4.22E+01	5.11E+02	-	-	2.21E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	1.91E+03	2.07E+01	2.46E+03	3.57E+02	1.39E+03	2.22E+01	3.56E+02	-	1.91E+02	2.31E+03	3.54E+02	1.39E+03	4.37E+01	5.27E+02	-	-	2.31E+03
2052	-	-	2.27E+01	5.24E+02	2.00E+03	1.97E+01	2.56E+03	3.74E+02	1.45E+03	2.26E+01	3.63E+02	-	2.00E+02	2.41E+03	3.71E+02	1.45E+03	4.52E+01	5.41E+02	-	-	2.41E+03
2053	-	-	2.33E+01	5.39E+02	2.09E+03	1.86E+01	2.67E+03	3.90E+02	1.52E+03	2.29E+01	3.69E+02	-	2.09E+02	2.51E+03	3.88E+02	1.52E+03	4.66E+01	5.56E+02	-	-	2.51E+03
2054	-	-	2.40E+01	5.54E+02	2.18E+03	1.73E+01	2.77E+03	4.07E+02	1.58E+03	2.33E+01	3.75E+02	-	2.18E+02	2.61E+03	4.04E+02	1.58E+03	4.80E+01	5.69E+02	-	-	2.61E+03
2055	-	-	2.46E+01	5.68E+02	2.26E+03	1.60E+01	2.87E+03	4.24E+02	1.65E+03	2.36E+01	3.80E+02	-	2.27E+02	2.70E+03	4.21E+02	1.65E+03	4.93E+01	5.83E+02	-	-	2.70E+03
2056	-	-	2.52E+01	5.82E+02	2.35E+03	1.47E+01	2.98E+03	4.41E+02	1.71E+03	2.39E+01	3.85E+02	-	2.36E+02	2.80E+03	4.38E+02	1.71E+03	5.06E+01	5.95E+02	-	-	2.80E+03
2057	-	-	2.58E+01	5.96E+02	2.44E+03	1.35E+01	3.08E+03	4.58E+02	1.78E+03	2.42E+01	3.90E+02	-	2.45E+02	2.90E+03	4.54E+02	1.78E+03	5.19E+01	6.08E+02	-	-	2.89E+03
2058	-	-	2.64E+01	6.09E+02	2.52E+03	1.19E+01	3.17E+03	4.73E+02	1.84E+03	2.45E+01	3.94E+02	-	2.53E+02	2.98E+03	4.69E+02	1.84E+03	5.31E+01	6.20E+02	-	-	2.98E+03
2059	-	-	2.69E+01	6.22E+02	2.59E+03	1.03E+01	3.25E+03	4.85E+02	1.88E+03	2.47E+01	3.98E+02	-	2.62E+02	3.05E+03	4.81E+02	1.88E+03	5.43E+01	6.32E+02	-	-	3.05E+03
2060	-	-	2.75E+01	6.35E+02	2.64E+03	8.62E+00	3.31E+03	4.94E+02	1.92E+03	2.50E+01	4.02E+02	-	2.70E+02	3.11E+03	4.91E+02	1.92E+03	5.55E+01	6.43E+02	-	-	3.11E+03
2061	-	-	2.80E+01	6.47E+02	2.68E+03	6.76E+00	3.36E+03	5.02E+02	1.95E+03	2.52E+01	4.05E+02	-	2.78E+02	3.16E+03	4.98E+02	1.95E+03	5.66E+01	6.53E+02	-	-	3.16E+03

Exhibit A-23. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	1.50E+01	-4.54E-01	4.54E+01	2.80E+00	1.09E+01	1.80E+00	2.89E+01	-	2.85E-01	4.47E+01	2.78E+00	1.09E+01	1.83E+00	2.92E+01	-	-	4.47E+01
2030	-	-	2.52E+00	5.83E+01	5.23E+01	-5.53E-01	1.13E+02	9.80E+00	3.81E+01	3.49E+00	5.61E+01	-	1.94E+00	1.09E+02	9.72E+00	3.81E+01	3.71E+00	5.78E+01	-	-	1.09E+02
2031	-	-	3.73E+00	8.63E+01	1.20E+02	6.02E-01	2.10E+02	2.24E+01	8.71E+01	5.07E+00	8.15E+01	-	5.91E+00	2.02E+02	2.22E+01	8.71E+01	5.74E+00	8.68E+01	-	-	2.02E+02
2032	-	-	4.91E+00	1.13E+02	2.02E+02	3.26E+00	3.23E+02	3.78E+01	1.47E+02	6.55E+00	1.05E+02	-	1.23E+01	3.09E+02	3.75E+01	1.47E+02	7.94E+00	1.16E+02	-	-	3.09E+02
2033	-	-	6.05E+00	1.40E+02	2.92E+02	6.83E+00	4.44E+02	5.46E+01	2.12E+02	7.94E+00	1.28E+02	-	2.03E+01	4.23E+02	5.42E+01	2.12E+02	1.02E+01	1.46E+02	-	-	4.23E+02
2034	-	-	7.16E+00	1.65E+02	3.81E+02	1.04E+01	5.64E+02	7.14E+01	2.78E+02	9.25E+00	1.49E+02	-	2.90E+01	5.36E+02	7.08E+01	2.78E+02	1.25E+01	1.75E+02	-	-	5.36E+02
2035	-	-	8.24E+00	1.90E+02	4.71E+02	1.36E+01	6.83E+02	8.82E+01	3.43E+02	1.05E+01	1.69E+02	-	3.81E+01	6.48E+02	8.75E+01	3.43E+02	1.48E+01	2.03E+02	-	-	6.48E+02
2036	-	-	9.28E+00	2.15E+02	5.61E+02	1.62E+01	8.01E+02	1.05E+02	4.08E+02	1.16E+01	1.87E+02	-	4.73E+01	7.59E+02	1.04E+02	4.08E+02	1.70E+01	2.29E+02	-	-	7.59E+02
2037	-	-	1.03E+01	2.38E+02	6.50E+02	1.85E+01	9.17E+02	1.22E+02	4.74E+02	1.27E+01	2.04E+02	-	5.67E+01	8.69E+02	1.21E+02	4.74E+02	1.91E+01	2.55E+02	-	-	8.68E+02
2038	-	-	1.13E+01	2.61E+02	7.40E+02	2.04E+01	1.03E+03	1.39E+02	5.39E+02	1.37E+01	2.20E+02	-	6.62E+01	9.78E+02	1.38E+02	5.39E+02	2.12E+01	2.79E+02	-	-	9.77E+02
2039	-	-	1.23E+01	2.84E+02	8.30E+02	2.19E+01	1.15E+03	1.55E+02	6.04E+02	1.46E+01	2.35E+02	-	7.59E+01	1.09E+03	1.54E+02	6.04E+02	2.32E+01	3.03E+02	-	-	1.08E+03
2040	-	-	1.32E+01	3.05E+02	9.19E+02	2.31E+01	1.26E+03	1.72E+02	6.70E+02	1.55E+01	2.49E+02	-	8.56E+01	1.19E+03	1.71E+02	6.70E+02	2.52E+01	3.26E+02	-	-	1.19E+03
2041	-	-	1.41E+01	3.26E+02	1.01E+03	2.39E+01	1.37E+03	1.89E+02	7.35E+02	1.63E+01	2.63E+02	-	9.52E+01	1.30E+03	1.88E+02	7.35E+02	2.71E+01	3.48E+02	-	-	1.30E+03
2042	-	-	1.50E+01	3.47E+02	1.10E+03	2.44E+01	1.49E+03	2.06E+02	8.00E+02	1.71E+01	2.75E+02	-	1.05E+02	1.40E+03	2.04E+02	8.00E+02	2.89E+01	3.69E+02	-	-	1.40E+03
2043	-	-	1.59E+01	3.67E+02	1.19E+03	2.46E+01	1.60E+03	2.23E+02	8.66E+02	1.78E+01	2.87E+02	-	1.14E+02	1.51E+03	2.21E+02	8.66E+02	3.07E+01	3.89E+02	-	-	1.51E+03
2044	-	-	1.67E+01	3.86E+02	1.28E+03	2.45E+01	1.71E+03	2.39E+02	9.31E+02	1.85E+01	2.98E+02	-	1.24E+02	1.61E+03	2.38E+02	9.31E+02	3.25E+01	4.08E+02	-	-	1.61E+03
2045	-	-	1.75E+01	4.05E+02	1.37E+03	2.43E+01	1.81E+03	2.56E+02	9.96E+02	1.91E+01	3.08E+02	-	1.33E+02	1.71E+03	2.54E+02	9.96E+02	3.42E+01	4.27E+02	-	-	1.71E+03
2046	-	-	1.83E+01	4.23E+02	1.46E+03	2.40E+01	1.92E+03	2.73E+02	1.06E+03	1.97E+01	3.17E+02	-	1.43E+02	1.81E+03	2.71E+02	1.06E+03	3.59E+01	4.45E+02	-	-	1.81E+03
2047	-	-	1.91E+01	4.41E+02	1.55E+03	2.36E+01	2.03E+03	2.90E+02	1.13E+03	2.03E+01	3.26E+02	-	1.53E+02	1.92E+03	2.88E+02	1.13E+03	3.75E+01	4.62E+02	-	-	1.91E+03
2048	-	-	1.98E+01	4.59E+02	1.64E+03	2.30E+01	2.14E+03	3.06E+02	1.19E+03	2.08E+01	3.34E+02	-	1.62E+02	2.02E+03	3.04E+02	1.19E+03	3.91E+01	4.79E+02	-	-	2.01E+03
2049	-	-	2.06E+01	4.76E+02	1.73E+03	2.23E+01	2.25E+03	3.23E+02	1.26E+03	2.13E+01	3.42E+02	-	1.72E+02	2.12E+03	3.21E+02	1.26E+03	4.07E+01	4.96E+02	-	-	2.11E+03
2050	-	-	2.13E+01	4.92E+02	1.82E+03	2.15E+01	2.35E+03	3.40E+02	1.32E+03	2.17E+01	3.50E+02	-	1.81E+02	2.22E+03	3.38E+02	1.32E+03	4.22E+01	5.11E+02	-	-	2.21E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	1.91E+03	2.07E+01	2.46E+03	3.57E+02	1.39E+03	2.22E+01	3.56E+02	-	1.91E+02	2.31E+03	3.54E+02	1.39E+03	4.37E+01	5.27E+02	-	-	2.31E+03
2052	-	-	2.27E+01	5.24E+02	2.00E+03	1.97E+01	2.56E+03	3.74E+02	1.45E+03	2.26E+01	3.63E+02	-	2.00E+02	2.41E+03	3.71E+02	1.45E+03	4.52E+01	5.41E+02	-	-	2.41E+03
2053	-	-	2.33E+01	5.39E+02	2.09E+03	1.86E+01	2.67E+03	3.90E+02	1.52E+03	2.29E+01	3.69E+02	-	2.09E+02	2.51E+03	3.88E+02	1.52E+03	4.66E+01	5.56E+02	-	-	2.51E+03
2054	-	-	2.40E+01	5.54E+02	2.18E+03	1.73E+01	2.77E+03	4.07E+02	1.58E+03	2.33E+01	3.75E+02	-	2.18E+02	2.61E+03	4.04E+02	1.58E+03	4.80E+01	5.69E+02	-	-	2.61E+03
2055	-	-	2.46E+01	5.68E+02	2.27E+03	1.60E+01	2.87E+03	4.24E+02	1.65E+03	2.36E+01	3.80E+02	-	2.27E+02	2.70E+03	4.21E+02	1.65E+03	4.93E+01	5.83E+02	-	-	2.70E+03
2056	-	-	2.52E+01	5.82E+02	2.35E+03	1.47E+01	2.98E+03	4.41E+02	1.71E+03	2.39E+01	3.85E+02	-	2.36E+02	2.80E+03	4.38E+02	1.71E+03	5.06E+01	5.95E+02	-	-	2.80E+03
2057	-	-	2.58E+01	5.96E+02	2.44E+03	1.35E+01	3.08E+03	4.58E+02	1.78E+03	2.42E+01	3.90E+02	-	2.45E+02	2.90E+03	4.54E+02	1.78E+03	5.19E+01	6.08E+02	-	-	2.89E+03
2058	-	-	2.64E+01	6.09E+02	2.52E+03	1.19E+01	3.17E+03	4.73E+02	1.84E+03	2.45E+01	3.94E+02	-	2.53E+02	2.98E+03	4.69E+02	1.84E+03	5.31E+01	6.20E+02	-	-	2.98E+03
2059	-	-	2.69E+01	6.22E+02	2.59E+03	1.03E+01	3.25E+03	4.85E+02	1.89E+03	2.47E+01	3.98E+02	-	2.62E+02	3.05E+03	4.81E+02	1.89E+03	5.43E+01	6.32E+02	-	-	3.05E+03
2060	-	-	2.75E+01	6.35E+02	2.64E+03	8.62E+00	3.31E+03	4.94E+02	1.92E+03	2.50E+01	4.02E+02	-	2.70E+02	3.11E+03	4.91E+02	1.92E+03	5.55E+01	6.43E+02	-	-	3.11E+03
2061	-	-	2.80E+01	6.47E+02	2.68E+03	6.76E+00	3.36E+03	5.02E+02	1.95E+03	2.52E+01	4.05E+02	-	2.78E+02	3.16E+03	4.98E+02	1.95E+03	5.66E+01	6.53E+02	-	-	3.16E+03

Exhibit A-24. Cumulative Emissions Profile AR4 100-yr – NGCC without CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	1.49E+01	-4.54E-01	4.53E+01	2.80E+00	1.12E+01	1.80E+00	2.89E+01	-	2.85E-01	4.50E+01	2.78E+00	1.12E+01	1.83E+00	2.92E+01	-	-	4.50E+01
2030	-	-	2.52E+00	5.83E+01	5.22E+01	-5.53E-01	1.13E+02	9.80E+00	3.93E+01	3.49E+00	5.61E+01	-	1.94E+00	1.11E+02	9.72E+00	3.93E+01	3.71E+00	5.78E+01	-	-	1.11E+02
2031	-	-	3.73E+00	8.63E+01	1.19E+02	6.02E-01	2.10E+02	2.24E+01	8.99E+01	5.07E+00	8.15E+01	-	5.91E+00	2.05E+02	2.22E+01	8.99E+01	5.74E+00	8.68E+01	-	-	2.05E+02
2032	-	-	4.91E+00	1.13E+02	2.01E+02	3.26E+00	3.23E+02	3.78E+01	1.52E+02	6.55E+00	1.05E+02	-	1.23E+01	3.14E+02	3.75E+01	1.52E+02	7.94E+00	1.16E+02	-	-	3.13E+02
2033	-	-	6.05E+00	1.40E+02	2.91E+02	6.83E+00	4.44E+02	5.46E+01	2.19E+02	7.94E+00	1.28E+02	-	2.03E+01	4.30E+02	5.42E+01	2.19E+02	1.02E+01	1.46E+02	-	-	4.29E+02
2034	-	-	7.16E+00	1.65E+02	3.80E+02	1.04E+01	5.64E+02	7.14E+01	2.87E+02	9.25E+00	1.49E+02	-	2.90E+01	5.45E+02	7.08E+01	2.87E+02	1.25E+01	1.75E+02	-	-	5.45E+02
2035	-	-	8.24E+00	1.90E+02	4.70E+02	1.36E+01	6.82E+02	8.82E+01	3.54E+02	1.05E+01	1.69E+02	-	3.81E+01	6.59E+02	8.75E+01	3.54E+02	1.48E+01	2.03E+02	-	-	6.59E+02
2036	-	-	9.28E+00	2.15E+02	5.60E+02	1.62E+01	8.00E+02	1.05E+02	4.21E+02	1.16E+01	1.87E+02	-	4.73E+01	7.72E+02	1.04E+02	4.21E+02	1.70E+01	2.29E+02	-	-	7.72E+02
2037	-	-	1.03E+01	2.38E+02	6.49E+02	1.85E+01	9.16E+02	1.22E+02	4.89E+02	1.27E+01	2.04E+02	-	5.67E+01	8.84E+02	1.21E+02	4.89E+02	1.91E+01	2.55E+02	-	-	8.84E+02
2038	-	-	1.13E+01	2.61E+02	7.39E+02	2.04E+01	1.03E+03	1.39E+02	5.56E+02	1.37E+01	2.20E+02	-	6.62E+01	9.95E+02	1.38E+02	5.56E+02	2.12E+01	2.79E+02	-	-	9.94E+02
2039	-	-	1.23E+01	2.84E+02	8.28E+02	2.19E+01	1.15E+03	1.55E+02	6.24E+02	1.46E+01	2.35E+02	-	7.59E+01	1.10E+03	1.54E+02	6.24E+02	2.32E+01	3.03E+02	-	-	1.10E+03
2040	-	-	1.32E+01	3.05E+02	9.18E+02	2.31E+01	1.26E+03	1.72E+02	6.91E+02	1.55E+01	2.49E+02	-	8.56E+01	1.21E+03	1.71E+02	6.91E+02	2.52E+01	3.26E+02	-	-	1.21E+03
2041	-	-	1.41E+01	3.26E+02	1.01E+03	2.39E+01	1.37E+03	1.89E+02	7.59E+02	1.63E+01	2.63E+02	-	9.52E+01	1.32E+03	1.88E+02	7.59E+02	2.71E+01	3.48E+02	-	-	1.32E+03
2042	-	-	1.50E+01	3.47E+02	1.10E+03	2.44E+01	1.48E+03	2.06E+02	8.26E+02	1.71E+01	2.75E+02	-	1.05E+02	1.43E+03	2.04E+02	8.26E+02	2.89E+01	3.69E+02	-	-	1.43E+03
2043	-	-	1.59E+01	3.67E+02	1.19E+03	2.46E+01	1.59E+03	2.22E+02	8.93E+02	1.78E+01	2.87E+02	-	1.14E+02	1.53E+03	2.21E+02	8.93E+02	3.07E+01	3.89E+02	-	-	1.53E+03
2044	-	-	1.67E+01	3.86E+02	1.28E+03	2.45E+01	1.70E+03	2.39E+02	9.61E+02	1.85E+01	2.98E+02	-	1.24E+02	1.64E+03	2.38E+02	9.61E+02	3.25E+01	4.08E+02	-	-	1.64E+03
2045	-	-	1.75E+01	4.05E+02	1.37E+03	2.43E+01	1.81E+03	2.56E+02	1.03E+03	1.91E+01	3.08E+02	-	1.33E+02	1.74E+03	2.54E+02	1.03E+03	3.42E+01	4.27E+02	-	-	1.74E+03
2046	-	-	1.83E+01	4.23E+02	1.45E+03	2.40E+01	1.92E+03	2.73E+02	1.10E+03	1.97E+01	3.17E+02	-	1.43E+02	1.85E+03	2.71E+02	1.10E+03	3.59E+01	4.45E+02	-	-	1.85E+03
2047	-	-	1.91E+01	4.41E+02	1.54E+03	2.36E+01	2.03E+03	2.90E+02	1.16E+03	2.03E+01	3.26E+02	-	1.53E+02	1.95E+03	2.88E+02	1.16E+03	3.75E+01	4.62E+02	-	-	1.95E+03
2048	-	-	1.98E+01	4.59E+02	1.63E+03	2.30E+01	2.14E+03	3.06E+02	1.23E+03	2.08E+01	3.34E+02	-	1.62E+02	2.05E+03	3.04E+02	1.23E+03	3.91E+01	4.79E+02	-	-	2.05E+03
2049	-	-	2.06E+01	4.76E+02	1.72E+03	2.23E+01	2.24E+03	3.23E+02	1.30E+03	2.13E+01	3.42E+02	-	1.72E+02	2.16E+03	3.21E+02	1.30E+03	4.07E+01	4.96E+02	-	-	2.16E+03
2050	-	-	2.13E+01	4.92E+02	1.81E+03	2.15E+01	2.35E+03	3.40E+02	1.37E+03	2.17E+01	3.50E+02	-	1.81E+02	2.26E+03	3.38E+02	1.37E+03	4.22E+01	5.11E+02	-	-	2.26E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	1.90E+03	2.07E+01	2.45E+03	3.57E+02	1.43E+03	2.22E+01	3.56E+02	-	1.91E+02	2.36E+03	3.54E+02	1.43E+03	4.37E+01	5.27E+02	-	-	2.36E+03
2052	-	-	2.27E+01	5.24E+02	1.99E+03	1.97E+01	2.56E+03	3.74E+02	1.50E+03	2.26E+01	3.63E+02	-	2.00E+02	2.46E+03	3.71E+02	1.50E+03	4.52E+01	5.41E+02	-	-	2.46E+03
2053	-	-	2.33E+01	5.39E+02	2.08E+03	1.86E+01	2.66E+03	3.90E+02	1.57E+03	2.29E+01	3.69E+02	-	2.09E+02	2.56E+03	3.88E+02	1.57E+03	4.66E+01	5.56E+02	-	-	2.56E+03
2054	-	-	2.40E+01	5.54E+02	2.17E+03	1.73E+01	2.77E+03	4.07E+02	1.64E+03	2.33E+01	3.75E+02	-	2.18E+02	2.66E+03	4.04E+02	1.64E+03	4.80E+01	5.69E+02	-	-	2.66E+03
2055	-	-	2.46E+01	5.68E+02	2.26E+03	1.60E+01	2.87E+03	4.24E+02	1.70E+03	2.36E+01	3.80E+02	-	2.27E+02	2.76E+03	4.21E+02	1.70E+03	4.93E+01	5.83E+02	-	-	2.76E+03
2056	-	-	2.52E+01	5.82E+02	2.35E+03	1.47E+01	2.97E+03	4.41E+02	1.77E+03	2.39E+01	3.85E+02	-	2.36E+02	2.86E+03	4.38E+02	1.77E+03	5.06E+01	5.95E+02	-	-	2.85E+03
2057	-	-	2.58E+01	5.96E+02	2.44E+03	1.35E+01	3.07E+03	4.58E+02	1.84E+03	2.42E+01	3.90E+02	-	2.45E+02	2.95E+03	4.54E+02	1.84E+03	5.19E+01	6.08E+02	-	-	2.95E+03
2058	-	-	2.64E+01	6.09E+02	2.52E+03	1.19E+01	3.17E+03	4.73E+02	1.90E+03	2.45E+01	3.94E+02	-	2.53E+02	3.04E+03	4.69E+02	1.90E+03	5.31E+01	6.20E+02	-	-	3.04E+03
2059	-	-	2.69E+01	6.22E+02	2.58E+03	1.03E+01	3.24E+03	4.85E+02	1.95E+03	2.47E+01	3.98E+02	-	2.62E+02	3.12E+03	4.81E+02	1.95E+03	5.43E+01	6.32E+02	-	-	3.11E+03
2060	-	-	2.75E+01	6.35E+02	2.64E+03	8.62E+00	3.31E+03	4.94E+02	1.98E+03	2.50E+01	4.02E+02	-	2.70E+02	3.18E+03	4.91E+02	1.98E+03	5.55E+01	6.43E+02	-	-	3.17E+03
2061	-	-	2.80E+01	6.47E+02	2.68E+03	6.76E+00	3.36E+03	5.02E+02	2.02E+03	2.52E+01	4.05E+02	-	2.78E+02	3.23E+03	4.98E+02	2.02E+03	5.66E+01	6.53E+02	-	-	3.22E+03

Exhibit A-25. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	5.82E+00	-4.54E-01	3.62E+01	2.80E+00	1.80E+00	1.80E+00	2.89E+01	-	2.85E-01	3.56E+01	2.78E+00	1.80E+00	1.83E+00	2.92E+01	-	-	3.56E+01
2030	-	-	2.52E+00	5.83E+01	2.04E+01	-5.53E-01	8.07E+01	9.80E+00	6.29E+00	3.49E+00	5.61E+01	-	1.94E+00	7.76E+01	9.73E+00	6.29E+00	3.71E+00	5.78E+01	-	-	7.76E+01
2031	-	-	3.73E+00	8.63E+01	4.66E+01	6.02E-01	1.37E+02	2.24E+01	1.44E+01	5.07E+00	8.15E+01	-	5.91E+00	1.29E+02	2.22E+01	1.44E+01	5.74E+00	8.68E+01	-	-	1.29E+02
2032	-	-	4.91E+00	1.13E+02	7.86E+01	3.26E+00	2.00E+02	3.78E+01	2.42E+01	6.56E+00	1.05E+02	-	1.23E+01	1.86E+02	3.75E+01	2.42E+01	7.94E+00	1.16E+02	-	-	1.86E+02
2033	-	-	6.05E+00	1.40E+02	1.14E+02	6.83E+00	2.66E+02	5.46E+01	3.50E+01	7.95E+00	1.28E+02	-	2.03E+01	2.46E+02	5.42E+01	3.50E+01	1.02E+01	1.46E+02	-	-	2.45E+02
2034	-	-	7.16E+00	1.65E+02	1.48E+02	1.04E+01	3.31E+02	7.14E+01	4.58E+01	9.26E+00	1.49E+02	-	2.90E+01	3.04E+02	7.09E+01	4.58E+01	1.25E+01	1.75E+02	-	-	3.04E+02
2035	-	-	8.24E+00	1.90E+02	1.83E+02	1.36E+01	3.96E+02	8.82E+01	5.66E+01	1.05E+01	1.69E+02	-	3.81E+01	3.62E+02	8.75E+01	5.66E+01	1.48E+01	2.03E+02	-	-	3.61E+02
2036	-	-	9.28E+00	2.15E+02	2.18E+02	1.62E+01	4.59E+02	1.05E+02	6.73E+01	1.16E+01	1.87E+02	-	4.73E+01	4.18E+02	1.04E+02	6.73E+01	1.70E+01	2.29E+02	-	-	4.18E+02
2037	-	-	1.03E+01	2.38E+02	2.53E+02	1.85E+01	5.20E+02	1.22E+02	7.81E+01	1.27E+01	2.04E+02	-	5.67E+01	4.73E+02	1.21E+02	7.81E+01	1.91E+01	2.55E+02	-	-	4.73E+02
2038	-	-	1.13E+01	2.61E+02	2.88E+02	2.04E+01	5.81E+02	1.39E+02	8.89E+01	1.37E+01	2.20E+02	-	6.62E+01	5.28E+02	1.38E+02	8.89E+01	2.12E+01	2.79E+02	-	-	5.27E+02
2039	-	-	1.23E+01	2.84E+02	3.23E+02	2.19E+01	6.41E+02	1.55E+02	9.97E+01	1.46E+01	2.35E+02	-	7.59E+01	5.81E+02	1.54E+02	9.97E+01	2.32E+01	3.03E+02	-	-	5.80E+02
2040	-	-	1.32E+01	3.05E+02	3.58E+02	2.31E+01	7.00E+02	1.72E+02	1.10E+02	1.55E+01	2.49E+02	-	8.56E+01	6.33E+02	1.71E+02	1.10E+02	2.52E+01	3.26E+02	-	-	6.32E+02
2041	-	-	1.41E+01	3.26E+02	3.93E+02	2.39E+01	7.57E+02	1.89E+02	1.21E+02	1.63E+01	2.63E+02	-	9.52E+01	6.84E+02	1.88E+02	1.21E+02	2.71E+01	3.48E+02	-	-	6.83E+02
2042	-	-	1.50E+01	3.47E+02	4.28E+02	2.44E+01	8.14E+02	2.06E+02	1.32E+02	1.71E+01	2.75E+02	-	1.05E+02	7.35E+02	2.04E+02	1.32E+02	2.90E+01	3.69E+02	-	-	7.34E+02
2043	-	-	1.59E+01	3.67E+02	4.63E+02	2.46E+01	8.70E+02	2.23E+02	1.43E+02	1.78E+01	2.87E+02	-	1.14E+02	7.84E+02	2.21E+02	1.43E+02	3.08E+01	3.89E+02	-	-	7.83E+02
2044	-	-	1.67E+01	3.86E+02	4.98E+02	2.45E+01	9.25E+02	2.39E+02	1.54E+02	1.85E+01	2.98E+02	-	1.24E+02	8.33E+02	2.38E+02	1.54E+02	3.25E+01	4.08E+02	-	-	8.32E+02
2045	-	-	1.75E+01	4.05E+02	5.33E+02	2.43E+01	9.80E+02	2.56E+02	1.64E+02	1.91E+01	3.08E+02	-	1.33E+02	8.81E+02	2.54E+02	1.64E+02	3.42E+01	4.27E+02	-	-	8.80E+02
2046	-	-	1.83E+01	4.23E+02	5.68E+02	2.40E+01	1.03E+03	2.73E+02	1.75E+02	1.97E+01	3.17E+02	-	1.43E+02	9.28E+02	2.71E+02	1.75E+02	3.59E+01	4.45E+02	-	-	9.27E+02
2047	-	-	1.91E+01	4.41E+02	6.03E+02	2.36E+01	1.09E+03	2.90E+02	1.86E+02	2.03E+01	3.26E+02	-	1.53E+02	9.75E+02	2.88E+02	1.86E+02	3.76E+01	4.62E+02	-	-	9.73E+02
2048	-	-	1.98E+01	4.59E+02	6.38E+02	2.30E+01	1.14E+03	3.07E+02	1.97E+02	2.08E+01	3.34E+02	-	1.62E+02	1.02E+03	3.04E+02	1.97E+02	3.92E+01	4.79E+02	-	-	1.02E+03
2049	-	-	2.06E+01	4.76E+02	6.72E+02	2.23E+01	1.19E+03	3.23E+02	2.07E+02	2.13E+01	3.42E+02	-	1.72E+02	1.07E+03	3.21E+02	2.07E+02	4.07E+01	4.96E+02	-	-	1.06E+03
2050	-	-	2.13E+01	4.92E+02	7.07E+02	2.15E+01	1.24E+03	3.40E+02	2.18E+02	2.17E+01	3.50E+02	-	1.81E+02	1.11E+03	3.38E+02	2.18E+02	4.23E+01	5.11E+02	-	-	1.11E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	7.42E+02	2.07E+01	1.29E+03	3.57E+02	2.29E+02	2.22E+01	3.56E+02	-	1.91E+02	1.16E+03	3.54E+02	2.29E+02	4.38E+01	5.27E+02	-	-	1.15E+03
2052	-	-	2.27E+01	5.24E+02	7.77E+02	1.97E+01	1.34E+03	3.74E+02	2.40E+02	2.26E+01	3.63E+02	-	2.00E+02	1.20E+03	3.71E+02	2.40E+02	4.52E+01	5.41E+02	-	-	1.20E+03
2053	-	-	2.33E+01	5.39E+02	8.12E+02	1.86E+01	1.39E+03	3.91E+02	2.51E+02	2.29E+01	3.69E+02	-	2.09E+02	1.24E+03	3.88E+02	2.51E+02	4.66E+01	5.56E+02	-	-	1.24E+03
2054	-	-	2.40E+01	5.54E+02	8.47E+02	1.73E+01	1.44E+03	4.07E+02	2.61E+02	2.33E+01	3.75E+02	-	2.18E+02	1.28E+03	4.04E+02	2.61E+02	4.80E+01	5.69E+02	-	-	1.28E+03
2055	-	-	2.46E+01	5.68E+02	8.82E+02	1.60E+01	1.49E+03	4.24E+02	2.72E+02	2.36E+01	3.80E+02	-	2.27E+02	1.33E+03	4.21E+02	2.72E+02	4.93E+01	5.83E+02	-	-	1.32E+03
2056	-	-	2.52E+01	5.82E+02	9.17E+02	1.47E+01	1.54E+03	4.41E+02	2.83E+02	2.39E+01	3.85E+02	-	2.36E+02	1.37E+03	4.38E+02	2.83E+02	5.06E+01	5.95E+02	-	-	1.37E+03
2057	-	-	2.58E+01	5.96E+02	9.52E+02	1.35E+01	1.59E+03	4.58E+02	2.94E+02	2.42E+01	3.90E+02	-	2.45E+02	1.41E+03	4.54E+02	2.94E+02	5.19E+01	6.08E+02	-	-	1.41E+03
2058	-	-	2.64E+01	6.09E+02	9.83E+02	1.19E+01	1.63E+03	4.73E+02	3.03E+02	2.45E+01	3.94E+02	-	2.53E+02	1.45E+03	4.69E+02	3.03E+02	5.32E+01	6.20E+02	-	-	1.45E+03
2059	-	-	2.69E+01	6.22E+02	1.01E+03	1.03E+01	1.67E+03	4.85E+02	3.11E+02	2.48E+01	3.98E+02	-	2.62E+02	1.48E+03	4.81E+02	3.11E+02	5.44E+01	6.32E+02	-	-	1.48E+03
2060	-	-	2.75E+01	6.35E+02	1.03E+03	8.62E+00	1.70E+03	4.94E+02	3.17E+02	2.50E+01	4.02E+02	-	2.70E+02	1.51E+03	4.91E+02	3.17E+02	5.55E+01	6.43E+02	-	-	1.51E+03
2061	-	-	2.80E+01	6.47E+02	1.04E+03	6.76E+00	1.73E+03	5.02E+02	3.22E+02	2.52E+01	4.05E+02	-	2.78E+02	1.53E+03	4.98E+02	3.22E+02	5.66E+01	6.53E+02	-	-	1.53E+03

Exhibit A-26. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	5.92E+00	-4.54E-01	3.63E+01	2.80E+00	1.88E+00	1.80E+00	2.89E+01	-	2.85E-01	3.57E+01	2.78E+00	1.88E+00	1.83E+00	2.92E+01	-	-	3.57E+01
2030	-	-	2.52E+00	5.83E+01	2.07E+01	-5.53E-01	8.10E+01	9.80E+00	6.58E+00	3.49E+00	5.61E+01	-	1.94E+00	7.79E+01	9.72E+00	6.58E+00	3.71E+00	5.78E+01	-	-	7.79E+01
2031	-	-	3.73E+00	8.63E+01	4.74E+01	6.02E-01	1.38E+02	2.24E+01	1.50E+01	5.07E+00	8.15E+01	-	5.91E+00	1.30E+02	2.22E+01	1.50E+01	5.74E+00	8.68E+01	-	-	1.30E+02
2032	-	-	4.91E+00	1.13E+02	7.99E+01	3.26E+00	2.02E+02	3.78E+01	2.54E+01	6.56E+00	1.05E+02	-	1.23E+01	1.87E+02	3.75E+01	2.54E+01	7.94E+00	1.16E+02	-	-	1.87E+02
2033	-	-	6.05E+00	1.40E+02	1.15E+02	6.83E+00	2.68E+02	5.46E+01	3.67E+01	7.95E+00	1.28E+02	-	2.03E+01	2.47E+02	5.42E+01	3.67E+01	1.02E+01	1.46E+02	-	-	2.47E+02
2034	-	-	7.16E+00	1.65E+02	1.51E+02	1.04E+01	3.34E+02	7.14E+01	4.80E+01	9.26E+00	1.49E+02	-	2.90E+01	3.06E+02	7.09E+01	4.80E+01	1.25E+01	1.75E+02	-	-	3.06E+02
2035	-	-	8.24E+00	1.90E+02	1.86E+02	1.36E+01	3.99E+02	8.82E+01	5.92E+01	1.05E+01	1.69E+02	-	3.81E+01	3.65E+02	8.75E+01	5.92E+01	1.48E+01	2.03E+02	-	-	3.64E+02
2036	-	-	9.28E+00	2.15E+02	2.22E+02	1.62E+01	4.62E+02	1.05E+02	7.05E+01	1.16E+01	1.87E+02	-	4.73E+01	4.21E+02	1.04E+02	7.05E+01	1.70E+01	2.29E+02	-	-	4.21E+02
2037	-	-	1.03E+01	2.38E+02	2.58E+02	1.85E+01	5.25E+02	1.22E+02	8.18E+01	1.27E+01	2.04E+02	-	5.67E+01	4.77E+02	1.21E+02	8.18E+01	1.91E+01	2.55E+02	-	-	4.77E+02
2038	-	-	1.13E+01	2.61E+02	2.93E+02	2.04E+01	5.86E+02	1.39E+02	9.31E+01	1.37E+01	2.20E+02	-	6.62E+01	5.32E+02	1.38E+02	9.31E+01	2.12E+01	2.79E+02	-	-	5.31E+02
2039	-	-	1.23E+01	2.84E+02	3.29E+02	2.19E+01	6.46E+02	1.55E+02	1.04E+02	1.46E+01	2.35E+02	-	7.59E+01	5.86E+02	1.54E+02	1.04E+02	2.32E+01	3.03E+02	-	-	5.85E+02
2040	-	-	1.32E+01	3.05E+02	3.64E+02	2.31E+01	7.06E+02	1.72E+02	1.16E+02	1.55E+01	2.49E+02	-	8.56E+01	6.38E+02	1.71E+02	1.16E+02	2.52E+01	3.26E+02	-	-	6.38E+02
2041	-	-	1.41E+01	3.26E+02	4.00E+02	2.39E+01	7.64E+02	1.89E+02	1.27E+02	1.63E+01	2.63E+02	-	9.52E+01	6.90E+02	1.88E+02	1.27E+02	2.71E+01	3.48E+02	-	-	6.89E+02
2042	-	-	1.50E+01	3.47E+02	4.35E+02	2.44E+01	8.21E+02	2.06E+02	1.38E+02	1.71E+01	2.75E+02	-	1.05E+02	7.41E+02	2.04E+02	1.38E+02	2.90E+01	3.69E+02	-	-	7.40E+02
2043	-	-	1.59E+01	3.67E+02	4.71E+02	2.46E+01	8.78E+02	2.23E+02	1.50E+02	1.78E+01	2.87E+02	-	1.14E+02	7.91E+02	2.21E+02	1.50E+02	3.08E+01	3.89E+02	-	-	7.90E+02
2044	-	-	1.67E+01	3.86E+02	5.06E+02	2.45E+01	9.34E+02	2.39E+02	1.61E+02	1.85E+01	2.98E+02	-	1.24E+02	8.40E+02	2.38E+02	1.61E+02	3.25E+01	4.08E+02	-	-	8.39E+02
2045	-	-	1.75E+01	4.05E+02	5.42E+02	2.43E+01	9.89E+02	2.56E+02	1.72E+02	1.91E+01	3.08E+02	-	1.33E+02	8.89E+02	2.54E+02	1.72E+02	3.42E+01	4.27E+02	-	-	8.87E+02
2046	-	-	1.83E+01	4.23E+02	5.77E+02	2.40E+01	1.04E+03	2.73E+02	1.83E+02	1.97E+01	3.17E+02	-	1.43E+02	9.36E+02	2.71E+02	1.83E+02	3.59E+01	4.45E+02	-	-	9.35E+02
2047	-	-	1.91E+01	4.41E+02	6.13E+02	2.36E+01	1.10E+03	2.90E+02	1.95E+02	2.03E+01	3.26E+02	-	1.53E+02	9.84E+02	2.88E+02	1.95E+02	3.76E+01	4.62E+02	-	-	9.82E+02
2048	-	-	1.98E+01	4.59E+02	6.48E+02	2.30E+01	1.15E+03	3.07E+02	2.06E+02	2.08E+01	3.34E+02	-	1.62E+02	1.03E+03	3.04E+02	2.06E+02	3.92E+01	4.79E+02	-	-	1.03E+03
2049	-	-	2.06E+01	4.76E+02	6.84E+02	2.23E+01	1.20E+03	3.23E+02	2.17E+02	2.13E+01	3.42E+02	-	1.72E+02	1.08E+03	3.21E+02	2.17E+02	4.07E+01	4.96E+02	-	-	1.07E+03
2050	-	-	2.13E+01	4.92E+02	7.19E+02	2.15E+01	1.25E+03	3.40E+02	2.29E+02	2.17E+01	3.50E+02	-	1.81E+02	1.12E+03	3.38E+02	2.29E+02	4.23E+01	5.11E+02	-	-	1.12E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	7.55E+02	2.07E+01	1.31E+03	3.57E+02	2.40E+02	2.22E+01	3.56E+02	-	1.91E+02	1.17E+03	3.54E+02	2.40E+02	4.38E+01	5.27E+02	-	-	1.16E+03
2052	-	-	2.27E+01	5.24E+02	7.90E+02	1.97E+01	1.36E+03	3.74E+02	2.51E+02	2.26E+01	3.63E+02	-	2.00E+02	1.21E+03	3.71E+02	2.51E+02	4.52E+01	5.41E+02	-	-	1.21E+03
2053	-	-	2.33E+01	5.39E+02	8.26E+02	1.86E+01	1.41E+03	3.90E+02	2.62E+02	2.29E+01	3.69E+02	-	2.09E+02	1.25E+03	3.88E+02	2.62E+02	4.66E+01	5.56E+02	-	-	1.25E+03
2054	-	-	2.40E+01	5.54E+02	8.61E+02	1.73E+01	1.46E+03	4.07E+02	2.74E+02	2.33E+01	3.75E+02	-	2.18E+02	1.30E+03	4.04E+02	2.74E+02	4.80E+01	5.69E+02	-	-	1.30E+03
2055	-	-	2.46E+01	5.68E+02	8.97E+02	1.60E+01	1.51E+03	4.24E+02	2.85E+02	2.36E+01	3.80E+02	-	2.27E+02	1.34E+03	4.21E+02	2.85E+02	4.93E+01	5.83E+02	-	-	1.34E+03
2056	-	-	2.52E+01	5.82E+02	9.32E+02	1.47E+01	1.55E+03	4.41E+02	2.96E+02	2.39E+01	3.85E+02	-	2.36E+02	1.38E+03	4.38E+02	2.96E+02	5.06E+01	5.95E+02	-	-	1.38E+03
2057	-	-	2.58E+01	5.96E+02	9.68E+02	1.35E+01	1.60E+03	4.58E+02	3.08E+02	2.42E+01	3.90E+02	-	2.45E+02	1.42E+03	4.54E+02	3.08E+02	5.19E+01	6.08E+02	-	-	1.42E+03
2058	-	-	2.64E+01	6.09E+02	1.00E+03	1.19E+01	1.65E+03	4.73E+02	3.18E+02	2.45E+01	3.94E+02	-	2.53E+02	1.46E+03	4.69E+02	3.18E+02	5.32E+01	6.20E+02	-	-	1.46E+03
2059	-	-	2.69E+01	6.22E+02	1.03E+03	1.03E+01	1.68E+03	4.85E+02	3.26E+02	2.48E+01	3.98E+02	-	2.62E+02	1.49E+03	4.81E+02	3.26E+02	5.44E+01	6.32E+02	-	-	1.49E+03
2060	-	-	2.75E+01	6.35E+02	1.05E+03	8.62E+00	1.72E+03	4.94E+02	3.32E+02	2.50E+01	4.02E+02	-	2.70E+02	1.52E+03	4.91E+02	3.32E+02	5.55E+01	6.43E+02	-	-	1.52E+03
2061	-	-	2.80E+01	6.47E+02	1.06E+03	6.76E+00	1.74E+03	5.02E+02	3.37E+02	2.52E+01	4.05E+02	-	2.78E+02	1.55E+03	4.98E+02	3.37E+02	5.66E+01	6.53E+02	-	-	1.55E+03

Exhibit A-27. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	5.92E+00	-4.54E-01	3.63E+01	2.80E+00	1.88E+00	1.80E+00	2.89E+01	-	2.85E-01	3.57E+01	2.78E+00	1.88E+00	1.83E+00	2.92E+01	-	-	3.57E+01
2030	-	-	2.52E+00	5.83E+01	2.07E+01	-5.53E-01	8.10E+01	9.80E+00	6.60E+00	3.49E+00	5.61E+01	-	1.94E+00	7.79E+01	9.72E+00	6.60E+00	3.71E+00	5.78E+01	-	-	7.79E+01
2031	-	-	3.73E+00	8.63E+01	4.74E+01	6.02E-01	1.38E+02	2.24E+01	1.51E+01	5.07E+00	8.15E+01	-	5.91E+00	1.30E+02	2.22E+01	1.51E+01	5.74E+00	8.68E+01	-	-	1.30E+02
2032	-	-	4.91E+00	1.13E+02	8.00E+01	3.26E+00	2.02E+02	3.78E+01	2.54E+01	6.56E+00	1.05E+02	-	1.23E+01	1.87E+02	3.75E+01	2.54E+01	7.94E+00	1.16E+02	-	-	1.87E+02
2033	-	-	6.05E+00	1.40E+02	1.16E+02	6.83E+00	2.68E+02	5.46E+01	3.68E+01	7.95E+00	1.28E+02	-	2.03E+01	2.47E+02	5.42E+01	3.68E+01	1.02E+01	1.46E+02	-	-	2.47E+02
2034	-	-	7.16E+00	1.65E+02	1.51E+02	1.04E+01	3.34E+02	7.14E+01	4.81E+01	9.26E+00	1.49E+02	-	2.90E+01	3.07E+02	7.09E+01	4.81E+01	1.25E+01	1.75E+02	-	-	3.06E+02
2035	-	-	8.24E+00	1.90E+02	1.87E+02	1.36E+01	3.99E+02	8.82E+01	5.94E+01	1.05E+01	1.69E+02	-	3.81E+01	3.65E+02	8.75E+01	5.94E+01	1.48E+01	2.03E+02	-	-	3.64E+02
2036	-	-	9.28E+00	2.15E+02	2.22E+02	1.62E+01	4.62E+02	1.05E+02	7.07E+01	1.16E+01	1.87E+02	-	4.73E+01	4.22E+02	1.04E+02	7.07E+01	1.70E+01	2.29E+02	-	-	4.21E+02
2037	-	-	1.03E+01	2.38E+02	2.58E+02	1.85E+01	5.25E+02	1.22E+02	8.20E+01	1.27E+01	2.04E+02	-	5.67E+01	4.77E+02	1.21E+02	8.20E+01	1.91E+01	2.55E+02	-	-	4.77E+02
2038	-	-	1.13E+01	2.61E+02	2.93E+02	2.04E+01	5.86E+02	1.39E+02	9.33E+01	1.37E+01	2.20E+02	-	6.62E+01	5.32E+02	1.38E+02	9.33E+01	2.12E+01	2.79E+02	-	-	5.31E+02
2039	-	-	1.23E+01	2.84E+02	3.29E+02	2.19E+01	6.47E+02	1.55E+02	1.05E+02	1.46E+01	2.35E+02	-	7.59E+01	5.86E+02	1.54E+02	1.05E+02	2.32E+01	3.03E+02	-	-	5.85E+02
2040	-	-	1.32E+01	3.05E+02	3.64E+02	2.31E+01	7.06E+02	1.72E+02	1.16E+02	1.55E+01	2.49E+02	-	8.56E+01	6.39E+02	1.71E+02	1.16E+02	2.52E+01	3.26E+02	-	-	6.38E+02
2041	-	-	1.41E+01	3.26E+02	4.00E+02	2.39E+01	7.64E+02	1.89E+02	1.27E+02	1.63E+01	2.63E+02	-	9.52E+01	6.90E+02	1.88E+02	1.27E+02	2.71E+01	3.48E+02	-	-	6.89E+02
2042	-	-	1.50E+01	3.47E+02	4.35E+02	2.44E+01	8.22E+02	2.06E+02	1.39E+02	1.71E+01	2.75E+02	-	1.05E+02	7.41E+02	2.04E+02	1.39E+02	2.90E+01	3.69E+02	-	-	7.40E+02
2043	-	-	1.59E+01	3.67E+02	4.71E+02	2.46E+01	8.78E+02	2.23E+02	1.50E+02	1.78E+01	2.87E+02	-	1.14E+02	7.91E+02	2.21E+02	1.50E+02	3.08E+01	3.89E+02	-	-	7.90E+02
2044	-	-	1.67E+01	3.86E+02	5.07E+02	2.45E+01	9.34E+02	2.39E+02	1.61E+02	1.85E+01	2.98E+02	-	1.24E+02	8.40E+02	2.38E+02	1.61E+02	3.25E+01	4.08E+02	-	-	8.39E+02
2045	-	-	1.75E+01	4.05E+02	5.42E+02	2.43E+01	9.89E+02	2.56E+02	1.72E+02	1.91E+01	3.08E+02	-	1.33E+02	8.89E+02	2.54E+02	1.72E+02	3.42E+01	4.27E+02	-	-	8.88E+02
2046	-	-	1.83E+01	4.23E+02	5.78E+02	2.40E+01	1.04E+03	2.73E+02	1.84E+02	1.97E+01	3.17E+02	-	1.43E+02	9.37E+02	2.71E+02	1.84E+02	3.59E+01	4.45E+02	-	-	9.35E+02
2047	-	-	1.91E+01	4.41E+02	6.13E+02	2.36E+01	1.10E+03	2.90E+02	1.95E+02	2.03E+01	3.26E+02	-	1.53E+02	9.84E+02	2.88E+02	1.95E+02	3.76E+01	4.62E+02	-	-	9.83E+02
2048	-	-	1.98E+01	4.59E+02	6.49E+02	2.30E+01	1.15E+03	3.07E+02	2.06E+02	2.08E+01	3.34E+02	-	1.62E+02	1.03E+03	3.04E+02	2.06E+02	3.92E+01	4.79E+02	-	-	1.03E+03
2049	-	-	2.06E+01	4.76E+02	6.84E+02	2.23E+01	1.20E+03	3.23E+02	2.18E+02	2.13E+01	3.42E+02	-	1.72E+02	1.08E+03	3.21E+02	2.18E+02	4.07E+01	4.96E+02	-	-	1.07E+03
2050	-	-	2.13E+01	4.92E+02	7.20E+02	2.15E+01	1.25E+03	3.40E+02	2.29E+02	2.17E+01	3.50E+02	-	1.81E+02	1.12E+03	3.38E+02	2.29E+02	4.23E+01	5.11E+02	-	-	1.12E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	7.55E+02	2.07E+01	1.31E+03	3.57E+02	2.40E+02	2.22E+01	3.56E+02	-	1.91E+02	1.17E+03	3.54E+02	2.40E+02	4.38E+01	5.27E+02	-	-	1.17E+03
2052	-	-	2.27E+01	5.24E+02	7.91E+02	1.97E+01	1.36E+03	3.74E+02	2.52E+02	2.26E+01	3.63E+02	-	2.00E+02	1.21E+03	3.71E+02	2.52E+02	4.52E+01	5.41E+02	-	-	1.21E+03
2053	-	-	2.33E+01	5.39E+02	8.26E+02	1.86E+01	1.41E+03	3.90E+02	2.63E+02	2.29E+01	3.69E+02	-	2.09E+02	1.25E+03	3.88E+02	2.63E+02	4.66E+01	5.56E+02	-	-	1.25E+03
2054	-	-	2.40E+01	5.54E+02	8.62E+02	1.73E+01	1.46E+03	4.07E+02	2.74E+02	2.33E+01	3.75E+02	-	2.18E+02	1.30E+03	4.04E+02	2.74E+02	4.80E+01	5.69E+02	-	-	1.30E+03
2055	-	-	2.46E+01	5.68E+02	8.98E+02	1.60E+01	1.51E+03	4.24E+02	2.86E+02	2.36E+01	3.80E+02	-	2.27E+02	1.34E+03	4.21E+02	2.86E+02	4.93E+01	5.83E+02	-	-	1.34E+03
2056	-	-	2.52E+01	5.82E+02	9.33E+02	1.47E+01	1.56E+03	4.41E+02	2.97E+02	2.39E+01	3.85E+02	-	2.36E+02	1.38E+03	4.38E+02	2.97E+02	5.06E+01	5.95E+02	-	-	1.38E+03
2057	-	-	2.58E+01	5.96E+02	9.69E+02	1.35E+01	1.60E+03	4.58E+02	3.08E+02	2.42E+01	3.90E+02	-	2.45E+02	1.42E+03	4.54E+02	3.08E+02	5.19E+01	6.08E+02	-	-	1.42E+03
2058	-	-	2.64E+01	6.09E+02	1.00E+03	1.19E+01	1.65E+03	4.73E+02	3.18E+02	2.45E+01	3.94E+02	-	2.53E+02	1.46E+03	4.69E+02	3.18E+02	5.32E+01	6.20E+02	-	-	1.46E+03
2059	-	-	2.69E+01	6.22E+02	1.03E+03	1.03E+01	1.69E+03	4.85E+02	3.26E+02	2.48E+01	3.98E+02	-	2.62E+02	1.50E+03	4.81E+02	3.26E+02	5.44E+01	6.32E+02	-	-	1.49E+03
2060	-	-	2.75E+01	6.35E+02	1.05E+03	8.62E+00	1.72E+03	4.94E+02	3.33E+02	2.50E+01	4.02E+02	-	2.70E+02	1.52E+03	4.91E+02	3.33E+02	5.55E+01	6.43E+02	-	-	1.52E+03
2061	-	-	2.80E+01	6.47E+02	1.06E+03	6.76E+00	1.74E+03	5.02E+02	3.38E+02	2.52E+01	4.05E+02	-	2.78E+02	1.55E+03	4.98E+02	3.38E+02	5.66E+01	6.53E+02	-	-	1.55E+03

Exhibit A-28. Cumulative Emissions Profile AR4 100-yr – NGCC with CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.28E+00	2.96E+01	5.89E+00	-4.54E-01	3.63E+01	2.80E+00	2.33E+00	1.80E+00	2.89E+01	-	2.85E-01	3.61E+01	2.78E+00	2.33E+00	1.83E+00	2.92E+01	-	-	3.61E+01
2030	-	-	2.52E+00	5.83E+01	2.06E+01	-5.53E-01	8.09E+01	9.80E+00	8.14E+00	3.49E+00	5.61E+01	-	1.94E+00	7.95E+01	9.72E+00	8.14E+00	3.71E+00	5.78E+01	-	-	7.94E+01
2031	-	-	3.73E+00	8.63E+01	4.71E+01	6.02E-01	1.38E+02	2.24E+01	1.86E+01	5.07E+00	8.15E+01	-	5.91E+00	1.34E+02	2.22E+01	1.86E+01	5.74E+00	8.68E+01	-	-	1.33E+02
2032	-	-	4.91E+00	1.13E+02	7.95E+01	3.26E+00	2.01E+02	3.78E+01	3.14E+01	6.55E+00	1.05E+02	-	1.23E+01	1.93E+02	3.75E+01	3.14E+01	7.94E+00	1.16E+02	-	-	1.93E+02
2033	-	-	6.05E+00	1.40E+02	1.15E+02	6.83E+00	2.67E+02	5.46E+01	4.54E+01	7.95E+00	1.28E+02	-	2.03E+01	2.56E+02	5.42E+01	4.54E+01	1.02E+01	1.46E+02	-	-	2.56E+02
2034	-	-	7.16E+00	1.65E+02	1.50E+02	1.04E+01	3.33E+02	7.14E+01	5.93E+01	9.26E+00	1.49E+02	-	2.90E+01	3.18E+02	7.09E+01	5.93E+01	1.25E+01	1.75E+02	-	-	3.17E+02
2035	-	-	8.24E+00	1.90E+02	1.85E+02	1.36E+01	3.98E+02	8.82E+01	7.33E+01	1.05E+01	1.69E+02	-	3.81E+01	3.79E+02	8.75E+01	7.33E+01	1.48E+01	2.03E+02	-	-	3.78E+02
2036	-	-	9.28E+00	2.15E+02	2.21E+02	1.62E+01	4.61E+02	1.05E+02	8.72E+01	1.16E+01	1.87E+02	-	4.73E+01	4.38E+02	1.04E+02	8.72E+01	1.70E+01	2.29E+02	-	-	4.38E+02
2037	-	-	1.03E+01	2.38E+02	2.56E+02	1.85E+01	5.23E+02	1.22E+02	1.01E+02	1.27E+01	2.04E+02	-	5.67E+01	4.97E+02	1.21E+02	1.01E+02	1.91E+01	2.55E+02	-	-	4.96E+02
2038	-	-	1.13E+01	2.61E+02	2.91E+02	2.04E+01	5.84E+02	1.39E+02	1.15E+02	1.37E+01	2.20E+02	-	6.62E+01	5.54E+02	1.38E+02	1.15E+02	2.12E+01	2.79E+02	-	-	5.53E+02
2039	-	-	1.23E+01	2.84E+02	3.27E+02	2.19E+01	6.44E+02	1.55E+02	1.29E+02	1.46E+01	2.35E+02	-	7.59E+01	6.10E+02	1.54E+02	1.29E+02	2.32E+01	3.03E+02	-	-	6.10E+02
2040	-	-	1.32E+01	3.05E+02	3.62E+02	2.31E+01	7.04E+02	1.72E+02	1.43E+02	1.55E+01	2.49E+02	-	8.56E+01	6.66E+02	1.71E+02	1.43E+02	2.52E+01	3.26E+02	-	-	6.65E+02
2041	-	-	1.41E+01	3.26E+02	3.97E+02	2.39E+01	7.62E+02	1.89E+02	1.57E+02	1.63E+01	2.63E+02	-	9.52E+01	7.20E+02	1.88E+02	1.57E+02	2.71E+01	3.48E+02	-	-	7.19E+02
2042	-	-	1.50E+01	3.47E+02	4.33E+02	2.44E+01	8.19E+02	2.06E+02	1.71E+02	1.71E+01	2.75E+02	-	1.05E+02	7.74E+02	2.04E+02	1.71E+02	2.90E+01	3.69E+02	-	-	7.73E+02
2043	-	-	1.59E+01	3.67E+02	4.68E+02	2.46E+01	8.75E+02	2.23E+02	1.85E+02	1.78E+01	2.87E+02	-	1.14E+02	8.26E+02	2.21E+02	1.85E+02	3.08E+01	3.89E+02	-	-	8.25E+02
2044	-	-	1.67E+01	3.86E+02	5.03E+02	2.45E+01	9.31E+02	2.39E+02	1.99E+02	1.85E+01	2.98E+02	-	1.24E+02	8.78E+02	2.38E+02	1.99E+02	3.25E+01	4.08E+02	-	-	8.77E+02
2045	-	-	1.75E+01	4.05E+02	5.39E+02	2.43E+01	9.86E+02	2.56E+02	2.13E+02	1.91E+01	3.08E+02	-	1.33E+02	9.29E+02	2.54E+02	2.13E+02	3.42E+01	4.27E+02	-	-	9.28E+02
2046	-	-	1.83E+01	4.23E+02	5.74E+02	2.40E+01	1.04E+03	2.73E+02	2.27E+02	1.97E+01	3.17E+02	-	1.43E+02	9.80E+02	2.71E+02	2.27E+02	3.59E+01	4.45E+02	-	-	9.78E+02
2047	-	-	1.91E+01	4.41E+02	6.09E+02	2.36E+01	1.09E+03	2.90E+02	2.41E+02	2.03E+01	3.26E+02	-	1.53E+02	1.03E+03	2.88E+02	2.41E+02	3.76E+01	4.62E+02	-	-	1.03E+03
2048	-	-	1.98E+01	4.59E+02	6.45E+02	2.30E+01	1.15E+03	3.07E+02	2.55E+02	2.08E+01	3.34E+02	-	1.62E+02	1.08E+03	3.04E+02	2.55E+02	3.92E+01	4.79E+02	-	-	1.08E+03
2049	-	-	2.06E+01	4.76E+02	6.80E+02	2.23E+01	1.20E+03	3.23E+02	2.69E+02	2.13E+01	3.42E+02	-	1.72E+02	1.13E+03	3.21E+02	2.69E+02	4.07E+01	4.96E+02	-	-	1.13E+03
2050	-	-	2.13E+01	4.92E+02	7.15E+02	2.15E+01	1.25E+03	3.40E+02	2.83E+02	2.17E+01	3.50E+02	-	1.81E+02	1.18E+03	3.38E+02	2.83E+02	4.23E+01	5.11E+02	-	-	1.17E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.20E+01	5.08E+02	7.51E+02	2.07E+01	1.30E+03	3.57E+02	2.97E+02	2.22E+01	3.56E+02	-	1.91E+02	1.22E+03	3.54E+02	2.97E+02	4.37E+01	5.27E+02	-	-	1.22E+03
2052	-	-	2.27E+01	5.24E+02	7.86E+02	1.97E+01	1.35E+03	3.74E+02	3.11E+02	2.26E+01	3.63E+02	-	2.00E+02	1.27E+03	3.71E+02	3.11E+02	4.52E+01	5.41E+02	-	-	1.27E+03
2053	-	-	2.33E+01	5.39E+02	8.21E+02	1.86E+01	1.40E+03	3.90E+02	3.25E+02	2.29E+01	3.69E+02	-	2.09E+02	1.32E+03	3.88E+02	3.25E+02	4.66E+01	5.56E+02	-	-	1.31E+03
2054	-	-	2.40E+01	5.54E+02	8.57E+02	1.73E+01	1.45E+03	4.07E+02	3.38E+02	2.33E+01	3.75E+02	-	2.18E+02	1.36E+03	4.04E+02	3.38E+02	4.80E+01	5.69E+02	-	-	1.36E+03
2055	-	-	2.46E+01	5.68E+02	8.92E+02	1.60E+01	1.50E+03	4.24E+02	3.52E+02	2.36E+01	3.80E+02	-	2.27E+02	1.41E+03	4.21E+02	3.52E+02	4.93E+01	5.83E+02	-	-	1.41E+03
2056	-	-	2.52E+01	5.82E+02	9.27E+02	1.47E+01	1.55E+03	4.41E+02	3.66E+02	2.39E+01	3.85E+02	-	2.36E+02	1.45E+03	4.38E+02	3.66E+02	5.06E+01	5.95E+02	-	-	1.45E+03
2057	-	-	2.58E+01	5.96E+02	9.62E+02	1.35E+01	1.60E+03	4.58E+02	3.80E+02	2.42E+01	3.90E+02	-	2.45E+02	1.50E+03	4.54E+02	3.80E+02	5.19E+01	6.08E+02	-	-	1.49E+03
2058	-	-	2.64E+01	6.09E+02	9.94E+02	1.19E+01	1.64E+03	4.73E+02	3.93E+02	2.45E+01	3.94E+02	-	2.53E+02	1.54E+03	4.69E+02	3.93E+02	5.32E+01	6.20E+02	-	-	1.54E+03
2059	-	-	2.69E+01	6.22E+02	1.02E+03	1.03E+01	1.68E+03	4.85E+02	4.03E+02	2.48E+01	3.98E+02	-	2.62E+02	1.57E+03	4.81E+02	4.03E+02	5.44E+01	6.32E+02	-	-	1.57E+03
2060	-	-	2.75E+01	6.35E+02	1.04E+03	8.62E+00	1.71E+03	4.94E+02	4.11E+02	2.50E+01	4.02E+02	-	2.70E+02	1.60E+03	4.91E+02	4.11E+02	5.55E+01	6.43E+02	-	-	1.60E+03
2061	-	-	2.80E+01	6.47E+02	1.06E+03	6.76E+00	1.74E+03	5.02E+02	4.17E+02	2.52E+01	4.05E+02	-	2.78E+02	1.63E+03	4.98E+02	4.17E+02	5.66E+01	6.53E+02	-	-	1.63E+03

Exhibit A-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.03E+02	6.06E+02	6.06E+02	6.22E+02
Lower GOR	6.03E+02	6.06E+02	6.06E+02	6.23E+02
Higher GOR	6.02E+02	6.05E+02	6.05E+02	6.22E+02

Exhibit A-30. CH_4 Sensitivity Analysis - Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.03E+02	6.06E+02	6.06E+02	6.22E+02
Decrease in Methane Emissions	6.01E+02	6.04E+02	6.04E+02	6.21E+02
Increase in Methane Emissions	6.04E+02	6.07E+02	6.07E+02	6.24E+02

Appendix B: AR4 20-yr Results

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR4 – 20-yr)
- Multiproduct Functional Unit – South Korea (AR4 – 20-yr)
- Multiproduct Functional Unit – China (AR4 – 20-yr)
- Multiproduct Functional Unit – India (AR4 – 20-yr)
- Single Product Functional Unit in kg CO2e – Japan (AR4 – 20-yr)
- Single Product Functional Unit in kg CO2e – South Korea (AR4 – 20-yr)
- Single Product Functional Unit in kg CO2e – China (AR4 – 20-yr)
- Single Product Functional Unit in kg CO2e – India (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR4 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR4 – 20-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR4 – 20-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR4 – 20-yr)

Exhibit B-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.69E+01	5.69E+01	-	6.40E+01	6.40E+01
Natural Gas Pipelines to GTP	-	7.39E+00	7.39E+00	-	8.31E+00	8.31E+00
Natural Gas Processing at GTP	-	2.29E+01	2.29E+01	-	2.58E+01	2.58E+01
CO2 Compression and Sequestration	-	7.66E-01	-	-	8.62E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.92E+01	3.92E+01	-	4.41E+01	4.41E+01
Ocean Transport	-	2.09E+01	2.09E+01	-	2.35E+01	2.35E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	2.59E+00	4.16E+00	4.16E+00	2.91E+00	4.69E+00	4.69E+00
Crude Oil Extraction, CO2-EOR	-	-	6.59E+00	-	-	7.42E+00
CO2-EOR Crude Oil Transport	-	-	8.39E-01	-	-	9.44E-01
Crude Oil Alaskan Pipeline Transport	1.68E+00	8.71E-01	8.71E-01	1.90E+00	9.80E-01	9.80E-01
Crude Oil Ocean Transport	8.82E-01	4.84E-01	9.51E-01	9.93E-01	5.45E-01	1.07E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.94E-01	4.94E-01	-	5.56E-01	5.56E-01
System Expansion: US Average Crude Oil Production and End Use	2.07E+01	8.46E+01	1.87E+01	4.11E+00	7.60E+01	1.85E+00
System Expansion: US Lower 48 LNG Export and End Use	5.86E+02	-	-	3.13E+02	-	-
Total	7.26E+02	6.59E+02	6.57E+02	4.51E+02	3.82E+02	3.80E+02
Upper	3.48E+01	6.25E+01	5.62E+01	3.80E+01	6.42E+01	6.84E+01
Lower	2.02E+01	1.69E+01	1.68E+01	2.29E+01	1.93E+01	1.94E+01

Exhibit B-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.70E+01	5.70E+01	-	6.42E+01	6.42E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.30E+01	2.30E+01	-	2.58E+01	2.58E+01
CO2 Compression and Sequestration	-	7.68E-01	-	-	8.64E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.44E+01	2.44E+01	-	2.74E+01	2.74E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	2.59E+00	4.17E+00	4.17E+00	2.92E+00	4.69E+00	4.69E+00
Crude Oil Extraction, CO2-EOR	-	-	6.60E+00	-	-	7.43E+00
CO2-EOR Crude Oil Transport	-	-	8.41E-01	-	-	9.46E-01
Crude Oil Alaskan Pipeline Transport	1.69E+00	8.73E-01	8.73E-01	1.90E+00	9.82E-01	9.82E-01
Crude Oil Ocean Transport	8.84E-01	4.85E-01	9.53E-01	9.95E-01	5.46E-01	1.07E+00
Crude Oil Refining and End Use	1.14E+02	5.91E+01	1.16E+02	1.29E+02	6.66E+01	1.31E+02
Construction	-	4.95E-01	4.95E-01	-	5.57E-01	5.57E-01
System Expansion: US Average Crude Oil Production and End Use	2.04E+01	8.44E+01	1.84E+01	3.82E+00	7.58E+01	1.55E+00
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	7.31E+02	6.63E+02	6.61E+02	4.56E+02	3.86E+02	3.84E+02
Upper	3.47E+01	5.54E+01	5.58E+01	3.99E+01	7.22E+01	6.13E+01
Lower	2.20E+01	1.80E+01	1.65E+01	2.30E+01	1.93E+01	1.86E+01

Exhibit B-3. Multiproduct Functional Unit in kg CO_2e – China (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.70E+01	5.70E+01	-	6.42E+01	6.42E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.30E+01	2.30E+01	-	2.58E+01	2.58E+01
CO2 Compression and Sequestration	-	7.68E-01	-	-	8.64E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.45E+01	2.45E+01	-	2.76E+01	2.76E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	2.59E+00	4.17E+00	4.17E+00	2.92E+00	4.70E+00	4.70E+00
Crude Oil Extraction, CO2-EOR	-	-	6.60E+00	-	-	7.43E+00
CO2-EOR Crude Oil Transport	-	-	8.41E-01	-	-	9.46E-01
Crude Oil Alaskan Pipeline Transport	1.69E+00	8.73E-01	8.73E-01	1.90E+00	9.82E-01	9.82E-01
Crude Oil Ocean Transport	8.84E-01	4.85E-01	9.53E-01	9.95E-01	5.46E-01	1.07E+00
Crude Oil Refining and End Use	1.14E+02	5.92E+01	1.16E+02	1.29E+02	6.66E+01	1.31E+02
Construction	-	4.95E-01	4.95E-01	-	5.57E-01	5.57E-01
System Expansion: US Average Crude Oil Production and End Use	2.05E+01	8.44E+01	1.84E+01	3.85E+00	7.58E+01	1.54E+00
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	7.31E+02	6.63E+02	6.61E+02	4.57E+02	3.86E+02	3.84E+02
Upper	3.48E+01	5.55E+01	6.12E+01	3.92E+01	6.44E+01	6.21E+01
Lower	2.08E+01	1.72E+01	1.72E+01	2.31E+01	1.88E+01	1.94E+01

Exhibit B-4. Multiproduct Functional Unit in kg CO_2e – India (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.76E+01	5.76E+01	-	6.48E+01	6.48E+01
Natural Gas Pipelines to GTP	-	7.48E+00	7.48E+00	-	8.42E+00	8.42E+00
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	7.75E-01	-	-	8.73E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.53E+01	1.53E+01	-	1.72E+01	1.72E+01
Liquefaction	-	3.97E+01	3.97E+01	-	4.46E+01	4.46E+01
Ocean Transport	-	4.29E+01	4.29E+01	-	4.83E+01	4.83E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	2.62E+00	4.21E+00	4.21E+00	2.95E+00	4.74E+00	4.74E+00
Crude Oil Extraction, CO2-EOR	-	-	6.67E+00	-	-	7.51E+00
CO2-EOR Crude Oil Transport	-	-	8.49E-01	-	-	9.56E-01
Crude Oil Alaskan Pipeline Transport	1.70E+00	8.82E-01	8.82E-01	1.92E+00	9.92E-01	9.92E-01
Crude Oil Ocean Transport	8.93E-01	4.90E-01	9.63E-01	1.00E+00	5.52E-01	1.08E+00
Crude Oil Refining and End Use	1.16E+02	5.98E+01	1.17E+02	1.30E+02	6.72E+01	1.32E+02
Construction	-	5.00E-01	5.00E-01	-	5.63E-01	5.63E-01
System Expansion: US Average Crude Oil Production and End Use	1.91E+01	8.37E+01	1.70E+01	2.29E+00	7.50E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.89E+02	-	-	3.16E+02	-	-
Total	7.29E+02	6.83E+02	6.81E+02	4.55E+02	4.08E+02	4.06E+02
Upper	3.32E+01	6.81E+01	5.22E+01	3.89E+01	7.01E+01	6.39E+01
Lower	2.05E+01	1.71E+01	1.70E+01	2.28E+01	1.96E+01	1.89E+01

Exhibit B-5. Single Product Functional Unit in kg CO_2e – Japan (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.69E+01	5.69E+01	-	6.40E+01	6.40E+01
Natural Gas Pipelines to GTP	-	7.39E+00	7.39E+00	-	8.31E+00	8.31E+00
Natural Gas Processing at GTP	-	2.29E+01	2.29E+01	-	2.58E+01	2.58E+01
CO2 Compression and Sequestration	-	6.59E-01	-	-	7.41E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.92E+01	3.92E+01	-	4.41E+01	4.41E+01
Ocean Transport	-	2.09E+01	2.09E+01	-	2.35E+01	2.35E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.94E-01	4.94E-01	-	5.56E-01	5.56E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.86E+02	-	-	3.13E+02	-	-
Total	5.86E+02	5.10E+02	5.09E+02	3.13E+02	2.33E+02	2.32E+02
Upper	2.86E+01	4.84E+01	4.36E+01	3.21E+01	3.92E+01	4.18E+01
Lower	1.86E+01	1.30E+01	1.30E+01	2.10E+01	1.18E+01	1.18E+01

Exhibit B-6. Single Product Functional Unit in kg CO_2e – South Korea (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.70E+01	5.70E+01	-	6.42E+01	6.42E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.30E+01	2.30E+01	-	2.58E+01	2.58E+01
CO2 Compression and Sequestration	-	6.60E-01	-	-	7.43E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.44E+01	2.44E+01	-	2.74E+01	2.74E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.95E-01	4.95E-01	-	5.57E-01	5.57E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	5.91E+02	5.14E+02	5.13E+02	3.18E+02	2.37E+02	2.36E+02
Upper	2.90E+01	4.29E+01	4.33E+01	3.28E+01	4.43E+01	3.78E+01
Lower	2.03E+01	1.39E+01	1.28E+01	2.11E+01	1.19E+01	1.15E+01

Exhibit B-7. Single Product Functional Unit in kg CO_2e – China (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.70E+01	5.70E+01	-	6.42E+01	6.42E+01
Natural Gas Pipelines to GTP	-	7.40E+00	7.40E+00	-	8.33E+00	8.33E+00
Natural Gas Processing at GTP	-	2.30E+01	2.30E+01	-	2.58E+01	2.58E+01
CO2 Compression and Sequestration	-	6.60E-01	-	-	7.43E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.51E+01	1.51E+01	-	1.70E+01	1.70E+01
Liquefaction	-	3.93E+01	3.93E+01	-	4.42E+01	4.42E+01
Ocean Transport	-	2.45E+01	2.45E+01	-	2.76E+01	2.76E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.95E-01	4.95E-01	-	5.57E-01	5.57E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.91E+02	-	-	3.18E+02	-	-
Total	5.91E+02	5.14E+02	5.13E+02	3.18E+02	2.37E+02	2.37E+02
Upper	2.91E+01	4.30E+01	4.75E+01	3.28E+01	3.96E+01	3.83E+01
Lower	1.91E+01	1.33E+01	1.33E+01	2.12E+01	1.15E+01	1.20E+01

Exhibit B-8. Single Product Functional Unit in kg CO_2e – India (AR4 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	5.76E+01	5.76E+01	-	6.48E+01	6.48E+01
Natural Gas Pipelines to GTP	-	7.48E+00	7.48E+00	-	8.42E+00	8.42E+00
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	6.67E-01	-	-	7.50E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.53E+01	1.53E+01	-	1.72E+01	1.72E+01
Liquefaction	-	3.97E+01	3.97E+01	-	4.46E+01	4.46E+01
Ocean Transport	-	4.29E+01	4.29E+01	-	4.83E+01	4.83E+01
LNG Regasification	-	4.17E+00	4.17E+00	-	4.69E+00	4.69E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.42E+01	4.42E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.00E-01	5.00E-01	-	5.63E-01	5.63E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.89E+02	-	-	3.16E+02	-	-
Total	5.89E+02	5.34E+02	5.33E+02	3.16E+02	2.60E+02	2.59E+02
Upper	2.76E+01	5.32E+01	4.08E+01	3.27E+01	4.46E+01	4.07E+01
Lower	1.89E+01	1.33E+01	1.33E+01	2.08E+01	1.25E+01	1.20E+01

Exhibit B-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.30E-01	-	-	2.59E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	1.65E-01	7.47E-03	3.99E-09	1.68E+00
Crude Oil Ocean Transport	8.24E-01	5.76E-02	-	5.93E-07	8.82E-01
Crude Oil Refining and End Use	1.14E+02	4.64E-01	5.24E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.96E+01	1.10E+00	1.18E-02	-	2.07E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	1.22E+02	3.11E-01	1.31E-07	5.86E+02
Construction	-	-	-	-	-
Total	6.02E+02	1.24E+02	3.35E-01	7.28E-07	7.26E+02

Exhibit B-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.30E-01	-	-	2.59E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	1.66E-01	7.48E-03	4.00E-09	1.69E+00
Crude Oil Ocean Transport	8.26E-01	5.77E-02	-	5.94E-07	8.84E-01
Crude Oil Refining and End Use	1.14E+02	4.65E-01	5.25E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	1.09E+00	1.16E-02	-	2.04E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.23E+02	3.21E-01	1.32E-07	5.91E+02
Construction	-	-	-	-	-
Total	6.05E+02	1.25E+02	3.45E-01	7.29E-07	7.31E+02

Exhibit B-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.30E-01	-	-	2.59E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	1.66E-01	7.48E-03	4.00E-09	1.69E+00
Crude Oil Ocean Transport	8.26E-01	5.77E-02	-	5.94E-07	8.84E-01
Crude Oil Refining and End Use	1.14E+02	4.65E-01	5.25E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.94E+01	1.09E+00	1.16E-02	-	2.05E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.23E+02	3.21E-01	1.32E-07	5.91E+02
Construction	-	-	-	-	-
Total	6.05E+02	1.25E+02	3.45E-01	7.29E-07	7.31E+02

Exhibit B-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.49E+00	1.31E-01	-	-	2.62E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.53E+00	1.67E-01	7.56E-03	4.04E-09	1.70E+00
Crude Oil Ocean Transport	8.34E-01	5.83E-02	-	6.00E-07	8.93E-01
Crude Oil Refining and End Use	1.15E+02	4.70E-01	5.31E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.81E+01	1.02E+00	1.09E-02	-	1.91E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	1.23E+02	3.17E-01	1.31E-07	5.89E+02
Construction	-	-	-	-	-
Total	6.04E+02	1.25E+02	3.41E-01	7.35E-07	7.29E+02

Exhibit B-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	3.83E+01	-	-	5.69E+01
Natural Gas Pipelines to GTP	2.14E-03	7.39E+00	-	-	7.39E+00
Natural Gas Processing at GTP	2.18E+01	1.12E+00	2.50E-05	-	2.29E+01
CO2 Compression and Sequestration	6.56E-01	1.07E-01	1.43E-03	1.48E-03	7.66E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	9.90E+00	5.21E-07	-	1.51E+01
Liquefaction	2.25E+01	1.67E+01	-	9.52E-08	3.92E+01
Ocean Transport	1.68E+01	4.10E+00	-	-	2.09E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	2.72E+00	-	-	4.16E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.82E-01	8.55E-02	3.86E-03	2.06E-09	8.71E-01
Crude Oil Ocean Transport	4.42E-01	4.22E-02	-	4.38E-07	4.84E-01
Crude Oil Refining and End Use	5.88E+01	2.40E-01	2.71E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	8.00E+01	4.50E+00	4.81E-02	-	8.46E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	2.11E-02	2.42E-03	-	4.94E-01
Total	5.73E+02	8.64E+01	5.85E-02	1.54E-03	6.59E+02

Exhibit B-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	3.84E+01	-	-	5.70E+01
Natural Gas Pipelines to GTP	2.15E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.18E+01	1.13E+00	2.50E-05	-	2.30E+01
CO2 Compression and Sequestration	6.58E-01	1.07E-01	1.44E-03	1.48E-03	7.68E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	9.91E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	-	9.54E-08	3.93E+01
Ocean Transport	1.95E+01	4.88E+00	-	-	2.44E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	2.72E+00	-	-	4.17E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	8.56E-02	3.87E-03	2.07E-09	8.73E-01
Crude Oil Ocean Transport	4.43E-01	4.23E-02	-	4.39E-07	4.85E-01
Crude Oil Refining and End Use	5.89E+01	2.40E-01	2.72E-03	-	5.91E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	4.49E+00	4.80E-02	-	8.44E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.12E-02	2.43E-03	-	4.95E-01
Total	5.76E+02	8.73E+01	5.85E-02	1.55E-03	6.63E+02

Exhibit B-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	3.84E+01	-	-	5.70E+01
Natural Gas Pipelines to GTP	2.15E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.18E+01	1.13E+00	2.51E-05	-	2.30E+01
CO2 Compression and Sequestration	6.58E-01	1.07E-01	1.44E-03	1.48E-03	7.68E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	9.92E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	-	9.54E-08	3.93E+01
Ocean Transport	1.96E+01	4.92E+00	-	-	2.45E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	2.72E+00	-	-	4.17E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	8.57E-02	3.87E-03	2.07E-09	8.73E-01
Crude Oil Ocean Transport	4.43E-01	4.23E-02	-	4.39E-07	4.85E-01
Crude Oil Refining and End Use	5.89E+01	2.40E-01	2.72E-03	-	5.92E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	4.49E+00	4.80E-02	-	8.44E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.12E-02	2.43E-03	-	4.95E-01
Total	5.76E+02	8.74E+01	5.85E-02	1.55E-03	6.63E+02

Exhibit B-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	3.88E+01	-	-	5.76E+01
Natural Gas Pipelines to GTP	2.17E-03	7.48E+00	-	-	7.48E+00
Natural Gas Processing at GTP	2.21E+01	1.14E+00	2.53E-05	-	2.32E+01
CO2 Compression and Sequestration	6.64E-01	1.08E-01	1.45E-03	1.50E-03	7.75E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.00E+01	5.28E-07	-	1.53E+01
Liquefaction	2.27E+01	1.69E+01	-	9.64E-08	3.97E+01
Ocean Transport	3.39E+01	9.04E+00	-	-	4.29E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	2.75E+00	-	-	4.21E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.91E-01	8.65E-02	3.91E-03	2.09E-09	8.82E-01
Crude Oil Ocean Transport	4.48E-01	4.27E-02	-	4.44E-07	4.90E-01
Crude Oil Refining and End Use	5.95E+01	2.43E-01	2.74E-03	-	5.98E+01
System Expansion: US Average Crude Oil Production and End Use	7.92E+01	4.45E+00	4.76E-02	-	8.37E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	2.14E-02	2.45E-03	-	5.00E-01
Total	5.91E+02	9.22E+01	5.82E-02	1.56E-03	6.83E+02

Exhibit B-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	3.83E+01	-	-	5.69E+01
Natural Gas Pipelines to GTP	2.14E-03	7.39E+00	-	-	7.39E+00
Natural Gas Processing at GTP	2.18E+01	1.12E+00	2.50E-05	-	2.29E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	9.90E+00	5.21E-07	-	1.51E+01
Liquefaction	2.25E+01	1.67E+01	-	9.52E-08	3.92E+01
Ocean Transport	1.68E+01	4.10E+00	-	-	2.09E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	2.72E+00	-	-	4.16E+00
Crude Oil Extraction, CO2-EOR	5.58E+00	9.70E-01	1.80E-02	1.92E-02	6.59E+00
CO2-EOR Crude Oil Transport	7.53E-01	8.24E-02	3.72E-03	1.99E-09	8.39E-01
Crude Oil Alaskan Pipeline Transport	7.82E-01	8.55E-02	3.86E-03	2.06E-09	8.71E-01
Crude Oil Ocean Transport	8.68E-01	8.29E-02	-	8.61E-07	9.51E-01
Crude Oil Refining and End Use	1.15E+02	4.71E-01	5.32E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.77E+01	9.94E-01	1.06E-02	-	1.87E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	2.11E-02	2.42E-03	-	4.94E-01
Total	5.73E+02	8.41E+01	4.40E-02	1.93E-02	6.57E+02

Exhibit B-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	3.84E+01	-	-	5.70E+01
Natural Gas Pipelines to GTP	2.15E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.18E+01	1.13E+00	2.50E-05	-	2.30E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	9.91E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	-	9.54E-08	3.93E+01
Ocean Transport	1.95E+01	4.88E+00	-	-	2.44E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	2.72E+00	-	-	4.17E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	9.72E-01	1.80E-02	1.92E-02	6.60E+00
CO2-EOR Crude Oil Transport	7.55E-01	8.25E-02	3.73E-03	1.99E-09	8.41E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	8.56E-02	3.87E-03	2.07E-09	8.73E-01
Crude Oil Ocean Transport	8.70E-01	8.31E-02	-	8.62E-07	9.53E-01
Crude Oil Refining and End Use	1.16E+02	4.72E-01	5.33E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	9.80E-01	1.05E-02	-	1.84E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.12E-02	2.43E-03	-	4.95E-01
Total	5.76E+02	8.50E+01	4.39E-02	1.93E-02	6.61E+02

Exhibit B-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	3.84E+01	-	-	5.70E+01
Natural Gas Pipelines to GTP	2.15E-03	7.40E+00	-	-	7.40E+00
Natural Gas Processing at GTP	2.18E+01	1.13E+00	2.51E-05	-	2.30E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	9.92E+00	5.22E-07	-	1.51E+01
Liquefaction	2.25E+01	1.68E+01	-	9.54E-08	3.93E+01
Ocean Transport	1.96E+01	4.92E+00	-	-	2.45E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	2.72E+00	-	-	4.17E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	9.72E-01	1.80E-02	1.93E-02	6.60E+00
CO2-EOR Crude Oil Transport	7.55E-01	8.25E-02	3.73E-03	1.99E-09	8.41E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	8.57E-02	3.87E-03	2.07E-09	8.73E-01
Crude Oil Ocean Transport	8.70E-01	8.31E-02	-	8.62E-07	9.53E-01
Crude Oil Refining and End Use	1.16E+02	4.72E-01	5.33E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	9.79E-01	1.05E-02	-	1.84E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.12E-02	2.43E-03	-	4.95E-01
Total	5.76E+02	8.51E+01	4.39E-02	1.93E-02	6.61E+02

Exhibit B-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR4 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	3.88E+01	-	-	5.76E+01
Natural Gas Pipelines to GTP	2.17E-03	7.48E+00	-	-	7.48E+00
Natural Gas Processing at GTP	2.21E+01	1.14E+00	2.53E-05	-	2.32E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.00E+01	5.28E-07	-	1.53E+01
Liquefaction	2.27E+01	1.69E+01	-	9.64E-08	3.97E+01
Ocean Transport	3.39E+01	9.04E+00	-	-	4.29E+01
LNG Regasification	3.02E+00	1.15E+00	-	6.38E-05	4.17E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	2.75E+00	-	-	4.21E+00
Crude Oil Extraction, CO2-EOR	5.65E+00	9.82E-01	1.82E-02	1.94E-02	6.67E+00
CO2-EOR Crude Oil Transport	7.62E-01	8.34E-02	3.77E-03	2.01E-09	8.49E-01
Crude Oil Alaskan Pipeline Transport	7.91E-01	8.65E-02	3.91E-03	2.09E-09	8.82E-01
Crude Oil Ocean Transport	8.79E-01	8.39E-02	-	8.71E-07	9.63E-01
Crude Oil Refining and End Use	1.17E+02	4.77E-01	5.39E-03	-	1.17E+02
System Expansion: US Average Crude Oil Production and End Use	1.61E+01	9.07E-01	9.69E-03	-	1.70E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	2.14E-02	2.45E-03	-	5.00E-01
Total	5.91E+02	8.99E+01	4.34E-02	1.95E-02	6.81E+02

Exhibit B-21. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	1.72E+01	-4.70E-01	4.77E+01	4.23E+00	1.09E+01	2.71E+00	2.90E+01	-	2.95E-01	4.72E+01	4.20E+00	1.09E+01	2.75E+00	2.93E+01	-	-	4.71E+01
2030	-	-	2.64E+00	5.85E+01	6.02E+01	-5.73E-01	1.21E+02	1.48E+01	3.82E+01	5.26E+00	5.63E+01	-	2.01E+00	1.17E+02	1.47E+01	3.82E+01	5.50E+00	5.80E+01	-	-	1.16E+02
2031	-	-	3.91E+00	8.65E+01	1.38E+02	6.24E-01	2.29E+02	3.38E+01	8.73E+01	7.64E+00	8.18E+01	-	6.12E+00	2.17E+02	3.36E+01	8.73E+01	8.37E+00	8.70E+01	-	-	2.16E+02
2032	-	-	5.13E+00	1.14E+02	2.32E+02	3.38E+00	3.55E+02	5.70E+01	1.47E+02	9.88E+00	1.06E+02	-	1.27E+01	3.33E+02	5.67E+01	1.47E+02	1.14E+01	1.17E+02	-	-	3.32E+02
2033	-	-	6.33E+00	1.40E+02	3.36E+02	7.07E+00	4.89E+02	8.24E+01	2.13E+02	1.20E+01	1.28E+02	-	2.10E+01	4.56E+02	8.20E+01	2.13E+02	1.45E+01	1.46E+02	-	-	4.56E+02
2034	-	-	7.49E+00	1.66E+02	4.39E+02	1.08E+01	6.23E+02	1.08E+02	2.78E+02	1.39E+01	1.49E+02	-	3.01E+01	5.79E+02	1.07E+02	2.78E+02	1.76E+01	1.75E+02	-	-	5.78E+02
2035	-	-	8.62E+00	1.91E+02	5.42E+02	1.40E+01	7.56E+02	1.33E+02	3.44E+02	1.58E+01	1.69E+02	-	3.95E+01	7.01E+02	1.32E+02	3.44E+02	2.05E+01	2.03E+02	-	-	7.00E+02
2036	-	-	9.72E+00	2.15E+02	6.45E+02	1.68E+01	8.87E+02	1.58E+02	4.09E+02	1.75E+01	1.87E+02	-	4.90E+01	8.22E+02	1.58E+02	4.09E+02	2.34E+01	2.30E+02	-	-	8.20E+02
2037	-	-	1.08E+01	2.39E+02	7.49E+02	1.91E+01	1.02E+03	1.84E+02	4.75E+02	1.91E+01	2.05E+02	-	5.87E+01	9.41E+02	1.83E+02	4.75E+02	2.62E+01	2.55E+02	-	-	9.39E+02
2038	-	-	1.18E+01	2.62E+02	8.52E+02	2.11E+01	1.15E+03	2.09E+02	5.40E+02	2.06E+01	2.21E+02	-	6.86E+01	1.06E+03	2.08E+02	5.40E+02	2.89E+01	2.80E+02	-	-	1.06E+03
2039	-	-	1.28E+01	2.84E+02	9.55E+02	2.27E+01	1.27E+03	2.35E+02	6.06E+02	2.21E+01	2.36E+02	-	7.86E+01	1.18E+03	2.33E+02	6.06E+02	3.15E+01	3.04E+02	-	-	1.17E+03
2040	-	-	1.38E+01	3.06E+02	1.06E+03	2.40E+01	1.40E+03	2.60E+02	6.71E+02	2.34E+01	2.50E+02	-	8.86E+01	1.29E+03	2.58E+02	6.71E+02	3.40E+01	3.27E+02	-	-	1.29E+03
2041	-	-	1.48E+01	3.27E+02	1.16E+03	2.48E+01	1.53E+03	2.85E+02	7.37E+02	2.46E+01	2.63E+02	-	9.86E+01	1.41E+03	2.84E+02	7.37E+02	3.64E+01	3.49E+02	-	-	1.41E+03
2042	-	-	1.57E+01	3.48E+02	1.26E+03	2.53E+01	1.65E+03	3.11E+02	8.02E+02	2.58E+01	2.76E+02	-	1.09E+02	1.52E+03	3.09E+02	8.02E+02	3.88E+01	3.70E+02	-	-	1.52E+03
2043	-	-	1.66E+01	3.68E+02	1.37E+03	2.54E+01	1.78E+03	3.36E+02	8.68E+02	2.69E+01	2.87E+02	-	1.18E+02	1.64E+03	3.34E+02	8.68E+02	4.11E+01	3.90E+02	-	-	1.63E+03
2044	-	-	1.75E+01	3.87E+02	1.47E+03	2.54E+01	1.90E+03	3.61E+02	9.33E+02	2.79E+01	2.98E+02	-	1.28E+02	1.75E+03	3.59E+02	9.33E+02	4.33E+01	4.09E+02	-	-	1.75E+03
2045	-	-	1.83E+01	4.06E+02	1.57E+03	2.52E+01	2.02E+03	3.87E+02	9.99E+02	2.88E+01	3.08E+02	-	1.38E+02	1.86E+03	3.85E+02	9.99E+02	4.54E+01	4.28E+02	-	-	1.86E+03
2046	-	-	1.92E+01	4.25E+02	1.68E+03	2.49E+01	2.15E+03	4.12E+02	1.06E+03	2.97E+01	3.18E+02	-	1.48E+02	1.97E+03	4.10E+02	1.06E+03	4.75E+01	4.46E+02	-	-	1.97E+03
2047	-	-	2.00E+01	4.43E+02	1.78E+03	2.44E+01	2.27E+03	4.37E+02	1.13E+03	3.06E+01	3.27E+02	-	1.58E+02	2.08E+03	4.35E+02	1.13E+03	4.95E+01	4.64E+02	-	-	2.08E+03
2048	-	-	2.08E+01	4.60E+02	1.88E+03	2.38E+01	2.39E+03	4.63E+02	1.20E+03	3.13E+01	3.35E+02	-	1.68E+02	2.19E+03	4.60E+02	1.20E+03	5.15E+01	4.81E+02	-	-	2.19E+03
2049	-	-	2.15E+01	4.77E+02	1.99E+03	2.31E+01	2.51E+03	4.88E+02	1.26E+03	3.21E+01	3.43E+02	-	1.78E+02	2.30E+03	4.85E+02	1.26E+03	5.34E+01	4.97E+02	-	-	2.30E+03
2050	-	-	2.23E+01	4.93E+02	2.09E+03	2.23E+01	2.63E+03	5.13E+02	1.33E+03	3.28E+01	3.51E+02	-	1.88E+02	2.41E+03	5.11E+02	1.33E+03	5.53E+01	5.13E+02	-	-	2.41E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	2.19E+03	2.15E+01	2.75E+03	5.39E+02	1.39E+03	3.34E+01	3.57E+02	-	1.98E+02	2.52E+03	5.36E+02	1.39E+03	5.71E+01	5.28E+02	-	-	2.51E+03
2052	-	-	2.37E+01	5.25E+02	2.30E+03	2.05E+01	2.87E+03	5.64E+02	1.46E+03	3.40E+01	3.64E+02	-	2.07E+02	2.63E+03	5.61E+02	1.46E+03	5.89E+01	5.43E+02	-	-	2.62E+03
2053	-	-	2.44E+01	5.40E+02	2.40E+03	1.93E+01	2.98E+03	5.89E+02	1.52E+03	3.46E+01	3.70E+02	-	2.17E+02	2.73E+03	5.86E+02	1.52E+03	6.06E+01	5.57E+02	-	-	2.73E+03
2054	-	-	2.51E+01	5.55E+02	2.50E+03	1.79E+01	3.10E+03	6.15E+02	1.59E+03	3.51E+01	3.76E+02	-	2.26E+02	2.84E+03	6.11E+02	1.59E+03	6.22E+01	5.71E+02	-	-	2.83E+03
2055	-	-	2.57E+01	5.70E+02	2.61E+03	1.66E+01	3.22E+03	6.40E+02	1.65E+03	3.56E+01	3.81E+02	-	2.35E+02	2.95E+03	6.37E+02	1.65E+03	6.38E+01	5.84E+02	-	-	2.94E+03
2056	-	-	2.64E+01	5.84E+02	2.71E+03	1.53E+01	3.34E+03	6.65E+02	1.72E+03	3.61E+01	3.86E+02	-	2.44E+02	3.05E+03	6.62E+02	1.72E+03	6.54E+01	5.97E+02	-	-	3.04E+03
2057	-	-	2.70E+01	5.98E+02	2.81E+03	1.39E+01	3.45E+03	6.91E+02	1.79E+03	3.65E+01	3.91E+02	-	2.54E+02	3.16E+03	6.87E+02	1.79E+03	6.69E+01	6.10E+02	-	-	3.15E+03
2058	-	-	2.76E+01	6.11E+02	2.91E+03	1.24E+01	3.56E+03	7.14E+02	1.84E+03	3.69E+01	3.95E+02	-	2.62E+02	3.25E+03	7.10E+02	1.84E+03	6.84E+01	6.22E+02	-	-	3.24E+03
2059	-	-	2.82E+01	6.24E+02	2.98E+03	1.07E+01	3.64E+03	7.32E+02	1.89E+03	3.73E+01	3.99E+02	-	2.71E+02	3.33E+03	7.28E+02	1.89E+03	6.98E+01	6.33E+02	-	-	3.32E+03
2060	-	-	2.87E+01	6.37E+02	3.04E+03	8.93E+00	3.71E+03	7.46E+02	1.93E+03	3.77E+01	4.03E+02	-	2.80E+02	3.39E+03	7.42E+02	1.93E+03	7.12E+01	6.44E+02	-	-	3.39E+03
2061	-	-	2.93E+01	6.49E+02	3.09E+03	7.00E+00	3.77E+03	7.58E+02	1.96E+03	3.80E+01	4.06E+02	-	2.88E+02	3.45E+03	7.54E+02	1.96E+03	7.25E+01	6.55E+02	-	-	3.44E+03

Exhibit B-22. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	1.73E+01	-4.70E-01	4.78E+01	4.23E+00	1.10E+01	2.71E+00	2.90E+01	-	2.95E-01	4.72E+01	4.20E+00	1.10E+01	2.75E+00	2.93E+01	-	-	4.72E+01
2030	-	-	2.64E+00	5.85E+01	6.06E+01	-5.73E-01	1.21E+02	1.48E+01	3.85E+01	5.26E+00	5.63E+01	-	2.01E+00	1.17E+02	1.47E+01	3.85E+01	5.50E+00	5.80E+01	-	-	1.17E+02
2031	-	-	3.91E+00	8.65E+01	1.38E+02	6.24E-01	2.29E+02	3.38E+01	8.80E+01	7.64E+00	8.18E+01	-	6.12E+00	2.17E+02	3.36E+01	8.80E+01	8.37E+00	8.70E+01	-	-	2.17E+02
2032	-	-	5.13E+00	1.14E+02	2.34E+02	3.38E+00	3.56E+02	5.70E+01	1.49E+02	9.88E+00	1.06E+02	-	1.27E+01	3.34E+02	5.67E+01	1.49E+02	1.14E+01	1.17E+02	-	-	3.33E+02
2033	-	-	6.33E+00	1.40E+02	3.37E+02	7.07E+00	4.91E+02	8.24E+01	2.15E+02	1.20E+01	1.28E+02	-	2.10E+01	4.58E+02	8.20E+01	2.15E+02	1.45E+01	1.46E+02	-	-	4.57E+02
2034	-	-	7.49E+00	1.66E+02	4.41E+02	1.08E+01	6.25E+02	1.08E+02	2.81E+02	1.39E+01	1.49E+02	-	3.01E+01	5.82E+02	1.07E+02	2.81E+02	1.76E+01	1.75E+02	-	-	5.80E+02
2035	-	-	8.62E+00	1.91E+02	5.45E+02	1.40E+01	7.59E+02	1.33E+02	3.47E+02	1.58E+01	1.69E+02	-	3.95E+01	7.04E+02	1.32E+02	3.47E+02	2.05E+01	2.03E+02	-	-	7.02E+02
2036	-	-	9.72E+00	2.15E+02	6.49E+02	1.68E+01	8.91E+02	1.58E+02	4.13E+02	1.75E+01	1.87E+02	-	4.90E+01	8.25E+02	1.58E+02	4.13E+02	2.34E+01	2.30E+02	-	-	8.23E+02
2037	-	-	1.08E+01	2.39E+02	7.53E+02	1.91E+01	1.02E+03	1.84E+02	4.79E+02	1.91E+01	2.05E+02	-	5.87E+01	9.45E+02	1.83E+02	4.79E+02	2.62E+01	2.55E+02	-	-	9.43E+02
2038	-	-	1.18E+01	2.62E+02	8.57E+02	2.11E+01	1.15E+03	2.09E+02	5.45E+02	2.06E+01	2.21E+02	-	6.86E+01	1.06E+03	2.08E+02	5.45E+02	2.89E+01	2.80E+02	-	-	1.06E+03
2039	-	-	1.28E+01	2.84E+02	9.60E+02	2.27E+01	1.28E+03	2.35E+02	6.11E+02	2.21E+01	2.36E+02	-	7.86E+01	1.18E+03	2.33E+02	6.11E+02	3.15E+01	3.04E+02	-	-	1.18E+03
2040	-	-	1.38E+01	3.06E+02	1.06E+03	2.40E+01	1.41E+03	2.60E+02	6.77E+02	2.34E+01	2.50E+02	-	8.86E+01	1.30E+03	2.58E+02	6.77E+02	3.40E+01	3.27E+02	-	-	1.30E+03
2041	-	-	1.48E+01	3.27E+02	1.17E+03	2.48E+01	1.53E+03	2.85E+02	7.43E+02	2.46E+01	2.63E+02	-	9.86E+01	1.41E+03	2.84E+02	7.43E+02	3.64E+01	3.49E+02	-	-	1.41E+03
2042	-	-	1.57E+01	3.48E+02	1.27E+03	2.53E+01	1.66E+03	3.11E+02	8.09E+02	2.58E+01	2.76E+02	-	1.09E+02	1.53E+03	3.09E+02	8.09E+02	3.88E+01	3.70E+02	-	-	1.53E+03
2043	-	-	1.66E+01	3.68E+02	1.38E+03	2.54E+01	1.79E+03	3.36E+02	8.75E+02	2.69E+01	2.87E+02	-	1.18E+02	1.64E+03	3.34E+02	8.75E+02	4.11E+01	3.90E+02	-	-	1.64E+03
2044	-	-	1.75E+01	3.87E+02	1.48E+03	2.54E+01	1.91E+03	3.61E+02	9.41E+02	2.79E+01	2.98E+02	-	1.28E+02	1.76E+03	3.59E+02	9.41E+02	4.33E+01	4.09E+02	-	-	1.75E+03
2045	-	-	1.83E+01	4.06E+02	1.58E+03	2.52E+01	2.03E+03	3.87E+02	1.01E+03	2.88E+01	3.08E+02	-	1.38E+02	1.87E+03	3.85E+02	1.01E+03	4.54E+01	4.28E+02	-	-	1.86E+03
2046	-	-	1.92E+01	4.25E+02	1.69E+03	2.49E+01	2.16E+03	4.12E+02	1.07E+03	2.97E+01	3.18E+02	-	1.48E+02	1.98E+03	4.10E+02	1.07E+03	4.75E+01	4.46E+02	-	-	1.98E+03
2047	-	-	2.00E+01	4.43E+02	1.79E+03	2.44E+01	2.28E+03	4.37E+02	1.14E+03	3.06E+01	3.27E+02	-	1.58E+02	2.09E+03	4.35E+02	1.14E+03	4.95E+01	4.64E+02	-	-	2.09E+03
2048	-	-	2.08E+01	4.60E+02	1.89E+03	2.38E+01	2.40E+03	4.63E+02	1.20E+03	3.13E+01	3.35E+02	-	1.68E+02	2.20E+03	4.60E+02	1.20E+03	5.15E+01	4.81E+02	-	-	2.20E+03
2049	-	-	2.15E+01	4.77E+02	2.00E+03	2.31E+01	2.52E+03	4.88E+02	1.27E+03	3.21E+01	3.43E+02	-	1.78E+02	2.31E+03	4.85E+02	1.27E+03	5.34E+01	4.97E+02	-	-	2.31E+03
2050	-	-	2.23E+01	4.93E+02	2.10E+03	2.23E+01	2.64E+03	5.13E+02	1.34E+03	3.28E+01	3.51E+02	-	1.88E+02	2.42E+03	5.11E+02	1.34E+03	5.53E+01	5.13E+02	-	-	2.42E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	2.21E+03	2.15E+01	2.76E+03	5.39E+02	1.40E+03	3.34E+01	3.57E+02	-	1.98E+02	2.53E+03	5.36E+02	1.40E+03	5.71E+01	5.28E+02	-	-	2.52E+03
2052	-	-	2.37E+01	5.25E+02	2.31E+03	2.05E+01	2.88E+03	5.64E+02	1.47E+03	3.40E+01	3.64E+02	-	2.07E+02	2.64E+03	5.61E+02	1.47E+03	5.89E+01	5.43E+02	-	-	2.63E+03
2053	-	-	2.44E+01	5.40E+02	2.41E+03	1.93E+01	3.00E+03	5.89E+02	1.53E+03	3.46E+01	3.70E+02	-	2.17E+02	2.75E+03	5.86E+02	1.53E+03	6.06E+01	5.57E+02	-	-	2.74E+03
2054	-	-	2.51E+01	5.55E+02	2.52E+03	1.79E+01	3.12E+03	6.15E+02	1.60E+03	3.51E+01	3.76E+02	-	2.26E+02	2.85E+03	6.11E+02	1.60E+03	6.22E+01	5.71E+02	-	-	2.85E+03
2055	-	-	2.57E+01	5.70E+02	2.62E+03	1.66E+01	3.23E+03	6.40E+02	1.67E+03	3.56E+01	3.81E+02	-	2.35E+02	2.96E+03	6.37E+02	1.67E+03	6.38E+01	5.84E+02	-	-	2.95E+03
2056	-	-	2.64E+01	5.84E+02	2.73E+03	1.53E+01	3.35E+03	6.65E+02	1.73E+03	3.61E+01	3.86E+02	-	2.44E+02	3.06E+03	6.62E+02	1.73E+03	6.54E+01	5.97E+02	-	-	3.06E+03
2057	-	-	2.70E+01	5.98E+02	2.83E+03	1.39E+01	3.47E+03	6.91E+02	1.80E+03	3.65E+01	3.91E+02	-	2.54E+02	3.17E+03	6.87E+02	1.80E+03	6.69E+01	6.10E+02	-	-	3.16E+03
2058	-	-	2.76E+01	6.11E+02	2.92E+03	1.24E+01	3.57E+03	7.14E+02	1.86E+03	3.69E+01	3.95E+02	-	2.62E+02	3.27E+03	7.10E+02	1.86E+03	6.84E+01	6.22E+02	-	-	3.26E+03
2059	-	-	2.82E+01	6.24E+02	3.00E+03	1.07E+01	3.66E+03	7.32E+02	1.91E+03	3.73E+01	3.99E+02	-	2.71E+02	3.34E+03	7.28E+02	1.91E+03	6.98E+01	6.33E+02	-	-	3.34E+03
2060	-	-	2.87E+01	6.37E+02	3.06E+03	8.93E+00	3.73E+03	7.46E+02	1.94E+03	3.77E+01	4.03E+02	-	2.80E+02	3.41E+03	7.42E+02	1.94E+03	7.12E+01	6.44E+02	-	-	3.40E+03
2061	-	-	2.93E+01	6.49E+02	3.10E+03	7.00E+00	3.79E+03	7.58E+02	1.97E+03	3.80E+01	4.06E+02	-	2.88E+02	3.46E+03	7.54E+02	1.97E+03	7.25E+01	6.55E+02	-	-	3.45E+03

Exhibit B-23. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	1.73E+01	-4.70E-01	4.78E+01	4.23E+00	1.10E+01	2.71E+00	2.90E+01	-	2.95E-01	4.72E+01	4.20E+00	1.10E+01	2.75E+00	2.93E+01	-	-	4.72E+01
2030	-	-	2.64E+00	5.85E+01	6.06E+01	-5.73E-01	1.21E+02	1.48E+01	3.85E+01	5.26E+00	5.63E+01	-	2.01E+00	1.17E+02	1.47E+01	3.85E+01	5.50E+00	5.80E+01	-	-	1.17E+02
2031	-	-	3.91E+00	8.65E+01	1.38E+02	6.24E-01	2.30E+02	3.38E+01	8.80E+01	7.64E+00	8.18E+01	-	6.12E+00	2.17E+02	3.36E+01	8.80E+01	8.38E+00	8.70E+01	-	-	2.17E+02
2032	-	-	5.13E+00	1.14E+02	2.34E+02	3.38E+00	3.56E+02	5.70E+01	1.49E+02	9.88E+00	1.06E+02	-	1.27E+01	3.34E+02	5.67E+01	1.49E+02	1.14E+01	1.17E+02	-	-	3.33E+02
2033	-	-	6.33E+00	1.40E+02	3.38E+02	7.07E+00	4.91E+02	8.24E+01	2.15E+02	1.20E+01	1.28E+02	-	2.10E+01	4.58E+02	8.20E+01	2.15E+02	1.45E+01	1.46E+02	-	-	4.57E+02
2034	-	-	7.49E+00	1.66E+02	4.41E+02	1.08E+01	6.26E+02	1.08E+02	2.81E+02	1.39E+01	1.49E+02	-	3.01E+01	5.82E+02	1.07E+02	2.81E+02	1.76E+01	1.75E+02	-	-	5.81E+02
2035	-	-	8.62E+00	1.91E+02	5.45E+02	1.40E+01	7.59E+02	1.33E+02	3.47E+02	1.58E+01	1.69E+02	-	3.95E+01	7.04E+02	1.32E+02	3.47E+02	2.05E+01	2.03E+02	-	-	7.03E+02
2036	-	-	9.72E+00	2.15E+02	6.49E+02	1.68E+01	8.91E+02	1.58E+02	4.13E+02	1.75E+01	1.87E+02	-	4.90E+01	8.25E+02	1.58E+02	4.13E+02	2.34E+01	2.30E+02	-	-	8.23E+02
2037	-	-	1.08E+01	2.39E+02	7.53E+02	1.91E+01	1.02E+03	1.84E+02	4.79E+02	1.91E+01	2.05E+02	-	5.87E+01	9.45E+02	1.83E+02	4.79E+02	2.62E+01	2.55E+02	-	-	9.43E+02
2038	-	-	1.18E+01	2.62E+02	8.57E+02	2.11E+01	1.15E+03	2.09E+02	5.45E+02	2.06E+01	2.21E+02	-	6.86E+01	1.06E+03	2.08E+02	5.45E+02	2.89E+01	2.80E+02	-	-	1.06E+03
2039	-	-	1.28E+01	2.84E+02	9.61E+02	2.27E+01	1.28E+03	2.35E+02	6.11E+02	2.21E+01	2.36E+02	-	7.86E+01	1.18E+03	2.33E+02	6.11E+02	3.15E+01	3.04E+02	-	-	1.18E+03
2040	-	-	1.38E+01	3.06E+02	1.06E+03	2.40E+01	1.41E+03	2.60E+02	6.77E+02	2.34E+01	2.50E+02	-	8.86E+01	1.30E+03	2.58E+02	6.77E+02	3.40E+01	3.27E+02	-	-	1.30E+03
2041	-	-	1.48E+01	3.27E+02	1.17E+03	2.48E+01	1.54E+03	2.85E+02	7.43E+02	2.46E+01	2.63E+02	-	9.86E+01	1.41E+03	2.84E+02	7.43E+02	3.65E+01	3.49E+02	-	-	1.41E+03
2042	-	-	1.57E+01	3.48E+02	1.27E+03	2.53E+01	1.66E+03	3.11E+02	8.09E+02	2.58E+01	2.76E+02	-	1.09E+02	1.53E+03	3.09E+02	8.09E+02	3.88E+01	3.70E+02	-	-	1.53E+03
2043	-	-	1.66E+01	3.68E+02	1.38E+03	2.54E+01	1.79E+03	3.36E+02	8.75E+02	2.69E+01	2.87E+02	-	1.18E+02	1.64E+03	3.34E+02	8.75E+02	4.11E+01	3.90E+02	-	-	1.64E+03
2044	-	-	1.75E+01	3.87E+02	1.48E+03	2.54E+01	1.91E+03	3.61E+02	9.41E+02	2.79E+01	2.98E+02	-	1.28E+02	1.76E+03	3.59E+02	9.41E+02	4.33E+01	4.09E+02	-	-	1.75E+03
2045	-	-	1.83E+01	4.06E+02	1.58E+03	2.52E+01	2.03E+03	3.87E+02	1.01E+03	2.88E+01	3.08E+02	-	1.38E+02	1.87E+03	3.85E+02	1.01E+03	4.54E+01	4.28E+02	-	-	1.86E+03
2046	-	-	1.92E+01	4.25E+02	1.69E+03	2.49E+01	2.16E+03	4.12E+02	1.07E+03	2.97E+01	3.18E+02	-	1.48E+02	1.98E+03	4.10E+02	1.07E+03	4.75E+01	4.46E+02	-	-	1.98E+03
2047	-	-	2.00E+01	4.43E+02	1.79E+03	2.44E+01	2.28E+03	4.37E+02	1.14E+03	3.06E+01	3.27E+02	-	1.58E+02	2.09E+03	4.35E+02	1.14E+03	4.96E+01	4.64E+02	-	-	2.09E+03
2048	-	-	2.08E+01	4.60E+02	1.90E+03	2.38E+01	2.40E+03	4.63E+02	1.20E+03	3.13E+01	3.35E+02	-	1.68E+02	2.20E+03	4.60E+02	1.20E+03	5.15E+01	4.81E+02	-	-	2.20E+03
2049	-	-	2.15E+01	4.77E+02	2.00E+03	2.31E+01	2.52E+03	4.88E+02	1.27E+03	3.21E+01	3.43E+02	-	1.78E+02	2.31E+03	4.85E+02	1.27E+03	5.34E+01	4.97E+02	-	-	2.31E+03
2050	-	-	2.23E+01	4.93E+02	2.10E+03	2.23E+01	2.64E+03	5.13E+02	1.34E+03	3.28E+01	3.51E+02	-	1.88E+02	2.42E+03	5.11E+02	1.34E+03	5.53E+01	5.13E+02	-	-	2.42E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	2.21E+03	2.15E+01	2.76E+03	5.39E+02	1.40E+03	3.34E+01	3.57E+02	-	1.98E+02	2.53E+03	5.36E+02	1.40E+03	5.71E+01	5.28E+02	-	-	2.52E+03
2052	-	-	2.37E+01	5.25E+02	2.31E+03	2.05E+01	2.88E+03	5.64E+02	1.47E+03	3.40E+01	3.64E+02	-	2.07E+02	2.64E+03	5.61E+02	1.47E+03	5.89E+01	5.43E+02	-	-	2.63E+03
2053	-	-	2.44E+01	5.40E+02	2.41E+03	1.93E+01	3.00E+03	5.89E+02	1.54E+03	3.46E+01	3.70E+02	-	2.17E+02	2.75E+03	5.86E+02	1.54E+03	6.06E+01	5.57E+02	-	-	2.74E+03
2054	-	-	2.51E+01	5.55E+02	2.52E+03	1.79E+01	3.12E+03	6.15E+02	1.60E+03	3.51E+01	3.76E+02	-	2.26E+02	2.85E+03	6.11E+02	1.60E+03	6.22E+01	5.71E+02	-	-	2.85E+03
2055	-	-	2.57E+01	5.70E+02	2.62E+03	1.66E+01	3.23E+03	6.40E+02	1.67E+03	3.56E+01	3.81E+02	-	2.35E+02	2.96E+03	6.37E+02	1.67E+03	6.38E+01	5.84E+02	-	-	2.95E+03
2056	-	-	2.64E+01	5.84E+02	2.73E+03	1.53E+01	3.35E+03	6.65E+02	1.73E+03	3.61E+01	3.86E+02	-	2.44E+02	3.07E+03	6.62E+02	1.73E+03	6.54E+01	5.97E+02	-	-	3.06E+03
2057	-	-	2.70E+01	5.98E+02	2.83E+03	1.39E+01	3.47E+03	6.91E+02	1.80E+03	3.65E+01	3.91E+02	-	2.54E+02	3.17E+03	6.87E+02	1.80E+03	6.69E+01	6.10E+02	-	-	3.16E+03
2058	-	-	2.76E+01	6.11E+02	2.92E+03	1.24E+01	3.57E+03	7.14E+02	1.86E+03	3.69E+01	3.95E+02	-	2.62E+02	3.27E+03	7.10E+02	1.86E+03	6.84E+01	6.22E+02	-	-	3.26E+03
2059	-	-	2.82E+01	6.24E+02	3.00E+03	1.07E+01	3.66E+03	7.32E+02	1.91E+03	3.73E+01	3.99E+02	-	2.71E+02	3.34E+03	7.28E+02	1.91E+03	6.98E+01	6.33E+02	-	-	3.34E+03
2060	-	-	2.87E+01	6.37E+02	3.06E+03	8.93E+00	3.73E+03	7.46E+02	1.94E+03	3.77E+01	4.03E+02	-	2.80E+02	3.41E+03	7.42E+02	1.94E+03	7.12E+01	6.44E+02	-	-	3.40E+03
2061	-	-	2.93E+01	6.49E+02	3.10E+03	7.00E+00	3.79E+03	7.58E+02	1.97E+03	3.80E+01	4.06E+02	-	2.88E+02	3.46E+03	7.54E+02	1.97E+03	7.25E+01	6.55E+02	-	-	3.46E+03

Exhibit B-24. Cumulative Emissions Profile AR4 20-yr – NGCC without CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	1.73E+01	-4.70E-01	4.78E+01	4.23E+00	1.14E+01	2.71E+00	2.90E+01	-	2.95E-01	4.77E+01	4.20E+00	1.14E+01	2.75E+00	2.93E+01	-	-	4.76E+01
2030	-	-	2.64E+00	5.85E+01	6.04E+01	-5.73E-01	1.21E+02	1.48E+01	4.00E+01	5.26E+00	5.63E+01	-	2.01E+00	1.18E+02	1.47E+01	4.00E+01	5.50E+00	5.80E+01	-	-	1.18E+02
2031	-	-	3.91E+00	8.65E+01	1.38E+02	6.24E-01	2.29E+02	3.38E+01	9.15E+01	7.64E+00	8.18E+01	-	6.12E+00	2.21E+02	3.36E+01	9.15E+01	8.37E+00	8.70E+01	-	-	2.21E+02
2032	-	-	5.13E+00	1.14E+02	2.33E+02	3.38E+00	3.55E+02	5.70E+01	1.54E+02	9.88E+00	1.06E+02	-	1.27E+01	3.40E+02	5.67E+01	1.54E+02	1.14E+01	1.17E+02	-	-	3.39E+02
2033	-	-	6.33E+00	1.40E+02	3.37E+02	7.07E+00	4.90E+02	8.24E+01	2.23E+02	1.20E+01	1.28E+02	-	2.10E+01	4.66E+02	8.19E+01	2.23E+02	1.45E+01	1.46E+02	-	-	4.66E+02
2034	-	-	7.49E+00	1.66E+02	4.40E+02	1.08E+01	6.25E+02	1.08E+02	2.92E+02	1.39E+01	1.49E+02	-	3.01E+01	5.93E+02	1.07E+02	2.92E+02	1.76E+01	1.75E+02	-	-	5.91E+02
2035	-	-	8.62E+00	1.91E+02	5.44E+02	1.40E+01	7.58E+02	1.33E+02	3.60E+02	1.58E+01	1.69E+02	-	3.95E+01	7.17E+02	1.32E+02	3.60E+02	2.05E+01	2.03E+02	-	-	7.16E+02
2036	-	-	9.72E+00	2.15E+02	6.48E+02	1.68E+01	8.89E+02	1.58E+02	4.29E+02	1.75E+01	1.87E+02	-	4.90E+01	8.41E+02	1.58E+02	4.29E+02	2.34E+01	2.30E+02	-	-	8.39E+02
2037	-	-	1.08E+01	2.39E+02	7.51E+02	1.91E+01	1.02E+03	1.84E+02	4.97E+02	1.91E+01	2.05E+02	-	5.87E+01	9.64E+02	1.83E+02	4.97E+02	2.62E+01	2.55E+02	-	-	9.62E+02
2038	-	-	1.18E+01	2.62E+02	8.55E+02	2.11E+01	1.15E+03	2.09E+02	5.66E+02	2.06E+01	2.21E+02	-	6.86E+01	1.09E+03	2.08E+02	5.66E+02	2.89E+01	2.80E+02	-	-	1.08E+03
2039	-	-	1.28E+01	2.84E+02	9.59E+02	2.27E+01	1.28E+03	2.35E+02	6.35E+02	2.21E+01	2.36E+02	-	7.86E+01	1.21E+03	2.33E+02	6.35E+02	3.15E+01	3.04E+02	-	-	1.20E+03
2040	-	-	1.38E+01	3.06E+02	1.06E+03	2.40E+01	1.41E+03	2.60E+02	7.03E+02	2.34E+01	2.50E+02	-	8.86E+01	1.33E+03	2.58E+02	7.03E+02	3.40E+01	3.27E+02	-	-	1.32E+03
2041	-	-	1.48E+01	3.27E+02	1.17E+03	2.48E+01	1.53E+03	2.85E+02	7.72E+02	2.46E+01	2.63E+02	-	9.86E+01	1.44E+03	2.84E+02	7.72E+02	3.64E+01	3.49E+02	-	-	1.44E+03
2042	-	-	1.57E+01	3.48E+02	1.27E+03	2.53E+01	1.66E+03	3.11E+02	8.40E+02	2.58E+01	2.76E+02	-	1.09E+02	1.56E+03	3.09E+02	8.40E+02	3.88E+01	3.70E+02	-	-	1.56E+03
2043	-	-	1.66E+01	3.68E+02	1.37E+03	2.54E+01	1.78E+03	3.36E+02	9.09E+02	2.69E+01	2.87E+02	-	1.18E+02	1.68E+03	3.34E+02	9.09E+02	4.11E+01	3.90E+02	-	-	1.67E+03
2044	-	-	1.75E+01	3.87E+02	1.48E+03	2.54E+01	1.91E+03	3.61E+02	9.78E+02	2.79E+01	2.98E+02	-	1.28E+02	1.79E+03	3.59E+02	9.78E+02	4.33E+01	4.09E+02	-	-	1.79E+03
2045	-	-	1.83E+01	4.06E+02	1.58E+03	2.52E+01	2.03E+03	3.87E+02	1.05E+03	2.88E+01	3.08E+02	-	1.38E+02	1.91E+03	3.85E+02	1.05E+03	4.54E+01	4.28E+02	-	-	1.90E+03
2046	-	-	1.92E+01	4.25E+02	1.68E+03	2.49E+01	2.15E+03	4.12E+02	1.11E+03	2.97E+01	3.18E+02	-	1.48E+02	2.02E+03	4.10E+02	1.11E+03	4.75E+01	4.46E+02	-	-	2.02E+03
2047	-	-	2.00E+01	4.43E+02	1.79E+03	2.44E+01	2.27E+03	4.37E+02	1.18E+03	3.06E+01	3.27E+02	-	1.58E+02	2.14E+03	4.35E+02	1.18E+03	4.95E+01	4.64E+02	-	-	2.13E+03
2048	-	-	2.08E+01	4.60E+02	1.89E+03	2.38E+01	2.40E+03	4.63E+02	1.25E+03	3.13E+01	3.35E+02	-	1.68E+02	2.25E+03	4.60E+02	1.25E+03	5.15E+01	4.81E+02	-	-	2.24E+03
2049	-	-	2.15E+01	4.77E+02	1.99E+03	2.31E+01	2.52E+03	4.88E+02	1.32E+03	3.21E+01	3.43E+02	-	1.78E+02	2.36E+03	4.85E+02	1.32E+03	5.34E+01	4.97E+02	-	-	2.36E+03
2050	-	-	2.23E+01	4.93E+02	2.10E+03	2.23E+01	2.64E+03	5.13E+02	1.39E+03	3.28E+01	3.51E+02	-	1.88E+02	2.47E+03	5.11E+02	1.39E+03	5.53E+01	5.13E+02	-	-	2.47E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	2.20E+03	2.15E+01	2.76E+03	5.39E+02	1.46E+03	3.34E+01	3.57E+02	-	1.98E+02	2.58E+03	5.36E+02	1.46E+03	5.71E+01	5.28E+02	-	-	2.58E+03
2052	-	-	2.37E+01	5.25E+02	2.31E+03	2.05E+01	2.88E+03	5.64E+02	1.53E+03	3.40E+01	3.64E+02	-	2.07E+02	2.70E+03	5.61E+02	1.53E+03	5.89E+01	5.43E+02	-	-	2.69E+03
2053	-	-	2.44E+01	5.40E+02	2.41E+03	1.93E+01	2.99E+03	5.89E+02	1.59E+03	3.46E+01	3.70E+02	-	2.17E+02	2.81E+03	5.86E+02	1.59E+03	6.06E+01	5.57E+02	-	-	2.80E+03
2054	-	-	2.51E+01	5.55E+02	2.51E+03	1.79E+01	3.11E+03	6.15E+02	1.66E+03	3.51E+01	3.76E+02	-	2.26E+02	2.92E+03	6.11E+02	1.66E+03	6.22E+01	5.71E+02	-	-	2.91E+03
2055	-	-	2.57E+01	5.70E+02	2.62E+03	1.66E+01	3.23E+03	6.40E+02	1.73E+03	3.56E+01	3.81E+02	-	2.35E+02	3.02E+03	6.37E+02	1.73E+03	6.38E+01	5.84E+02	-	-	3.02E+03
2056	-	-	2.64E+01	5.84E+02	2.72E+03	1.53E+01	3.35E+03	6.65E+02	1.80E+03	3.61E+01	3.86E+02	-	2.44E+02	3.13E+03	6.62E+02	1.80E+03	6.54E+01	5.97E+02	-	-	3.13E+03
2057	-	-	2.70E+01	5.98E+02	2.82E+03	1.39E+01	3.46E+03	6.91E+02	1.87E+03	3.65E+01	3.91E+02	-	2.54E+02	3.24E+03	6.87E+02	1.87E+03	6.69E+01	6.10E+02	-	-	3.23E+03
2058	-	-	2.76E+01	6.11E+02	2.92E+03	1.24E+01	3.57E+03	7.14E+02	1.93E+03	3.69E+01	3.95E+02	-	2.62E+02	3.34E+03	7.10E+02	1.93E+03	6.84E+01	6.22E+02	-	-	3.33E+03
2059	-	-	2.82E+01	6.24E+02	2.99E+03	1.07E+01	3.65E+03	7.32E+02	1.98E+03	3.73E+01	3.99E+02	-	2.71E+02	3.42E+03	7.28E+02	1.98E+03	6.98E+01	6.33E+02	-	-	3.41E+03
2060	-	-	2.87E+01	6.37E+02	3.05E+03	8.93E+00	3.72E+03	7.46E+02	2.02E+03	3.76E+01	4.03E+02	-	2.80E+02	3.49E+03	7.42E+02	2.02E+03	7.12E+01	6.44E+02	-	-	3.48E+03
2061	-	-	2.93E+01	6.49E+02	3.10E+03	7.00E+00	3.78E+03	7.58E+02	2.05E+03	3.80E+01	4.06E+02	-	2.88E+02	3.54E+03	7.54E+02	2.05E+03	7.25E+01	6.55E+02	-	-	3.53E+03

Exhibit B-25. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	8.16E+00	-4.70E-01	3.87E+01	4.23E+00	1.91E+00	2.71E+00	2.90E+01	-	2.95E-01	3.81E+01	4.20E+00	1.91E+00	2.75E+00	2.93E+01	-	-	3.81E+01
2030	-	-	2.64E+00	5.85E+01	2.86E+01	-5.73E-01	8.91E+01	1.48E+01	6.69E+00	5.26E+00	5.63E+01	-	2.01E+00	8.50E+01	1.47E+01	6.69E+00	5.50E+00	5.80E+01	-	-	8.49E+01
2031	-	-	3.91E+00	8.65E+01	6.53E+01	6.24E-01	1.56E+02	3.38E+01	1.53E+01	7.64E+00	8.18E+01	-	6.12E+00	1.45E+02	3.36E+01	1.53E+01	8.38E+00	8.70E+01	-	-	1.44E+02
2032	-	-	5.13E+00	1.14E+02	1.10E+02	3.38E+00	2.32E+02	5.70E+01	2.58E+01	9.88E+00	1.06E+02	-	1.27E+01	2.11E+02	5.67E+01	2.58E+01	1.14E+01	1.17E+02	-	-	2.11E+02
2033	-	-	6.33E+00	1.40E+02	1.59E+02	7.07E+00	3.13E+02	8.24E+01	3.73E+01	1.20E+01	1.28E+02	-	2.10E+01	2.81E+02	8.20E+01	3.73E+01	1.45E+01	1.46E+02	-	-	2.80E+02
2034	-	-	7.49E+00	1.66E+02	2.08E+02	1.08E+01	3.92E+02	1.08E+02	4.87E+01	1.40E+01	1.49E+02	-	3.01E+01	3.50E+02	1.07E+02	4.87E+01	1.76E+01	1.75E+02	-	-	3.49E+02
2035	-	-	8.62E+00	1.91E+02	2.57E+02	1.40E+01	4.71E+02	1.33E+02	6.02E+01	1.58E+01	1.69E+02	-	3.95E+01	4.18E+02	1.32E+02	6.02E+01	2.05E+01	2.03E+02	-	-	4.16E+02
2036	-	-	9.72E+00	2.15E+02	3.06E+02	1.68E+01	5.48E+02	1.58E+02	7.17E+01	1.75E+01	1.87E+02	-	4.90E+01	4.84E+02	1.58E+02	7.17E+01	2.34E+01	2.30E+02	-	-	4.82E+02
2037	-	-	1.08E+01	2.39E+02	3.55E+02	1.91E+01	6.24E+02	1.84E+02	8.31E+01	1.91E+01	2.05E+02	-	5.87E+01	5.50E+02	1.83E+02	8.31E+01	2.62E+01	2.55E+02	-	-	5.48E+02
2038	-	-	1.18E+01	2.62E+02	4.04E+02	2.11E+01	6.99E+02	2.09E+02	9.46E+01	2.07E+01	2.21E+02	-	6.86E+01	6.14E+02	2.08E+02	9.46E+01	2.89E+01	2.80E+02	-	-	6.12E+02
2039	-	-	1.28E+01	2.84E+02	4.53E+02	2.27E+01	7.73E+02	2.35E+02	1.06E+02	2.21E+01	2.36E+02	-	7.86E+01	6.77E+02	2.33E+02	1.06E+02	3.15E+01	3.04E+02	-	-	6.75E+02
2040	-	-	1.38E+01	3.06E+02	5.02E+02	2.40E+01	8.46E+02	2.60E+02	1.18E+02	2.34E+01	2.50E+02	-	8.86E+01	7.40E+02	2.58E+02	1.18E+02	3.40E+01	3.27E+02	-	-	7.37E+02
2041	-	-	1.48E+01	3.27E+02	5.51E+02	2.48E+01	9.18E+02	2.85E+02	1.29E+02	2.46E+01	2.63E+02	-	9.86E+01	8.01E+02	2.84E+02	1.29E+02	3.64E+01	3.49E+02	-	-	7.98E+02
2042	-	-	1.57E+01	3.48E+02	6.00E+02	2.53E+01	9.89E+02	3.11E+02	1.40E+02	2.58E+01	2.76E+02	-	1.09E+02	8.61E+02	3.09E+02	1.40E+02	3.88E+01	3.70E+02	-	-	8.58E+02
2043	-	-	1.66E+01	3.68E+02	6.49E+02	2.54E+01	1.06E+03	3.36E+02	1.52E+02	2.69E+01	2.87E+02	-	1.18E+02	9.21E+02	3.34E+02	1.52E+02	4.11E+01	3.90E+02	-	-	9.17E+02
2044	-	-	1.75E+01	3.87E+02	6.98E+02	2.54E+01	1.13E+03	3.61E+02	1.63E+02	2.79E+01	2.98E+02	-	1.28E+02	9.79E+02	3.59E+02	1.63E+02	4.33E+01	4.09E+02	-	-	9.75E+02
2045	-	-	1.83E+01	4.06E+02	7.47E+02	2.52E+01	1.20E+03	3.87E+02	1.75E+02	2.88E+01	3.08E+02	-	1.38E+02	1.04E+03	3.85E+02	1.75E+02	4.54E+01	4.28E+02	-	-	1.03E+03
2046	-	-	1.92E+01	4.25E+02	7.96E+02	2.49E+01	1.26E+03	4.12E+02	1.86E+02	2.97E+01	3.18E+02	-	1.48E+02	1.09E+03	4.10E+02	1.86E+02	4.75E+01	4.46E+02	-	-	1.09E+03
2047	-	-	2.00E+01	4.43E+02	8.45E+02	2.44E+01	1.33E+03	4.37E+02	1.98E+02	3.06E+01	3.27E+02	-	1.58E+02	1.15E+03	4.35E+02	1.98E+02	4.95E+01	4.64E+02	-	-	1.15E+03
2048	-	-	2.08E+01	4.60E+02	8.94E+02	2.38E+01	1.40E+03	4.63E+02	2.09E+02	3.14E+01	3.35E+02	-	1.68E+02	1.21E+03	4.60E+02	2.09E+02	5.15E+01	4.81E+02	-	-	1.20E+03
2049	-	-	2.15E+01	4.77E+02	9.43E+02	2.31E+01	1.46E+03	4.88E+02	2.21E+02	3.21E+01	3.43E+02	-	1.78E+02	1.26E+03	4.85E+02	2.21E+02	5.34E+01	4.97E+02	-	-	1.26E+03
2050	-	-	2.23E+01	4.93E+02	9.92E+02	2.23E+01	1.53E+03	5.13E+02	2.32E+02	3.28E+01	3.51E+02	-	1.88E+02	1.32E+03	5.11E+02	2.32E+02	5.53E+01	5.13E+02	-	-	1.31E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	1.04E+03	2.15E+01	1.59E+03	5.39E+02	2.44E+02	3.34E+01	3.57E+02	-	1.98E+02	1.37E+03	5.36E+02	2.44E+02	5.71E+01	5.28E+02	-	-	1.36E+03
2052	-	-	2.37E+01	5.25E+02	1.09E+03	2.05E+01	1.66E+03	5.64E+02	2.55E+02	3.40E+01	3.64E+02	-	2.07E+02	1.42E+03	5.61E+02	2.55E+02	5.89E+01	5.43E+02	-	-	1.42E+03
2053	-	-	2.44E+01	5.40E+02	1.14E+03	1.93E+01	1.72E+03	5.90E+02	2.67E+02	3.46E+01	3.70E+02	-	2.17E+02	1.48E+03	5.86E+02	2.67E+02	6.06E+01	5.57E+02	-	-	1.47E+03
2054	-	-	2.51E+01	5.55E+02	1.19E+03	1.79E+01	1.79E+03	6.15E+02	2.78E+02	3.51E+01	3.76E+02	-	2.26E+02	1.53E+03	6.12E+02	2.78E+02	6.22E+01	5.71E+02	-	-	1.52E+03
2055	-	-	2.57E+01	5.70E+02	1.24E+03	1.66E+01	1.85E+03	6.40E+02	2.90E+02	3.56E+01	3.81E+02	-	2.35E+02	1.58E+03	6.37E+02	2.90E+02	6.38E+01	5.84E+02	-	-	1.57E+03
2056	-	-	2.64E+01	5.84E+02	1.29E+03	1.53E+01	1.91E+03	6.66E+02	3.01E+02	3.61E+01	3.86E+02	-	2.44E+02	1.63E+03	6.62E+02	3.01E+02	6.54E+01	5.97E+02	-	-	1.63E+03
2057	-	-	2.70E+01	5.98E+02	1.33E+03	1.39E+01	1.97E+03	6.91E+02	3.12E+02	3.65E+01	3.91E+02	-	2.54E+02	1.68E+03	6.87E+02	3.12E+02	6.69E+01	6.10E+02	-	-	1.68E+03
2058	-	-	2.76E+01	6.11E+02	1.38E+03	1.24E+01	2.03E+03	7.14E+02	3.23E+02	3.69E+01	3.95E+02	-	2.62E+02	1.73E+03	7.10E+02	3.23E+02	6.84E+01	6.22E+02	-	-	1.72E+03
2059	-	-	2.82E+01	6.24E+02	1.41E+03	1.07E+01	2.08E+03	7.32E+02	3.31E+02	3.73E+01	3.99E+02	-	2.71E+02	1.77E+03	7.28E+02	3.31E+02	6.98E+01	6.33E+02	-	-	1.76E+03
2060	-	-	2.87E+01	6.37E+02	1.44E+03	8.93E+00	2.12E+03	7.46E+02	3.38E+02	3.77E+01	4.03E+02	-	2.80E+02	1.80E+03	7.42E+02	3.38E+02	7.12E+01	6.44E+02	-	-	1.80E+03
2061	-	-	2.93E+01	6.49E+02	1.46E+03	7.00E+00	2.15E+03	7.58E+02	3.43E+02	3.80E+01	4.06E+02	-	2.88E+02	1.83E+03	7.54E+02	3.43E+02	7.25E+01	6.55E+02	-	-	1.82E+03

Exhibit B-26. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	8.28E+00	-4.70E-01	3.88E+01	4.23E+00	2.01E+00	2.71E+00	2.90E+01	-	2.95E-01	3.82E+01	4.20E+00	2.01E+00	2.75E+00	2.93E+01	-	-	3.82E+01
2030	-	-	2.64E+00	5.85E+01	2.90E+01	-5.73E-01	8.95E+01	1.48E+01	7.04E+00	5.26E+00	5.63E+01	-	2.01E+00	8.54E+01	1.47E+01	7.04E+00	5.50E+00	5.80E+01	-	-	8.53E+01
2031	-	-	3.91E+00	8.65E+01	6.62E+01	6.24E-01	1.57E+02	3.38E+01	1.61E+01	7.64E+00	8.18E+01	-	6.12E+00	1.45E+02	3.36E+01	1.61E+01	8.38E+00	8.70E+01	-	-	1.45E+02
2032	-	-	5.13E+00	1.14E+02	1.12E+02	3.38E+00	2.34E+02	5.70E+01	2.71E+01	9.88E+00	1.06E+02	-	1.27E+01	2.12E+02	5.67E+01	2.71E+01	1.14E+01	1.17E+02	-	-	2.12E+02
2033	-	-	6.33E+00	1.40E+02	1.61E+02	7.07E+00	3.15E+02	8.24E+01	3.92E+01	1.20E+01	1.28E+02	-	2.10E+01	2.83E+02	8.20E+01	3.92E+01	1.45E+01	1.46E+02	-	-	2.82E+02
2034	-	-	7.49E+00	1.66E+02	2.11E+02	1.08E+01	3.95E+02	1.08E+02	5.13E+01	1.40E+01	1.49E+02	-	3.01E+01	3.52E+02	1.07E+02	5.13E+01	1.76E+01	1.75E+02	-	-	3.51E+02
2035	-	-	8.62E+00	1.91E+02	2.61E+02	1.40E+01	4.74E+02	1.33E+02	6.33E+01	1.58E+01	1.69E+02	-	3.95E+01	4.21E+02	1.32E+02	6.33E+01	2.05E+01	2.03E+02	-	-	4.19E+02
2036	-	-	9.72E+00	2.15E+02	3.10E+02	1.68E+01	5.52E+02	1.58E+02	7.54E+01	1.75E+01	1.87E+02	-	4.90E+01	4.88E+02	1.58E+02	7.54E+01	2.34E+01	2.30E+02	-	-	4.86E+02
2037	-	-	1.08E+01	2.39E+02	3.60E+02	1.91E+01	6.29E+02	1.84E+02	8.75E+01	1.91E+01	2.05E+02	-	5.87E+01	5.54E+02	1.83E+02	8.75E+01	2.62E+01	2.55E+02	-	-	5.52E+02
2038	-	-	1.18E+01	2.62E+02	4.10E+02	2.11E+01	7.05E+02	2.09E+02	9.95E+01	2.07E+01	2.21E+02	-	6.86E+01	6.19E+02	2.08E+02	9.95E+01	2.89E+01	2.80E+02	-	-	6.17E+02
2039	-	-	1.28E+01	2.84E+02	4.59E+02	2.27E+01	7.79E+02	2.35E+02	1.12E+02	2.21E+01	2.36E+02	-	7.86E+01	6.83E+02	2.33E+02	1.12E+02	3.15E+01	3.04E+02	-	-	6.80E+02
2040	-	-	1.38E+01	3.06E+02	5.09E+02	2.40E+01	8.53E+02	2.60E+02	1.24E+02	2.34E+01	2.50E+02	-	8.86E+01	7.46E+02	2.58E+02	1.24E+02	3.40E+01	3.27E+02	-	-	7.43E+02
2041	-	-	1.48E+01	3.27E+02	5.59E+02	2.48E+01	9.25E+02	2.85E+02	1.36E+02	2.46E+01	2.63E+02	-	9.86E+01	8.08E+02	2.84E+02	1.36E+02	3.64E+01	3.49E+02	-	-	8.04E+02
2042	-	-	1.57E+01	3.48E+02	6.08E+02	2.53E+01	9.97E+02	3.11E+02	1.48E+02	2.58E+01	2.76E+02	-	1.09E+02	8.69E+02	3.09E+02	1.48E+02	3.88E+01	3.70E+02	-	-	8.65E+02
2043	-	-	1.66E+01	3.68E+02	6.58E+02	2.54E+01	1.07E+03	3.36E+02	1.60E+02	2.69E+01	2.87E+02	-	1.18E+02	9.29E+02	3.34E+02	1.60E+02	4.11E+01	3.90E+02	-	-	9.25E+02
2044	-	-	1.75E+01	3.87E+02	7.08E+02	2.54E+01	1.14E+03	3.61E+02	1.72E+02	2.79E+01	2.98E+02	-	1.28E+02	9.88E+02	3.59E+02	1.72E+02	4.33E+01	4.09E+02	-	-	9.84E+02
2045	-	-	1.83E+01	4.06E+02	7.57E+02	2.52E+01	1.21E+03	3.87E+02	1.84E+02	2.88E+01	3.08E+02	-	1.38E+02	1.05E+03	3.85E+02	1.84E+02	4.54E+01	4.28E+02	-	-	1.04E+03
2046	-	-	1.92E+01	4.25E+02	8.07E+02	2.49E+01	1.28E+03	4.12E+02	1.96E+02	2.97E+01	3.18E+02	-	1.48E+02	1.10E+03	4.10E+02	1.96E+02	4.75E+01	4.46E+02	-	-	1.10E+03
2047	-	-	2.00E+01	4.43E+02	8.57E+02	2.44E+01	1.34E+03	4.37E+02	2.08E+02	3.06E+01	3.27E+02	-	1.58E+02	1.16E+03	4.35E+02	2.08E+02	4.95E+01	4.64E+02	-	-	1.16E+03
2048	-	-	2.08E+01	4.60E+02	9.06E+02	2.38E+01	1.41E+03	4.63E+02	2.20E+02	3.14E+01	3.35E+02	-	1.68E+02	1.22E+03	4.60E+02	2.20E+02	5.15E+01	4.81E+02	-	-	1.21E+03
2049	-	-	2.15E+01	4.77E+02	9.56E+02	2.31E+01	1.48E+03	4.88E+02	2.32E+02	3.21E+01	3.43E+02	-	1.78E+02	1.27E+03	4.85E+02	2.32E+02	5.34E+01	4.97E+02	-	-	1.27E+03
2050	-	-	2.23E+01	4.93E+02	1.01E+03	2.23E+01	1.54E+03	5.13E+02	2.44E+02	3.28E+01	3.51E+02	-	1.88E+02	1.33E+03	5.11E+02	2.44E+02	5.53E+01	5.13E+02	-	-	1.32E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	1.06E+03	2.15E+01	1.61E+03	5.39E+02	2.56E+02	3.34E+01	3.57E+02	-	1.98E+02	1.38E+03	5.36E+02	2.56E+02	5.71E+01	5.28E+02	-	-	1.38E+03
2052	-	-	2.37E+01	5.25E+02	1.10E+03	2.05E+01	1.67E+03	5.64E+02	2.68E+02	3.40E+01	3.64E+02	-	2.07E+02	1.44E+03	5.61E+02	2.68E+02	5.89E+01	5.43E+02	-	-	1.43E+03
2053	-	-	2.44E+01	5.40E+02	1.15E+03	1.93E+01	1.74E+03	5.90E+02	2.81E+02	3.46E+01	3.70E+02	-	2.17E+02	1.49E+03	5.86E+02	2.81E+02	6.06E+01	5.57E+02	-	-	1.48E+03
2054	-	-	2.51E+01	5.55E+02	1.20E+03	1.79E+01	1.80E+03	6.15E+02	2.93E+02	3.51E+01	3.76E+02	-	2.26E+02	1.54E+03	6.12E+02	2.93E+02	6.22E+01	5.71E+02	-	-	1.54E+03
2055	-	-	2.57E+01	5.70E+02	1.25E+03	1.66E+01	1.87E+03	6.40E+02	3.05E+02	3.56E+01	3.81E+02	-	2.35E+02	1.60E+03	6.37E+02	3.05E+02	6.38E+01	5.84E+02	-	-	1.59E+03
2056	-	-	2.64E+01	5.84E+02	1.30E+03	1.53E+01	1.93E+03	6.66E+02	3.17E+02	3.61E+01	3.86E+02	-	2.44E+02	1.65E+03	6.62E+02	3.17E+02	6.54E+01	5.97E+02	-	-	1.64E+03
2057	-	-	2.70E+01	5.98E+02	1.35E+03	1.39E+01	1.99E+03	6.91E+02	3.29E+02	3.65E+01	3.91E+02	-	2.54E+02	1.70E+03	6.87E+02	3.29E+02	6.69E+01	6.10E+02	-	-	1.69E+03
2058	-	-	2.76E+01	6.11E+02	1.40E+03	1.24E+01	2.05E+03	7.14E+02	3.40E+02	3.69E+01	3.95E+02	-	2.62E+02	1.75E+03	7.10E+02	3.40E+02	6.84E+01	6.22E+02	-	-	1.74E+03
2059	-	-	2.82E+01	6.24E+02	1.43E+03	1.07E+01	2.10E+03	7.32E+02	3.48E+02	3.73E+01	3.99E+02	-	2.71E+02	1.79E+03	7.28E+02	3.48E+02	6.98E+01	6.33E+02	-	-	1.78E+03
2060	-	-	2.87E+01	6.37E+02	1.46E+03	8.93E+00	2.14E+03	7.46E+02	3.55E+02	3.77E+01	4.03E+02	-	2.80E+02	1.82E+03	7.42E+02	3.55E+02	7.12E+01	6.44E+02	-	-	1.81E+03
2061	-	-	2.93E+01	6.49E+02	1.48E+03	7.00E+00	2.17E+03	7.58E+02	3.61E+02	3.80E+01	4.06E+02	-	2.88E+02	1.85E+03	7.54E+02	3.61E+02	7.25E+01	6.55E+02	-	-	1.84E+03

Exhibit B-27. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	8.28E+00	-4.70E-01	3.88E+01	4.23E+00	2.02E+00	2.71E+00	2.90E+01	-	2.95E-01	3.83E+01	4.20E+00	2.02E+00	2.75E+00	2.93E+01	-	-	3.82E+01
2030	-	-	2.64E+00	5.85E+01	2.90E+01	-5.73E-01	8.95E+01	1.48E+01	7.05E+00	5.26E+00	5.63E+01	-	2.01E+00	8.54E+01	1.47E+01	7.05E+00	5.50E+00	5.80E+01	-	-	8.53E+01
2031	-	-	3.91E+00	8.65E+01	6.63E+01	6.24E-01	1.57E+02	3.38E+01	1.61E+01	7.64E+00	8.18E+01	-	6.12E+00	1.45E+02	3.36E+01	1.61E+01	8.38E+00	8.70E+01	-	-	1.45E+02
2032	-	-	5.13E+00	1.14E+02	1.12E+02	3.38E+00	2.34E+02	5.70E+01	2.72E+01	9.88E+00	1.06E+02	-	1.27E+01	2.13E+02	5.67E+01	2.72E+01	1.14E+01	1.17E+02	-	-	2.12E+02
2033	-	-	6.33E+00	1.40E+02	1.61E+02	7.07E+00	3.15E+02	8.24E+01	3.93E+01	1.20E+01	1.28E+02	-	2.10E+01	2.83E+02	8.20E+01	3.93E+01	1.45E+01	1.46E+02	-	-	2.82E+02
2034	-	-	7.49E+00	1.66E+02	2.11E+02	1.08E+01	3.95E+02	1.08E+02	5.14E+01	1.40E+01	1.49E+02	-	3.01E+01	3.52E+02	1.07E+02	5.14E+01	1.76E+01	1.75E+02	-	-	3.51E+02
2035	-	-	8.62E+00	1.91E+02	2.61E+02	1.40E+01	4.74E+02	1.33E+02	6.35E+01	1.58E+01	1.69E+02	-	3.95E+01	4.21E+02	1.32E+02	6.35E+01	2.05E+01	2.03E+02	-	-	4.19E+02
2036	-	-	9.72E+00	2.15E+02	3.11E+02	1.68E+01	5.52E+02	1.58E+02	7.56E+01	1.75E+01	1.87E+02	-	4.90E+01	4.88E+02	1.58E+02	7.56E+01	2.34E+01	2.30E+02	-	-	4.86E+02
2037	-	-	1.08E+01	2.39E+02	3.60E+02	1.91E+01	6.29E+02	1.84E+02	8.77E+01	1.91E+01	2.05E+02	-	5.87E+01	5.54E+02	1.83E+02	8.77E+01	2.62E+01	2.55E+02	-	-	5.52E+02
2038	-	-	1.18E+01	2.62E+02	4.10E+02	2.11E+01	7.05E+02	2.09E+02	9.98E+01	2.07E+01	2.21E+02	-	6.86E+01	6.19E+02	2.08E+02	9.98E+01	2.89E+01	2.80E+02	-	-	6.17E+02
2039	-	-	1.28E+01	2.84E+02	4.60E+02	2.27E+01	7.79E+02	2.35E+02	1.12E+02	2.21E+01	2.36E+02	-	7.86E+01	6.83E+02	2.33E+02	1.12E+02	3.15E+01	3.04E+02	-	-	6.81E+02
2040	-	-	1.38E+01	3.06E+02	5.09E+02	2.40E+01	8.53E+02	2.60E+02	1.24E+02	2.34E+01	2.50E+02	-	8.86E+01	7.46E+02	2.58E+02	1.24E+02	3.40E+01	3.27E+02	-	-	7.43E+02
2041	-	-	1.48E+01	3.27E+02	5.59E+02	2.48E+01	9.26E+02	2.85E+02	1.36E+02	2.46E+01	2.63E+02	-	9.86E+01	8.08E+02	2.84E+02	1.36E+02	3.64E+01	3.49E+02	-	-	8.05E+02
2042	-	-	1.57E+01	3.48E+02	6.09E+02	2.53E+01	9.97E+02	3.11E+02	1.48E+02	2.58E+01	2.76E+02	-	1.09E+02	8.69E+02	3.09E+02	1.48E+02	3.88E+01	3.70E+02	-	-	8.65E+02
2043	-	-	1.66E+01	3.68E+02	6.58E+02	2.54E+01	1.07E+03	3.36E+02	1.60E+02	2.69E+01	2.87E+02	-	1.18E+02	9.29E+02	3.34E+02	1.60E+02	4.11E+01	3.90E+02	-	-	9.25E+02
2044	-	-	1.75E+01	3.87E+02	7.08E+02	2.54E+01	1.14E+03	3.61E+02	1.72E+02	2.79E+01	2.98E+02	-	1.28E+02	9.88E+02	3.59E+02	1.72E+02	4.33E+01	4.09E+02	-	-	9.84E+02
2045	-	-	1.83E+01	4.06E+02	7.58E+02	2.52E+01	1.21E+03	3.87E+02	1.84E+02	2.88E+01	3.08E+02	-	1.38E+02	1.05E+03	3.85E+02	1.84E+02	4.54E+01	4.28E+02	-	-	1.04E+03
2046	-	-	1.92E+01	4.25E+02	8.07E+02	2.49E+01	1.28E+03	4.12E+02	1.97E+02	2.97E+01	3.18E+02	-	1.48E+02	1.10E+03	4.10E+02	1.97E+02	4.75E+01	4.46E+02	-	-	1.10E+03
2047	-	-	2.00E+01	4.43E+02	8.57E+02	2.44E+01	1.34E+03	4.37E+02	2.09E+02	3.06E+01	3.27E+02	-	1.58E+02	1.16E+03	4.35E+02	2.09E+02	4.95E+01	4.64E+02	-	-	1.16E+03
2048	-	-	2.08E+01	4.60E+02	9.07E+02	2.38E+01	1.41E+03	4.63E+02	2.21E+02	3.14E+01	3.35E+02	-	1.68E+02	1.22E+03	4.60E+02	2.21E+02	5.15E+01	4.81E+02	-	-	1.21E+03
2049	-	-	2.15E+01	4.77E+02	9.57E+02	2.31E+01	1.48E+03	4.88E+02	2.33E+02	3.21E+01	3.43E+02	-	1.78E+02	1.27E+03	4.85E+02	2.33E+02	5.34E+01	4.97E+02	-	-	1.27E+03
2050	-	-	2.23E+01	4.93E+02	1.01E+03	2.23E+01	1.54E+03	5.13E+02	2.45E+02	3.28E+01	3.51E+02	-	1.88E+02	1.33E+03	5.11E+02	2.45E+02	5.53E+01	5.13E+02	-	-	1.32E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	1.06E+03	2.15E+01	1.61E+03	5.39E+02	2.57E+02	3.34E+01	3.57E+02	-	1.98E+02	1.38E+03	5.36E+02	2.57E+02	5.71E+01	5.28E+02	-	-	1.38E+03
2052	-	-	2.37E+01	5.25E+02	1.11E+03	2.05E+01	1.68E+03	5.64E+02	2.69E+02	3.40E+01	3.64E+02	-	2.07E+02	1.44E+03	5.61E+02	2.69E+02	5.89E+01	5.43E+02	-	-	1.43E+03
2053	-	-	2.44E+01	5.40E+02	1.16E+03	1.93E+01	1.74E+03	5.90E+02	2.81E+02	3.46E+01	3.70E+02	-	2.17E+02	1.49E+03	5.86E+02	2.81E+02	6.06E+01	5.57E+02	-	-	1.49E+03
2054	-	-	2.51E+01	5.55E+02	1.20E+03	1.79E+01	1.80E+03	6.15E+02	2.93E+02	3.51E+01	3.76E+02	-	2.26E+02	1.54E+03	6.12E+02	2.93E+02	6.22E+01	5.71E+02	-	-	1.54E+03
2055	-	-	2.57E+01	5.70E+02	1.25E+03	1.66E+01	1.87E+03	6.40E+02	3.05E+02	3.56E+01	3.81E+02	-	2.35E+02	1.60E+03	6.37E+02	3.05E+02	6.38E+01	5.84E+02	-	-	1.59E+03
2056	-	-	2.64E+01	5.84E+02	1.30E+03	1.53E+01	1.93E+03	6.66E+02	3.17E+02	3.61E+01	3.86E+02	-	2.44E+02	1.65E+03	6.62E+02	3.17E+02	6.54E+01	5.97E+02	-	-	1.64E+03
2057	-	-	2.70E+01	5.98E+02	1.35E+03	1.39E+01	1.99E+03	6.91E+02	3.30E+02	3.65E+01	3.91E+02	-	2.54E+02	1.70E+03	6.87E+02	3.30E+02	6.69E+01	6.10E+02	-	-	1.69E+03
2058	-	-	2.76E+01	6.11E+02	1.40E+03	1.24E+01	2.05E+03	7.14E+02	3.40E+02	3.69E+01	3.95E+02	-	2.62E+02	1.75E+03	7.10E+02	3.40E+02	6.84E+01	6.22E+02	-	-	1.74E+03
2059	-	-	2.82E+01	6.24E+02	1.43E+03	1.07E+01	2.10E+03	7.32E+02	3.49E+02	3.73E+01	3.99E+02	-	2.71E+02	1.79E+03	7.28E+02	3.49E+02	6.98E+01	6.33E+02	-	-	1.78E+03
2060	-	-	2.87E+01	6.37E+02	1.46E+03	8.93E+00	2.14E+03	7.46E+02	3.56E+02	3.77E+01	4.03E+02	-	2.80E+02	1.82E+03	7.42E+02	3.56E+02	7.12E+01	6.44E+02	-	-	1.81E+03
2061	-	-	2.93E+01	6.49E+02	1.49E+03	7.00E+00	2.17E+03	7.58E+02	3.62E+02	3.80E+01	4.06E+02	-	2.88E+02	1.85E+03	7.54E+02	3.62E+02	7.25E+01	6.55E+02	-	-	1.84E+03

Exhibit B-28. Cumulative Emissions Profile AR4 20-yr – NGCC with CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.34E+00	2.97E+01	8.24E+00	-4.70E-01	3.88E+01	4.23E+00	2.53E+00	2.71E+00	2.90E+01	-	2.95E-01	3.88E+01	4.20E+00	2.53E+00	2.75E+00	2.93E+01	-	-	3.87E+01
2030	-	-	2.64E+00	5.85E+01	2.88E+01	-5.73E-01	8.94E+01	1.48E+01	8.87E+00	5.26E+00	5.63E+01	-	2.01E+00	8.72E+01	1.47E+01	8.87E+00	5.50E+00	5.80E+01	-	-	8.71E+01
2031	-	-	3.91E+00	8.65E+01	6.59E+01	6.24E-01	1.57E+02	3.38E+01	2.03E+01	7.64E+00	8.18E+01	-	6.12E+00	1.50E+02	3.36E+01	2.03E+01	8.38E+00	8.70E+01	-	-	1.49E+02
2032	-	-	5.13E+00	1.14E+02	1.11E+02	3.38E+00	2.33E+02	5.70E+01	3.42E+01	9.88E+00	1.06E+02	-	1.27E+01	2.20E+02	5.67E+01	3.42E+01	1.14E+01	1.17E+02	-	-	2.19E+02
2033	-	-	6.33E+00	1.40E+02	1.61E+02	7.07E+00	3.14E+02	8.24E+01	4.94E+01	1.20E+01	1.28E+02	-	2.10E+01	2.93E+02	8.20E+01	4.94E+01	1.45E+01	1.46E+02	-	-	2.92E+02
2034	-	-	7.49E+00	1.66E+02	2.10E+02	1.08E+01	3.94E+02	1.08E+02	6.46E+01	1.40E+01	1.49E+02	-	3.01E+01	3.66E+02	1.07E+02	6.46E+01	1.76E+01	1.75E+02	-	-	3.65E+02
2035	-	-	8.62E+00	1.91E+02	2.59E+02	1.40E+01	4.73E+02	1.33E+02	7.98E+01	1.58E+01	1.69E+02	-	3.95E+01	4.37E+02	1.32E+02	7.98E+01	2.05E+01	2.03E+02	-	-	4.36E+02
2036	-	-	9.72E+00	2.15E+02	3.09E+02	1.68E+01	5.51E+02	1.58E+02	9.51E+01	1.75E+01	1.87E+02	-	4.90E+01	5.07E+02	1.58E+02	9.51E+01	2.34E+01	2.30E+02	-	-	5.06E+02
2037	-	-	1.08E+01	2.39E+02	3.58E+02	1.91E+01	6.27E+02	1.84E+02	1.10E+02	1.91E+01	2.05E+02	-	5.87E+01	5.77E+02	1.83E+02	1.10E+02	2.62E+01	2.55E+02	-	-	5.75E+02
2038	-	-	1.18E+01	2.62E+02	4.08E+02	2.11E+01	7.03E+02	2.09E+02	1.25E+02	2.06E+01	2.21E+02	-	6.86E+01	6.45E+02	2.08E+02	1.25E+02	2.89E+01	2.80E+02	-	-	6.43E+02
2039	-	-	1.28E+01	2.84E+02	4.57E+02	2.27E+01	7.77E+02	2.35E+02	1.41E+02	2.21E+01	2.36E+02	-	7.86E+01	7.12E+02	2.33E+02	1.41E+02	3.15E+01	3.04E+02	-	-	7.09E+02
2040	-	-	1.38E+01	3.06E+02	5.07E+02	2.40E+01	8.50E+02	2.60E+02	1.56E+02	2.34E+01	2.50E+02	-	8.86E+01	7.78E+02	2.58E+02	1.56E+02	3.40E+01	3.27E+02	-	-	7.75E+02
2041	-	-	1.48E+01	3.27E+02	5.56E+02	2.48E+01	9.23E+02	2.85E+02	1.71E+02	2.46E+01	2.63E+02	-	9.86E+01	8.43E+02	2.84E+02	1.71E+02	3.64E+01	3.49E+02	-	-	8.40E+02
2042	-	-	1.57E+01	3.48E+02	6.05E+02	2.53E+01	9.94E+02	3.11E+02	1.86E+02	2.58E+01	2.76E+02	-	1.09E+02	9.07E+02	3.09E+02	1.86E+02	3.88E+01	3.70E+02	-	-	9.04E+02
2043	-	-	1.66E+01	3.68E+02	6.55E+02	2.54E+01	1.06E+03	3.36E+02	2.02E+02	2.69E+01	2.87E+02	-	1.18E+02	9.70E+02	3.34E+02	2.02E+02	4.11E+01	3.90E+02	-	-	9.66E+02
2044	-	-	1.75E+01	3.87E+02	7.04E+02	2.54E+01	1.13E+03	3.61E+02	2.17E+02	2.79E+01	2.98E+02	-	1.28E+02	1.03E+03	3.59E+02	2.17E+02	4.33E+01	4.09E+02	-	-	1.03E+03
2045	-	-	1.83E+01	4.06E+02	7.54E+02	2.52E+01	1.20E+03	3.87E+02	2.32E+02	2.88E+01	3.08E+02	-	1.38E+02	1.09E+03	3.85E+02	2.32E+02	4.54E+01	4.28E+02	-	-	1.09E+03
2046	-	-	1.92E+01	4.25E+02	8.03E+02	2.49E+01	1.27E+03	4.12E+02	2.47E+02	2.97E+01	3.18E+02	-	1.48E+02	1.16E+03	4.10E+02	2.47E+02	4.75E+01	4.46E+02	-	-	1.15E+03
2047	-	-	2.00E+01	4.43E+02	8.53E+02	2.44E+01	1.34E+03	4.37E+02	2.62E+02	3.06E+01	3.27E+02	-	1.58E+02	1.22E+03	4.35E+02	2.62E+02	4.95E+01	4.64E+02	-	-	1.21E+03
2048	-	-	2.08E+01	4.60E+02	9.02E+02	2.38E+01	1.41E+03	4.63E+02	2.78E+02	3.13E+01	3.35E+02	-	1.68E+02	1.28E+03	4.60E+02	2.78E+02	5.15E+01	4.81E+02	-	-	1.27E+03
2049	-	-	2.15E+01	4.77E+02	9.51E+02	2.31E+01	1.47E+03	4.88E+02	2.93E+02	3.21E+01	3.43E+02	-	1.78E+02	1.33E+03	4.85E+02	2.93E+02	5.34E+01	4.97E+02	-	-	1.33E+03
2050	-	-	2.23E+01	4.93E+02	1.00E+03	2.23E+01	1.54E+03	5.13E+02	3.08E+02	3.28E+01	3.51E+02	-	1.88E+02	1.39E+03	5.11E+02	3.08E+02	5.53E+01	5.13E+02	-	-	1.39E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.30E+01	5.10E+02	1.05E+03	2.15E+01	1.60E+03	5.39E+02	3.23E+02	3.34E+01	3.57E+02	-	1.98E+02	1.45E+03	5.36E+02	3.23E+02	5.71E+01	5.28E+02	-	-	1.44E+03
2052	-	-	2.37E+01	5.25E+02	1.10E+03	2.05E+01	1.67E+03	5.64E+02	3.38E+02	3.40E+01	3.64E+02	-	2.07E+02	1.51E+03	5.61E+02	3.38E+02	5.89E+01	5.43E+02	-	-	1.50E+03
2053	-	-	2.44E+01	5.40E+02	1.15E+03	1.93E+01	1.73E+03	5.89E+02	3.54E+02	3.46E+01	3.70E+02	-	2.17E+02	1.56E+03	5.86E+02	3.54E+02	6.06E+01	5.57E+02	-	-	1.56E+03
2054	-	-	2.51E+01	5.55E+02	1.20E+03	1.79E+01	1.80E+03	6.15E+02	3.69E+02	3.51E+01	3.76E+02	-	2.26E+02	1.62E+03	6.12E+02	3.69E+02	6.22E+01	5.71E+02	-	-	1.61E+03
2055	-	-	2.57E+01	5.70E+02	1.25E+03	1.66E+01	1.86E+03	6.40E+02	3.84E+02	3.56E+01	3.81E+02	-	2.35E+02	1.68E+03	6.37E+02	3.84E+02	6.38E+01	5.84E+02	-	-	1.67E+03
2056	-	-	2.64E+01	5.84E+02	1.30E+03	1.53E+01	1.92E+03	6.66E+02	3.99E+02	3.61E+01	3.86E+02	-	2.44E+02	1.73E+03	6.62E+02	3.99E+02	6.54E+01	5.97E+02	-	-	1.72E+03
2057	-	-	2.70E+01	5.98E+02	1.35E+03	1.39E+01	1.99E+03	6.91E+02	4.14E+02	3.65E+01	3.91E+02	-	2.54E+02	1.79E+03	6.87E+02	4.14E+02	6.69E+01	6.10E+02	-	-	1.78E+03
2058	-	-	2.76E+01	6.11E+02	1.39E+03	1.24E+01	2.04E+03	7.14E+02	4.28E+02	3.69E+01	3.95E+02	-	2.62E+02	1.84E+03	7.10E+02	4.28E+02	6.84E+01	6.22E+02	-	-	1.83E+03
2059	-	-	2.82E+01	6.24E+02	1.43E+03	1.07E+01	2.09E+03	7.32E+02	4.39E+02	3.73E+01	3.99E+02	-	2.71E+02	1.88E+03	7.28E+02	4.39E+02	6.98E+01	6.33E+02	-	-	1.87E+03
2060	-	-	2.87E+01	6.37E+02	1.45E+03	8.93E+00	2.13E+03	7.46E+02	4.48E+02	3.77E+01	4.03E+02	-	2.80E+02	1.91E+03	7.42E+02	4.48E+02	7.12E+01	6.44E+02	-	-	1.91E+03
2061	-	-	2.93E+01	6.49E+02	1.48E+03	7.00E+00	2.16E+03	7.58E+02	4.55E+02	3.80E+01	4.06E+02	-	2.88E+02	1.94E+03	7.54E+02	4.55E+02	7.25E+01	6.55E+02	-	-	1.94E+03

Exhibit B-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.57E+02	6.61E+02	6.61E+02	6.81E+02
Lower GOR	6.59E+02	6.62E+02	6.63E+02	6.82E+02
Higher GOR	6.56E+02	6.60E+02	6.60E+02	6.80E+02

Exhibit B-30. CH_4 Sensitivity Analysis - Scenario 3 NGCC without CCS in kg CO_2e (AR4 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.57E+02	6.61E+02	6.61E+02	6.81E+02
Decrease in Methane Emissions	6.53E+02	6.57E+02	6.57E+02	6.77E+02
Increase in Methane Emissions	6.62E+02	6.65E+02	6.66E+02	6.86E+02

Appendix C: AR5 100-yr Results

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR5 – 100-yr)
- Multiproduct Functional Unit – South Korea (AR5 – 100-yr)
- Multiproduct Functional Unit – China (AR5 – 100-yr)
- Multiproduct Functional Unit – India (AR5 – 100-yr)
- Single Product Functional Unit in kg CO2e – Japan (AR4 – 100-yr)
- Single Product Functional Unit in kg CO2e – South Korea (AR5 – 100-yr)
- Single Product Functional Unit in kg CO2e – China (AR5 – 100-yr)
- Single Product Functional Unit in kg CO2e – India (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR5 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR5 – 100-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR5 – 100-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR5 – 100-yr)

Exhibit C-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.77E+01	3.77E+01	-	4.25E+01	4.25E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.24E+01	2.24E+01	-	2.52E+01	2.52E+01
CO2 Compression and Sequestration	-	7.13E-01	-	-	8.03E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.08E+01	3.08E+01	-	3.47E+01	3.47E+01
Ocean Transport	-	1.88E+01	1.88E+01	-	2.12E+01	2.12E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	2.52E+00	2.80E+00	2.80E+00	2.84E+00	3.16E+00	3.16E+00
Crude Oil Extraction, CO2-EOR	-	-	6.12E+00	-	-	6.88E+00
CO2-EOR Crude Oil Transport	-	-	7.98E-01	-	-	8.98E-01
Crude Oil Alaskan Pipeline Transport	1.60E+00	8.29E-01	8.29E-01	1.80E+00	9.32E-01	9.32E-01
Crude Oil Ocean Transport	8.53E-01	4.63E-01	9.10E-01	9.60E-01	5.21E-01	1.02E+00
Crude Oil Refining and End Use	1.14E+02	5.89E+01	1.16E+02	1.28E+02	6.63E+01	1.30E+02
Construction	-	4.84E-01	4.84E-01	-	5.45E-01	5.45E-01
System Expansion: US Average Crude Oil Production and End Use	2.02E+01	8.23E+01	1.82E+01	4.00E+00	7.40E+01	1.80E+00
System Expansion: US Lower 48 LNG Export and End Use	5.25E+02	-	-	2.44E+02	-	-
Total	6.64E+02	6.16E+02	6.15E+02	3.82E+02	3.33E+02	3.32E+02
Upper	2.56E+01	4.78E+01	4.36E+01	2.77E+01	4.86E+01	5.18E+01
Lower	1.42E+01	1.14E+01	1.11E+01	1.62E+01	1.28E+01	1.28E+01

Exhibit C-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.78E+01	3.78E+01	-	4.26E+01	4.26E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.17E+00	4.17E+00
Natural Gas Processing at GTP	-	2.24E+01	2.24E+01	-	2.52E+01	2.52E+01
CO2 Compression and Sequestration	-	7.15E-01	-	-	8.04E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.19E+01	2.19E+01	-	2.47E+01	2.47E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	2.53E+00	2.81E+00	2.81E+00	2.84E+00	3.16E+00	3.16E+00
Crude Oil Extraction, CO2-EOR	-	-	6.13E+00	-	-	6.90E+00
CO2-EOR Crude Oil Transport	-	-	8.00E-01	-	-	9.00E-01
Crude Oil Alaskan Pipeline Transport	1.61E+00	8.30E-01	8.30E-01	1.81E+00	9.34E-01	9.34E-01
Crude Oil Ocean Transport	8.55E-01	4.64E-01	9.12E-01	9.62E-01	5.22E-01	1.03E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.85E-01	4.85E-01	-	5.46E-01	5.46E-01
System Expansion: US Average Crude Oil Production and End Use	1.99E+01	8.22E+01	1.79E+01	3.72E+00	7.38E+01	1.51E+00
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	6.68E+02	6.19E+02	6.19E+02	3.86E+02	3.37E+02	3.36E+02
Upper	2.53E+01	4.28E+01	4.39E+01	2.91E+01	5.39E+01	4.59E+01
Lower	1.56E+01	1.20E+01	1.09E+01	1.68E+01	1.31E+01	1.25E+01

Exhibit C-3. Multiproduct Functional Unit in kg CO_2e – China (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.78E+01	3.78E+01	-	4.26E+01	4.26E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.17E+00	4.17E+00
Natural Gas Processing at GTP	-	2.24E+01	2.24E+01	-	2.52E+01	2.52E+01
CO2 Compression and Sequestration	-	7.15E-01	-	-	8.05E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.21E+01	2.21E+01	-	2.48E+01	2.48E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	2.53E+00	2.81E+00	2.81E+00	2.84E+00	3.16E+00	3.16E+00
Crude Oil Extraction, CO2-EOR	-	-	6.13E+00	-	-	6.90E+00
CO2-EOR Crude Oil Transport	-	-	8.00E-01	-	-	9.00E-01
Crude Oil Alaskan Pipeline Transport	1.61E+00	8.30E-01	8.30E-01	1.81E+00	9.34E-01	9.34E-01
Crude Oil Ocean Transport	8.55E-01	4.64E-01	9.12E-01	9.62E-01	5.22E-01	1.03E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.85E-01	4.85E-01	-	5.46E-01	5.46E-01
System Expansion: US Average Crude Oil Production and End Use	1.99E+01	8.22E+01	1.79E+01	3.75E+00	7.38E+01	1.50E+00
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	6.68E+02	6.20E+02	6.19E+02	3.87E+02	3.37E+02	3.36E+02
Upper	2.54E+01	4.35E+01	4.72E+01	2.88E+01	4.78E+01	4.66E+01
Lower	1.53E+01	1.14E+01	1.13E+01	1.68E+01	1.21E+01	1.31E+01

Exhibit C-4. Multiproduct Functional Unit in kg CO_2e – India (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.82E+01	3.82E+01	-	4.30E+01	4.30E+01
Natural Gas Pipelines to GTP	-	3.74E+00	3.74E+00	-	4.21E+00	4.21E+00
Natural Gas Processing at GTP	-	2.26E+01	2.26E+01	-	2.55E+01	2.55E+01
CO2 Compression and Sequestration	-	7.22E-01	-	-	8.13E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.02E+01	1.02E+01	-	1.15E+01	1.15E+01
Liquefaction	-	3.12E+01	3.12E+01	-	3.51E+01	3.51E+01
Ocean Transport	-	3.84E+01	3.84E+01	-	4.32E+01	4.32E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	2.55E+00	2.84E+00	2.84E+00	2.87E+00	3.19E+00	3.19E+00
Crude Oil Extraction, CO2-EOR	-	-	6.19E+00	-	-	6.97E+00
CO2-EOR Crude Oil Transport	-	-	8.08E-01	-	-	9.09E-01
Crude Oil Alaskan Pipeline Transport	1.62E+00	8.39E-01	8.39E-01	1.83E+00	9.44E-01	9.44E-01
Crude Oil Ocean Transport	8.64E-01	4.69E-01	9.21E-01	9.72E-01	5.28E-01	1.04E+00
Crude Oil Refining and End Use	1.15E+02	5.96E+01	1.17E+02	1.30E+02	6.71E+01	1.32E+02
Construction	-	4.90E-01	4.90E-01	-	5.51E-01	5.51E-01
System Expansion: US Average Crude Oil Production and End Use	1.86E+01	8.15E+01	1.66E+01	2.23E+00	7.30E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.28E+02	-	-	2.47E+02	-	-
Total	6.67E+02	6.37E+02	6.36E+02	3.85E+02	3.57E+02	3.56E+02
Upper	2.41E+01	5.08E+01	4.06E+01	2.86E+01	5.38E+01	4.90E+01
Lower	1.48E+01	1.11E+01	1.11E+01	1.66E+01	1.30E+01	1.26E+01

Exhibit C-5. Single Product Functional Unit in kg CO_2e – Japan (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.77E+01	3.77E+01	-	4.25E+01	4.25E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.16E+00	4.16E+00
Natural Gas Processing at GTP	-	2.24E+01	2.24E+01	-	2.52E+01	2.52E+01
CO2 Compression and Sequestration	-	6.14E-01	-	-	6.90E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.08E+01	3.08E+01	-	3.47E+01	3.47E+01
Ocean Transport	-	1.88E+01	1.88E+01	-	2.12E+01	2.12E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.84E-01	4.84E-01	-	5.45E-01	5.45E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.25E+02	-	-	2.44E+02	-	-
Total	5.25E+02	4.71E+02	4.70E+02	2.44E+02	1.88E+02	1.87E+02
Upper	1.96E+01	3.65E+01	3.33E+01	2.20E+01	2.74E+01	2.92E+01
Lower	1.26E+01	8.69E+00	8.50E+00	1.44E+01	7.26E+00	7.24E+00

Exhibit C-6. Single Product Functional Unit in kg CO_2e – South Korea (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.78E+01	3.78E+01	-	4.26E+01	4.26E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.17E+00	4.17E+00
Natural Gas Processing at GTP	-	2.24E+01	2.24E+01	-	2.52E+01	2.52E+01
CO2 Compression and Sequestration	-	6.15E-01	-	-	6.92E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.19E+01	2.19E+01	-	2.47E+01	2.47E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.85E-01	4.85E-01	-	5.46E-01	5.46E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	5.29E+02	4.74E+02	4.73E+02	2.49E+02	1.92E+02	1.91E+02
Upper	1.99E+01	3.28E+01	3.36E+01	2.21E+01	3.07E+01	2.61E+01
Lower	1.40E+01	9.15E+00	8.37E+00	1.50E+01	7.45E+00	7.10E+00

Exhibit C-7. Single Product Functional Unit in kg CO_2e – China (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.78E+01	3.78E+01	-	4.26E+01	4.26E+01
Natural Gas Pipelines to GTP	-	3.70E+00	3.70E+00	-	4.17E+00	4.17E+00
Natural Gas Processing at GTP	-	2.24E+01	2.24E+01	-	2.52E+01	2.52E+01
CO2 Compression and Sequestration	-	6.15E-01	-	-	6.92E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.01E+01	1.01E+01	-	1.14E+01	1.14E+01
Liquefaction	-	3.09E+01	3.09E+01	-	3.48E+01	3.48E+01
Ocean Transport	-	2.21E+01	2.21E+01	-	2.48E+01	2.48E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.85E-01	4.85E-01	-	5.46E-01	5.46E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.29E+02	-	-	2.49E+02	-	-
Total	5.29E+02	4.74E+02	4.74E+02	2.49E+02	1.92E+02	1.91E+02
Upper	1.97E+01	3.33E+01	3.61E+01	2.26E+01	2.72E+01	2.65E+01
Lower	1.36E+01	8.75E+00	8.66E+00	1.50E+01	6.89E+00	7.48E+00

Exhibit C-8. Single Product Functional Unit in kg CO_2e – India (AR5 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.82E+01	3.82E+01	-	4.30E+01	4.30E+01
Natural Gas Pipelines to GTP	-	3.74E+00	3.74E+00	-	4.21E+00	4.21E+00
Natural Gas Processing at GTP	-	2.26E+01	2.26E+01	-	2.55E+01	2.55E+01
CO2 Compression and Sequestration	-	6.21E-01	-	-	6.99E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.02E+01	1.02E+01	-	1.15E+01	1.15E+01
Liquefaction	-	3.12E+01	3.12E+01	-	3.51E+01	3.51E+01
Ocean Transport	-	3.84E+01	3.84E+01	-	4.32E+01	4.32E+01
LNG Regasification	-	3.59E+00	3.59E+00	-	4.05E+00	4.05E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.38E+01	4.38E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.90E-01	4.90E-01	-	5.51E-01	5.51E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.28E+02	-	-	2.47E+02	-	-
Total	5.28E+02	4.92E+02	4.91E+02	2.47E+02	2.12E+02	2.11E+02
Upper	1.87E+01	3.92E+01	3.14E+01	2.26E+01	3.20E+01	2.90E+01
Lower	1.31E+01	8.61E+00	8.60E+00	1.47E+01	7.74E+00	7.45E+00

Exhibit C-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	6.48E-02	-	-	2.52E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	8.26E-02	8.09E-03	5.75E-09	1.60E+00
Crude Oil Ocean Transport	8.24E-01	2.88E-02	-	8.54E-07	8.53E-01
Crude Oil Refining and End Use	1.14E+02	2.32E-01	5.68E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.96E+01	5.51E-01	1.28E-02	-	2.02E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	6.11E+01	3.37E-01	1.89E-07	5.25E+02
Construction	-	-	-	-	-
Total	6.02E+02	6.20E+01	3.64E-01	1.05E-06	6.64E+02

Exhibit C-10.Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	6.49E-02	-	-	2.53E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	8.28E-02	8.11E-03	5.76E-09	1.61E+00
Crude Oil Ocean Transport	8.26E-01	2.89E-02	-	8.56E-07	8.55E-01
Crude Oil Refining and End Use	1.14E+02	2.32E-01	5.69E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	5.44E-01	1.26E-02	-	1.99E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	6.16E+01	3.47E-01	1.90E-07	5.29E+02
Construction	-	-	-	-	-
Total	6.05E+02	6.26E+01	3.74E-01	1.05E-06	6.68E+02

Exhibit C-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	6.49E-02	-	-	2.53E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	8.28E-02	8.11E-03	5.76E-09	1.61E+00
Crude Oil Ocean Transport	8.26E-01	2.89E-02	-	8.56E-07	8.55E-01
Crude Oil Refining and End Use	1.14E+02	2.32E-01	5.69E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.94E+01	5.44E-01	1.26E-02	-	1.99E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	6.17E+01	3.48E-01	1.90E-07	5.29E+02
Construction	-	-	-	-	-
Total	6.05E+02	6.26E+01	3.74E-01	1.05E-06	6.68E+02

Exhibit C-12.Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.49E+00	6.55E-02	-	-	2.55E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.53E+00	8.36E-02	8.19E-03	5.82E-09	1.62E+00
Crude Oil Ocean Transport	8.34E-01	2.91E-02	-	8.65E-07	8.64E-01
Crude Oil Refining and End Use	1.15E+02	2.35E-01	5.75E-03	-	1.15E+02
System Expansion: US Average Crude Oil Production and End Use	1.81E+01	5.09E-01	1.18E-02	-	1.86E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	6.15E+01	3.44E-01	1.90E-07	5.28E+02
Construction	-	-	-	-	-
Total	6.04E+02	6.24E+01	3.70E-01	1.06E-06	6.67E+02

Exhibit C-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.92E+01	-	-	3.77E+01
Natural Gas Pipelines to GTP	2.14E-03	3.69E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.18E+01	5.62E-01	2.71E-05	-	2.24E+01
CO2 Compression and Sequestration	6.56E-01	5.34E-02	1.55E-03	2.13E-03	7.13E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.95E+00	5.65E-07	-	1.01E+01
Liquefaction	2.25E+01	8.37E+00	-	1.37E-07	3.08E+01
Ocean Transport	1.68E+01	2.05E+00	-	-	1.88E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	1.36E+00	-	-	2.80E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.82E-01	4.27E-02	4.18E-03	2.97E-09	8.29E-01
Crude Oil Ocean Transport	4.42E-01	2.11E-02	-	6.32E-07	4.63E-01
Crude Oil Refining and End Use	5.88E+01	1.20E-01	2.94E-03	-	5.89E+01
System Expansion: US Average Crude Oil Production and End Use	8.00E+01	2.25E+00	5.21E-02	-	8.23E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	1.06E-02	2.63E-03	-	4.84E-01
Total	5.73E+02	4.32E+01	6.34E-02	2.23E-03	6.16E+02

Exhibit C-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.92E+01	-	-	3.78E+01
Natural Gas Pipelines to GTP	2.15E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.18E+01	5.63E-01	2.71E-05	-	2.24E+01
CO2 Compression and Sequestration	6.58E-01	5.35E-02	1.56E-03	2.14E-03	7.15E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	-	1.38E-07	3.09E+01
Ocean Transport	1.95E+01	2.44E+00	-	-	2.19E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.36E+00	-	-	2.81E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	4.28E-02	4.19E-03	2.98E-09	8.30E-01
Crude Oil Ocean Transport	4.43E-01	2.11E-02	-	6.33E-07	4.64E-01
Crude Oil Refining and End Use	5.89E+01	1.20E-01	2.94E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	2.25E+00	5.20E-02	-	8.22E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	1.06E-02	2.63E-03	-	4.85E-01
Total	5.76E+02	4.37E+01	6.34E-02	2.23E-03	6.19E+02

Exhibit C-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.92E+01	-	-	3.78E+01
Natural Gas Pipelines to GTP	2.15E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.18E+01	5.63E-01	2.71E-05	-	2.24E+01
CO2 Compression and Sequestration	6.58E-01	5.35E-02	1.56E-03	2.14E-03	7.15E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	-	1.38E-07	3.09E+01
Ocean Transport	1.96E+01	2.46E+00	-	-	2.21E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.36E+00	-	-	2.81E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	4.28E-02	4.19E-03	2.98E-09	8.30E-01
Crude Oil Ocean Transport	4.43E-01	2.12E-02	-	6.33E-07	4.64E-01
Crude Oil Refining and End Use	5.89E+01	1.20E-01	2.94E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	2.25E+00	5.20E-02	-	8.22E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	1.06E-02	2.63E-03	-	4.85E-01
Total	5.76E+02	4.37E+01	6.34E-02	2.23E-03	6.20E+02

Exhibit C-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	1.94E+01	-	-	3.82E+01
Natural Gas Pipelines to GTP	2.17E-03	3.74E+00	-	-	3.74E+00
Natural Gas Processing at GTP	2.21E+01	5.68E-01	2.74E-05	-	2.26E+01
CO2 Compression and Sequestration	6.64E-01	5.40E-02	1.57E-03	2.16E-03	7.22E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	5.01E+00	5.72E-07	-	1.02E+01
Liquefaction	2.27E+01	8.47E+00	-	1.39E-07	3.12E+01
Ocean Transport	3.39E+01	4.52E+00	-	-	3.84E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	1.38E+00	-	-	2.84E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.91E-01	4.33E-02	4.24E-03	3.01E-09	8.39E-01
Crude Oil Ocean Transport	4.48E-01	2.14E-02	-	6.40E-07	4.69E-01
Crude Oil Refining and End Use	5.95E+01	1.21E-01	2.97E-03	-	5.96E+01
System Expansion: US Average Crude Oil Production and End Use	7.92E+01	2.23E+00	5.16E-02	-	8.15E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	1.07E-02	2.66E-03	-	4.90E-01
Total	5.91E+02	4.61E+01	6.31E-02	2.25E-03	6.37E+02

Exhibit C-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.92E+01	-	-	3.77E+01
Natural Gas Pipelines to GTP	2.14E-03	3.69E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.18E+01	5.62E-01	2.71E-05	-	2.24E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.95E+00	5.65E-07	-	1.01E+01
Liquefaction	2.25E+01	8.37E+00	-	1.37E-07	3.08E+01
Ocean Transport	1.68E+01	2.05E+00	-	-	1.88E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	1.36E+00	-	-	2.80E+00
Crude Oil Extraction, CO2-EOR	5.58E+00	4.85E-01	1.95E-02	2.77E-02	6.12E+00
CO2-EOR Crude Oil Transport	7.53E-01	4.12E-02	4.03E-03	2.87E-09	7.98E-01
Crude Oil Alaskan Pipeline Transport	7.82E-01	4.27E-02	4.18E-03	2.97E-09	8.29E-01
Crude Oil Ocean Transport	8.68E-01	4.14E-02	-	1.24E-06	9.10E-01
Crude Oil Refining and End Use	1.15E+02	2.36E-01	5.77E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.77E+01	4.97E-01	1.15E-02	-	1.82E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	1.06E-02	2.63E-03	-	4.84E-01
Total	5.73E+02	4.21E+01	4.76E-02	2.78E-02	6.15E+02

Exhibit C-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.92E+01	-	-	3.78E+01
Natural Gas Pipelines to GTP	2.15E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.18E+01	5.63E-01	2.71E-05	-	2.24E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	-	1.38E-07	3.09E+01
Ocean Transport	1.95E+01	2.44E+00	-	-	2.19E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.36E+00	-	-	2.81E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	4.86E-01	1.95E-02	2.78E-02	6.13E+00
CO2-EOR Crude Oil Transport	7.55E-01	4.13E-02	4.04E-03	2.87E-09	8.00E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	4.28E-02	4.19E-03	2.98E-09	8.30E-01
Crude Oil Ocean Transport	8.70E-01	4.15E-02	-	1.24E-06	9.12E-01
Crude Oil Refining and End Use	1.16E+02	2.36E-01	5.78E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	4.90E-01	1.14E-02	-	1.79E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	1.06E-02	2.63E-03	-	4.85E-01
Total	5.76E+02	4.25E+01	4.75E-02	2.78E-02	6.19E+02

Exhibit C-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.92E+01	-	-	3.78E+01
Natural Gas Pipelines to GTP	2.15E-03	3.70E+00	-	-	3.70E+00
Natural Gas Processing at GTP	2.18E+01	5.63E-01	2.71E-05	-	2.24E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.96E+00	5.66E-07	-	1.01E+01
Liquefaction	2.25E+01	8.39E+00	-	1.38E-07	3.09E+01
Ocean Transport	1.96E+01	2.46E+00	-	-	2.21E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.36E+00	-	-	2.81E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	4.86E-01	1.95E-02	2.78E-02	6.13E+00
CO2-EOR Crude Oil Transport	7.55E-01	4.13E-02	4.04E-03	2.87E-09	8.00E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	4.28E-02	4.19E-03	2.98E-09	8.30E-01
Crude Oil Ocean Transport	8.70E-01	4.15E-02	-	1.24E-06	9.12E-01
Crude Oil Refining and End Use	1.16E+02	2.36E-01	5.78E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	4.90E-01	1.13E-02	-	1.79E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	1.06E-02	2.63E-03	-	4.85E-01
Total	5.76E+02	4.25E+01	4.75E-02	2.78E-02	6.19E+02

Exhibit C-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	1.94E+01	-	-	3.82E+01
Natural Gas Pipelines to GTP	2.17E-03	3.74E+00	-	-	3.74E+00
Natural Gas Processing at GTP	2.21E+01	5.68E-01	2.74E-05	-	2.26E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	5.01E+00	5.72E-07	-	1.02E+01
Liquefaction	2.27E+01	8.47E+00	-	1.39E-07	3.12E+01
Ocean Transport	3.39E+01	4.52E+00	-	-	3.84E+01
LNG Regasification	3.02E+00	5.76E-01	-	9.20E-05	3.59E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	1.38E+00	-	-	2.84E+00
Crude Oil Extraction, CO2-EOR	5.65E+00	4.91E-01	1.97E-02	2.80E-02	6.19E+00
CO2-EOR Crude Oil Transport	7.62E-01	4.17E-02	4.08E-03	2.90E-09	8.08E-01
Crude Oil Alaskan Pipeline Transport	7.91E-01	4.33E-02	4.24E-03	3.01E-09	8.39E-01
Crude Oil Ocean Transport	8.79E-01	4.20E-02	-	1.26E-06	9.21E-01
Crude Oil Refining and End Use	1.17E+02	2.38E-01	5.84E-03	-	1.17E+02
System Expansion: US Average Crude Oil Production and End Use	1.61E+01	4.53E-01	1.05E-02	-	1.66E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	1.07E-02	2.66E-03	-	4.90E-01
Total	5.91E+02	4.50E+01	4.71E-02	2.81E-02	6.36E+02

Exhibit C-21. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.54E+01	-4.57E-01	4.59E+01	3.13E+00	1.08E+01	2.01E+00	2.89E+01	-	2.87E-01	4.52E+01	3.11E+00	1.08E+01	2.04E+00	2.92E+01	-	-	4.52E+01
2030	-	-	2.55E+00	5.84E+01	5.40E+01	-5.58E-01	1.14E+02	1.10E+01	3.79E+01	3.90E+00	5.62E+01	-	1.95E+00	1.11E+02	1.09E+01	3.79E+01	4.13E+00	5.79E+01	-	-	1.11E+02
2031	-	-	3.77E+00	8.63E+01	1.23E+02	6.07E-01	2.14E+02	2.51E+01	8.67E+01	5.67E+00	8.16E+01	-	5.96E+00	2.05E+02	2.49E+01	8.67E+01	6.35E+00	8.69E+01	-	-	2.05E+02
2032	-	-	4.96E+00	1.14E+02	2.08E+02	3.29E+00	3.30E+02	4.23E+01	1.46E+02	7.33E+00	1.05E+02	-	1.24E+01	3.14E+02	4.20E+01	1.46E+02	8.75E+00	1.16E+02	-	-	3.14E+02
2033	-	-	6.11E+00	1.40E+02	3.01E+02	6.88E+00	4.54E+02	6.11E+01	2.11E+02	8.89E+00	1.28E+02	-	2.05E+01	4.30E+02	6.07E+01	2.11E+02	1.12E+01	1.46E+02	-	-	4.29E+02
2034	-	-	7.24E+00	1.66E+02	3.93E+02	1.05E+01	5.76E+02	7.99E+01	2.76E+02	1.04E+01	1.49E+02	-	2.93E+01	5.45E+02	7.93E+01	2.76E+02	1.37E+01	1.75E+02	-	-	5.44E+02
2035	-	-	8.33E+00	1.91E+02	4.86E+02	1.37E+01	6.98E+02	9.87E+01	3.41E+02	1.17E+01	1.69E+02	-	3.84E+01	6.59E+02	9.80E+01	3.41E+02	1.61E+01	2.03E+02	-	-	6.58E+02
2036	-	-	9.39E+00	2.15E+02	5.78E+02	1.63E+01	8.19E+02	1.17E+02	4.06E+02	1.30E+01	1.87E+02	-	4.77E+01	7.72E+02	1.17E+02	4.06E+02	1.85E+01	2.29E+02	-	-	7.71E+02
2037	-	-	1.04E+01	2.38E+02	6.71E+02	1.86E+01	9.38E+02	1.36E+02	4.72E+02	1.42E+01	2.04E+02	-	5.72E+01	8.83E+02	1.35E+02	4.72E+02	2.08E+01	2.55E+02	-	-	8.83E+02
2038	-	-	1.14E+01	2.61E+02	7.63E+02	2.06E+01	1.06E+03	1.55E+02	5.37E+02	1.53E+01	2.20E+02	-	6.68E+01	9.94E+02	1.54E+02	5.37E+02	2.30E+01	2.80E+02	-	-	9.93E+02
2039	-	-	1.24E+01	2.84E+02	8.56E+02	2.21E+01	1.17E+03	1.74E+02	6.02E+02	1.64E+01	2.36E+02	-	7.65E+01	1.10E+03	1.73E+02	6.02E+02	2.52E+01	3.03E+02	-	-	1.10E+03
2040	-	-	1.33E+01	3.05E+02	9.48E+02	2.33E+01	1.29E+03	1.93E+02	6.67E+02	1.73E+01	2.50E+02	-	8.63E+01	1.21E+03	1.91E+02	6.67E+02	2.73E+01	3.26E+02	-	-	1.21E+03
2041	-	-	1.43E+01	3.26E+02	1.04E+03	2.41E+01	1.41E+03	2.11E+02	7.32E+02	1.83E+01	2.63E+02	-	9.60E+01	1.32E+03	2.10E+02	7.32E+02	2.93E+01	3.48E+02	-	-	1.32E+03
2042	-	-	1.52E+01	3.47E+02	1.13E+03	2.46E+01	1.52E+03	2.30E+02	7.97E+02	1.91E+01	2.75E+02	-	1.06E+02	1.43E+03	2.29E+02	7.97E+02	3.13E+01	3.69E+02	-	-	1.43E+03
2043	-	-	1.60E+01	3.67E+02	1.23E+03	2.48E+01	1.63E+03	2.49E+02	8.62E+02	1.99E+01	2.87E+02	-	1.15E+02	1.53E+03	2.47E+02	8.62E+02	3.32E+01	3.89E+02	-	-	1.53E+03
2044	-	-	1.69E+01	3.86E+02	1.32E+03	2.47E+01	1.75E+03	2.68E+02	9.27E+02	2.07E+01	2.98E+02	-	1.25E+02	1.64E+03	2.66E+02	9.27E+02	3.50E+01	4.08E+02	-	-	1.64E+03
2045	-	-	1.77E+01	4.05E+02	1.41E+03	2.45E+01	1.86E+03	2.87E+02	9.92E+02	2.14E+01	3.08E+02	-	1.35E+02	1.74E+03	2.85E+02	9.92E+02	3.68E+01	4.27E+02	-	-	1.74E+03
2046	-	-	1.85E+01	4.24E+02	1.50E+03	2.42E+01	1.97E+03	3.05E+02	1.06E+03	2.21E+01	3.17E+02	-	1.44E+02	1.85E+03	3.03E+02	1.06E+03	3.86E+01	4.45E+02	-	-	1.84E+03
2047	-	-	1.93E+01	4.42E+02	1.60E+03	2.38E+01	2.08E+03	3.24E+02	1.12E+03	2.27E+01	3.26E+02	-	1.54E+02	1.95E+03	3.22E+02	1.12E+03	4.04E+01	4.63E+02	-	-	1.95E+03
2048	-	-	2.01E+01	4.59E+02	1.69E+03	2.32E+01	2.19E+03	3.43E+02	1.19E+03	2.33E+01	3.35E+02	-	1.64E+02	2.05E+03	3.41E+02	1.19E+03	4.20E+01	4.80E+02	-	-	2.05E+03
2049	-	-	2.08E+01	4.76E+02	1.78E+03	2.25E+01	2.30E+03	3.62E+02	1.25E+03	2.38E+01	3.43E+02	-	1.73E+02	2.15E+03	3.59E+02	1.25E+03	4.37E+01	4.96E+02	-	-	2.15E+03
2050	-	-	2.15E+01	4.92E+02	1.87E+03	2.17E+01	2.41E+03	3.81E+02	1.32E+03	2.43E+01	3.50E+02	-	1.83E+02	2.25E+03	3.78E+02	1.32E+03	4.53E+01	5.12E+02	-	-	2.25E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	1.97E+03	2.09E+01	2.52E+03	3.99E+02	1.38E+03	2.48E+01	3.57E+02	-	1.92E+02	2.36E+03	3.97E+02	1.38E+03	4.69E+01	5.27E+02	-	-	2.35E+03
2052	-	-	2.29E+01	5.24E+02	2.06E+03	1.99E+01	2.63E+03	4.18E+02	1.45E+03	2.52E+01	3.63E+02	-	2.02E+02	2.46E+03	4.15E+02	1.45E+03	4.84E+01	5.42E+02	-	-	2.45E+03
2053	-	-	2.36E+01	5.39E+02	2.15E+03	1.87E+01	2.73E+03	4.37E+02	1.51E+03	2.57E+01	3.69E+02	-	2.11E+02	2.56E+03	4.34E+02	1.51E+03	4.99E+01	5.56E+02	-	-	2.55E+03
2054	-	-	2.42E+01	5.54E+02	2.24E+03	1.75E+01	2.84E+03	4.56E+02	1.58E+03	2.61E+01	3.75E+02	-	2.20E+02	2.65E+03	4.53E+02	1.58E+03	5.13E+01	5.70E+02	-	-	2.65E+03
2055	-	-	2.48E+01	5.69E+02	2.34E+03	1.61E+01	2.95E+03	4.75E+02	1.64E+03	2.64E+01	3.80E+02	-	2.29E+02	2.75E+03	4.71E+02	1.64E+03	5.27E+01	5.83E+02	-	-	2.75E+03
2056	-	-	2.55E+01	5.83E+02	2.43E+03	1.49E+01	3.05E+03	4.93E+02	1.71E+03	2.68E+01	3.85E+02	-	2.38E+02	2.85E+03	4.90E+02	1.71E+03	5.41E+01	5.96E+02	-	-	2.85E+03
2057	-	-	2.61E+01	5.96E+02	2.52E+03	1.36E+01	3.16E+03	5.12E+02	1.77E+03	2.71E+01	3.90E+02	-	2.47E+02	2.95E+03	5.09E+02	1.77E+03	5.54E+01	6.08E+02	-	-	2.94E+03
2058	-	-	2.66E+01	6.10E+02	2.60E+03	1.20E+01	3.25E+03	5.29E+02	1.83E+03	2.74E+01	3.94E+02	-	2.55E+02	3.04E+03	5.25E+02	1.83E+03	5.67E+01	6.20E+02	-	-	3.03E+03
2059	-	-	2.72E+01	6.23E+02	2.67E+03	1.04E+01	3.33E+03	5.43E+02	1.88E+03	2.77E+01	3.98E+02	-	2.64E+02	3.11E+03	5.39E+02	1.88E+03	5.80E+01	6.32E+02	-	-	3.11E+03
2060	-	-	2.78E+01	6.35E+02	2.72E+03	8.69E+00	3.39E+03	5.53E+02	1.91E+03	2.79E+01	4.02E+02	-	2.72E+02	3.17E+03	5.50E+02	1.91E+03	5.92E+01	6.43E+02	-	-	3.17E+03
2061	-	-	2.83E+01	6.48E+02	2.77E+03	6.81E+00	3.45E+03	5.62E+02	1.94E+03	2.82E+01	4.06E+02	-	2.80E+02	3.22E+03	5.58E+02	1.94E+03	6.03E+01	6.54E+02	-	-	3.22E+03

Exhibit C-22. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.55E+01	-4.57E-01	4.59E+01	3.13E+00	1.09E+01	2.01E+00	2.89E+01	-	2.87E-01	4.53E+01	3.11E+00	1.09E+01	2.04E+00	2.92E+01	-	-	4.53E+01
2030	-	-	2.55E+00	5.84E+01	5.43E+01	-5.58E-01	1.15E+02	1.10E+01	3.82E+01	3.90E+00	5.62E+01	-	1.95E+00	1.11E+02	1.09E+01	3.82E+01	4.13E+00	5.79E+01	-	-	1.11E+02
2031	-	-	3.77E+00	8.63E+01	1.24E+02	6.07E-01	2.15E+02	2.51E+01	8.73E+01	5.67E+00	8.16E+01	-	5.96E+00	2.06E+02	2.49E+01	8.73E+01	6.35E+00	8.69E+01	-	-	2.05E+02
2032	-	-	4.96E+00	1.14E+02	2.09E+02	3.29E+00	3.31E+02	4.23E+01	1.47E+02	7.33E+00	1.05E+02	-	1.24E+01	3.15E+02	4.20E+01	1.47E+02	8.75E+00	1.16E+02	-	-	3.14E+02
2033	-	-	6.11E+00	1.40E+02	3.02E+02	6.88E+00	4.55E+02	6.11E+01	2.13E+02	8.89E+00	1.28E+02	-	2.05E+01	4.31E+02	6.07E+01	2.13E+02	1.12E+01	1.46E+02	-	-	4.31E+02
2034	-	-	7.24E+00	1.66E+02	3.95E+02	1.05E+01	5.79E+02	7.99E+01	2.78E+02	1.04E+01	1.49E+02	-	2.93E+01	5.47E+02	7.93E+01	2.78E+02	1.37E+01	1.75E+02	-	-	5.46E+02
2035	-	-	8.33E+00	1.91E+02	4.88E+02	1.37E+01	7.01E+02	9.87E+01	3.44E+02	1.17E+01	1.69E+02	-	3.84E+01	6.61E+02	9.80E+01	3.44E+02	1.61E+01	2.03E+02	-	-	6.60E+02
2036	-	-	9.39E+00	2.15E+02	5.81E+02	1.63E+01	8.22E+02	1.17E+02	4.09E+02	1.30E+01	1.87E+02	-	4.77E+01	7.74E+02	1.17E+02	4.09E+02	1.85E+01	2.29E+02	-	-	7.74E+02
2037	-	-	1.04E+01	2.38E+02	6.74E+02	1.86E+01	9.42E+02	1.36E+02	4.75E+02	1.42E+01	2.04E+02	-	5.72E+01	8.87E+02	1.35E+02	4.75E+02	2.08E+01	2.55E+02	-	-	8.86E+02
2038	-	-	1.14E+01	2.61E+02	7.67E+02	2.06E+01	1.06E+03	1.55E+02	5.40E+02	1.53E+01	2.20E+02	-	6.68E+01	9.98E+02	1.54E+02	5.40E+02	2.30E+01	2.80E+02	-	-	9.97E+02
2039	-	-	1.24E+01	2.84E+02	8.60E+02	2.21E+01	1.18E+03	1.74E+02	6.06E+02	1.64E+01	2.36E+02	-	7.65E+01	1.11E+03	1.73E+02	6.06E+02	2.52E+01	3.03E+02	-	-	1.11E+03
2040	-	-	1.33E+01	3.05E+02	9.53E+02	2.33E+01	1.30E+03	1.93E+02	6.71E+02	1.73E+01	2.50E+02	-	8.63E+01	1.22E+03	1.91E+02	6.71E+02	2.73E+01	3.26E+02	-	-	1.22E+03
2041	-	-	1.43E+01	3.26E+02	1.05E+03	2.41E+01	1.41E+03	2.11E+02	7.36E+02	1.83E+01	2.63E+02	-	9.60E+01	1.33E+03	2.10E+02	7.36E+02	2.93E+01	3.48E+02	-	-	1.32E+03
2042	-	-	1.52E+01	3.47E+02	1.14E+03	2.46E+01	1.53E+03	2.30E+02	8.02E+02	1.91E+01	2.75E+02	-	1.06E+02	1.43E+03	2.29E+02	8.02E+02	3.13E+01	3.69E+02	-	-	1.43E+03
2043	-	-	1.60E+01	3.67E+02	1.23E+03	2.48E+01	1.64E+03	2.49E+02	8.67E+02	1.99E+01	2.87E+02	-	1.15E+02	1.54E+03	2.47E+02	8.67E+02	3.32E+01	3.89E+02	-	-	1.54E+03
2044	-	-	1.69E+01	3.86E+02	1.33E+03	2.47E+01	1.75E+03	2.68E+02	9.33E+02	2.07E+01	2.98E+02	-	1.25E+02	1.64E+03	2.66E+02	9.33E+02	3.50E+01	4.08E+02	-	-	1.64E+03
2045	-	-	1.77E+01	4.05E+02	1.42E+03	2.45E+01	1.87E+03	2.87E+02	9.98E+02	2.14E+01	3.08E+02	-	1.35E+02	1.75E+03	2.85E+02	9.98E+02	3.68E+01	4.27E+02	-	-	1.75E+03
2046	-	-	1.85E+01	4.24E+02	1.51E+03	2.42E+01	1.98E+03	3.05E+02	1.06E+03	2.21E+01	3.17E+02	-	1.44E+02	1.85E+03	3.03E+02	1.06E+03	3.86E+01	4.45E+02	-	-	1.85E+03
2047	-	-	1.93E+01	4.42E+02	1.60E+03	2.38E+01	2.09E+03	3.24E+02	1.13E+03	2.27E+01	3.26E+02	-	1.54E+02	1.96E+03	3.22E+02	1.13E+03	4.04E+01	4.63E+02	-	-	1.95E+03
2048	-	-	2.01E+01	4.59E+02	1.70E+03	2.32E+01	2.20E+03	3.43E+02	1.19E+03	2.33E+01	3.35E+02	-	1.64E+02	2.06E+03	3.41E+02	1.19E+03	4.20E+01	4.80E+02	-	-	2.06E+03
2049	-	-	2.08E+01	4.76E+02	1.79E+03	2.25E+01	2.31E+03	3.62E+02	1.26E+03	2.38E+01	3.43E+02	-	1.73E+02	2.16E+03	3.59E+02	1.26E+03	4.37E+01	4.96E+02	-	-	2.16E+03
2050	-	-	2.15E+01	4.92E+02	1.88E+03	2.17E+01	2.42E+03	3.81E+02	1.33E+03	2.43E+01	3.50E+02	-	1.83E+02	2.26E+03	3.78E+02	1.33E+03	4.53E+01	5.12E+02	-	-	2.26E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	1.98E+03	2.09E+01	2.53E+03	3.99E+02	1.39E+03	2.48E+01	3.57E+02	-	1.92E+02	2.36E+03	3.97E+02	1.39E+03	4.69E+01	5.27E+02	-	-	2.36E+03
2052	-	-	2.29E+01	5.24E+02	2.07E+03	1.99E+01	2.64E+03	4.18E+02	1.46E+03	2.52E+01	3.63E+02	-	2.02E+02	2.47E+03	4.15E+02	1.46E+03	4.84E+01	5.42E+02	-	-	2.46E+03
2053	-	-	2.36E+01	5.39E+02	2.16E+03	1.87E+01	2.74E+03	4.37E+02	1.52E+03	2.57E+01	3.69E+02	-	2.11E+02	2.56E+03	4.34E+02	1.52E+03	4.99E+01	5.56E+02	-	-	2.56E+03
2054	-	-	2.42E+01	5.54E+02	2.26E+03	1.75E+01	2.85E+03	4.56E+02	1.59E+03	2.61E+01	3.75E+02	-	2.20E+02	2.66E+03	4.53E+02	1.59E+03	5.13E+01	5.70E+02	-	-	2.66E+03
2055	-	-	2.48E+01	5.69E+02	2.35E+03	1.61E+01	2.96E+03	4.75E+02	1.65E+03	2.64E+01	3.80E+02	-	2.29E+02	2.76E+03	4.71E+02	1.65E+03	5.27E+01	5.83E+02	-	-	2.76E+03
2056	-	-	2.55E+01	5.83E+02	2.44E+03	1.49E+01	3.06E+03	4.93E+02	1.72E+03	2.68E+01	3.85E+02	-	2.38E+02	2.86E+03	4.90E+02	1.72E+03	5.41E+01	5.96E+02	-	-	2.86E+03
2057	-	-	2.61E+01	5.96E+02	2.53E+03	1.36E+01	3.17E+03	5.12E+02	1.78E+03	2.71E+01	3.90E+02	-	2.47E+02	2.96E+03	5.09E+02	1.78E+03	5.54E+01	6.08E+02	-	-	2.96E+03
2058	-	-	2.66E+01	6.10E+02	2.62E+03	1.20E+01	3.27E+03	5.29E+02	1.84E+03	2.74E+01	3.94E+02	-	2.55E+02	3.05E+03	5.25E+02	1.84E+03	5.67E+01	6.20E+02	-	-	3.05E+03
2059	-	-	2.72E+01	6.23E+02	2.68E+03	1.04E+01	3.34E+03	5.43E+02	1.89E+03	2.77E+01	3.98E+02	-	2.64E+02	3.12E+03	5.39E+02	1.89E+03	5.80E+01	6.32E+02	-	-	3.12E+03
2060	-	-	2.78E+01	6.35E+02	2.74E+03	8.69E+00	3.41E+03	5.53E+02	1.93E+03	2.79E+01	4.02E+02	-	2.72E+02	3.18E+03	5.50E+02	1.93E+03	5.92E+01	6.43E+02	-	-	3.18E+03
2061	-	-	2.83E+01	6.48E+02	2.78E+03	6.81E+00	3.46E+03	5.62E+02	1.96E+03	2.82E+01	4.06E+02	-	2.80E+02	3.23E+03	5.58E+02	1.96E+03	6.03E+01	6.54E+02	-	-	3.23E+03

Exhibit C-23. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.55E+01	-4.57E-01	4.59E+01	3.13E+00	1.09E+01	2.01E+00	2.89E+01	-	2.87E-01	4.53E+01	3.11E+00	1.09E+01	2.05E+00	2.92E+01	-	-	4.53E+01
2030	-	-	2.55E+00	5.84E+01	5.43E+01	-5.58E-01	1.15E+02	1.10E+01	3.82E+01	3.90E+00	5.62E+01	-	1.95E+00	1.11E+02	1.09E+01	3.82E+01	4.13E+00	5.79E+01	-	-	1.11E+02
2031	-	-	3.77E+00	8.63E+01	1.24E+02	6.07E-01	2.15E+02	2.51E+01	8.73E+01	5.67E+00	8.16E+01	-	5.96E+00	2.06E+02	2.49E+01	8.73E+01	6.36E+00	8.69E+01	-	-	2.05E+02
2032	-	-	4.96E+00	1.14E+02	2.09E+02	3.29E+00	3.31E+02	4.23E+01	1.47E+02	7.33E+00	1.05E+02	-	1.24E+01	3.15E+02	4.20E+01	1.47E+02	8.76E+00	1.16E+02	-	-	3.15E+02
2033	-	-	6.11E+00	1.40E+02	3.02E+02	6.88E+00	4.55E+02	6.11E+01	2.13E+02	8.89E+00	1.28E+02	-	2.05E+01	4.31E+02	6.07E+01	2.13E+02	1.12E+01	1.46E+02	-	-	4.31E+02
2034	-	-	7.24E+00	1.66E+02	3.95E+02	1.05E+01	5.79E+02	7.99E+01	2.78E+02	1.04E+01	1.49E+02	-	2.93E+01	5.47E+02	7.93E+01	2.78E+02	1.37E+01	1.75E+02	-	-	5.46E+02
2035	-	-	8.33E+00	1.91E+02	4.88E+02	1.37E+01	7.01E+02	9.87E+01	3.44E+02	1.17E+01	1.69E+02	-	3.84E+01	6.61E+02	9.80E+01	3.44E+02	1.61E+01	2.03E+02	-	-	6.61E+02
2036	-	-	9.39E+00	2.15E+02	5.81E+02	1.63E+01	8.22E+02	1.17E+02	4.09E+02	1.30E+01	1.87E+02	-	4.77E+01	7.75E+02	1.17E+02	4.09E+02	1.85E+01	2.29E+02	-	-	7.74E+02
2037	-	-	1.04E+01	2.38E+02	6.74E+02	1.86E+01	9.42E+02	1.36E+02	4.75E+02	1.42E+01	2.04E+02	-	5.72E+01	8.87E+02	1.35E+02	4.75E+02	2.08E+01	2.55E+02	-	-	8.86E+02
2038	-	-	1.14E+01	2.61E+02	7.67E+02	2.06E+01	1.06E+03	1.55E+02	5.40E+02	1.53E+01	2.20E+02	-	6.68E+01	9.98E+02	1.54E+02	5.40E+02	2.30E+01	2.80E+02	-	-	9.97E+02
2039	-	-	1.24E+01	2.84E+02	8.60E+02	2.21E+01	1.18E+03	1.74E+02	6.06E+02	1.64E+01	2.36E+02	-	7.65E+01	1.11E+03	1.73E+02	6.06E+02	2.52E+01	3.03E+02	-	-	1.11E+03
2040	-	-	1.33E+01	3.05E+02	9.53E+02	2.33E+01	1.30E+03	1.93E+02	6.71E+02	1.73E+01	2.50E+02	-	8.63E+01	1.22E+03	1.91E+02	6.71E+02	2.73E+01	3.26E+02	-	-	1.22E+03
2041	-	-	1.43E+01	3.26E+02	1.05E+03	2.41E+01	1.41E+03	2.11E+02	7.37E+02	1.83E+01	2.63E+02	-	9.60E+01	1.33E+03	2.10E+02	7.37E+02	2.93E+01	3.48E+02	-	-	1.32E+03
2042	-	-	1.52E+01	3.47E+02	1.14E+03	2.46E+01	1.53E+03	2.30E+02	8.02E+02	1.91E+01	2.75E+02	-	1.06E+02	1.43E+03	2.29E+02	8.02E+02	3.13E+01	3.69E+02	-	-	1.43E+03
2043	-	-	1.60E+01	3.67E+02	1.23E+03	2.48E+01	1.64E+03	2.49E+02	8.68E+02	1.99E+01	2.87E+02	-	1.15E+02	1.54E+03	2.47E+02	8.68E+02	3.32E+01	3.89E+02	-	-	1.54E+03
2044	-	-	1.69E+01	3.86E+02	1.33E+03	2.47E+01	1.75E+03	2.68E+02	9.33E+02	2.07E+01	2.98E+02	-	1.25E+02	1.64E+03	2.66E+02	9.33E+02	3.51E+01	4.08E+02	-	-	1.64E+03
2045	-	-	1.77E+01	4.05E+02	1.42E+03	2.45E+01	1.87E+03	2.87E+02	9.99E+02	2.14E+01	3.08E+02	-	1.35E+02	1.75E+03	2.85E+02	9.99E+02	3.69E+01	4.27E+02	-	-	1.75E+03
2046	-	-	1.85E+01	4.24E+02	1.51E+03	2.42E+01	1.98E+03	3.05E+02	1.06E+03	2.21E+01	3.17E+02	-	1.44E+02	1.85E+03	3.03E+02	1.06E+03	3.86E+01	4.45E+02	-	-	1.85E+03
2047	-	-	1.93E+01	4.42E+02	1.60E+03	2.38E+01	2.09E+03	3.24E+02	1.13E+03	2.27E+01	3.26E+02	-	1.54E+02	1.96E+03	3.22E+02	1.13E+03	4.04E+01	4.63E+02	-	-	1.95E+03
2048	-	-	2.01E+01	4.59E+02	1.70E+03	2.32E+01	2.20E+03	3.43E+02	1.20E+03	2.33E+01	3.35E+02	-	1.64E+02	2.06E+03	3.41E+02	1.20E+03	4.21E+01	4.80E+02	-	-	2.06E+03
2049	-	-	2.08E+01	4.76E+02	1.79E+03	2.25E+01	2.31E+03	3.62E+02	1.26E+03	2.38E+01	3.43E+02	-	1.73E+02	2.16E+03	3.59E+02	1.26E+03	4.37E+01	4.96E+02	-	-	2.16E+03
2050	-	-	2.15E+01	4.92E+02	1.88E+03	2.17E+01	2.42E+03	3.81E+02	1.33E+03	2.43E+01	3.50E+02	-	1.83E+02	2.26E+03	3.78E+02	1.33E+03	4.53E+01	5.12E+02	-	-	2.26E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	1.98E+03	2.09E+01	2.53E+03	3.99E+02	1.39E+03	2.48E+01	3.57E+02	-	1.92E+02	2.36E+03	3.97E+02	1.39E+03	4.69E+01	5.27E+02	-	-	2.36E+03
2052	-	-	2.29E+01	5.24E+02	2.07E+03	1.99E+01	2.64E+03	4.18E+02	1.46E+03	2.52E+01	3.63E+02	-	2.02E+02	2.47E+03	4.15E+02	1.46E+03	4.84E+01	5.42E+02	-	-	2.46E+03
2053	-	-	2.36E+01	5.39E+02	2.16E+03	1.87E+01	2.74E+03	4.37E+02	1.52E+03	2.57E+01	3.69E+02	-	2.11E+02	2.56E+03	4.34E+02	1.52E+03	4.99E+01	5.56E+02	-	-	2.56E+03
2054	-	-	2.42E+01	5.54E+02	2.26E+03	1.75E+01	2.85E+03	4.56E+02	1.59E+03	2.61E+01	3.75E+02	-	2.20E+02	2.66E+03	4.53E+02	1.59E+03	5.13E+01	5.70E+02	-	-	2.66E+03
2055	-	-	2.48E+01	5.69E+02	2.35E+03	1.61E+01	2.96E+03	4.75E+02	1.65E+03	2.64E+01	3.80E+02	-	2.29E+02	2.76E+03	4.71E+02	1.65E+03	5.27E+01	5.83E+02	-	-	2.76E+03
2056	-	-	2.55E+01	5.83E+02	2.44E+03	1.49E+01	3.06E+03	4.93E+02	1.72E+03	2.68E+01	3.85E+02	-	2.38E+02	2.86E+03	4.90E+02	1.72E+03	5.41E+01	5.96E+02	-	-	2.86E+03
2057	-	-	2.61E+01	5.96E+02	2.53E+03	1.36E+01	3.17E+03	5.12E+02	1.78E+03	2.71E+01	3.90E+02	-	2.47E+02	2.96E+03	5.09E+02	1.78E+03	5.54E+01	6.08E+02	-	-	2.96E+03
2058	-	-	2.66E+01	6.10E+02	2.62E+03	1.20E+01	3.27E+03	5.29E+02	1.84E+03	2.74E+01	3.94E+02	-	2.55E+02	3.05E+03	5.25E+02	1.84E+03	5.67E+01	6.20E+02	-	-	3.05E+03
2059	-	-	2.72E+01	6.23E+02	2.68E+03	1.04E+01	3.34E+03	5.43E+02	1.89E+03	2.77E+01	3.98E+02	-	2.64E+02	3.12E+03	5.39E+02	1.89E+03	5.80E+01	6.32E+02	-	-	3.12E+03
2060	-	-	2.78E+01	6.35E+02	2.74E+03	8.69E+00	3.41E+03	5.53E+02	1.93E+03	2.79E+01	4.02E+02	-	2.72E+02	3.18E+03	5.50E+02	1.93E+03	5.92E+01	6.43E+02	-	-	3.18E+03
2061	-	-	2.83E+01	6.48E+02	2.78E+03	6.81E+00	3.46E+03	5.62E+02	1.96E+03	2.82E+01	4.06E+02	-	2.80E+02	3.23E+03	5.58E+02	1.96E+03	6.03E+01	6.54E+02	-	-	3.23E+03

Exhibit C-24. Cumulative Emissions Profile AR5 100-yr – NGCC without CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.55E+01	-4.57E-01	4.59E+01	3.13E+00	1.13E+01	2.01E+00	2.89E+01	-	2.87E-01	4.57E+01	3.11E+00	1.13E+01	2.04E+00	2.92E+01	-	-	4.56E+01
2030	-	-	2.55E+00	5.84E+01	5.41E+01	-5.58E-01	1.15E+02	1.10E+01	3.95E+01	3.90E+00	5.62E+01	-	1.95E+00	1.12E+02	1.09E+01	3.95E+01	4.13E+00	5.79E+01	-	-	1.12E+02
2031	-	-	3.77E+00	8.63E+01	1.24E+02	6.07E-01	2.14E+02	2.51E+01	9.03E+01	5.67E+00	8.16E+01	-	5.96E+00	2.09E+02	2.49E+01	9.03E+01	6.35E+00	8.69E+01	-	-	2.08E+02
2032	-	-	4.96E+00	1.14E+02	2.09E+02	3.29E+00	3.31E+02	4.23E+01	1.52E+02	7.33E+00	1.05E+02	-	1.24E+01	3.20E+02	4.20E+01	1.52E+02	8.75E+00	1.16E+02	-	-	3.19E+02
2033	-	-	6.11E+00	1.40E+02	3.02E+02	6.88E+00	4.55E+02	6.11E+01	2.20E+02	8.89E+00	1.28E+02	-	2.05E+01	4.38E+02	6.07E+01	2.20E+02	1.12E+01	1.46E+02	-	-	4.38E+02
2034	-	-	7.24E+00	1.66E+02	3.95E+02	1.05E+01	5.78E+02	7.99E+01	2.88E+02	1.03E+01	1.49E+02	-	2.93E+01	5.56E+02	7.93E+01	2.88E+02	1.37E+01	1.75E+02	-	-	5.56E+02
2035	-	-	8.33E+00	1.91E+02	4.87E+02	1.37E+01	7.00E+02	9.87E+01	3.55E+02	1.17E+01	1.69E+02	-	3.84E+01	6.73E+02	9.80E+01	3.55E+02	1.61E+01	2.03E+02	-	-	6.72E+02
2036	-	-	9.39E+00	2.15E+02	5.80E+02	1.63E+01	8.21E+02	1.17E+02	4.23E+02	1.30E+01	1.87E+02	-	4.77E+01	7.88E+02	1.17E+02	4.23E+02	1.85E+01	2.29E+02	-	-	7.88E+02
2037	-	-	1.04E+01	2.38E+02	6.73E+02	1.86E+01	9.40E+02	1.36E+02	4.91E+02	1.42E+01	2.04E+02	-	5.72E+01	9.03E+02	1.35E+02	4.91E+02	2.08E+01	2.55E+02	-	-	9.02E+02
2038	-	-	1.14E+01	2.61E+02	7.66E+02	2.06E+01	1.06E+03	1.55E+02	5.59E+02	1.53E+01	2.20E+02	-	6.68E+01	1.02E+03	1.54E+02	5.59E+02	2.30E+01	2.80E+02	-	-	1.02E+03
2039	-	-	1.24E+01	2.84E+02	8.59E+02	2.21E+01	1.18E+03	1.74E+02	6.26E+02	1.64E+01	2.36E+02	-	7.65E+01	1.13E+03	1.73E+02	6.26E+02	2.51E+01	3.03E+02	-	-	1.13E+03
2040	-	-	1.33E+01	3.05E+02	9.51E+02	2.33E+01	1.29E+03	1.93E+02	6.94E+02	1.73E+01	2.50E+02	-	8.63E+01	1.24E+03	1.91E+02	6.94E+02	2.72E+01	3.26E+02	-	-	1.24E+03
2041	-	-	1.43E+01	3.26E+02	1.04E+03	2.41E+01	1.41E+03	2.11E+02	7.62E+02	1.83E+01	2.63E+02	-	9.60E+01	1.35E+03	2.10E+02	7.62E+02	2.93E+01	3.48E+02	-	-	1.35E+03
2042	-	-	1.52E+01	3.47E+02	1.14E+03	2.46E+01	1.52E+03	2.30E+02	8.29E+02	1.91E+01	2.75E+02	-	1.06E+02	1.46E+03	2.29E+02	8.29E+02	3.13E+01	3.69E+02	-	-	1.46E+03
2043	-	-	1.60E+01	3.67E+02	1.23E+03	2.48E+01	1.64E+03	2.49E+02	8.97E+02	1.99E+01	2.87E+02	-	1.15E+02	1.57E+03	2.47E+02	8.97E+02	3.32E+01	3.89E+02	-	-	1.57E+03
2044	-	-	1.69E+01	3.86E+02	1.32E+03	2.47E+01	1.75E+03	2.68E+02	9.65E+02	2.07E+01	2.98E+02	-	1.25E+02	1.68E+03	2.66E+02	9.65E+02	3.50E+01	4.08E+02	-	-	1.67E+03
2045	-	-	1.77E+01	4.05E+02	1.42E+03	2.45E+01	1.86E+03	2.87E+02	1.03E+03	2.14E+01	3.08E+02	-	1.35E+02	1.78E+03	2.85E+02	1.03E+03	3.68E+01	4.27E+02	-	-	1.78E+03
2046	-	-	1.85E+01	4.24E+02	1.51E+03	2.42E+01	1.97E+03	3.05E+02	1.10E+03	2.21E+01	3.17E+02	-	1.44E+02	1.89E+03	3.03E+02	1.10E+03	3.86E+01	4.45E+02	-	-	1.89E+03
2047	-	-	1.93E+01	4.42E+02	1.60E+03	2.38E+01	2.09E+03	3.24E+02	1.17E+03	2.27E+01	3.26E+02	-	1.54E+02	2.00E+03	3.22E+02	1.17E+03	4.04E+01	4.63E+02	-	-	1.99E+03
2048	-	-	2.01E+01	4.59E+02	1.69E+03	2.32E+01	2.20E+03	3.43E+02	1.24E+03	2.33E+01	3.35E+02	-	1.64E+02	2.10E+03	3.41E+02	1.24E+03	4.20E+01	4.80E+02	-	-	2.10E+03
2049	-	-	2.08E+01	4.76E+02	1.79E+03	2.25E+01	2.31E+03	3.62E+02	1.30E+03	2.38E+01	3.43E+02	-	1.73E+02	2.20E+03	3.59E+02	1.30E+03	4.37E+01	4.96E+02	-	-	2.20E+03
2050	-	-	2.15E+01	4.92E+02	1.88E+03	2.17E+01	2.42E+03	3.81E+02	1.37E+03	2.43E+01	3.50E+02	-	1.83E+02	2.31E+03	3.78E+02	1.37E+03	4.53E+01	5.12E+02	-	-	2.31E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	1.97E+03	2.09E+01	2.52E+03	3.99E+02	1.44E+03	2.48E+01	3.57E+02	-	1.92E+02	2.41E+03	3.97E+02	1.44E+03	4.69E+01	5.27E+02	-	-	2.41E+03
2052	-	-	2.29E+01	5.24E+02	2.07E+03	1.99E+01	2.63E+03	4.18E+02	1.51E+03	2.52E+01	3.63E+02	-	2.02E+02	2.51E+03	4.15E+02	1.51E+03	4.84E+01	5.42E+02	-	-	2.51E+03
2053	-	-	2.36E+01	5.39E+02	2.16E+03	1.87E+01	2.74E+03	4.37E+02	1.57E+03	2.57E+01	3.69E+02	-	2.11E+02	2.62E+03	4.34E+02	1.57E+03	4.99E+01	5.56E+02	-	-	2.61E+03
2054	-	-	2.42E+01	5.54E+02	2.25E+03	1.75E+01	2.85E+03	4.56E+02	1.64E+03	2.60E+01	3.75E+02	-	2.20E+02	2.72E+03	4.53E+02	1.64E+03	5.13E+01	5.70E+02	-	-	2.72E+03
2055	-	-	2.48E+01	5.69E+02	2.34E+03	1.61E+01	2.95E+03	4.75E+02	1.71E+03	2.64E+01	3.80E+02	-	2.29E+02	2.82E+03	4.71E+02	1.71E+03	5.27E+01	5.83E+02	-	-	2.82E+03
2056	-	-	2.55E+01	5.83E+02	2.44E+03	1.49E+01	3.06E+03	4.93E+02	1.78E+03	2.68E+01	3.85E+02	-	2.38E+02	2.92E+03	4.90E+02	1.78E+03	5.41E+01	5.96E+02	-	-	2.92E+03
2057	-	-	2.61E+01	5.96E+02	2.53E+03	1.36E+01	3.17E+03	5.12E+02	1.84E+03	2.71E+01	3.90E+02	-	2.47E+02	3.02E+03	5.09E+02	1.84E+03	5.54E+01	6.08E+02	-	-	3.02E+03
2058	-	-	2.66E+01	6.10E+02	2.61E+03	1.20E+01	3.26E+03	5.29E+02	1.91E+03	2.74E+01	3.94E+02	-	2.55E+02	3.11E+03	5.25E+02	1.91E+03	5.67E+01	6.20E+02	-	-	3.11E+03
2059	-	-	2.72E+01	6.23E+02	2.68E+03	1.04E+01	3.34E+03	5.42E+02	1.95E+03	2.77E+01	3.98E+02	-	2.64E+02	3.19E+03	5.39E+02	1.95E+03	5.80E+01	6.32E+02	-	-	3.18E+03
2060	-	-	2.78E+01	6.35E+02	2.73E+03	8.69E+00	3.40E+03	5.53E+02	1.99E+03	2.79E+01	4.02E+02	-	2.72E+02	3.25E+03	5.50E+02	1.99E+03	5.92E+01	6.43E+02	-	-	3.24E+03
2061	-	-	2.83E+01	6.48E+02	2.78E+03	6.81E+00	3.46E+03	5.62E+02	2.02E+03	2.82E+01	4.06E+02	-	2.80E+02	3.30E+03	5.58E+02	2.02E+03	6.03E+01	6.54E+02	-	-	3.30E+03

Exhibit C-25. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.37E+00	-4.57E-01	3.68E+01	3.13E+00	1.82E+00	2.01E+00	2.89E+01	-	2.87E-01	3.62E+01	3.11E+00	1.82E+00	2.05E+00	2.92E+01	-	-	3.62E+01
2030	-	-	2.55E+00	5.84E+01	2.23E+01	-5.58E-01	8.27E+01	1.10E+01	6.38E+00	3.90E+00	5.62E+01	-	1.95E+00	7.94E+01	1.09E+01	6.38E+00	4.13E+00	5.79E+01	-	-	7.93E+01
2031	-	-	3.77E+00	8.63E+01	5.10E+01	6.07E-01	1.42E+02	2.51E+01	1.46E+01	5.67E+00	8.16E+01	-	5.96E+00	1.33E+02	2.49E+01	1.46E+01	6.36E+00	8.69E+01	-	-	1.33E+02
2032	-	-	4.96E+00	1.14E+02	8.60E+01	3.29E+00	2.08E+02	4.23E+01	2.46E+01	7.33E+00	1.05E+02	-	1.24E+01	1.92E+02	4.20E+01	2.46E+01	8.75E+00	1.16E+02	-	-	1.92E+02
2033	-	-	6.11E+00	1.40E+02	1.24E+02	6.88E+00	2.77E+02	6.11E+01	3.55E+01	8.89E+00	1.28E+02	-	2.05E+01	2.54E+02	6.07E+01	3.55E+01	1.12E+01	1.46E+02	-	-	2.53E+02
2034	-	-	7.24E+00	1.66E+02	1.62E+02	1.05E+01	3.46E+02	7.99E+01	4.65E+01	1.04E+01	1.49E+02	-	2.93E+01	3.15E+02	7.94E+01	4.65E+01	1.37E+01	1.75E+02	-	-	3.14E+02
2035	-	-	8.33E+00	1.91E+02	2.01E+02	1.37E+01	4.13E+02	9.87E+01	5.74E+01	1.17E+01	1.69E+02	-	3.84E+01	3.75E+02	9.80E+01	5.74E+01	1.61E+01	2.03E+02	-	-	3.74E+02
2036	-	-	9.39E+00	2.15E+02	2.39E+02	1.63E+01	4.79E+02	1.17E+02	6.84E+01	1.30E+01	1.87E+02	-	4.77E+01	4.34E+02	1.17E+02	6.84E+01	1.85E+01	2.29E+02	-	-	4.33E+02
2037	-	-	1.04E+01	2.38E+02	2.77E+02	1.86E+01	5.45E+02	1.36E+02	7.93E+01	1.42E+01	2.04E+02	-	5.72E+01	4.91E+02	1.35E+02	7.93E+01	2.08E+01	2.55E+02	-	-	4.90E+02
2038	-	-	1.14E+01	2.61E+02	3.15E+02	2.06E+01	6.09E+02	1.55E+02	9.02E+01	1.53E+01	2.20E+02	-	6.68E+01	5.48E+02	1.54E+02	9.02E+01	2.30E+01	2.80E+02	-	-	5.47E+02
2039	-	-	1.24E+01	2.84E+02	3.54E+02	2.21E+01	6.72E+02	1.74E+02	1.01E+02	1.64E+01	2.36E+02	-	7.65E+01	6.03E+02	1.73E+02	1.01E+02	2.52E+01	3.03E+02	-	-	6.02E+02
2040	-	-	1.33E+01	3.05E+02	3.92E+02	2.33E+01	7.34E+02	1.93E+02	1.12E+02	1.74E+01	2.50E+02	-	8.63E+01	6.58E+02	1.91E+02	1.12E+02	2.73E+01	3.26E+02	-	-	6.57E+02
2041	-	-	1.43E+01	3.26E+02	4.30E+02	2.41E+01	7.95E+02	2.11E+02	1.23E+02	1.83E+01	2.63E+02	-	9.60E+01	7.12E+02	2.10E+02	1.23E+02	2.93E+01	3.48E+02	-	-	7.10E+02
2042	-	-	1.52E+01	3.47E+02	4.68E+02	2.46E+01	8.55E+02	2.30E+02	1.34E+02	1.91E+01	2.75E+02	-	1.06E+02	7.64E+02	2.29E+02	1.34E+02	3.13E+01	3.69E+02	-	-	7.63E+02
2043	-	-	1.60E+01	3.67E+02	5.06E+02	2.48E+01	9.14E+02	2.49E+02	1.45E+02	1.99E+01	2.87E+02	-	1.15E+02	8.16E+02	2.47E+02	1.45E+02	3.32E+01	3.89E+02	-	-	8.14E+02
2044	-	-	1.69E+01	3.86E+02	5.45E+02	2.47E+01	9.73E+02	2.68E+02	1.56E+02	2.07E+01	2.98E+02	-	1.25E+02	8.67E+02	2.66E+02	1.56E+02	3.50E+01	4.08E+02	-	-	8.65E+02
2045	-	-	1.77E+01	4.05E+02	5.83E+02	2.45E+01	1.03E+03	2.87E+02	1.67E+02	2.14E+01	3.08E+02	-	1.35E+02	9.17E+02	2.85E+02	1.67E+02	3.69E+01	4.27E+02	-	-	9.15E+02
2046	-	-	1.85E+01	4.24E+02	6.21E+02	2.42E+01	1.09E+03	3.05E+02	1.78E+02	2.21E+01	3.17E+02	-	1.44E+02	9.67E+02	3.03E+02	1.78E+02	3.86E+01	4.45E+02	-	-	9.65E+02
2047	-	-	1.93E+01	4.42E+02	6.59E+02	2.38E+01	1.14E+03	3.24E+02	1.89E+02	2.27E+01	3.26E+02	-	1.54E+02	1.02E+03	3.22E+02	1.89E+02	4.04E+01	4.63E+02	-	-	1.01E+03
2048	-	-	2.01E+01	4.59E+02	6.98E+02	2.32E+01	1.20E+03	3.43E+02	2.00E+02	2.33E+01	3.35E+02	-	1.64E+02	1.06E+03	3.41E+02	2.00E+02	4.21E+01	4.80E+02	-	-	1.06E+03
2049	-	-	2.08E+01	4.76E+02	7.36E+02	2.25E+01	1.25E+03	3.62E+02	2.11E+02	2.38E+01	3.43E+02	-	1.73E+02	1.11E+03	3.59E+02	2.11E+02	4.37E+01	4.96E+02	-	-	1.11E+03
2050	-	-	2.15E+01	4.92E+02	7.74E+02	2.17E+01	1.31E+03	3.81E+02	2.21E+02	2.43E+01	3.50E+02	-	1.83E+02	1.16E+03	3.78E+02	2.21E+02	4.53E+01	5.12E+02	-	-	1.16E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	8.12E+02	2.09E+01	1.36E+03	3.99E+02	2.32E+02	2.48E+01	3.57E+02	-	1.92E+02	1.21E+03	3.97E+02	2.32E+02	4.69E+01	5.27E+02	-	-	1.20E+03
2052	-	-	2.29E+01	5.24E+02	8.50E+02	1.99E+01	1.42E+03	4.18E+02	2.43E+02	2.53E+01	3.63E+02	-	2.02E+02	1.25E+03	4.15E+02	2.43E+02	4.84E+01	5.42E+02	-	-	1.25E+03
2053	-	-	2.36E+01	5.39E+02	8.89E+02	1.87E+01	1.47E+03	4.37E+02	2.54E+02	2.57E+01	3.69E+02	-	2.11E+02	1.30E+03	4.34E+02	2.54E+02	4.99E+01	5.56E+02	-	-	1.29E+03
2054	-	-	2.42E+01	5.54E+02	9.27E+02	1.75E+01	1.52E+03	4.56E+02	2.65E+02	2.61E+01	3.75E+02	-	2.20E+02	1.34E+03	4.53E+02	2.65E+02	5.13E+01	5.70E+02	-	-	1.34E+03
2055	-	-	2.48E+01	5.69E+02	9.65E+02	1.61E+01	1.57E+03	4.75E+02	2.76E+02	2.64E+01	3.80E+02	-	2.29E+02	1.39E+03	4.71E+02	2.76E+02	5.27E+01	5.83E+02	-	-	1.38E+03
2056	-	-	2.55E+01	5.83E+02	1.00E+03	1.49E+01	1.63E+03	4.93E+02	2.87E+02	2.68E+01	3.85E+02	-	2.38E+02	1.43E+03	4.90E+02	2.87E+02	5.41E+01	5.96E+02	-	-	1.43E+03
2057	-	-	2.61E+01	5.96E+02	1.04E+03	1.36E+01	1.68E+03	5.12E+02	2.98E+02	2.71E+01	3.90E+02	-	2.47E+02	1.47E+03	5.09E+02	2.98E+02	5.54E+01	6.08E+02	-	-	1.47E+03
2058	-	-	2.66E+01	6.10E+02	1.08E+03	1.20E+01	1.72E+03	5.29E+02	3.08E+02	2.74E+01	3.94E+02	-	2.55E+02	1.51E+03	5.26E+02	3.08E+02	5.67E+01	6.20E+02	-	-	1.51E+03
2059	-	-	2.72E+01	6.23E+02	1.10E+03	1.04E+01	1.76E+03	5.43E+02	3.16E+02	2.77E+01	3.98E+02	-	2.64E+02	1.55E+03	5.39E+02	3.16E+02	5.80E+01	6.32E+02	-	-	1.54E+03
2060	-	-	2.78E+01	6.35E+02	1.13E+03	8.69E+00	1.80E+03	5.53E+02	3.22E+02	2.80E+01	4.02E+02	-	2.72E+02	1.58E+03	5.50E+02	3.22E+02	5.92E+01	6.43E+02	-	-	1.57E+03
2061	-	-	2.83E+01	6.48E+02	1.14E+03	6.81E+00	1.83E+03	5.62E+02	3.27E+02	2.82E+01	4.06E+02	-	2.80E+02	1.60E+03	5.58E+02	3.27E+02	6.04E+01	6.54E+02	-	-	1.60E+03

Exhibit C-26. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.47E+00	-4.57E-01	3.69E+01	3.13E+00	1.91E+00	2.01E+00	2.89E+01	-	2.87E-01	3.63E+01	3.11E+00	1.91E+00	2.05E+00	2.92E+01	-	-	3.63E+01
2030	-	-	2.55E+00	5.84E+01	2.27E+01	-5.58E-01	8.30E+01	1.10E+01	6.69E+00	3.90E+00	5.62E+01	-	1.95E+00	7.97E+01	1.09E+01	6.69E+00	4.13E+00	5.79E+01	-	-	7.96E+01
2031	-	-	3.77E+00	8.63E+01	5.18E+01	6.07E-01	1.42E+02	2.51E+01	1.53E+01	5.67E+00	8.16E+01	-	5.96E+00	1.34E+02	2.49E+01	1.53E+01	6.36E+00	8.69E+01	-	-	1.33E+02
2032	-	-	4.96E+00	1.14E+02	8.74E+01	3.29E+00	2.09E+02	4.23E+01	2.58E+01	7.33E+00	1.05E+02	-	1.24E+01	1.93E+02	4.20E+01	2.58E+01	8.75E+00	1.16E+02	-	-	1.93E+02
2033	-	-	6.11E+00	1.40E+02	1.26E+02	6.88E+00	2.79E+02	6.11E+01	3.73E+01	8.89E+00	1.28E+02	-	2.05E+01	2.56E+02	6.07E+01	3.73E+01	1.12E+01	1.46E+02	-	-	2.55E+02
2034	-	-	7.24E+00	1.66E+02	1.65E+02	1.05E+01	3.48E+02	7.99E+01	4.87E+01	1.04E+01	1.49E+02	-	2.93E+01	3.17E+02	7.94E+01	4.87E+01	1.37E+01	1.75E+02	-	-	3.17E+02
2035	-	-	8.33E+00	1.91E+02	2.04E+02	1.37E+01	4.16E+02	9.87E+01	6.02E+01	1.17E+01	1.69E+02	-	3.84E+01	3.78E+02	9.80E+01	6.02E+01	1.61E+01	2.03E+02	-	-	3.77E+02
2036	-	-	9.39E+00	2.15E+02	2.43E+02	1.63E+01	4.83E+02	1.17E+02	7.17E+01	1.30E+01	1.87E+02	-	4.77E+01	4.37E+02	1.17E+02	7.17E+01	1.85E+01	2.29E+02	-	-	4.36E+02
2037	-	-	1.04E+01	2.38E+02	2.82E+02	1.86E+01	5.49E+02	1.36E+02	8.31E+01	1.42E+01	2.04E+02	-	5.72E+01	4.95E+02	1.35E+02	8.31E+01	2.08E+01	2.55E+02	-	-	4.94E+02
2038	-	-	1.14E+01	2.61E+02	3.20E+02	2.06E+01	6.14E+02	1.55E+02	9.46E+01	1.53E+01	2.20E+02	-	6.68E+01	5.52E+02	1.54E+02	9.46E+01	2.30E+01	2.80E+02	-	-	5.51E+02
2039	-	-	1.24E+01	2.84E+02	3.59E+02	2.21E+01	6.77E+02	1.74E+02	1.06E+02	1.64E+01	2.36E+02	-	7.65E+01	6.08E+02	1.73E+02	1.06E+02	2.52E+01	3.03E+02	-	-	6.07E+02
2040	-	-	1.33E+01	3.05E+02	3.98E+02	2.33E+01	7.40E+02	1.93E+02	1.18E+02	1.74E+01	2.50E+02	-	8.63E+01	6.64E+02	1.91E+02	1.18E+02	2.73E+01	3.26E+02	-	-	6.62E+02
2041	-	-	1.43E+01	3.26E+02	4.37E+02	2.41E+01	8.02E+02	2.11E+02	1.29E+02	1.83E+01	2.63E+02	-	9.60E+01	7.18E+02	2.10E+02	1.29E+02	2.93E+01	3.48E+02	-	-	7.16E+02
2042	-	-	1.52E+01	3.47E+02	4.76E+02	2.46E+01	8.62E+02	2.30E+02	1.40E+02	1.91E+01	2.75E+02	-	1.06E+02	7.71E+02	2.29E+02	1.40E+02	3.13E+01	3.69E+02	-	-	7.69E+02
2043	-	-	1.60E+01	3.67E+02	5.15E+02	2.48E+01	9.22E+02	2.49E+02	1.52E+02	1.99E+01	2.87E+02	-	1.15E+02	8.23E+02	2.47E+02	1.52E+02	3.32E+01	3.89E+02	-	-	8.21E+02
2044	-	-	1.69E+01	3.86E+02	5.53E+02	2.47E+01	9.81E+02	2.68E+02	1.63E+02	2.07E+01	2.98E+02	-	1.25E+02	8.75E+02	2.66E+02	1.63E+02	3.50E+01	4.08E+02	-	-	8.73E+02
2045	-	-	1.77E+01	4.05E+02	5.92E+02	2.45E+01	1.04E+03	2.87E+02	1.75E+02	2.14E+01	3.08E+02	-	1.35E+02	9.25E+02	2.85E+02	1.75E+02	3.69E+01	4.27E+02	-	-	9.24E+02
2046	-	-	1.85E+01	4.24E+02	6.31E+02	2.42E+01	1.10E+03	3.05E+02	1.86E+02	2.21E+01	3.17E+02	-	1.44E+02	9.76E+02	3.03E+02	1.86E+02	3.86E+01	4.45E+02	-	-	9.74E+02
2047	-	-	1.93E+01	4.42E+02	6.70E+02	2.38E+01	1.15E+03	3.24E+02	1.98E+02	2.27E+01	3.26E+02	-	1.54E+02	1.03E+03	3.22E+02	1.98E+02	4.04E+01	4.63E+02	-	-	1.02E+03
2048	-	-	2.01E+01	4.59E+02	7.09E+02	2.32E+01	1.21E+03	3.43E+02	2.09E+02	2.33E+01	3.35E+02	-	1.64E+02	1.07E+03	3.41E+02	2.09E+02	4.21E+01	4.80E+02	-	-	1.07E+03
2049	-	-	2.08E+01	4.76E+02	7.48E+02	2.25E+01	1.27E+03	3.62E+02	2.21E+02	2.38E+01	3.43E+02	-	1.73E+02	1.12E+03	3.59E+02	2.21E+02	4.37E+01	4.96E+02	-	-	1.12E+03
2050	-	-	2.15E+01	4.92E+02	7.86E+02	2.17E+01	1.32E+03	3.81E+02	2.32E+02	2.43E+01	3.50E+02	-	1.83E+02	1.17E+03	3.78E+02	2.32E+02	4.53E+01	5.12E+02	-	-	1.17E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	8.25E+02	2.09E+01	1.38E+03	3.99E+02	2.44E+02	2.48E+01	3.57E+02	-	1.92E+02	1.22E+03	3.97E+02	2.44E+02	4.69E+01	5.27E+02	-	-	1.21E+03
2052	-	-	2.29E+01	5.24E+02	8.64E+02	1.99E+01	1.43E+03	4.18E+02	2.55E+02	2.53E+01	3.63E+02	-	2.02E+02	1.26E+03	4.15E+02	2.55E+02	4.84E+01	5.42E+02	-	-	1.26E+03
2053	-	-	2.36E+01	5.39E+02	9.03E+02	1.87E+01	1.48E+03	4.37E+02	2.67E+02	2.57E+01	3.69E+02	-	2.11E+02	1.31E+03	4.34E+02	2.67E+02	4.99E+01	5.56E+02	-	-	1.31E+03
2054	-	-	2.42E+01	5.54E+02	9.42E+02	1.75E+01	1.54E+03	4.56E+02	2.78E+02	2.61E+01	3.75E+02	-	2.20E+02	1.35E+03	4.53E+02	2.78E+02	5.13E+01	5.70E+02	-	-	1.35E+03
2055	-	-	2.48E+01	5.69E+02	9.80E+02	1.61E+01	1.59E+03	4.75E+02	2.90E+02	2.64E+01	3.80E+02	-	2.29E+02	1.40E+03	4.71E+02	2.90E+02	5.27E+01	5.83E+02	-	-	1.40E+03
2056	-	-	2.55E+01	5.83E+02	1.02E+03	1.49E+01	1.64E+03	4.93E+02	3.01E+02	2.68E+01	3.85E+02	-	2.38E+02	1.44E+03	4.90E+02	3.01E+02	5.41E+01	5.96E+02	-	-	1.44E+03
2057	-	-	2.61E+01	5.96E+02	1.06E+03	1.36E+01	1.69E+03	5.12E+02	3.12E+02	2.71E+01	3.90E+02	-	2.47E+02	1.49E+03	5.09E+02	3.12E+02	5.54E+01	6.08E+02	-	-	1.49E+03
2058	-	-	2.66E+01	6.10E+02	1.09E+03	1.20E+01	1.74E+03	5.29E+02	3.23E+02	2.74E+01	3.94E+02	-	2.55E+02	1.53E+03	5.26E+02	3.23E+02	5.67E+01	6.20E+02	-	-	1.53E+03
2059	-	-	2.72E+01	6.23E+02	1.12E+03	1.04E+01	1.78E+03	5.43E+02	3.31E+02	2.77E+01	3.98E+02	-	2.64E+02	1.56E+03	5.39E+02	3.31E+02	5.80E+01	6.32E+02	-	-	1.56E+03
2060	-	-	2.78E+01	6.35E+02	1.14E+03	8.69E+00	1.81E+03	5.53E+02	3.38E+02	2.80E+01	4.02E+02	-	2.72E+02	1.59E+03	5.50E+02	3.38E+02	5.92E+01	6.43E+02	-	-	1.59E+03
2061	-	-	2.83E+01	6.48E+02	1.16E+03	6.81E+00	1.84E+03	5.62E+02	3.43E+02	2.82E+01	4.06E+02	-	2.80E+02	1.62E+03	5.58E+02	3.43E+02	6.04E+01	6.54E+02	-	-	1.61E+03

Exhibit C-27. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.48E+00	-4.57E-01	3.69E+01	3.13E+00	1.92E+00	2.01E+00	2.89E+01	-	2.87E-01	3.63E+01	3.11E+00	1.92E+00	2.05E+00	2.92E+01	-	-	3.63E+01
2030	-	-	2.55E+00	5.84E+01	2.27E+01	-5.58E-01	8.30E+01	1.10E+01	6.70E+00	3.90E+00	5.62E+01	-	1.95E+00	7.97E+01	1.09E+01	6.70E+00	4.13E+00	5.79E+01	-	-	7.96E+01
2031	-	-	3.77E+00	8.63E+01	5.18E+01	6.07E-01	1.43E+02	2.51E+01	1.53E+01	5.67E+00	8.16E+01	-	5.96E+00	1.34E+02	2.49E+01	1.53E+01	6.36E+00	8.69E+01	-	-	1.33E+02
2032	-	-	4.96E+00	1.14E+02	8.74E+01	3.29E+00	2.09E+02	4.23E+01	2.59E+01	7.33E+00	1.05E+02	-	1.24E+01	1.93E+02	4.20E+01	2.59E+01	8.75E+00	1.16E+02	-	-	1.93E+02
2033	-	-	6.11E+00	1.40E+02	1.26E+02	6.88E+00	2.79E+02	6.11E+01	3.74E+01	8.89E+00	1.28E+02	-	2.05E+01	2.56E+02	6.07E+01	3.74E+01	1.12E+01	1.46E+02	-	-	2.55E+02
2034	-	-	7.24E+00	1.66E+02	1.65E+02	1.05E+01	3.48E+02	7.99E+01	4.88E+01	1.04E+01	1.49E+02	-	2.93E+01	3.17E+02	7.94E+01	4.88E+01	1.37E+01	1.75E+02	-	-	3.17E+02
2035	-	-	8.33E+00	1.91E+02	2.04E+02	1.37E+01	4.17E+02	9.87E+01	6.03E+01	1.17E+01	1.69E+02	-	3.84E+01	3.78E+02	9.80E+01	6.03E+01	1.61E+01	2.03E+02	-	-	3.77E+02
2036	-	-	9.39E+00	2.15E+02	2.43E+02	1.63E+01	4.83E+02	1.17E+02	7.18E+01	1.30E+01	1.87E+02	-	4.77E+01	4.37E+02	1.17E+02	7.18E+01	1.85E+01	2.29E+02	-	-	4.36E+02
2037	-	-	1.04E+01	2.38E+02	2.82E+02	1.86E+01	5.49E+02	1.36E+02	8.33E+01	1.42E+01	2.04E+02	-	5.72E+01	4.95E+02	1.35E+02	8.33E+01	2.08E+01	2.55E+02	-	-	4.94E+02
2038	-	-	1.14E+01	2.61E+02	3.21E+02	2.06E+01	6.14E+02	1.55E+02	9.48E+01	1.53E+01	2.20E+02	-	6.68E+01	5.52E+02	1.54E+02	9.48E+01	2.30E+01	2.80E+02	-	-	5.51E+02
2039	-	-	1.24E+01	2.84E+02	3.59E+02	2.21E+01	6.78E+02	1.74E+02	1.06E+02	1.64E+01	2.36E+02	-	7.65E+01	6.09E+02	1.73E+02	1.06E+02	2.52E+01	3.03E+02	-	-	6.07E+02
2040	-	-	1.33E+01	3.05E+02	3.98E+02	2.33E+01	7.40E+02	1.93E+02	1.18E+02	1.74E+01	2.50E+02	-	8.63E+01	6.64E+02	1.91E+02	1.18E+02	2.73E+01	3.26E+02	-	-	6.62E+02
2041	-	-	1.43E+01	3.26E+02	4.37E+02	2.41E+01	8.02E+02	2.11E+02	1.29E+02	1.83E+01	2.63E+02	-	9.60E+01	7.18E+02	2.10E+02	1.29E+02	2.93E+01	3.48E+02	-	-	7.16E+02
2042	-	-	1.52E+01	3.47E+02	4.76E+02	2.46E+01	8.63E+02	2.30E+02	1.41E+02	1.91E+01	2.75E+02	-	1.06E+02	7.71E+02	2.29E+02	1.41E+02	3.13E+01	3.69E+02	-	-	7.70E+02
2043	-	-	1.60E+01	3.67E+02	5.15E+02	2.48E+01	9.23E+02	2.49E+02	1.52E+02	1.99E+01	2.87E+02	-	1.15E+02	8.23E+02	2.47E+02	1.52E+02	3.32E+01	3.89E+02	-	-	8.22E+02
2044	-	-	1.69E+01	3.86E+02	5.54E+02	2.47E+01	9.82E+02	2.68E+02	1.64E+02	2.07E+01	2.98E+02	-	1.25E+02	8.75E+02	2.66E+02	1.64E+02	3.50E+01	4.08E+02	-	-	8.73E+02
2045	-	-	1.77E+01	4.05E+02	5.93E+02	2.45E+01	1.04E+03	2.87E+02	1.75E+02	2.14E+01	3.08E+02	-	1.35E+02	9.26E+02	2.85E+02	1.75E+02	3.69E+01	4.27E+02	-	-	9.24E+02
2046	-	-	1.85E+01	4.24E+02	6.31E+02	2.42E+01	1.10E+03	3.05E+02	1.87E+02	2.21E+01	3.17E+02	-	1.44E+02	9.76E+02	3.03E+02	1.87E+02	3.86E+01	4.45E+02	-	-	9.74E+02
2047	-	-	1.93E+01	4.42E+02	6.70E+02	2.38E+01	1.15E+03	3.24E+02	1.98E+02	2.27E+01	3.26E+02	-	1.54E+02	1.03E+03	3.22E+02	1.98E+02	4.04E+01	4.63E+02	-	-	1.02E+03
2048	-	-	2.01E+01	4.59E+02	7.09E+02	2.32E+01	1.21E+03	3.43E+02	2.10E+02	2.33E+01	3.35E+02	-	1.64E+02	1.07E+03	3.41E+02	2.10E+02	4.21E+01	4.80E+02	-	-	1.07E+03
2049	-	-	2.08E+01	4.76E+02	7.48E+02	2.25E+01	1.27E+03	3.62E+02	2.21E+02	2.38E+01	3.43E+02	-	1.73E+02	1.12E+03	3.59E+02	2.21E+02	4.37E+01	4.96E+02	-	-	1.12E+03
2050	-	-	2.15E+01	4.92E+02	7.87E+02	2.17E+01	1.32E+03	3.81E+02	2.33E+02	2.43E+01	3.50E+02	-	1.83E+02	1.17E+03	3.78E+02	2.33E+02	4.53E+01	5.12E+02	-	-	1.17E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	8.26E+02	2.09E+01	1.38E+03	3.99E+02	2.44E+02	2.48E+01	3.57E+02	-	1.92E+02	1.22E+03	3.97E+02	2.44E+02	4.69E+01	5.27E+02	-	-	1.21E+03
2052	-	-	2.29E+01	5.24E+02	8.65E+02	1.99E+01	1.43E+03	4.18E+02	2.56E+02	2.53E+01	3.63E+02	-	2.02E+02	1.26E+03	4.15E+02	2.56E+02	4.84E+01	5.42E+02	-	-	1.26E+03
2053	-	-	2.36E+01	5.39E+02	9.03E+02	1.87E+01	1.49E+03	4.37E+02	2.67E+02	2.57E+01	3.69E+02	-	2.11E+02	1.31E+03	4.34E+02	2.67E+02	4.99E+01	5.56E+02	-	-	1.31E+03
2054	-	-	2.42E+01	5.54E+02	9.42E+02	1.75E+01	1.54E+03	4.56E+02	2.79E+02	2.61E+01	3.75E+02	-	2.20E+02	1.36E+03	4.53E+02	2.79E+02	5.13E+01	5.70E+02	-	-	1.35E+03
2055	-	-	2.48E+01	5.69E+02	9.81E+02	1.61E+01	1.59E+03	4.75E+02	2.90E+02	2.64E+01	3.80E+02	-	2.29E+02	1.40E+03	4.71E+02	2.90E+02	5.27E+01	5.83E+02	-	-	1.40E+03
2056	-	-	2.55E+01	5.83E+02	1.02E+03	1.49E+01	1.64E+03	4.93E+02	3.02E+02	2.68E+01	3.85E+02	-	2.38E+02	1.45E+03	4.90E+02	3.02E+02	5.41E+01	5.96E+02	-	-	1.44E+03
2057	-	-	2.61E+01	5.96E+02	1.06E+03	1.36E+01	1.69E+03	5.12E+02	3.13E+02	2.71E+01	3.90E+02	-	2.47E+02	1.49E+03	5.09E+02	3.13E+02	5.54E+01	6.08E+02	-	-	1.49E+03
2058	-	-	2.66E+01	6.10E+02	1.09E+03	1.20E+01	1.74E+03	5.29E+02	3.23E+02	2.74E+01	3.94E+02	-	2.55E+02	1.53E+03	5.26E+02	3.23E+02	5.67E+01	6.20E+02	-	-	1.53E+03
2059	-	-	2.72E+01	6.23E+02	1.12E+03	1.04E+01	1.78E+03	5.43E+02	3.32E+02	2.77E+01	3.98E+02	-	2.64E+02	1.56E+03	5.39E+02	3.32E+02	5.80E+01	6.32E+02	-	-	1.56E+03
2060	-	-	2.78E+01	6.35E+02	1.14E+03	8.69E+00	1.82E+03	5.53E+02	3.38E+02	2.80E+01	4.02E+02	-	2.72E+02	1.59E+03	5.50E+02	3.38E+02	5.92E+01	6.43E+02	-	-	1.59E+03
2061	-	-	2.83E+01	6.48E+02	1.16E+03	6.81E+00	1.84E+03	5.62E+02	3.44E+02	2.82E+01	4.06E+02	-	2.80E+02	1.62E+03	5.58E+02	3.44E+02	6.04E+01	6.54E+02	-	-	1.62E+03

Exhibit C-28. Cumulative Emissions Profile AR5 100-yr – NGCC with CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.44E+00	-4.57E-01	3.69E+01	3.13E+00	2.38E+00	2.01E+00	2.89E+01	-	2.87E-01	3.68E+01	3.11E+00	2.38E+00	2.05E+00	2.92E+01	-	-	3.67E+01
2030	-	-	2.55E+00	5.84E+01	2.25E+01	-5.58E-01	8.29E+01	1.10E+01	8.31E+00	3.90E+00	5.62E+01	-	1.95E+00	8.13E+01	1.09E+01	8.31E+00	4.13E+00	5.79E+01	-	-	8.12E+01
2031	-	-	3.77E+00	8.63E+01	5.15E+01	6.07E-01	1.42E+02	2.51E+01	1.90E+01	5.67E+00	8.16E+01	-	5.96E+00	1.37E+02	2.49E+01	1.90E+01	6.36E+00	8.69E+01	-	-	1.37E+02
2032	-	-	4.96E+00	1.14E+02	8.69E+01	3.29E+00	2.09E+02	4.23E+01	3.21E+01	7.33E+00	1.05E+02	-	1.24E+01	2.00E+02	4.20E+01	3.21E+01	8.75E+00	1.16E+02	-	-	1.99E+02
2033	-	-	6.11E+00	1.40E+02	1.26E+02	6.88E+00	2.78E+02	6.11E+01	4.63E+01	8.89E+00	1.28E+02	-	2.05E+01	2.65E+02	6.07E+01	4.63E+01	1.12E+01	1.46E+02	-	-	2.64E+02
2034	-	-	7.24E+00	1.66E+02	1.64E+02	1.05E+01	3.47E+02	7.99E+01	6.06E+01	1.04E+01	1.49E+02	-	2.93E+01	3.29E+02	7.94E+01	6.06E+01	1.37E+01	1.75E+02	-	-	3.29E+02
2035	-	-	8.33E+00	1.91E+02	2.03E+02	1.37E+01	4.15E+02	9.87E+01	7.48E+01	1.17E+01	1.69E+02	-	3.84E+01	3.92E+02	9.80E+01	7.48E+01	1.61E+01	2.03E+02	-	-	3.92E+02
2036	-	-	9.39E+00	2.15E+02	2.41E+02	1.63E+01	4.82E+02	1.17E+02	8.91E+01	1.30E+01	1.87E+02	-	4.77E+01	4.54E+02	1.17E+02	8.91E+01	1.85E+01	2.29E+02	-	-	4.54E+02
2037	-	-	1.04E+01	2.38E+02	2.80E+02	1.86E+01	5.47E+02	1.36E+02	1.03E+02	1.42E+01	2.04E+02	-	5.72E+01	5.15E+02	1.35E+02	1.03E+02	2.08E+01	2.55E+02	-	-	5.14E+02
2038	-	-	1.14E+01	2.61E+02	3.19E+02	2.06E+01	6.12E+02	1.55E+02	1.18E+02	1.53E+01	2.20E+02	-	6.68E+01	5.75E+02	1.54E+02	1.18E+02	2.30E+01	2.80E+02	-	-	5.74E+02
2039	-	-	1.24E+01	2.84E+02	3.57E+02	2.21E+01	6.75E+02	1.74E+02	1.32E+02	1.64E+01	2.36E+02	-	7.65E+01	6.34E+02	1.73E+02	1.32E+02	2.52E+01	3.03E+02	-	-	6.33E+02
2040	-	-	1.33E+01	3.05E+02	3.96E+02	2.33E+01	7.38E+02	1.93E+02	1.46E+02	1.74E+01	2.50E+02	-	8.63E+01	6.92E+02	1.91E+02	1.46E+02	2.73E+01	3.26E+02	-	-	6.91E+02
2041	-	-	1.43E+01	3.26E+02	4.34E+02	2.41E+01	7.99E+02	2.11E+02	1.60E+02	1.83E+01	2.63E+02	-	9.60E+01	7.49E+02	2.10E+02	1.60E+02	2.93E+01	3.48E+02	-	-	7.47E+02
2042	-	-	1.52E+01	3.47E+02	4.73E+02	2.46E+01	8.60E+02	2.30E+02	1.75E+02	1.91E+01	2.75E+02	-	1.06E+02	8.05E+02	2.29E+02	1.75E+02	3.13E+01	3.69E+02	-	-	8.03E+02
2043	-	-	1.60E+01	3.67E+02	5.12E+02	2.48E+01	9.20E+02	2.49E+02	1.89E+02	1.99E+01	2.87E+02	-	1.15E+02	8.60E+02	2.47E+02	1.89E+02	3.32E+01	3.89E+02	-	-	8.58E+02
2044	-	-	1.69E+01	3.86E+02	5.50E+02	2.47E+01	9.78E+02	2.68E+02	2.03E+02	2.07E+01	2.98E+02	-	1.25E+02	9.14E+02	2.66E+02	2.03E+02	3.50E+01	4.08E+02	-	-	9.12E+02
2045	-	-	1.77E+01	4.05E+02	5.89E+02	2.45E+01	1.04E+03	2.87E+02	2.17E+02	2.14E+01	3.08E+02	-	1.35E+02	9.68E+02	2.85E+02	2.17E+02	3.69E+01	4.27E+02	-	-	9.66E+02
2046	-	-	1.85E+01	4.24E+02	6.28E+02	2.42E+01	1.09E+03	3.05E+02	2.32E+02	2.21E+01	3.17E+02	-	1.44E+02	1.02E+03	3.03E+02	2.32E+02	3.86E+01	4.45E+02	-	-	1.02E+03
2047	-	-	1.93E+01	4.42E+02	6.66E+02	2.38E+01	1.15E+03	3.24E+02	2.46E+02	2.27E+01	3.26E+02	-	1.54E+02	1.07E+03	3.22E+02	2.46E+02	4.04E+01	4.63E+02	-	-	1.07E+03
2048	-	-	2.01E+01	4.59E+02	7.05E+02	2.32E+01	1.21E+03	3.43E+02	2.60E+02	2.33E+01	3.35E+02	-	1.64E+02	1.12E+03	3.41E+02	2.60E+02	4.21E+01	4.80E+02	-	-	1.12E+03
2049	-	-	2.08E+01	4.76E+02	7.43E+02	2.25E+01	1.26E+03	3.62E+02	2.74E+02	2.38E+01	3.43E+02	-	1.73E+02	1.18E+03	3.59E+02	2.74E+02	4.37E+01	4.96E+02	-	-	1.17E+03
2050	-	-	2.15E+01	4.92E+02	7.82E+02	2.17E+01	1.32E+03	3.81E+02	2.89E+02	2.43E+01	3.50E+02	-	1.83E+02	1.23E+03	3.78E+02	2.89E+02	4.53E+01	5.12E+02	-	-	1.22E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.22E+01	5.09E+02	8.21E+02	2.09E+01	1.37E+03	3.99E+02	3.03E+02	2.48E+01	3.57E+02	-	1.92E+02	1.28E+03	3.97E+02	3.03E+02	4.69E+01	5.27E+02	-	-	1.27E+03
2052	-	-	2.29E+01	5.24E+02	8.59E+02	1.99E+01	1.43E+03	4.18E+02	3.17E+02	2.52E+01	3.63E+02	-	2.02E+02	1.33E+03	4.15E+02	3.17E+02	4.84E+01	5.42E+02	-	-	1.32E+03
2053	-	-	2.36E+01	5.39E+02	8.98E+02	1.87E+01	1.48E+03	4.37E+02	3.31E+02	2.57E+01	3.69E+02	-	2.11E+02	1.37E+03	4.34E+02	3.31E+02	4.99E+01	5.56E+02	-	-	1.37E+03
2054	-	-	2.42E+01	5.54E+02	9.37E+02	1.75E+01	1.53E+03	4.56E+02	3.46E+02	2.61E+01	3.75E+02	-	2.20E+02	1.42E+03	4.53E+02	3.46E+02	5.13E+01	5.70E+02	-	-	1.42E+03
2055	-	-	2.48E+01	5.69E+02	9.75E+02	1.61E+01	1.58E+03	4.75E+02	3.60E+02	2.64E+01	3.80E+02	-	2.29E+02	1.47E+03	4.71E+02	3.60E+02	5.27E+01	5.83E+02	-	-	1.47E+03
2056	-	-	2.55E+01	5.83E+02	1.01E+03	1.49E+01	1.64E+03	4.93E+02	3.74E+02	2.68E+01	3.85E+02	-	2.38E+02	1.52E+03	4.90E+02	3.74E+02	5.41E+01	5.96E+02	-	-	1.51E+03
2057	-	-	2.61E+01	5.96E+02	1.05E+03	1.36E+01	1.69E+03	5.12E+02	3.88E+02	2.71E+01	3.90E+02	-	2.47E+02	1.56E+03	5.09E+02	3.88E+02	5.54E+01	6.08E+02	-	-	1.56E+03
2058	-	-	2.66E+01	6.10E+02	1.09E+03	1.20E+01	1.74E+03	5.29E+02	4.01E+02	2.74E+01	3.94E+02	-	2.55E+02	1.61E+03	5.26E+02	4.01E+02	5.67E+01	6.20E+02	-	-	1.60E+03
2059	-	-	2.72E+01	6.23E+02	1.11E+03	1.04E+01	1.78E+03	5.43E+02	4.11E+02	2.77E+01	3.98E+02	-	2.64E+02	1.64E+03	5.39E+02	4.11E+02	5.80E+01	6.32E+02	-	-	1.64E+03
2060	-	-	2.78E+01	6.35E+02	1.14E+03	8.69E+00	1.81E+03	5.53E+02	4.19E+02	2.80E+01	4.02E+02	-	2.72E+02	1.68E+03	5.50E+02	4.19E+02	5.92E+01	6.43E+02	-	-	1.67E+03
2061	-	-	2.83E+01	6.48E+02	1.15E+03	6.81E+00	1.84E+03	5.62E+02	4.26E+02	2.82E+01	4.06E+02	-	2.80E+02	1.70E+03	5.58E+02	4.26E+02	6.04E+01	6.54E+02	-	-	1.70E+03

Exhibit C-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.15E+02	6.19E+02	6.19E+02	6.36E+02
Lower GOR	6.16E+02	6.19E+02	6.20E+02	6.37E+02
Higher GOR	6.15E+02	6.18E+02	6.18E+02	6.36E+02

Exhibit C-30. CH_4 Sensitivity Analysis - Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.15E+02	6.19E+02	6.19E+02	6.36E+02
Decrease in Methane Emissions	6.13E+02	6.17E+02	6.17E+02	6.34E+02
Increase in Methane Emissions	6.18E+02	6.21E+02	6.21E+02	6.38E+02

Appendix D: AR5 20-yr Results

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR5 – 20-yr)
- Multiproduct Functional Unit – South Korea (AR5 – 20-yr)
- Multiproduct Functional Unit – China (AR5 – 20-yr)
- Multiproduct Functional Unit – India (AR5 – 20-yr)
- Single Product Functional Unit in kg CO2e – Japan (AR5 – 20-yr)
- Single Product Functional Unit in kg CO2e – South Korea (AR5 – 20-yr)
- Single Product Functional Unit in kg CO2e – China (AR5 – 20-yr)
- Single Product Functional Unit in kg CO2e – India (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR5 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR5 – 20-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR5 – 20-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR5 – 20-yr)

Exhibit D-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.49E+01	6.49E+01	-	7.30E+01	7.30E+01
Natural Gas Pipelines to GTP	-	8.93E+00	8.93E+00	-	1.00E+01	1.00E+01
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	7.88E-01	-	-	8.87E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.71E+01	1.71E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.27E+01	4.27E+01	-	4.80E+01	4.80E+01
Ocean Transport	-	2.17E+01	2.17E+01	-	2.45E+01	2.45E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	2.61E+00	4.73E+00	4.73E+00	2.94E+00	5.32E+00	5.32E+00
Crude Oil Extraction, CO2-EOR	-	-	6.79E+00	-	-	7.65E+00
CO2-EOR Crude Oil Transport	-	-	8.56E-01	-	-	9.64E-01
Crude Oil Alaskan Pipeline Transport	1.72E+00	8.89E-01	8.89E-01	1.93E+00	1.00E+00	1.00E+00
Crude Oil Ocean Transport	8.94E-01	4.93E-01	9.69E-01	1.01E+00	5.55E-01	1.09E+00
Crude Oil Refining and End Use	1.14E+02	5.91E+01	1.16E+02	1.29E+02	6.65E+01	1.31E+02
Construction	-	4.99E-01	4.99E-01	-	5.61E-01	5.61E-01
System Expansion: US Average Crude Oil Production and End Use	2.10E+01	8.55E+01	1.89E+01	4.16E+00	7.68E+01	1.87E+00
System Expansion: US Lower 48 LNG Export and End Use	6.12E+02	-	-	3.42E+02	-	-
Total	7.52E+02	6.77E+02	6.75E+02	4.80E+02	4.02E+02	3.99E+02
Upper	3.87E+01	6.87E+01	6.15E+01	4.23E+01	7.07E+01	7.53E+01
Lower	2.27E+01	1.91E+01	1.91E+01	2.56E+01	2.20E+01	2.21E+01

Exhibit D-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.50E+01	6.50E+01	-	7.32E+01	7.32E+01
Natural Gas Pipelines to GTP	-	8.94E+00	8.94E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	7.90E-01	-	-	8.89E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.54E+01	2.54E+01	-	2.86E+01	2.86E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	2.62E+00	4.74E+00	4.74E+00	2.95E+00	5.33E+00	5.33E+00
Crude Oil Extraction, CO2-EOR	-	-	6.81E+00	-	-	7.66E+00
CO2-EOR Crude Oil Transport	-	-	8.58E-01	-	-	9.66E-01
Crude Oil Alaskan Pipeline Transport	1.72E+00	8.90E-01	8.90E-01	1.94E+00	1.00E+00	1.00E+00
Crude Oil Ocean Transport	8.96E-01	4.94E-01	9.70E-01	1.01E+00	5.56E-01	1.09E+00
Crude Oil Refining and End Use	1.14E+02	5.92E+01	1.16E+02	1.29E+02	6.66E+01	1.31E+02
Construction	-	5.00E-01	5.00E-01	-	5.62E-01	5.62E-01
System Expansion: US Average Crude Oil Production and End Use	2.07E+01	8.54E+01	1.86E+01	3.87E+00	7.67E+01	1.57E+00
System Expansion: US Lower 48 LNG Export and End Use	6.16E+02	-	-	3.47E+02	-	-
Total	7.57E+02	6.81E+02	6.79E+02	4.86E+02	4.06E+02	4.04E+02
Upper	3.86E+01	6.07E+01	6.07E+01	4.45E+01	7.98E+01	6.78E+01
Lower	2.46E+01	2.05E+01	1.89E+01	2.56E+01	2.19E+01	2.12E+01

Exhibit D-3. Multiproduct Functional Unit in kg CO_2e – China (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.50E+01	6.50E+01	-	7.32E+01	7.32E+01
Natural Gas Pipelines to GTP	-	8.95E+00	8.95E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	7.90E-01	-	-	8.89E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.56E+01	2.56E+01	-	2.88E+01	2.88E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	2.62E+00	4.74E+00	4.74E+00	2.95E+00	5.33E+00	5.33E+00
Crude Oil Extraction, CO2-EOR	-	-	6.81E+00	-	-	7.66E+00
CO2-EOR Crude Oil Transport	-	-	8.58E-01	-	-	9.66E-01
Crude Oil Alaskan Pipeline Transport	1.72E+00	8.90E-01	8.90E-01	1.94E+00	1.00E+00	1.00E+00
Crude Oil Ocean Transport	8.96E-01	4.94E-01	9.70E-01	1.01E+00	5.56E-01	1.09E+00
Crude Oil Refining and End Use	1.14E+02	5.92E+01	1.16E+02	1.29E+02	6.66E+01	1.31E+02
Construction	-	5.00E-01	5.00E-01	-	5.62E-01	5.62E-01
System Expansion: US Average Crude Oil Production and End Use	2.07E+01	8.53E+01	1.86E+01	3.90E+00	7.67E+01	1.56E+00
System Expansion: US Lower 48 LNG Export and End Use	6.17E+02	-	-	3.47E+02	-	-
Total	7.57E+02	6.81E+02	6.79E+02	4.86E+02	4.07E+02	4.04E+02
Upper	3.88E+01	6.05E+01	6.71E+01	4.36E+01	7.14E+01	6.86E+01
Lower	2.31E+01	1.96E+01	1.96E+01	2.58E+01	2.16E+01	2.20E+01

Exhibit D-4. Multiproduct Functional Unit in kg CO_2e – India (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.57E+01	6.57E+01	-	7.39E+01	7.39E+01
Natural Gas Pipelines to GTP	-	9.04E+00	9.04E+00	-	1.02E+01	1.02E+01
Natural Gas Processing at GTP	-	2.34E+01	2.34E+01	-	2.64E+01	2.64E+01
CO2 Compression and Sequestration	-	7.98E-01	-	-	8.98E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.73E+01	1.73E+01	-	1.95E+01	1.95E+01
Liquefaction	-	4.32E+01	4.32E+01	-	4.86E+01	4.86E+01
Ocean Transport	-	4.48E+01	4.48E+01	-	5.04E+01	5.04E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	2.65E+00	4.78E+00	4.78E+00	2.98E+00	5.39E+00	5.39E+00
Crude Oil Extraction, CO2-EOR	-	-	6.88E+00	-	-	7.74E+00
CO2-EOR Crude Oil Transport	-	-	8.67E-01	-	-	9.75E-01
Crude Oil Alaskan Pipeline Transport	1.74E+00	9.00E-01	9.00E-01	1.96E+00	1.01E+00	1.01E+00
Crude Oil Ocean Transport	9.05E-01	4.99E-01	9.80E-01	1.02E+00	5.62E-01	1.10E+00
Crude Oil Refining and End Use	1.16E+02	5.98E+01	1.17E+02	1.30E+02	6.73E+01	1.32E+02
Construction	-	5.05E-01	5.05E-01	-	5.68E-01	5.68E-01
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	8.46E+01	1.72E+01	2.32E+00	7.59E+01	-
System Expansion: US Lower 48 LNG Export and End Use	6.15E+02	-	-	3.45E+02	-	-
Total	7.55E+02	7.02E+02	7.00E+02	4.84E+02	4.30E+02	4.27E+02
Upper	3.70E+01	7.53E+01	5.70E+01	4.31E+01	7.69E+01	7.01E+01
Lower	2.29E+01	1.95E+01	1.94E+01	2.53E+01	2.24E+01	2.15E+01

Exhibit D-5. Single Product Functional Unit in kg CO_2e – Japan (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.49E+01	6.49E+01	-	7.30E+01	7.30E+01
Natural Gas Pipelines to GTP	-	8.93E+00	8.93E+00	-	1.00E+01	1.00E+01
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	6.78E-01	-	-	7.63E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.71E+01	1.71E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.27E+01	4.27E+01	-	4.80E+01	4.80E+01
Ocean Transport	-	2.17E+01	2.17E+01	-	2.45E+01	2.45E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.99E-01	4.99E-01	-	5.61E-01	5.61E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.12E+02	-	-	3.42E+02	-	-
Total	6.12E+02	5.27E+02	5.26E+02	3.42E+02	2.52E+02	2.51E+02
Upper	3.24E+01	5.34E+01	4.79E+01	3.63E+01	4.43E+01	4.73E+01
Lower	2.11E+01	1.49E+01	1.49E+01	2.37E+01	1.38E+01	1.39E+01

Exhibit D-6. Single Product Functional Unit in kg CO_2e – South Korea (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.50E+01	6.50E+01	-	7.32E+01	7.32E+01
Natural Gas Pipelines to GTP	-	8.94E+00	8.94E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	6.79E-01	-	-	7.64E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.54E+01	2.54E+01	-	2.86E+01	2.86E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.00E-01	5.00E-01	-	5.62E-01	5.62E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.16E+02	-	-	3.47E+02	-	-
Total	6.16E+02	5.31E+02	5.30E+02	3.47E+02	2.56E+02	2.55E+02
Upper	3.29E+01	4.72E+01	4.74E+01	3.73E+01	5.03E+01	4.29E+01
Lower	2.29E+01	1.60E+01	1.47E+01	2.37E+01	1.38E+01	1.34E+01

Exhibit D-7. Single Product Functional Unit in kg CO_2e – China (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.50E+01	6.50E+01	-	7.32E+01	7.32E+01
Natural Gas Pipelines to GTP	-	8.95E+00	8.95E+00	-	1.01E+01	1.01E+01
Natural Gas Processing at GTP	-	2.32E+01	2.32E+01	-	2.61E+01	2.61E+01
CO2 Compression and Sequestration	-	6.79E-01	-	-	7.65E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.72E+01	1.72E+01	-	1.93E+01	1.93E+01
Liquefaction	-	4.28E+01	4.28E+01	-	4.81E+01	4.81E+01
Ocean Transport	-	2.56E+01	2.56E+01	-	2.88E+01	2.88E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.00E-01	5.00E-01	-	5.62E-01	5.62E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.17E+02	-	-	3.47E+02	-	-
Total	6.17E+02	5.31E+02	5.30E+02	3.47E+02	2.56E+02	2.55E+02
Upper	3.29E+01	4.71E+01	5.23E+01	3.71E+01	4.50E+01	4.34E+01
Lower	2.14E+01	1.53E+01	1.53E+01	2.39E+01	1.36E+01	1.39E+01

Exhibit D-8. Single Product Functional Unit in kg CO_2e – India (AR5 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.57E+01	6.57E+01	-	7.39E+01	7.39E+01
Natural Gas Pipelines to GTP	-	9.04E+00	9.04E+00	-	1.02E+01	1.02E+01
Natural Gas Processing at GTP	-	2.34E+01	2.34E+01	-	2.64E+01	2.64E+01
CO2 Compression and Sequestration	-	6.86E-01	-	-	7.72E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.73E+01	1.73E+01	-	1.95E+01	1.95E+01
Liquefaction	-	4.32E+01	4.32E+01	-	4.86E+01	4.86E+01
Ocean Transport	-	4.48E+01	4.48E+01	-	5.04E+01	5.04E+01
LNG Regasification	-	4.41E+00	4.41E+00	-	4.96E+00	4.96E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.44E+01	4.44E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.05E-01	5.05E-01	-	5.68E-01	5.68E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.15E+02	-	-	3.45E+02	-	-
Total	6.15E+02	5.52E+02	5.51E+02	3.45E+02	2.80E+02	2.79E+02
Upper	3.13E+01	5.91E+01	4.48E+01	3.69E+01	5.00E+01	4.58E+01
Lower	2.12E+01	1.53E+01	1.53E+01	2.34E+01	1.46E+01	1.41E+01

Exhibit D-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.57E-01	-	-	2.61E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	2.00E-01	7.28E-03	4.28E-09	1.72E+00
Crude Oil Ocean Transport	8.24E-01	6.96E-02	-	6.36E-07	8.94E-01
Crude Oil Refining and End Use	1.14E+02	5.61E-01	5.11E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.96E+01	1.33E+00	1.15E-02	-	2.10E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	1.48E+02	3.03E-01	1.41E-07	6.12E+02
Construction	-	-	-	-	-
Total	6.02E+02	1.50E+02	3.27E-01	7.81E-07	7.52E+02

Exhibit D-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.57E-01	-	-	2.62E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	2.00E-01	7.29E-03	4.29E-09	1.72E+00
Crude Oil Ocean Transport	8.26E-01	6.97E-02	-	6.38E-07	8.96E-01
Crude Oil Refining and End Use	1.14E+02	5.62E-01	5.12E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	1.31E+00	1.13E-02	-	2.07E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.49E+02	3.12E-01	1.41E-07	6.16E+02
Construction	-	-	-	-	-
Total	6.05E+02	1.51E+02	3.36E-01	7.83E-07	7.57E+02

Exhibit D-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.57E-01	-	-	2.62E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	2.00E-01	7.29E-03	4.29E-09	1.72E+00
Crude Oil Ocean Transport	8.26E-01	6.97E-02	-	6.37E-07	8.96E-01
Crude Oil Refining and End Use	1.14E+02	5.62E-01	5.12E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.94E+01	1.32E+00	1.13E-02	-	2.07E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.49E+02	3.13E-01	1.41E-07	6.17E+02
Construction	-	-	-	-	-
Total	6.05E+02	1.51E+02	3.37E-01	7.83E-07	7.57E+02

Exhibit D-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.49E+00	1.58E-01	-	-	2.65E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.53E+00	2.02E-01	7.36E-03	4.34E-09	1.74E+00
Crude Oil Ocean Transport	8.34E-01	7.04E-02	-	6.44E-07	9.05E-01
Crude Oil Refining and End Use	1.15E+02	5.67E-01	5.17E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.81E+01	1.23E+00	1.06E-02	-	1.93E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	1.49E+02	3.09E-01	1.41E-07	6.15E+02
Construction	-	-	-	-	-
Total	6.04E+02	1.51E+02	3.32E-01	7.89E-07	7.55E+02

Exhibit D-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.63E+01	-	-	6.49E+01
Natural Gas Pipelines to GTP	2.14E-03	8.92E+00	-	-	8.93E+00
Natural Gas Processing at GTP	2.18E+01	1.36E+00	2.44E-05	-	2.32E+01
CO2 Compression and Sequestration	6.56E-01	1.29E-01	1.40E-03	1.59E-03	7.88E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.20E+01	5.08E-07	-	1.71E+01
Liquefaction	2.25E+01	2.02E+01	-	1.02E-07	4.27E+01
Ocean Transport	1.68E+01	4.95E+00	-	-	2.17E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	3.28E+00	-	-	4.73E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.82E-01	1.03E-01	3.76E-03	2.21E-09	8.89E-01
Crude Oil Ocean Transport	4.42E-01	5.10E-02	-	4.71E-07	4.93E-01
Crude Oil Refining and End Use	5.88E+01	2.90E-01	2.64E-03	-	5.91E+01
System Expansion: US Average Crude Oil Production and End Use	8.00E+01	5.44E+00	4.69E-02	-	8.55E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	2.55E-02	2.36E-03	-	4.99E-01
Total	5.73E+02	1.04E+02	5.71E-02	1.66E-03	6.77E+02

Exhibit D-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.64E+01	-	-	6.50E+01
Natural Gas Pipelines to GTP	2.15E-03	8.94E+00	-	-	8.94E+00
Natural Gas Processing at GTP	2.18E+01	1.36E+00	2.44E-05	-	2.32E+01
CO2 Compression and Sequestration	6.58E-01	1.29E-01	1.40E-03	1.59E-03	7.90E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.20E+01	5.09E-07	-	1.72E+01
Liquefaction	2.25E+01	2.03E+01	-	1.02E-07	4.28E+01
Ocean Transport	1.95E+01	5.90E+00	-	-	2.54E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.29E+00	-	-	4.74E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	1.03E-01	3.77E-03	2.22E-09	8.90E-01
Crude Oil Ocean Transport	4.43E-01	5.11E-02	-	4.72E-07	4.94E-01
Crude Oil Refining and End Use	5.89E+01	2.90E-01	2.65E-03	-	5.92E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	5.43E+00	4.68E-02	-	8.54E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.56E-02	2.37E-03	-	5.00E-01
Total	5.76E+02	1.06E+02	5.70E-02	1.66E-03	6.81E+02

Exhibit D-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.64E+01	-	-	6.50E+01
Natural Gas Pipelines to GTP	2.15E-03	8.94E+00	-	-	8.95E+00
Natural Gas Processing at GTP	2.18E+01	1.36E+00	2.44E-05	-	2.32E+01
CO2 Compression and Sequestration	6.58E-01	1.29E-01	1.40E-03	1.59E-03	7.90E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.20E+01	5.09E-07	-	1.72E+01
Liquefaction	2.25E+01	2.03E+01	-	1.02E-07	4.28E+01
Ocean Transport	1.96E+01	5.94E+00	-	-	2.56E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.29E+00	-	-	4.74E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	1.03E-01	3.77E-03	2.22E-09	8.90E-01
Crude Oil Ocean Transport	4.43E-01	5.11E-02	-	4.72E-07	4.94E-01
Crude Oil Refining and End Use	5.89E+01	2.90E-01	2.65E-03	-	5.92E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	5.43E+00	4.68E-02	-	8.53E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.56E-02	2.37E-03	-	5.00E-01
Total	5.76E+02	1.06E+02	5.70E-02	1.66E-03	6.81E+02

Exhibit D-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	4.69E+01	-	-	6.57E+01
Natural Gas Pipelines to GTP	2.17E-03	9.03E+00	-	-	9.04E+00
Natural Gas Processing at GTP	2.21E+01	1.37E+00	2.47E-05	-	2.34E+01
CO2 Compression and Sequestration	6.64E-01	1.31E-01	1.41E-03	1.61E-03	7.98E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.21E+01	5.14E-07	-	1.73E+01
Liquefaction	2.27E+01	2.05E+01	-	1.03E-07	4.32E+01
Ocean Transport	3.39E+01	1.09E+01	-	-	4.48E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	3.32E+00	-	-	4.78E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.91E-01	1.05E-01	3.81E-03	2.24E-09	9.00E-01
Crude Oil Ocean Transport	4.48E-01	5.16E-02	-	4.76E-07	4.99E-01
Crude Oil Refining and End Use	5.95E+01	2.93E-01	2.67E-03	-	5.98E+01
System Expansion: US Average Crude Oil Production and End Use	7.92E+01	5.38E+00	4.64E-02	-	8.46E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	2.59E-02	2.39E-03	-	5.05E-01
Total	5.91E+02	1.11E+02	5.67E-02	1.68E-03	7.02E+02

Exhibit D-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.63E+01	-	-	6.49E+01
Natural Gas Pipelines to GTP	2.14E-03	8.92E+00	-	-	8.93E+00
Natural Gas Processing at GTP	2.18E+01	1.36E+00	2.44E-05	-	2.32E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.20E+01	5.08E-07	-	1.71E+01
Liquefaction	2.25E+01	2.02E+01	-	1.02E-07	4.27E+01
Ocean Transport	1.68E+01	4.95E+00	-	-	2.17E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	3.28E+00	-	-	4.73E+00
Crude Oil Extraction, CO2-EOR	5.58E+00	1.17E+00	1.75E-02	2.06E-02	6.79E+00
CO2-EOR Crude Oil Transport	7.53E-01	9.95E-02	3.63E-03	2.13E-09	8.56E-01
Crude Oil Alaskan Pipeline Transport	7.82E-01	1.03E-01	3.76E-03	2.21E-09	8.89E-01
Crude Oil Ocean Transport	8.68E-01	1.00E-01	-	9.24E-07	9.69E-01
Crude Oil Refining and End Use	1.15E+02	5.69E-01	5.19E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.77E+01	1.20E+00	1.04E-02	-	1.89E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	2.55E-02	2.36E-03	-	4.99E-01
Total	5.73E+02	1.02E+02	4.28E-02	2.07E-02	6.75E+02

Exhibit D-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.64E+01	-	-	6.50E+01
Natural Gas Pipelines to GTP	2.15E-03	8.94E+00	-	-	8.94E+00
Natural Gas Processing at GTP	2.18E+01	1.36E+00	2.44E-05	-	2.32E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.20E+01	5.09E-07	-	1.72E+01
Liquefaction	2.25E+01	2.03E+01	-	1.02E-07	4.28E+01
Ocean Transport	1.95E+01	5.90E+00	-	-	2.54E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.29E+00	-	-	4.74E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	1.17E+00	1.76E-02	2.07E-02	6.81E+00
CO2-EOR Crude Oil Transport	7.55E-01	9.97E-02	3.63E-03	2.14E-09	8.58E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	1.03E-01	3.77E-03	2.22E-09	8.90E-01
Crude Oil Ocean Transport	8.70E-01	1.00E-01	-	9.26E-07	9.70E-01
Crude Oil Refining and End Use	1.16E+02	5.70E-01	5.20E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	1.18E+00	1.02E-02	-	1.86E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.56E-02	2.37E-03	-	5.00E-01
Total	5.76E+02	1.03E+02	4.28E-02	2.07E-02	6.79E+02

Exhibit D-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.64E+01	-	-	6.50E+01
Natural Gas Pipelines to GTP	2.15E-03	8.94E+00	-	-	8.95E+00
Natural Gas Processing at GTP	2.18E+01	1.36E+00	2.44E-05	-	2.32E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.20E+01	5.09E-07	-	1.72E+01
Liquefaction	2.25E+01	2.03E+01	-	1.02E-07	4.28E+01
Ocean Transport	1.96E+01	5.94E+00	-	-	2.56E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.29E+00	-	-	4.74E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	1.17E+00	1.76E-02	2.07E-02	6.81E+00
CO2-EOR Crude Oil Transport	7.55E-01	9.97E-02	3.63E-03	2.14E-09	8.58E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	1.03E-01	3.77E-03	2.22E-09	8.90E-01
Crude Oil Ocean Transport	8.70E-01	1.00E-01	-	9.26E-07	9.70E-01
Crude Oil Refining and End Use	1.16E+02	5.70E-01	5.20E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	1.18E+00	1.02E-02	-	1.86E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.56E-02	2.37E-03	-	5.00E-01
Total	5.76E+02	1.03E+02	4.27E-02	2.07E-02	6.79E+02

Exhibit D-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR5 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	4.69E+01	-	-	6.57E+01
Natural Gas Pipelines to GTP	2.17E-03	9.03E+00	-	-	9.04E+00
Natural Gas Processing at GTP	2.21E+01	1.37E+00	2.47E-05	-	2.34E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.21E+01	5.14E-07	-	1.73E+01
Liquefaction	2.27E+01	2.05E+01	-	1.03E-07	4.32E+01
Ocean Transport	3.39E+01	1.09E+01	-	-	4.48E+01
LNG Regasification	3.02E+00	1.39E+00	-	6.85E-05	4.41E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	3.32E+00	-	-	4.78E+00
Crude Oil Extraction, CO2-EOR	5.65E+00	1.19E+00	1.77E-02	2.09E-02	6.88E+00
CO2-EOR Crude Oil Transport	7.62E-01	1.01E-01	3.67E-03	2.16E-09	8.67E-01
Crude Oil Alaskan Pipeline Transport	7.91E-01	1.05E-01	3.81E-03	2.24E-09	9.00E-01
Crude Oil Ocean Transport	8.79E-01	1.01E-01	-	9.35E-07	9.80E-01
Crude Oil Refining and End Use	1.17E+02	5.76E-01	5.25E-03	-	1.17E+02
System Expansion: US Average Crude Oil Production and End Use	1.61E+01	1.10E+00	9.44E-03	-	1.72E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	2.59E-02	2.39E-03	-	5.05E-01
Total	5.91E+02	1.09E+02	4.23E-02	2.09E-02	7.00E+02

Exhibit D-21. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	1.80E+01	-4.75E-01	4.85E+01	4.68E+00	1.10E+01	3.00E+00	2.90E+01	-	2.98E-01	4.80E+01	4.66E+00	1.10E+01	3.04E+00	2.93E+01	-	-	4.79E+01
2030	-	-	2.68E+00	5.85E+01	6.28E+01	-5.79E-01	1.23E+02	1.64E+01	3.83E+01	5.82E+00	5.63E+01	-	2.03E+00	1.19E+02	1.63E+01	3.83E+01	6.07E+00	5.80E+01	-	-	1.19E+02
2031	-	-	3.96E+00	8.66E+01	1.44E+02	6.30E-01	2.35E+02	3.74E+01	8.76E+01	8.46E+00	8.18E+01	-	6.18E+00	2.22E+02	3.73E+01	8.76E+01	9.22E+00	8.71E+01	-	-	2.21E+02
2032	-	-	5.21E+00	1.14E+02	2.42E+02	3.41E+00	3.65E+02	6.32E+01	1.48E+02	1.09E+01	1.06E+02	-	1.28E+01	3.41E+02	6.29E+01	1.48E+02	1.25E+01	1.17E+02	-	-	3.40E+02
2033	-	-	6.42E+00	1.40E+02	3.50E+02	7.14E+00	5.04E+02	9.13E+01	2.14E+02	1.33E+01	1.28E+02	-	2.12E+01	4.68E+02	9.08E+01	2.14E+02	1.59E+01	1.46E+02	-	-	4.67E+02
2034	-	-	7.60E+00	1.66E+02	4.58E+02	1.09E+01	6.42E+02	1.19E+02	2.79E+02	1.54E+01	1.49E+02	-	3.04E+01	5.94E+02	1.19E+02	2.79E+02	1.92E+01	1.75E+02	-	-	5.93E+02
2035	-	-	8.74E+00	1.91E+02	5.66E+02	1.42E+01	7.80E+02	1.47E+02	3.45E+02	1.75E+01	1.69E+02	-	3.99E+01	7.19E+02	1.47E+02	3.45E+02	2.24E+01	2.03E+02	-	-	7.17E+02
2036	-	-	9.86E+00	2.15E+02	6.73E+02	1.70E+01	9.16E+02	1.76E+02	4.11E+02	1.94E+01	1.88E+02	-	4.95E+01	8.43E+02	1.75E+02	4.11E+02	2.54E+01	2.30E+02	-	-	8.41E+02
2037	-	-	1.09E+01	2.39E+02	7.81E+02	1.93E+01	1.05E+03	2.04E+02	4.76E+02	2.12E+01	2.05E+02	-	5.93E+01	9.65E+02	2.03E+02	4.76E+02	2.84E+01	2.56E+02	-	-	9.63E+02
2038	-	-	1.20E+01	2.62E+02	8.89E+02	2.13E+01	1.18E+03	2.32E+02	5.42E+02	2.29E+01	2.21E+02	-	6.93E+01	1.09E+03	2.31E+02	5.42E+02	3.13E+01	2.80E+02	-	-	1.08E+03
2039	-	-	1.30E+01	2.84E+02	9.97E+02	2.30E+01	1.32E+03	2.60E+02	6.08E+02	2.44E+01	2.36E+02	-	7.94E+01	1.21E+03	2.58E+02	6.08E+02	3.41E+01	3.04E+02	-	-	1.20E+03
2040	-	-	1.40E+01	3.06E+02	1.10E+03	2.42E+01	1.45E+03	2.88E+02	6.73E+02	2.59E+01	2.50E+02	-	8.95E+01	1.33E+03	2.86E+02	6.73E+02	3.68E+01	3.27E+02	-	-	1.32E+03
2041	-	-	1.50E+01	3.27E+02	1.21E+03	2.50E+01	1.58E+03	3.16E+02	7.39E+02	2.73E+01	2.64E+02	-	9.96E+01	1.45E+03	3.14E+02	7.39E+02	3.94E+01	3.49E+02	-	-	1.44E+03
2042	-	-	1.59E+01	3.48E+02	1.32E+03	2.55E+01	1.71E+03	3.44E+02	8.05E+02	2.85E+01	2.76E+02	-	1.10E+02	1.56E+03	3.42E+02	8.05E+02	4.19E+01	3.70E+02	-	-	1.56E+03
2043	-	-	1.68E+01	3.68E+02	1.43E+03	2.57E+01	1.84E+03	3.72E+02	8.71E+02	2.97E+01	2.88E+02	-	1.20E+02	1.68E+03	3.70E+02	8.71E+02	4.44E+01	3.90E+02	-	-	1.68E+03
2044	-	-	1.77E+01	3.88E+02	1.54E+03	2.57E+01	1.97E+03	4.00E+02	9.36E+02	3.09E+01	2.99E+02	-	1.30E+02	1.80E+03	3.98E+02	9.36E+02	4.67E+01	4.09E+02	-	-	1.79E+03
2045	-	-	1.86E+01	4.06E+02	1.64E+03	2.55E+01	2.09E+03	4.28E+02	1.00E+03	3.19E+01	3.09E+02	-	1.40E+02	1.91E+03	4.26E+02	1.00E+03	4.90E+01	4.28E+02	-	-	1.91E+03
2046	-	-	1.94E+01	4.25E+02	1.75E+03	2.51E+01	2.22E+03	4.56E+02	1.07E+03	3.29E+01	3.18E+02	-	1.50E+02	2.03E+03	4.54E+02	1.07E+03	5.12E+01	4.46E+02	-	-	2.02E+03
2047	-	-	2.03E+01	4.43E+02	1.86E+03	2.47E+01	2.35E+03	4.84E+02	1.13E+03	3.38E+01	3.27E+02	-	1.60E+02	2.14E+03	4.82E+02	1.13E+03	5.34E+01	4.64E+02	-	-	2.13E+03
2048	-	-	2.11E+01	4.60E+02	1.97E+03	2.41E+01	2.47E+03	5.13E+02	1.20E+03	3.47E+01	3.36E+02	-	1.70E+02	2.25E+03	5.10E+02	1.20E+03	5.54E+01	4.81E+02	-	-	2.25E+03
2049	-	-	2.18E+01	4.77E+02	2.07E+03	2.33E+01	2.60E+03	5.41E+02	1.26E+03	3.55E+01	3.43E+02	-	1.80E+02	2.36E+03	5.38E+02	1.26E+03	5.75E+01	4.97E+02	-	-	2.36E+03
2050	-	-	2.26E+01	4.94E+02	2.18E+03	2.25E+01	2.72E+03	5.69E+02	1.33E+03	3.63E+01	3.51E+02	-	1.90E+02	2.48E+03	5.66E+02	1.33E+03	5.94E+01	5.13E+02	-	-	2.47E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	2.29E+03	2.17E+01	2.84E+03	5.97E+02	1.40E+03	3.70E+01	3.58E+02	-	2.00E+02	2.59E+03	5.94E+02	1.40E+03	6.14E+01	5.29E+02	-	-	2.58E+03
2052	-	-	2.40E+01	5.26E+02	2.40E+03	2.07E+01	2.97E+03	6.25E+02	1.46E+03	3.77E+01	3.64E+02	-	2.09E+02	2.70E+03	6.22E+02	1.46E+03	6.32E+01	5.43E+02	-	-	2.69E+03
2053	-	-	2.47E+01	5.41E+02	2.50E+03	1.95E+01	3.09E+03	6.53E+02	1.53E+03	3.83E+01	3.70E+02	-	2.19E+02	2.81E+03	6.50E+02	1.53E+03	6.50E+01	5.58E+02	-	-	2.80E+03
2054	-	-	2.54E+01	5.56E+02	2.61E+03	1.81E+01	3.21E+03	6.81E+02	1.59E+03	3.89E+01	3.76E+02	-	2.28E+02	2.92E+03	6.78E+02	1.59E+03	6.68E+01	5.71E+02	-	-	2.91E+03
2055	-	-	2.61E+01	5.70E+02	2.72E+03	1.68E+01	3.33E+03	7.09E+02	1.66E+03	3.94E+01	3.81E+02	-	2.38E+02	3.03E+03	7.06E+02	1.66E+03	6.84E+01	5.85E+02	-	-	3.02E+03
2056	-	-	2.67E+01	5.84E+02	2.83E+03	1.54E+01	3.45E+03	7.37E+02	1.72E+03	3.99E+01	3.86E+02	-	2.47E+02	3.14E+03	7.34E+02	1.72E+03	7.01E+01	5.98E+02	-	-	3.13E+03
2057	-	-	2.74E+01	5.98E+02	2.94E+03	1.41E+01	3.58E+03	7.65E+02	1.79E+03	4.04E+01	3.91E+02	-	2.56E+02	3.24E+03	7.61E+02	1.79E+03	7.17E+01	6.10E+02	-	-	3.23E+03
2058	-	-	2.80E+01	6.11E+02	3.03E+03	1.25E+01	3.68E+03	7.90E+02	1.85E+03	4.09E+01	3.95E+02	-	2.65E+02	3.34E+03	7.86E+02	1.85E+03	7.33E+01	6.22E+02	-	-	3.33E+03
2059	-	-	2.86E+01	6.24E+02	3.11E+03	1.08E+01	3.77E+03	8.11E+02	1.90E+03	4.13E+01	3.99E+02	-	2.74E+02	3.42E+03	8.07E+02	1.90E+03	7.47E+01	6.34E+02	-	-	3.41E+03
2060	-	-	2.91E+01	6.37E+02	3.17E+03	9.02E+00	3.85E+03	8.27E+02	1.93E+03	4.17E+01	4.03E+02	-	2.82E+02	3.49E+03	8.23E+02	1.93E+03	7.62E+01	6.45E+02	-	-	3.48E+03
2061	-	-	2.97E+01	6.49E+02	3.22E+03	7.07E+00	3.91E+03	8.40E+02	1.96E+03	4.21E+01	4.07E+02	-	2.91E+02	3.54E+03	8.35E+02	1.96E+03	7.76E+01	6.55E+02	-	-	3.53E+03

Exhibit D-22. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	1.81E+01	-4.75E-01	4.86E+01	4.68E+00	1.10E+01	3.00E+00	2.90E+01	-	2.98E-01	4.80E+01	4.66E+00	1.10E+01	3.04E+00	2.93E+01	-	-	4.80E+01
2030	-	-	2.68E+00	5.85E+01	6.32E+01	-5.79E-01	1.24E+02	1.64E+01	3.86E+01	5.82E+00	5.63E+01	-	2.03E+00	1.19E+02	1.63E+01	3.86E+01	6.07E+00	5.80E+01	-	-	1.19E+02
2031	-	-	3.96E+00	8.66E+01	1.44E+02	6.30E-01	2.36E+02	3.74E+01	8.83E+01	8.46E+00	8.18E+01	-	6.18E+00	2.22E+02	3.73E+01	8.83E+01	9.22E+00	8.71E+01	-	-	2.22E+02
2032	-	-	5.21E+00	1.14E+02	2.44E+02	3.41E+00	3.66E+02	6.32E+01	1.49E+02	1.09E+01	1.06E+02	-	1.28E+01	3.42E+02	6.29E+01	1.49E+02	1.25E+01	1.17E+02	-	-	3.41E+02
2033	-	-	6.42E+00	1.40E+02	3.52E+02	7.14E+00	5.06E+02	9.13E+01	2.15E+02	1.33E+01	1.28E+02	-	2.12E+01	4.69E+02	9.08E+01	2.15E+02	1.59E+01	1.46E+02	-	-	4.68E+02
2034	-	-	7.60E+00	1.66E+02	4.60E+02	1.09E+01	6.45E+02	1.19E+02	2.81E+02	1.54E+01	1.49E+02	-	3.04E+01	5.96E+02	1.19E+02	2.81E+02	1.92E+01	1.75E+02	-	-	5.95E+02
2035	-	-	8.74E+00	1.91E+02	5.69E+02	1.42E+01	7.83E+02	1.47E+02	3.48E+02	1.75E+01	1.69E+02	-	3.99E+01	7.22E+02	1.47E+02	3.48E+02	2.24E+01	2.03E+02	-	-	7.20E+02
2036	-	-	9.86E+00	2.15E+02	6.77E+02	1.70E+01	9.19E+02	1.76E+02	4.14E+02	1.94E+01	1.88E+02	-	4.95E+01	8.46E+02	1.75E+02	4.14E+02	2.54E+01	2.30E+02	-	-	8.44E+02
2037	-	-	1.09E+01	2.39E+02	7.85E+02	1.93E+01	1.05E+03	2.04E+02	4.80E+02	2.12E+01	2.05E+02	-	5.93E+01	9.69E+02	2.03E+02	4.80E+02	2.84E+01	2.56E+02	-	-	9.67E+02
2038	-	-	1.20E+01	2.62E+02	8.94E+02	2.13E+01	1.19E+03	2.32E+02	5.46E+02	2.29E+01	2.21E+02	-	6.93E+01	1.09E+03	2.31E+02	5.46E+02	3.13E+01	2.80E+02	-	-	1.09E+03
2039	-	-	1.30E+01	2.84E+02	1.00E+03	2.30E+01	1.32E+03	2.60E+02	6.13E+02	2.44E+01	2.36E+02	-	7.94E+01	1.21E+03	2.58E+02	6.13E+02	3.41E+01	3.04E+02	-	-	1.21E+03
2040	-	-	1.40E+01	3.06E+02	1.11E+03	2.42E+01	1.46E+03	2.88E+02	6.79E+02	2.59E+01	2.50E+02	-	8.95E+01	1.33E+03	2.86E+02	6.79E+02	3.68E+01	3.27E+02	-	-	1.33E+03
2041	-	-	1.50E+01	3.27E+02	1.22E+03	2.50E+01	1.59E+03	3.16E+02	7.45E+02	2.73E+01	2.64E+02	-	9.96E+01	1.45E+03	3.14E+02	7.45E+02	3.94E+01	3.49E+02	-	-	1.45E+03
2042	-	-	1.59E+01	3.48E+02	1.33E+03	2.55E+01	1.72E+03	3.44E+02	8.11E+02	2.85E+01	2.76E+02	-	1.10E+02	1.57E+03	3.42E+02	8.11E+02	4.19E+01	3.70E+02	-	-	1.57E+03
2043	-	-	1.68E+01	3.68E+02	1.44E+03	2.57E+01	1.85E+03	3.72E+02	8.77E+02	2.97E+01	2.88E+02	-	1.20E+02	1.69E+03	3.70E+02	8.77E+02	4.44E+01	3.90E+02	-	-	1.68E+03
2044	-	-	1.77E+01	3.88E+02	1.54E+03	2.57E+01	1.97E+03	4.00E+02	9.44E+02	3.09E+01	2.99E+02	-	1.30E+02	1.80E+03	3.98E+02	9.44E+02	4.67E+01	4.09E+02	-	-	1.80E+03
2045	-	-	1.86E+01	4.06E+02	1.65E+03	2.55E+01	2.10E+03	4.28E+02	1.01E+03	3.19E+01	3.09E+02	-	1.40E+02	1.92E+03	4.26E+02	1.01E+03	4.90E+01	4.28E+02	-	-	1.91E+03
2046	-	-	1.94E+01	4.25E+02	1.76E+03	2.51E+01	2.23E+03	4.56E+02	1.08E+03	3.29E+01	3.18E+02	-	1.50E+02	2.03E+03	4.54E+02	1.08E+03	5.12E+01	4.46E+02	-	-	2.03E+03
2047	-	-	2.03E+01	4.43E+02	1.87E+03	2.47E+01	2.36E+03	4.84E+02	1.14E+03	3.38E+01	3.27E+02	-	1.60E+02	2.15E+03	4.82E+02	1.14E+03	5.34E+01	4.64E+02	-	-	2.14E+03
2048	-	-	2.11E+01	4.60E+02	1.98E+03	2.41E+01	2.48E+03	5.13E+02	1.21E+03	3.47E+01	3.36E+02	-	1.70E+02	2.26E+03	5.10E+02	1.21E+03	5.54E+01	4.81E+02	-	-	2.25E+03
2049	-	-	2.18E+01	4.77E+02	2.09E+03	2.33E+01	2.61E+03	5.41E+02	1.27E+03	3.55E+01	3.43E+02	-	1.80E+02	2.37E+03	5.38E+02	1.27E+03	5.75E+01	4.97E+02	-	-	2.37E+03
2050	-	-	2.26E+01	4.94E+02	2.19E+03	2.25E+01	2.73E+03	5.69E+02	1.34E+03	3.63E+01	3.51E+02	-	1.90E+02	2.49E+03	5.66E+02	1.34E+03	5.94E+01	5.13E+02	-	-	2.48E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	2.30E+03	2.17E+01	2.86E+03	5.97E+02	1.41E+03	3.70E+01	3.58E+02	-	2.00E+02	2.60E+03	5.94E+02	1.41E+03	6.14E+01	5.29E+02	-	-	2.59E+03
2052	-	-	2.40E+01	5.26E+02	2.41E+03	2.07E+01	2.98E+03	6.25E+02	1.47E+03	3.77E+01	3.64E+02	-	2.09E+02	2.71E+03	6.22E+02	1.47E+03	6.32E+01	5.43E+02	-	-	2.70E+03
2053	-	-	2.47E+01	5.41E+02	2.52E+03	1.95E+01	3.10E+03	6.53E+02	1.54E+03	3.83E+01	3.70E+02	-	2.19E+02	2.82E+03	6.50E+02	1.54E+03	6.50E+01	5.58E+02	-	-	2.81E+03
2054	-	-	2.54E+01	5.56E+02	2.63E+03	1.81E+01	3.23E+03	6.81E+02	1.61E+03	3.89E+01	3.76E+02	-	2.28E+02	2.93E+03	6.78E+02	1.61E+03	6.68E+01	5.71E+02	-	-	2.92E+03
2055	-	-	2.61E+01	5.70E+02	2.74E+03	1.68E+01	3.35E+03	7.09E+02	1.67E+03	3.94E+01	3.81E+02	-	2.38E+02	3.04E+03	7.06E+02	1.67E+03	6.84E+01	5.85E+02	-	-	3.03E+03
2056	-	-	2.67E+01	5.84E+02	2.84E+03	1.54E+01	3.47E+03	7.37E+02	1.74E+03	3.99E+01	3.86E+02	-	2.47E+02	3.15E+03	7.34E+02	1.74E+03	7.01E+01	5.98E+02	-	-	3.14E+03
2057	-	-	2.74E+01	5.98E+02	2.95E+03	1.41E+01	3.59E+03	7.65E+02	1.80E+03	4.04E+01	3.91E+02	-	2.56E+02	3.26E+03	7.61E+02	1.80E+03	7.17E+01	6.10E+02	-	-	3.25E+03
2058	-	-	2.80E+01	6.11E+02	3.05E+03	1.25E+01	3.70E+03	7.90E+02	1.86E+03	4.09E+01	3.95E+02	-	2.65E+02	3.36E+03	7.86E+02	1.86E+03	7.33E+01	6.22E+02	-	-	3.35E+03
2059	-	-	2.86E+01	6.24E+02	3.13E+03	1.08E+01	3.79E+03	8.11E+02	1.91E+03	4.13E+01	3.99E+02	-	2.74E+02	3.44E+03	8.07E+02	1.91E+03	7.47E+01	6.34E+02	-	-	3.43E+03
2060	-	-	2.91E+01	6.37E+02	3.19E+03	9.02E+00	3.86E+03	8.27E+02	1.95E+03	4.17E+01	4.03E+02	-	2.82E+02	3.50E+03	8.23E+02	1.95E+03	7.62E+01	6.45E+02	-	-	3.49E+03
2061	-	-	2.97E+01	6.49E+02	3.24E+03	7.07E+00	3.93E+03	8.40E+02	1.98E+03	4.21E+01	4.07E+02	-	2.91E+02	3.56E+03	8.35E+02	1.98E+03	7.76E+01	6.55E+02	-	-	3.55E+03

Exhibit D-23. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	1.81E+01	-4.75E-01	4.86E+01	4.68E+00	1.10E+01	3.00E+00	2.90E+01	-	2.98E-01	4.81E+01	4.66E+00	1.10E+01	3.04E+00	2.93E+01	-	-	4.80E+01
2030	-	-	2.68E+00	5.85E+01	6.32E+01	-5.79E-01	1.24E+02	1.64E+01	3.86E+01	5.82E+00	5.63E+01	-	2.03E+00	1.19E+02	1.63E+01	3.86E+01	6.08E+00	5.80E+01	-	-	1.19E+02
2031	-	-	3.96E+00	8.66E+01	1.44E+02	6.30E-01	2.36E+02	3.74E+01	8.83E+01	8.46E+00	8.18E+01	-	6.18E+00	2.22E+02	3.73E+01	8.83E+01	9.22E+00	8.71E+01	-	-	2.22E+02
2032	-	-	5.21E+00	1.14E+02	2.44E+02	3.41E+00	3.66E+02	6.32E+01	1.49E+02	1.09E+01	1.06E+02	-	1.28E+01	3.42E+02	6.29E+01	1.49E+02	1.25E+01	1.17E+02	-	-	3.41E+02
2033	-	-	6.42E+00	1.40E+02	3.52E+02	7.14E+00	5.06E+02	9.13E+01	2.15E+02	1.33E+01	1.28E+02	-	2.12E+01	4.69E+02	9.08E+01	2.15E+02	1.59E+01	1.46E+02	-	-	4.68E+02
2034	-	-	7.60E+00	1.66E+02	4.61E+02	1.09E+01	6.45E+02	1.19E+02	2.82E+02	1.54E+01	1.49E+02	-	3.04E+01	5.96E+02	1.19E+02	2.82E+02	1.92E+01	1.75E+02	-	-	5.95E+02
2035	-	-	8.74E+00	1.91E+02	5.69E+02	1.42E+01	7.83E+02	1.47E+02	3.48E+02	1.75E+01	1.69E+02	-	3.99E+01	7.22E+02	1.47E+02	3.48E+02	2.24E+01	2.03E+02	-	-	7.20E+02
2036	-	-	9.86E+00	2.15E+02	6.77E+02	1.70E+01	9.20E+02	1.76E+02	4.14E+02	1.94E+01	1.88E+02	-	4.95E+01	8.46E+02	1.75E+02	4.14E+02	2.55E+01	2.30E+02	-	-	8.44E+02
2037	-	-	1.09E+01	2.39E+02	7.86E+02	1.93E+01	1.06E+03	2.04E+02	4.80E+02	2.12E+01	2.05E+02	-	5.93E+01	9.69E+02	2.03E+02	4.80E+02	2.84E+01	2.56E+02	-	-	9.67E+02
2038	-	-	1.20E+01	2.62E+02	8.94E+02	2.13E+01	1.19E+03	2.32E+02	5.47E+02	2.29E+01	2.21E+02	-	6.93E+01	1.09E+03	2.31E+02	5.47E+02	3.13E+01	2.80E+02	-	-	1.09E+03
2039	-	-	1.30E+01	2.84E+02	1.00E+03	2.30E+01	1.32E+03	2.60E+02	6.13E+02	2.44E+01	2.36E+02	-	7.94E+01	1.21E+03	2.58E+02	6.13E+02	3.41E+01	3.04E+02	-	-	1.21E+03
2040	-	-	1.40E+01	3.06E+02	1.11E+03	2.42E+01	1.46E+03	2.88E+02	6.79E+02	2.59E+01	2.50E+02	-	8.95E+01	1.33E+03	2.86E+02	6.79E+02	3.68E+01	3.27E+02	-	-	1.33E+03
2041	-	-	1.50E+01	3.27E+02	1.22E+03	2.50E+01	1.59E+03	3.16E+02	7.45E+02	2.73E+01	2.64E+02	-	9.96E+01	1.45E+03	3.14E+02	7.45E+02	3.94E+01	3.49E+02	-	-	1.45E+03
2042	-	-	1.59E+01	3.48E+02	1.33E+03	2.55E+01	1.72E+03	3.44E+02	8.12E+02	2.85E+01	2.76E+02	-	1.10E+02	1.57E+03	3.42E+02	8.12E+02	4.20E+01	3.70E+02	-	-	1.57E+03
2043	-	-	1.68E+01	3.68E+02	1.44E+03	2.57E+01	1.85E+03	3.72E+02	8.78E+02	2.97E+01	2.88E+02	-	1.20E+02	1.69E+03	3.70E+02	8.78E+02	4.44E+01	3.90E+02	-	-	1.68E+03
2044	-	-	1.77E+01	3.88E+02	1.54E+03	2.57E+01	1.98E+03	4.00E+02	9.44E+02	3.09E+01	2.99E+02	-	1.30E+02	1.80E+03	3.98E+02	9.44E+02	4.67E+01	4.09E+02	-	-	1.80E+03
2045	-	-	1.86E+01	4.06E+02	1.65E+03	2.55E+01	2.10E+03	4.28E+02	1.01E+03	3.19E+01	3.09E+02	-	1.40E+02	1.92E+03	4.26E+02	1.01E+03	4.90E+01	4.28E+02	-	-	1.91E+03
2046	-	-	1.94E+01	4.25E+02	1.76E+03	2.51E+01	2.23E+03	4.56E+02	1.08E+03	3.29E+01	3.18E+02	-	1.50E+02	2.03E+03	4.54E+02	1.08E+03	5.12E+01	4.46E+02	-	-	2.03E+03
2047	-	-	2.03E+01	4.43E+02	1.87E+03	2.47E+01	2.36E+03	4.84E+02	1.14E+03	3.38E+01	3.27E+02	-	1.60E+02	2.15E+03	4.82E+02	1.14E+03	5.34E+01	4.64E+02	-	-	2.14E+03
2048	-	-	2.11E+01	4.60E+02	1.98E+03	2.41E+01	2.48E+03	5.13E+02	1.21E+03	3.47E+01	3.36E+02	-	1.70E+02	2.26E+03	5.10E+02	1.21E+03	5.55E+01	4.81E+02	-	-	2.26E+03
2049	-	-	2.18E+01	4.77E+02	2.09E+03	2.33E+01	2.61E+03	5.41E+02	1.28E+03	3.55E+01	3.43E+02	-	1.80E+02	2.37E+03	5.38E+02	1.28E+03	5.75E+01	4.97E+02	-	-	2.37E+03
2050	-	-	2.26E+01	4.94E+02	2.19E+03	2.25E+01	2.73E+03	5.69E+02	1.34E+03	3.63E+01	3.51E+02	-	1.90E+02	2.49E+03	5.66E+02	1.34E+03	5.95E+01	5.13E+02	-	-	2.48E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	2.30E+03	2.17E+01	2.86E+03	5.97E+02	1.41E+03	3.70E+01	3.58E+02	-	2.00E+02	2.60E+03	5.94E+02	1.41E+03	6.14E+01	5.29E+02	-	-	2.59E+03
2052	-	-	2.40E+01	5.26E+02	2.41E+03	2.07E+01	2.98E+03	6.25E+02	1.47E+03	3.77E+01	3.64E+02	-	2.09E+02	2.71E+03	6.22E+02	1.47E+03	6.33E+01	5.43E+02	-	-	2.70E+03
2053	-	-	2.47E+01	5.41E+02	2.52E+03	1.95E+01	3.10E+03	6.53E+02	1.54E+03	3.83E+01	3.70E+02	-	2.19E+02	2.82E+03	6.50E+02	1.54E+03	6.51E+01	5.58E+02	-	-	2.81E+03
2054	-	-	2.54E+01	5.56E+02	2.63E+03	1.81E+01	3.23E+03	6.81E+02	1.61E+03	3.89E+01	3.76E+02	-	2.28E+02	2.93E+03	6.78E+02	1.61E+03	6.68E+01	5.71E+02	-	-	2.92E+03
2055	-	-	2.61E+01	5.70E+02	2.74E+03	1.68E+01	3.35E+03	7.09E+02	1.67E+03	3.94E+01	3.81E+02	-	2.38E+02	3.04E+03	7.06E+02	1.67E+03	6.85E+01	5.85E+02	-	-	3.03E+03
2056	-	-	2.67E+01	5.84E+02	2.84E+03	1.54E+01	3.47E+03	7.37E+02	1.74E+03	3.99E+01	3.86E+02	-	2.47E+02	3.15E+03	7.34E+02	1.74E+03	7.01E+01	5.98E+02	-	-	3.14E+03
2057	-	-	2.74E+01	5.98E+02	2.95E+03	1.41E+01	3.59E+03	7.65E+02	1.81E+03	4.04E+01	3.91E+02	-	2.56E+02	3.26E+03	7.61E+02	1.81E+03	7.17E+01	6.10E+02	-	-	3.25E+03
2058	-	-	2.80E+01	6.11E+02	3.05E+03	1.25E+01	3.70E+03	7.90E+02	1.86E+03	4.09E+01	3.95E+02	-	2.65E+02	3.36E+03	7.86E+02	1.86E+03	7.33E+01	6.22E+02	-	-	3.35E+03
2059	-	-	2.86E+01	6.24E+02	3.13E+03	1.08E+01	3.79E+03	8.11E+02	1.91E+03	4.13E+01	3.99E+02	-	2.74E+02	3.44E+03	8.07E+02	1.91E+03	7.48E+01	6.34E+02	-	-	3.43E+03
2060	-	-	2.91E+01	6.37E+02	3.19E+03	9.02E+00	3.87E+03	8.27E+02	1.95E+03	4.17E+01	4.03E+02	-	2.82E+02	3.50E+03	8.23E+02	1.95E+03	7.62E+01	6.45E+02	-	-	3.49E+03
2061	-	-	2.97E+01	6.49E+02	3.24E+03	7.07E+00	3.93E+03	8.40E+02	1.98E+03	4.21E+01	4.07E+02	-	2.91E+02	3.56E+03	8.35E+02	1.98E+03	7.76E+01	6.55E+02	-	-	3.55E+03

Exhibit D-24. Cumulative Emissions Profile AR5 20-yr – NGCC without CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	1.80E+01	-4.75E-01	4.86E+01	4.68E+00	1.15E+01	3.00E+00	2.90E+01	-	2.98E-01	4.85E+01	4.66E+00	1.15E+01	3.04E+00	2.93E+01	-	-	4.85E+01
2030	-	-	2.68E+00	5.85E+01	6.31E+01	-5.79E-01	1.24E+02	1.64E+01	4.02E+01	5.82E+00	5.63E+01	-	2.03E+00	1.21E+02	1.63E+01	4.02E+01	6.07E+00	5.80E+01	-	-	1.21E+02
2031	-	-	3.96E+00	8.66E+01	1.44E+02	6.30E-01	2.35E+02	3.74E+01	9.20E+01	8.46E+00	8.18E+01	-	6.18E+00	2.26E+02	3.73E+01	9.20E+01	9.22E+00	8.71E+01	-	-	2.26E+02
2032	-	-	5.21E+00	1.14E+02	2.43E+02	3.41E+00	3.66E+02	6.32E+01	1.55E+02	1.09E+01	1.06E+02	-	1.28E+01	3.48E+02	6.29E+01	1.55E+02	1.25E+01	1.17E+02	-	-	3.47E+02
2033	-	-	6.42E+00	1.40E+02	3.51E+02	7.14E+00	5.05E+02	9.13E+01	2.24E+02	1.33E+01	1.28E+02	-	2.12E+01	4.78E+02	9.08E+01	2.24E+02	1.59E+01	1.46E+02	-	-	4.77E+02
2034	-	-	7.60E+00	1.66E+02	4.60E+02	1.09E+01	6.44E+02	1.19E+02	2.93E+02	1.54E+01	1.49E+02	-	3.04E+01	6.08E+02	1.19E+02	2.93E+02	1.92E+01	1.75E+02	-	-	6.06E+02
2035	-	-	8.74E+00	1.91E+02	5.68E+02	1.42E+01	7.82E+02	1.47E+02	3.62E+02	1.75E+01	1.69E+02	-	3.99E+01	7.36E+02	1.47E+02	3.62E+02	2.24E+01	2.03E+02	-	-	7.34E+02
2036	-	-	9.86E+00	2.15E+02	6.76E+02	1.70E+01	9.18E+02	1.76E+02	4.31E+02	1.94E+01	1.88E+02	-	4.95E+01	8.63E+02	1.75E+02	4.31E+02	2.54E+01	2.30E+02	-	-	8.61E+02
2037	-	-	1.09E+01	2.39E+02	7.84E+02	1.93E+01	1.05E+03	2.04E+02	5.00E+02	2.12E+01	2.05E+02	-	5.93E+01	9.89E+02	2.03E+02	5.00E+02	2.84E+01	2.56E+02	-	-	9.87E+02
2038	-	-	1.20E+01	2.62E+02	8.92E+02	2.13E+01	1.19E+03	2.32E+02	5.69E+02	2.29E+01	2.21E+02	-	6.93E+01	1.11E+03	2.31E+02	5.69E+02	3.13E+01	2.80E+02	-	-	1.11E+03
2039	-	-	1.30E+01	2.84E+02	1.00E+03	2.30E+01	1.32E+03	2.60E+02	6.38E+02	2.44E+01	2.36E+02	-	7.94E+01	1.24E+03	2.58E+02	6.38E+02	3.41E+01	3.04E+02	-	-	1.23E+03
2040	-	-	1.40E+01	3.06E+02	1.11E+03	2.42E+01	1.45E+03	2.88E+02	7.07E+02	2.59E+01	2.50E+02	-	8.95E+01	1.36E+03	2.86E+02	7.07E+02	3.68E+01	3.27E+02	-	-	1.36E+03
2041	-	-	1.50E+01	3.27E+02	1.22E+03	2.50E+01	1.58E+03	3.16E+02	7.76E+02	2.73E+01	2.64E+02	-	9.96E+01	1.48E+03	3.14E+02	7.76E+02	3.94E+01	3.49E+02	-	-	1.48E+03
2042	-	-	1.59E+01	3.48E+02	1.32E+03	2.55E+01	1.71E+03	3.44E+02	8.45E+02	2.85E+01	2.76E+02	-	1.10E+02	1.60E+03	3.42E+02	8.45E+02	4.19E+01	3.70E+02	-	-	1.60E+03
2043	-	-	1.68E+01	3.68E+02	1.43E+03	2.57E+01	1.84E+03	3.72E+02	9.14E+02	2.97E+01	2.88E+02	-	1.20E+02	1.72E+03	3.70E+02	9.14E+02	4.44E+01	3.90E+02	-	-	1.72E+03
2044	-	-	1.77E+01	3.88E+02	1.54E+03	2.57E+01	1.97E+03	4.00E+02	9.83E+02	3.09E+01	2.99E+02	-	1.30E+02	1.84E+03	3.98E+02	9.83E+02	4.67E+01	4.09E+02	-	-	1.84E+03
2045	-	-	1.86E+01	4.06E+02	1.65E+03	2.55E+01	2.10E+03	4.28E+02	1.05E+03	3.19E+01	3.09E+02	-	1.40E+02	1.96E+03	4.26E+02	1.05E+03	4.90E+01	4.28E+02	-	-	1.96E+03
2046	-	-	1.94E+01	4.25E+02	1.76E+03	2.51E+01	2.23E+03	4.56E+02	1.12E+03	3.29E+01	3.18E+02	-	1.50E+02	2.08E+03	4.54E+02	1.12E+03	5.12E+01	4.46E+02	-	-	2.07E+03
2047	-	-	2.03E+01	4.43E+02	1.87E+03	2.47E+01	2.35E+03	4.84E+02	1.19E+03	3.38E+01	3.27E+02	-	1.60E+02	2.20E+03	4.82E+02	1.19E+03	5.34E+01	4.64E+02	-	-	2.19E+03
2048	-	-	2.11E+01	4.60E+02	1.97E+03	2.41E+01	2.48E+03	5.13E+02	1.26E+03	3.47E+01	3.36E+02	-	1.70E+02	2.31E+03	5.10E+02	1.26E+03	5.54E+01	4.81E+02	-	-	2.31E+03
2049	-	-	2.18E+01	4.77E+02	2.08E+03	2.33E+01	2.60E+03	5.41E+02	1.33E+03	3.55E+01	3.43E+02	-	1.80E+02	2.43E+03	5.38E+02	1.33E+03	5.75E+01	4.97E+02	-	-	2.42E+03
2050	-	-	2.26E+01	4.94E+02	2.19E+03	2.25E+01	2.73E+03	5.69E+02	1.40E+03	3.63E+01	3.51E+02	-	1.90E+02	2.54E+03	5.66E+02	1.40E+03	5.94E+01	5.13E+02	-	-	2.54E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	2.30E+03	2.17E+01	2.85E+03	5.97E+02	1.47E+03	3.70E+01	3.58E+02	-	2.00E+02	2.66E+03	5.94E+02	1.47E+03	6.14E+01	5.29E+02	-	-	2.65E+03
2052	-	-	2.40E+01	5.26E+02	2.41E+03	2.07E+01	2.98E+03	6.25E+02	1.53E+03	3.77E+01	3.64E+02	-	2.09E+02	2.77E+03	6.22E+02	1.53E+03	6.32E+01	5.43E+02	-	-	2.76E+03
2053	-	-	2.47E+01	5.41E+02	2.51E+03	1.95E+01	3.10E+03	6.53E+02	1.60E+03	3.83E+01	3.70E+02	-	2.19E+02	2.88E+03	6.50E+02	1.60E+03	6.50E+01	5.58E+02	-	-	2.88E+03
2054	-	-	2.54E+01	5.56E+02	2.62E+03	1.81E+01	3.22E+03	6.81E+02	1.67E+03	3.89E+01	3.76E+02	-	2.28E+02	3.00E+03	6.78E+02	1.67E+03	6.68E+01	5.71E+02	-	-	2.99E+03
2055	-	-	2.61E+01	5.70E+02	2.73E+03	1.68E+01	3.34E+03	7.09E+02	1.74E+03	3.94E+01	3.81E+02	-	2.38E+02	3.11E+03	7.06E+02	1.74E+03	6.84E+01	5.85E+02	-	-	3.10E+03
2056	-	-	2.67E+01	5.84E+02	2.84E+03	1.54E+01	3.46E+03	7.37E+02	1.81E+03	3.99E+01	3.86E+02	-	2.47E+02	3.22E+03	7.33E+02	1.81E+03	7.01E+01	5.98E+02	-	-	3.21E+03
2057	-	-	2.74E+01	5.98E+02	2.95E+03	1.41E+01	3.59E+03	7.65E+02	1.88E+03	4.04E+01	3.91E+02	-	2.56E+02	3.33E+03	7.61E+02	1.88E+03	7.17E+01	6.10E+02	-	-	3.32E+03
2058	-	-	2.80E+01	6.11E+02	3.04E+03	1.25E+01	3.70E+03	7.90E+02	1.94E+03	4.09E+01	3.95E+02	-	2.65E+02	3.43E+03	7.86E+02	1.94E+03	7.32E+01	6.22E+02	-	-	3.42E+03
2059	-	-	2.86E+01	6.24E+02	3.12E+03	1.08E+01	3.78E+03	8.11E+02	1.99E+03	4.13E+01	3.99E+02	-	2.74E+02	3.52E+03	8.07E+02	1.99E+03	7.47E+01	6.34E+02	-	-	3.51E+03
2060	-	-	2.91E+01	6.37E+02	3.18E+03	9.02E+00	3.86E+03	8.27E+02	2.03E+03	4.17E+01	4.03E+02	-	2.82E+02	3.58E+03	8.23E+02	2.03E+03	7.62E+01	6.45E+02	-	-	3.57E+03
2061	-	-	2.97E+01	6.49E+02	3.23E+03	7.07E+00	3.92E+03	8.40E+02	2.06E+03	4.21E+01	4.07E+02	-	2.91E+02	3.64E+03	8.35E+02	2.06E+03	7.76E+01	6.55E+02	-	-	3.63E+03

Exhibit D-25. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	8.91E+00	-4.75E-01	3.95E+01	4.68E+00	1.95E+00	3.00E+00	2.90E+01	-	2.98E-01	3.90E+01	4.66E+00	1.95E+00	3.04E+00	2.93E+01	-	-	3.89E+01
2030	-	-	2.68E+00	5.85E+01	3.12E+01	-5.79E-01	9.18E+01	1.64E+01	6.82E+00	5.83E+00	5.63E+01	-	2.03E+00	8.74E+01	1.63E+01	6.82E+00	6.07E+00	5.80E+01	-	-	8.72E+01
2031	-	-	3.96E+00	8.66E+01	7.13E+01	6.30E-01	1.62E+02	3.74E+01	1.56E+01	8.47E+00	8.18E+01	-	6.18E+00	1.50E+02	3.73E+01	1.56E+01	9.22E+00	8.71E+01	-	-	1.49E+02
2032	-	-	5.21E+00	1.14E+02	1.20E+02	3.41E+00	2.43E+02	6.32E+01	2.63E+01	1.09E+01	1.06E+02	-	1.28E+01	2.19E+02	6.29E+01	2.63E+01	1.25E+01	1.17E+02	-	-	2.18E+02
2033	-	-	6.42E+00	1.40E+02	1.74E+02	7.14E+00	3.28E+02	9.13E+01	3.80E+01	1.33E+01	1.28E+02	-	2.12E+01	2.92E+02	9.08E+01	3.80E+01	1.59E+01	1.46E+02	-	-	2.91E+02
2034	-	-	7.60E+00	1.66E+02	2.27E+02	1.09E+01	4.12E+02	1.19E+02	4.97E+01	1.55E+01	1.49E+02	-	3.04E+01	3.64E+02	1.19E+02	4.97E+01	1.92E+01	1.75E+02	-	-	3.63E+02
2035	-	-	8.74E+00	1.91E+02	2.81E+02	1.42E+01	4.95E+02	1.47E+02	6.14E+01	1.75E+01	1.69E+02	-	3.99E+01	4.35E+02	1.47E+02	6.14E+01	2.24E+01	2.03E+02	-	-	4.34E+02
2036	-	-	9.86E+00	2.15E+02	3.34E+02	1.70E+01	5.76E+02	1.76E+02	7.30E+01	1.94E+01	1.88E+02	-	4.95E+01	5.05E+02	1.75E+02	7.30E+01	2.55E+01	2.30E+02	-	-	5.03E+02
2037	-	-	1.09E+01	2.39E+02	3.88E+02	1.93E+01	6.57E+02	2.04E+02	8.47E+01	2.12E+01	2.05E+02	-	5.93E+01	5.74E+02	2.03E+02	8.47E+01	2.84E+01	2.56E+02	-	-	5.71E+02
2038	-	-	1.20E+01	2.62E+02	4.41E+02	2.13E+01	7.36E+02	2.32E+02	9.64E+01	2.29E+01	2.21E+02	-	6.93E+01	6.41E+02	2.31E+02	9.64E+01	3.13E+01	2.80E+02	-	-	6.39E+02
2039	-	-	1.30E+01	2.84E+02	4.94E+02	2.30E+01	8.15E+02	2.60E+02	1.08E+02	2.44E+01	2.36E+02	-	7.94E+01	7.08E+02	2.59E+02	1.08E+02	3.41E+01	3.04E+02	-	-	7.05E+02
2040	-	-	1.40E+01	3.06E+02	5.48E+02	2.42E+01	8.92E+02	2.88E+02	1.20E+02	2.59E+01	2.50E+02	-	8.95E+01	7.73E+02	2.86E+02	1.20E+02	3.68E+01	3.27E+02	-	-	7.70E+02
2041	-	-	1.50E+01	3.27E+02	6.01E+02	2.50E+01	9.69E+02	3.16E+02	1.31E+02	2.73E+01	2.64E+02	-	9.96E+01	8.38E+02	3.14E+02	1.31E+02	3.94E+01	3.49E+02	-	-	8.34E+02
2042	-	-	1.59E+01	3.48E+02	6.55E+02	2.55E+01	1.04E+03	3.44E+02	1.43E+02	2.86E+01	2.76E+02	-	1.10E+02	9.01E+02	3.42E+02	1.43E+02	4.19E+01	3.70E+02	-	-	8.97E+02
2043	-	-	1.68E+01	3.68E+02	7.08E+02	2.57E+01	1.12E+03	3.72E+02	1.55E+02	2.98E+01	2.88E+02	-	1.20E+02	9.64E+02	3.70E+02	1.55E+02	4.44E+01	3.90E+02	-	-	9.60E+02
2044	-	-	1.77E+01	3.88E+02	7.62E+02	2.57E+01	1.19E+03	4.00E+02	1.67E+02	3.09E+01	2.99E+02	-	1.30E+02	1.03E+03	3.98E+02	1.67E+02	4.67E+01	4.09E+02	-	-	1.02E+03
2045	-	-	1.86E+01	4.06E+02	8.15E+02	2.55E+01	1.27E+03	4.28E+02	1.78E+02	3.19E+01	3.09E+02	-	1.40E+02	1.09E+03	4.26E+02	1.78E+02	4.90E+01	4.28E+02	-	-	1.08E+03
2046	-	-	1.94E+01	4.25E+02	8.69E+02	2.51E+01	1.34E+03	4.56E+02	1.90E+02	3.29E+01	3.18E+02	-	1.50E+02	1.15E+03	4.54E+02	1.90E+02	5.12E+01	4.46E+02	-	-	1.14E+03
2047	-	-	2.03E+01	4.43E+02	9.22E+02	2.47E+01	1.41E+03	4.84E+02	2.02E+02	3.39E+01	3.27E+02	-	1.60E+02	1.21E+03	4.82E+02	2.02E+02	5.34E+01	4.64E+02	-	-	1.20E+03
2048	-	-	2.11E+01	4.60E+02	9.76E+02	2.41E+01	1.48E+03	5.13E+02	2.13E+02	3.47E+01	3.36E+02	-	1.70E+02	1.27E+03	5.10E+02	2.13E+02	5.55E+01	4.81E+02	-	-	1.26E+03
2049	-	-	2.18E+01	4.77E+02	1.03E+03	2.33E+01	1.55E+03	5.41E+02	2.25E+02	3.55E+01	3.43E+02	-	1.80E+02	1.32E+03	5.38E+02	2.25E+02	5.75E+01	4.97E+02	-	-	1.32E+03
2050	-	-	2.26E+01	4.94E+02	1.08E+03	2.25E+01	1.62E+03	5.69E+02	2.37E+02	3.63E+01	3.51E+02	-	1.90E+02	1.38E+03	5.66E+02	2.37E+02	5.95E+01	5.13E+02	-	-	1.38E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	1.14E+03	2.17E+01	1.69E+03	5.97E+02	2.48E+02	3.70E+01	3.58E+02	-	2.00E+02	1.44E+03	5.94E+02	2.48E+02	6.14E+01	5.29E+02	-	-	1.43E+03
2052	-	-	2.40E+01	5.26E+02	1.19E+03	2.07E+01	1.76E+03	6.25E+02	2.60E+02	3.77E+01	3.64E+02	-	2.09E+02	1.50E+03	6.22E+02	2.60E+02	6.32E+01	5.43E+02	-	-	1.49E+03
2053	-	-	2.47E+01	5.41E+02	1.24E+03	1.95E+01	1.83E+03	6.53E+02	2.72E+02	3.83E+01	3.70E+02	-	2.19E+02	1.55E+03	6.50E+02	2.72E+02	6.50E+01	5.58E+02	-	-	1.54E+03
2054	-	-	2.54E+01	5.56E+02	1.30E+03	1.81E+01	1.90E+03	6.81E+02	2.83E+02	3.89E+01	3.76E+02	-	2.28E+02	1.61E+03	6.78E+02	2.83E+02	6.68E+01	5.71E+02	-	-	1.60E+03
2055	-	-	2.61E+01	5.70E+02	1.35E+03	1.68E+01	1.96E+03	7.09E+02	2.95E+02	3.94E+01	3.81E+02	-	2.38E+02	1.66E+03	7.06E+02	2.95E+02	6.85E+01	5.85E+02	-	-	1.65E+03
2056	-	-	2.67E+01	5.84E+02	1.40E+03	1.54E+01	2.03E+03	7.37E+02	3.07E+02	4.00E+01	3.86E+02	-	2.47E+02	1.72E+03	7.34E+02	3.07E+02	7.01E+01	5.98E+02	-	-	1.71E+03
2057	-	-	2.74E+01	5.98E+02	1.46E+03	1.41E+01	2.10E+03	7.65E+02	3.18E+02	4.04E+01	3.91E+02	-	2.56E+02	1.77E+03	7.62E+02	3.18E+02	7.17E+01	6.10E+02	-	-	1.76E+03
2058	-	-	2.80E+01	6.11E+02	1.50E+03	1.25E+01	2.16E+03	7.91E+02	3.29E+02	4.09E+01	3.95E+02	-	2.65E+02	1.82E+03	7.87E+02	3.29E+02	7.33E+01	6.22E+02	-	-	1.81E+03
2059	-	-	2.86E+01	6.24E+02	1.54E+03	1.08E+01	2.21E+03	8.11E+02	3.37E+02	4.13E+01	3.99E+02	-	2.74E+02	1.86E+03	8.07E+02	3.37E+02	7.48E+01	6.34E+02	-	-	1.85E+03
2060	-	-	2.91E+01	6.37E+02	1.57E+03	9.02E+00	2.25E+03	8.27E+02	3.44E+02	4.17E+01	4.03E+02	-	2.82E+02	1.90E+03	8.23E+02	3.44E+02	7.62E+01	6.45E+02	-	-	1.89E+03
2061	-	-	2.97E+01	6.49E+02	1.60E+03	7.07E+00	2.28E+03	8.40E+02	3.49E+02	4.21E+01	4.07E+02	-	2.91E+02	1.93E+03	8.35E+02	3.49E+02	7.76E+01	6.55E+02	-	-	1.92E+03

Exhibit D-26. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	9.03E+00	-4.75E-01	3.96E+01	4.68E+00	2.05E+00	3.00E+00	2.90E+01	-	2.98E-01	3.91E+01	4.66E+00	2.05E+00	3.04E+00	2.93E+01	-	-	3.90E+01
2030	-	-	2.68E+00	5.85E+01	3.16E+01	-5.79E-01	9.22E+01	1.64E+01	7.18E+00	5.83E+00	5.63E+01	-	2.03E+00	8.77E+01	1.63E+01	7.18E+00	6.07E+00	5.80E+01	-	-	8.76E+01
2031	-	-	3.96E+00	8.66E+01	7.22E+01	6.30E-01	1.63E+02	3.74E+01	1.64E+01	8.47E+00	8.18E+01	-	6.18E+00	1.50E+02	3.73E+01	1.64E+01	9.22E+00	8.71E+01	-	-	1.50E+02
2032	-	-	5.21E+00	1.14E+02	1.22E+02	3.41E+00	2.44E+02	6.32E+01	2.77E+01	1.09E+01	1.06E+02	-	1.28E+01	2.20E+02	6.29E+01	2.77E+01	1.25E+01	1.17E+02	-	-	2.20E+02
2033	-	-	6.42E+00	1.40E+02	1.76E+02	7.14E+00	3.30E+02	9.13E+01	4.00E+01	1.33E+01	1.28E+02	-	2.12E+01	2.94E+02	9.08E+01	4.00E+01	1.59E+01	1.46E+02	-	-	2.93E+02
2034	-	-	7.60E+00	1.66E+02	2.30E+02	1.09E+01	4.15E+02	1.19E+02	5.23E+01	1.55E+01	1.49E+02	-	3.04E+01	3.67E+02	1.19E+02	5.23E+01	1.92E+01	1.75E+02	-	-	3.66E+02
2035	-	-	8.74E+00	1.91E+02	2.84E+02	1.42E+01	4.98E+02	1.47E+02	6.47E+01	1.75E+01	1.69E+02	-	3.99E+01	4.39E+02	1.47E+02	6.47E+01	2.24E+01	2.03E+02	-	-	4.37E+02
2036	-	-	9.86E+00	2.15E+02	3.39E+02	1.70E+01	5.81E+02	1.76E+02	7.70E+01	1.94E+01	1.88E+02	-	4.95E+01	5.09E+02	1.75E+02	7.70E+01	2.55E+01	2.30E+02	-	-	5.07E+02
2037	-	-	1.09E+01	2.39E+02	3.93E+02	1.93E+01	6.62E+02	2.04E+02	8.93E+01	2.12E+01	2.05E+02	-	5.93E+01	5.78E+02	2.03E+02	8.93E+01	2.84E+01	2.56E+02	-	-	5.76E+02
2038	-	-	1.20E+01	2.62E+02	4.47E+02	2.13E+01	7.42E+02	2.32E+02	1.02E+02	2.29E+01	2.21E+02	-	6.93E+01	6.47E+02	2.31E+02	1.02E+02	3.13E+01	2.80E+02	-	-	6.44E+02
2039	-	-	1.30E+01	2.84E+02	5.01E+02	2.30E+01	8.22E+02	2.60E+02	1.14E+02	2.44E+01	2.36E+02	-	7.94E+01	7.14E+02	2.59E+02	1.14E+02	3.41E+01	3.04E+02	-	-	7.11E+02
2040	-	-	1.40E+01	3.06E+02	5.55E+02	2.42E+01	9.00E+02	2.88E+02	1.26E+02	2.59E+01	2.50E+02	-	8.95E+01	7.80E+02	2.86E+02	1.26E+02	3.68E+01	3.27E+02	-	-	7.76E+02
2041	-	-	1.50E+01	3.27E+02	6.09E+02	2.50E+01	9.77E+02	3.16E+02	1.39E+02	2.73E+01	2.64E+02	-	9.96E+01	8.45E+02	3.14E+02	1.39E+02	3.94E+01	3.49E+02	-	-	8.41E+02
2042	-	-	1.59E+01	3.48E+02	6.64E+02	2.55E+01	1.05E+03	3.44E+02	1.51E+02	2.86E+01	2.76E+02	-	1.10E+02	9.09E+02	3.42E+02	1.51E+02	4.19E+01	3.70E+02	-	-	9.05E+02
2043	-	-	1.68E+01	3.68E+02	7.18E+02	2.57E+01	1.13E+03	3.72E+02	1.63E+02	2.98E+01	2.88E+02	-	1.20E+02	9.72E+02	3.70E+02	1.63E+02	4.44E+01	3.90E+02	-	-	9.68E+02
2044	-	-	1.77E+01	3.88E+02	7.72E+02	2.57E+01	1.20E+03	4.00E+02	1.75E+02	3.09E+01	2.99E+02	-	1.30E+02	1.03E+03	3.98E+02	1.75E+02	4.67E+01	4.09E+02	-	-	1.03E+03
2045	-	-	1.86E+01	4.06E+02	8.26E+02	2.55E+01	1.28E+03	4.28E+02	1.88E+02	3.19E+01	3.09E+02	-	1.40E+02	1.10E+03	4.26E+02	1.88E+02	4.90E+01	4.28E+02	-	-	1.09E+03
2046	-	-	1.94E+01	4.25E+02	8.80E+02	2.51E+01	1.35E+03	4.56E+02	2.00E+02	3.29E+01	3.18E+02	-	1.50E+02	1.16E+03	4.54E+02	2.00E+02	5.12E+01	4.46E+02	-	-	1.15E+03
2047	-	-	2.03E+01	4.43E+02	9.34E+02	2.47E+01	1.42E+03	4.84E+02	2.12E+02	3.39E+01	3.27E+02	-	1.60E+02	1.22E+03	4.82E+02	2.12E+02	5.34E+01	4.64E+02	-	-	1.21E+03
2048	-	-	2.11E+01	4.60E+02	9.89E+02	2.41E+01	1.49E+03	5.13E+02	2.25E+02	3.47E+01	3.36E+02	-	1.70E+02	1.28E+03	5.10E+02	2.25E+02	5.55E+01	4.81E+02	-	-	1.27E+03
2049	-	-	2.18E+01	4.77E+02	1.04E+03	2.33E+01	1.57E+03	5.41E+02	2.37E+02	3.55E+01	3.43E+02	-	1.80E+02	1.34E+03	5.38E+02	2.37E+02	5.75E+01	4.97E+02	-	-	1.33E+03
2050	-	-	2.26E+01	4.94E+02	1.10E+03	2.25E+01	1.64E+03	5.69E+02	2.49E+02	3.63E+01	3.51E+02	-	1.90E+02	1.40E+03	5.66E+02	2.49E+02	5.95E+01	5.13E+02	-	-	1.39E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	1.15E+03	2.17E+01	1.71E+03	5.97E+02	2.62E+02	3.70E+01	3.58E+02	-	2.00E+02	1.45E+03	5.94E+02	2.62E+02	6.14E+01	5.29E+02	-	-	1.45E+03
2052	-	-	2.40E+01	5.26E+02	1.21E+03	2.07E+01	1.78E+03	6.25E+02	2.74E+02	3.77E+01	3.64E+02	-	2.09E+02	1.51E+03	6.22E+02	2.74E+02	6.32E+01	5.43E+02	-	-	1.50E+03
2053	-	-	2.47E+01	5.41E+02	1.26E+03	1.95E+01	1.84E+03	6.53E+02	2.86E+02	3.83E+01	3.70E+02	-	2.19E+02	1.57E+03	6.50E+02	2.86E+02	6.50E+01	5.58E+02	-	-	1.56E+03
2054	-	-	2.54E+01	5.56E+02	1.31E+03	1.81E+01	1.91E+03	6.81E+02	2.99E+02	3.89E+01	3.76E+02	-	2.28E+02	1.62E+03	6.78E+02	2.99E+02	6.68E+01	5.71E+02	-	-	1.61E+03
2055	-	-	2.61E+01	5.70E+02	1.37E+03	1.68E+01	1.98E+03	7.09E+02	3.11E+02	3.94E+01	3.81E+02	-	2.38E+02	1.68E+03	7.06E+02	3.11E+02	6.85E+01	5.85E+02	-	-	1.67E+03
2056	-	-	2.67E+01	5.84E+02	1.42E+03	1.54E+01	2.05E+03	7.37E+02	3.23E+02	4.00E+01	3.86E+02	-	2.47E+02	1.73E+03	7.34E+02	3.23E+02	7.01E+01	5.98E+02	-	-	1.72E+03
2057	-	-	2.74E+01	5.98E+02	1.48E+03	1.41E+01	2.12E+03	7.65E+02	3.36E+02	4.04E+01	3.91E+02	-	2.56E+02	1.79E+03	7.62E+02	3.36E+02	7.17E+01	6.10E+02	-	-	1.78E+03
2058	-	-	2.80E+01	6.11E+02	1.52E+03	1.25E+01	2.18E+03	7.91E+02	3.47E+02	4.09E+01	3.95E+02	-	2.65E+02	1.84E+03	7.87E+02	3.47E+02	7.33E+01	6.22E+02	-	-	1.83E+03
2059	-	-	2.86E+01	6.24E+02	1.56E+03	1.08E+01	2.23E+03	8.11E+02	3.55E+02	4.13E+01	3.99E+02	-	2.74E+02	1.88E+03	8.07E+02	3.55E+02	7.48E+01	6.34E+02	-	-	1.87E+03
2060	-	-	2.91E+01	6.37E+02	1.59E+03	9.02E+00	2.27E+03	8.27E+02	3.63E+02	4.17E+01	4.03E+02	-	2.82E+02	1.92E+03	8.23E+02	3.63E+02	7.62E+01	6.45E+02	-	-	1.91E+03
2061	-	-	2.97E+01	6.49E+02	1.62E+03	7.07E+00	2.31E+03	8.40E+02	3.68E+02	4.21E+01	4.07E+02	-	2.91E+02	1.95E+03	8.35E+02	3.68E+02	7.76E+01	6.55E+02	-	-	1.94E+03

Exhibit D-27. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	9.03E+00	-4.75E-01	3.96E+01	4.68E+00	2.06E+00	3.00E+00	2.90E+01	-	2.98E-01	3.91E+01	4.66E+00	2.06E+00	3.04E+00	2.93E+01	-	-	3.90E+01
2030	-	-	2.68E+00	5.85E+01	3.16E+01	-5.79E-01	9.23E+01	1.64E+01	7.20E+00	5.83E+00	5.63E+01	-	2.03E+00	8.78E+01	1.63E+01	7.20E+00	6.07E+00	5.80E+01	-	-	8.76E+01
2031	-	-	3.96E+00	8.66E+01	7.23E+01	6.30E-01	1.63E+02	3.74E+01	1.65E+01	8.47E+00	8.18E+01	-	6.18E+00	1.50E+02	3.73E+01	1.65E+01	9.22E+00	8.71E+01	-	-	1.50E+02
2032	-	-	5.21E+00	1.14E+02	1.22E+02	3.41E+00	2.44E+02	6.32E+01	2.78E+01	1.09E+01	1.06E+02	-	1.28E+01	2.21E+02	6.29E+01	2.78E+01	1.25E+01	1.17E+02	-	-	2.20E+02
2033	-	-	6.42E+00	1.40E+02	1.76E+02	7.14E+00	3.30E+02	9.13E+01	4.01E+01	1.33E+01	1.28E+02	-	2.12E+01	2.94E+02	9.08E+01	4.01E+01	1.59E+01	1.46E+02	-	-	2.93E+02
2034	-	-	7.60E+00	1.66E+02	2.30E+02	1.09E+01	4.15E+02	1.19E+02	5.25E+01	1.55E+01	1.49E+02	-	3.04E+01	3.67E+02	1.19E+02	5.25E+01	1.92E+01	1.75E+02	-	-	3.66E+02
2035	-	-	8.74E+00	1.91E+02	2.85E+02	1.42E+01	4.99E+02	1.47E+02	6.48E+01	1.75E+01	1.69E+02	-	3.99E+01	4.39E+02	1.47E+02	6.48E+01	2.24E+01	2.03E+02	-	-	4.37E+02
2036	-	-	9.86E+00	2.15E+02	3.39E+02	1.70E+01	5.81E+02	1.76E+02	7.72E+01	1.94E+01	1.88E+02	-	4.95E+01	5.09E+02	1.75E+02	7.72E+01	2.55E+01	2.30E+02	-	-	5.07E+02
2037	-	-	1.09E+01	2.39E+02	3.93E+02	1.93E+01	6.62E+02	2.04E+02	8.95E+01	2.12E+01	2.05E+02	-	5.93E+01	5.79E+02	2.03E+02	8.95E+01	2.84E+01	2.56E+02	-	-	5.76E+02
2038	-	-	1.20E+01	2.62E+02	4.47E+02	2.13E+01	7.43E+02	2.32E+02	1.02E+02	2.29E+01	2.21E+02	-	6.93E+01	6.47E+02	2.31E+02	1.02E+02	3.13E+01	2.80E+02	-	-	6.44E+02
2039	-	-	1.30E+01	2.84E+02	5.01E+02	2.30E+01	8.22E+02	2.60E+02	1.14E+02	2.44E+01	2.36E+02	-	7.94E+01	7.14E+02	2.59E+02	1.14E+02	3.41E+01	3.04E+02	-	-	7.11E+02
2040	-	-	1.40E+01	3.06E+02	5.56E+02	2.42E+01	9.00E+02	2.88E+02	1.27E+02	2.59E+01	2.50E+02	-	8.95E+01	7.80E+02	2.86E+02	1.27E+02	3.68E+01	3.27E+02	-	-	7.77E+02
2041	-	-	1.50E+01	3.27E+02	6.10E+02	2.50E+01	9.77E+02	3.16E+02	1.39E+02	2.73E+01	2.64E+02	-	9.96E+01	8.45E+02	3.14E+02	1.39E+02	3.94E+01	3.49E+02	-	-	8.42E+02
2042	-	-	1.59E+01	3.48E+02	6.64E+02	2.55E+01	1.05E+03	3.44E+02	1.51E+02	2.86E+01	2.76E+02	-	1.10E+02	9.10E+02	3.42E+02	1.51E+02	4.19E+01	3.70E+02	-	-	9.05E+02
2043	-	-	1.68E+01	3.68E+02	7.18E+02	2.57E+01	1.13E+03	3.72E+02	1.64E+02	2.98E+01	2.88E+02	-	1.20E+02	9.73E+02	3.70E+02	1.64E+02	4.44E+01	3.90E+02	-	-	9.68E+02
2044	-	-	1.77E+01	3.88E+02	7.72E+02	2.57E+01	1.20E+03	4.00E+02	1.76E+02	3.09E+01	2.99E+02	-	1.30E+02	1.04E+03	3.98E+02	1.76E+02	4.67E+01	4.09E+02	-	-	1.03E+03
2045	-	-	1.86E+01	4.06E+02	8.27E+02	2.55E+01	1.28E+03	4.28E+02	1.88E+02	3.19E+01	3.09E+02	-	1.40E+02	1.10E+03	4.26E+02	1.88E+02	4.90E+01	4.28E+02	-	-	1.09E+03
2046	-	-	1.94E+01	4.25E+02	8.81E+02	2.51E+01	1.35E+03	4.56E+02	2.01E+02	3.29E+01	3.18E+02	-	1.50E+02	1.16E+03	4.54E+02	2.01E+02	5.12E+01	4.46E+02	-	-	1.15E+03
2047	-	-	2.03E+01	4.43E+02	9.35E+02	2.47E+01	1.42E+03	4.84E+02	2.13E+02	3.39E+01	3.27E+02	-	1.60E+02	1.22E+03	4.82E+02	2.13E+02	5.34E+01	4.64E+02	-	-	1.21E+03
2048	-	-	2.11E+01	4.60E+02	9.89E+02	2.41E+01	1.49E+03	5.13E+02	2.25E+02	3.47E+01	3.36E+02	-	1.70E+02	1.28E+03	5.10E+02	2.25E+02	5.55E+01	4.81E+02	-	-	1.27E+03
2049	-	-	2.18E+01	4.77E+02	1.04E+03	2.33E+01	1.57E+03	5.41E+02	2.38E+02	3.55E+01	3.43E+02	-	1.80E+02	1.34E+03	5.38E+02	2.38E+02	5.75E+01	4.97E+02	-	-	1.33E+03
2050	-	-	2.26E+01	4.94E+02	1.10E+03	2.25E+01	1.64E+03	5.69E+02	2.50E+02	3.63E+01	3.51E+02	-	1.90E+02	1.40E+03	5.66E+02	2.50E+02	5.95E+01	5.13E+02	-	-	1.39E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	1.15E+03	2.17E+01	1.71E+03	5.97E+02	2.62E+02	3.70E+01	3.58E+02	-	2.00E+02	1.45E+03	5.94E+02	2.62E+02	6.14E+01	5.29E+02	-	-	1.45E+03
2052	-	-	2.40E+01	5.26E+02	1.21E+03	2.07E+01	1.78E+03	6.25E+02	2.75E+02	3.77E+01	3.64E+02	-	2.09E+02	1.51E+03	6.22E+02	2.75E+02	6.32E+01	5.43E+02	-	-	1.50E+03
2053	-	-	2.47E+01	5.41E+02	1.26E+03	1.95E+01	1.85E+03	6.53E+02	2.87E+02	3.83E+01	3.70E+02	-	2.19E+02	1.57E+03	6.50E+02	2.87E+02	6.50E+01	5.58E+02	-	-	1.56E+03
2054	-	-	2.54E+01	5.56E+02	1.31E+03	1.81E+01	1.91E+03	6.81E+02	2.99E+02	3.89E+01	3.76E+02	-	2.28E+02	1.62E+03	6.78E+02	2.99E+02	6.68E+01	5.71E+02	-	-	1.62E+03
2055	-	-	2.61E+01	5.70E+02	1.37E+03	1.68E+01	1.98E+03	7.09E+02	3.12E+02	3.94E+01	3.81E+02	-	2.38E+02	1.68E+03	7.06E+02	3.12E+02	6.85E+01	5.85E+02	-	-	1.67E+03
2056	-	-	2.67E+01	5.84E+02	1.42E+03	1.54E+01	2.05E+03	7.37E+02	3.24E+02	4.00E+01	3.86E+02	-	2.47E+02	1.73E+03	7.34E+02	3.24E+02	7.01E+01	5.98E+02	-	-	1.73E+03
2057	-	-	2.74E+01	5.98E+02	1.48E+03	1.41E+01	2.12E+03	7.65E+02	3.36E+02	4.04E+01	3.91E+02	-	2.56E+02	1.79E+03	7.62E+02	3.36E+02	7.17E+01	6.10E+02	-	-	1.78E+03
2058	-	-	2.80E+01	6.11E+02	1.53E+03	1.25E+01	2.18E+03	7.91E+02	3.47E+02	4.09E+01	3.95E+02	-	2.65E+02	1.84E+03	7.87E+02	3.47E+02	7.33E+01	6.22E+02	-	-	1.83E+03
2059	-	-	2.86E+01	6.24E+02	1.56E+03	1.08E+01	2.23E+03	8.11E+02	3.56E+02	4.13E+01	3.99E+02	-	2.74E+02	1.88E+03	8.07E+02	3.56E+02	7.48E+01	6.34E+02	-	-	1.87E+03
2060	-	-	2.91E+01	6.37E+02	1.60E+03	9.02E+00	2.27E+03	8.27E+02	3.63E+02	4.17E+01	4.03E+02	-	2.82E+02	1.92E+03	8.23E+02	3.63E+02	7.62E+01	6.45E+02	-	-	1.91E+03
2061	-	-	2.97E+01	6.49E+02	1.62E+03	7.07E+00	2.31E+03	8.40E+02	3.69E+02	4.21E+01	4.07E+02	-	2.91E+02	1.95E+03	8.35E+02	3.69E+02	7.76E+01	6.55E+02	-	-	1.94E+03

Exhibit D-28. Cumulative Emissions Profile AR5 20-yr – NGCC with CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.36E+00	2.97E+01	8.99E+00	-4.75E-01	3.96E+01	4.68E+00	2.60E+00	3.00E+00	2.90E+01	-	2.98E-01	3.96E+01	4.66E+00	2.60E+00	3.04E+00	2.93E+01	-	-	3.96E+01
2030	-	-	2.68E+00	5.85E+01	3.15E+01	-5.79E-01	9.21E+01	1.64E+01	9.10E+00	5.82E+00	5.63E+01	-	2.03E+00	8.97E+01	1.63E+01	9.10E+00	6.07E+00	5.80E+01	-	-	8.95E+01
2031	-	-	3.96E+00	8.66E+01	7.19E+01	6.30E-01	1.63E+02	3.74E+01	2.08E+01	8.46E+00	8.18E+01	-	6.18E+00	1.55E+02	3.73E+01	2.08E+01	9.22E+00	8.71E+01	-	-	1.54E+02
2032	-	-	5.21E+00	1.14E+02	1.21E+02	3.41E+00	2.44E+02	6.32E+01	3.51E+01	1.09E+01	1.06E+02	-	1.28E+01	2.28E+02	6.29E+01	3.51E+01	1.25E+01	1.17E+02	-	-	2.27E+02
2033	-	-	6.42E+00	1.40E+02	1.75E+02	7.14E+00	3.29E+02	9.13E+01	5.07E+01	1.33E+01	1.28E+02	-	2.12E+01	3.05E+02	9.08E+01	5.07E+01	1.59E+01	1.46E+02	-	-	3.04E+02
2034	-	-	7.60E+00	1.66E+02	2.29E+02	1.09E+01	4.14E+02	1.19E+02	6.63E+01	1.55E+01	1.49E+02	-	3.04E+01	3.81E+02	1.19E+02	6.63E+01	1.92E+01	1.75E+02	-	-	3.80E+02
2035	-	-	8.74E+00	1.91E+02	2.83E+02	1.42E+01	4.97E+02	1.47E+02	8.19E+01	1.75E+01	1.69E+02	-	3.99E+01	4.56E+02	1.47E+02	8.19E+01	2.24E+01	2.03E+02	-	-	4.54E+02
2036	-	-	9.86E+00	2.15E+02	3.37E+02	1.70E+01	5.79E+02	1.76E+02	9.75E+01	1.94E+01	1.88E+02	-	4.95E+01	5.30E+02	1.75E+02	9.75E+01	2.54E+01	2.30E+02	-	-	5.28E+02
2037	-	-	1.09E+01	2.39E+02	3.91E+02	1.93E+01	6.60E+02	2.04E+02	1.13E+02	2.12E+01	2.05E+02	-	5.93E+01	6.02E+02	2.03E+02	1.13E+02	2.84E+01	2.56E+02	-	-	6.00E+02
2038	-	-	1.20E+01	2.62E+02	4.45E+02	2.13E+01	7.40E+02	2.32E+02	1.29E+02	2.29E+01	2.21E+02	-	6.93E+01	6.74E+02	2.31E+02	1.29E+02	3.13E+01	2.80E+02	-	-	6.71E+02
2039	-	-	1.30E+01	2.84E+02	4.99E+02	2.30E+01	8.19E+02	2.60E+02	1.44E+02	2.44E+01	2.36E+02	-	7.94E+01	7.44E+02	2.58E+02	1.44E+02	3.41E+01	3.04E+02	-	-	7.41E+02
2040	-	-	1.40E+01	3.06E+02	5.53E+02	2.42E+01	8.97E+02	2.88E+02	1.60E+02	2.59E+01	2.50E+02	-	8.95E+01	8.14E+02	2.86E+02	1.60E+02	3.68E+01	3.27E+02	-	-	8.10E+02
2041	-	-	1.50E+01	3.27E+02	6.07E+02	2.50E+01	9.74E+02	3.16E+02	1.76E+02	2.73E+01	2.64E+02	-	9.96E+01	8.82E+02	3.14E+02	1.76E+02	3.94E+01	3.49E+02	-	-	8.78E+02
2042	-	-	1.59E+01	3.48E+02	6.61E+02	2.55E+01	1.05E+03	3.44E+02	1.91E+02	2.86E+01	2.76E+02	-	1.10E+02	9.49E+02	3.42E+02	1.91E+02	4.19E+01	3.70E+02	-	-	9.45E+02
2043	-	-	1.68E+01	3.68E+02	7.15E+02	2.57E+01	1.13E+03	3.72E+02	2.07E+02	2.98E+01	2.88E+02	-	1.20E+02	1.02E+03	3.70E+02	2.07E+02	4.44E+01	3.90E+02	-	-	1.01E+03
2044	-	-	1.77E+01	3.88E+02	7.68E+02	2.57E+01	1.20E+03	4.00E+02	2.22E+02	3.09E+01	2.99E+02	-	1.30E+02	1.08E+03	3.98E+02	2.22E+02	4.67E+01	4.09E+02	-	-	1.08E+03
2045	-	-	1.86E+01	4.06E+02	8.22E+02	2.55E+01	1.27E+03	4.28E+02	2.38E+02	3.19E+01	3.09E+02	-	1.40E+02	1.15E+03	4.26E+02	2.38E+02	4.90E+01	4.28E+02	-	-	1.14E+03
2046	-	-	1.94E+01	4.25E+02	8.76E+02	2.51E+01	1.35E+03	4.56E+02	2.54E+02	3.29E+01	3.18E+02	-	1.50E+02	1.21E+03	4.54E+02	2.54E+02	5.12E+01	4.46E+02	-	-	1.21E+03
2047	-	-	2.03E+01	4.43E+02	9.30E+02	2.47E+01	1.42E+03	4.84E+02	2.69E+02	3.38E+01	3.27E+02	-	1.60E+02	1.27E+03	4.82E+02	2.69E+02	5.34E+01	4.64E+02	-	-	1.27E+03
2048	-	-	2.11E+01	4.60E+02	9.84E+02	2.41E+01	1.49E+03	5.13E+02	2.85E+02	3.47E+01	3.36E+02	-	1.70E+02	1.34E+03	5.10E+02	2.85E+02	5.55E+01	4.81E+02	-	-	1.33E+03
2049	-	-	2.18E+01	4.77E+02	1.04E+03	2.33E+01	1.56E+03	5.41E+02	3.00E+02	3.55E+01	3.43E+02	-	1.80E+02	1.40E+03	5.38E+02	3.00E+02	5.75E+01	4.97E+02	-	-	1.39E+03
2050	-	-	2.26E+01	4.94E+02	1.09E+03	2.25E+01	1.63E+03	5.69E+02	3.16E+02	3.63E+01	3.51E+02	-	1.90E+02	1.46E+03	5.66E+02	3.16E+02	5.95E+01	5.13E+02	-	-	1.45E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.33E+01	5.10E+02	1.15E+03	2.17E+01	1.70E+03	5.97E+02	3.32E+02	3.70E+01	3.58E+02	-	2.00E+02	1.52E+03	5.94E+02	3.32E+02	6.14E+01	5.29E+02	-	-	1.52E+03
2052	-	-	2.40E+01	5.26E+02	1.20E+03	2.07E+01	1.77E+03	6.25E+02	3.47E+02	3.77E+01	3.64E+02	-	2.09E+02	1.58E+03	6.22E+02	3.47E+02	6.32E+01	5.43E+02	-	-	1.58E+03
2053	-	-	2.47E+01	5.41E+02	1.25E+03	1.95E+01	1.84E+03	6.53E+02	3.63E+02	3.83E+01	3.70E+02	-	2.19E+02	1.64E+03	6.50E+02	3.63E+02	6.50E+01	5.58E+02	-	-	1.64E+03
2054	-	-	2.54E+01	5.56E+02	1.31E+03	1.81E+01	1.91E+03	6.81E+02	3.78E+02	3.89E+01	3.76E+02	-	2.28E+02	1.70E+03	6.78E+02	3.78E+02	6.68E+01	5.71E+02	-	-	1.69E+03
2055	-	-	2.61E+01	5.70E+02	1.36E+03	1.68E+01	1.97E+03	7.09E+02	3.94E+02	3.94E+01	3.81E+02	-	2.38E+02	1.76E+03	7.06E+02	3.94E+02	6.85E+01	5.85E+02	-	-	1.75E+03
2056	-	-	2.67E+01	5.84E+02	1.42E+03	1.54E+01	2.04E+03	7.37E+02	4.10E+02	4.00E+01	3.86E+02	-	2.47E+02	1.82E+03	7.34E+02	4.10E+02	7.01E+01	5.98E+02	-	-	1.81E+03
2057	-	-	2.74E+01	5.98E+02	1.47E+03	1.41E+01	2.11E+03	7.65E+02	4.25E+02	4.04E+01	3.91E+02	-	2.56E+02	1.88E+03	7.62E+02	4.25E+02	7.17E+01	6.10E+02	-	-	1.87E+03
2058	-	-	2.80E+01	6.11E+02	1.52E+03	1.25E+01	2.17E+03	7.90E+02	4.39E+02	4.09E+01	3.95E+02	-	2.65E+02	1.93E+03	7.87E+02	4.39E+02	7.33E+01	6.22E+02	-	-	1.92E+03
2059	-	-	2.86E+01	6.24E+02	1.56E+03	1.08E+01	2.22E+03	8.11E+02	4.50E+02	4.13E+01	3.99E+02	-	2.74E+02	1.98E+03	8.07E+02	4.50E+02	7.48E+01	6.34E+02	-	-	1.97E+03
2060	-	-	2.91E+01	6.37E+02	1.59E+03	9.02E+00	2.26E+03	8.27E+02	4.59E+02	4.17E+01	4.03E+02	-	2.82E+02	2.01E+03	8.23E+02	4.59E+02	7.62E+01	6.45E+02	-	-	2.00E+03
2061	-	-	2.97E+01	6.49E+02	1.61E+03	7.07E+00	2.30E+03	8.40E+02	4.67E+02	4.21E+01	4.07E+02	-	2.91E+02	2.05E+03	8.35E+02	4.67E+02	7.76E+01	6.55E+02	-	-	2.04E+03

Exhibit D-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.75E+02	6.79E+02	6.79E+02	7.00E+02
Lower GOR	6.76E+02	6.80E+02	6.80E+02	7.01E+02
Higher GOR	6.74E+02	6.78E+02	6.78E+02	6.99E+02

Exhibit D-30. CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR5 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.75E+02	6.79E+02	6.79E+02	7.00E+02
Decrease in Methane Emissions	6.70E+02	6.74E+02	6.74E+02	6.94E+02
Increase in Methane Emissions	6.80E+02	6.84E+02	6.84E+02	7.05E+02

Appendix E: AR6 100-yr Results

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR6 – 100-yr)
- Multiproduct Functional Unit – South Korea (AR6 – 100-yr)
- Multiproduct Functional Unit – China (AR6 – 100-yr)
- Multiproduct Functional Unit – India (AR6 – 100-yr)
- Single Product Functional Unit in kg CO2e – Japan (AR6 – 100-yr)
- Single Product Functional Unit in kg CO2e – South Korea (AR6 – 100-yr)
- Single Product Functional Unit in kg CO2e – China (AR6 – 100-yr)
- Single Product Functional Unit in kg CO2e – India (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 100-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 100-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 100-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR6 – 100-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR6 – 100-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR6 – 100-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR6 – 100-yr)

Exhibit E-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.44E+01	3.44E+01	-	3.88E+01	3.88E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.44E+00	3.44E+00
Natural Gas Processing at GTP	-	2.23E+01	2.23E+01	-	2.51E+01	2.51E+01
CO2 Compression and Sequestration	-	7.04E-01	-	-	7.92E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.27E+00	9.27E+00	-	1.04E+01	1.04E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	1.85E+01	1.85E+01	-	2.08E+01	2.08E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.51E+00	2.57E+00	2.57E+00	2.83E+00	2.89E+00	2.89E+00
Crude Oil Extraction, CO2-EOR	-	-	6.03E+00	-	-	6.79E+00
CO2-EOR Crude Oil Transport	-	-	7.91E-01	-	-	8.90E-01
Crude Oil Alaskan Pipeline Transport	1.59E+00	8.21E-01	8.21E-01	1.79E+00	9.24E-01	9.24E-01
Crude Oil Ocean Transport	8.48E-01	4.60E-01	9.03E-01	9.55E-01	5.17E-01	1.02E+00
Crude Oil Refining and End Use	1.14E+02	5.89E+01	1.16E+02	1.28E+02	6.63E+01	1.30E+02
Construction	-	4.82E-01	4.82E-01	-	5.42E-01	5.42E-01
System Expansion: US Average Crude Oil Production and End Use	2.01E+01	8.19E+01	1.81E+01	3.98E+00	7.36E+01	1.79E+00
System Expansion: US Lower 48 LNG Export and End Use	5.15E+02	-	-	2.32E+02	-	-
Total	6.54E+02	6.09E+02	6.08E+02	3.70E+02	3.25E+02	3.24E+02
Upper	2.40E+01	4.53E+01	4.14E+01	2.60E+01	4.59E+01	4.89E+01
Lower	1.32E+01	1.04E+01	1.02E+01	1.51E+01	1.17E+01	1.17E+01

Exhibit E-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.45E+01	3.45E+01	-	3.88E+01	3.88E+01
Natural Gas Pipelines to GTP	-	3.07E+00	3.07E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.23E+01	2.23E+01	-	2.51E+01	2.51E+01
CO2 Compression and Sequestration	-	7.05E-01	-	-	7.94E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.15E+01	2.15E+01	-	2.42E+01	2.42E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.52E+00	2.57E+00	2.57E+00	2.83E+00	2.90E+00	2.90E+00
Crude Oil Extraction, CO2-EOR	-	-	6.04E+00	-	-	6.80E+00
CO2-EOR Crude Oil Transport	-	-	7.92E-01	-	-	8.92E-01
Crude Oil Alaskan Pipeline Transport	1.59E+00	8.22E-01	8.22E-01	1.79E+00	9.26E-01	9.26E-01
Crude Oil Ocean Transport	8.50E-01	4.61E-01	9.04E-01	9.57E-01	5.18E-01	1.02E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.83E-01	4.83E-01	-	5.43E-01	5.43E-01
System Expansion: US Average Crude Oil Production and End Use	1.98E+01	8.18E+01	1.78E+01	3.71E+00	7.35E+01	1.51E+00
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	6.57E+02	6.12E+02	6.11E+02	3.74E+02	3.28E+02	3.28E+02
Upper	2.37E+01	4.07E+01	4.18E+01	2.72E+01	5.07E+01	4.33E+01
Lower	1.45E+01	1.09E+01	9.98E+00	1.57E+01	1.20E+01	1.14E+01

Exhibit E-3. Multiproduct Functional Unit in kg CO_2e – China (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.45E+01	3.45E+01	-	3.88E+01	3.88E+01
Natural Gas Pipelines to GTP	-	3.07E+00	3.07E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.23E+01	2.23E+01	-	2.51E+01	2.51E+01
CO2 Compression and Sequestration	-	7.06E-01	-	-	7.94E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.17E+01	2.17E+01	-	2.44E+01	2.44E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.52E+00	2.57E+00	2.57E+00	2.83E+00	2.90E+00	2.90E+00
Crude Oil Extraction, CO2-EOR	-	-	6.04E+00	-	-	6.80E+00
CO2-EOR Crude Oil Transport	-	-	7.93E-01	-	-	8.92E-01
Crude Oil Alaskan Pipeline Transport	1.59E+00	8.23E-01	8.23E-01	1.79E+00	9.26E-01	9.26E-01
Crude Oil Ocean Transport	8.50E-01	4.61E-01	9.04E-01	9.56E-01	5.18E-01	1.02E+00
Crude Oil Refining and End Use	1.14E+02	5.90E+01	1.16E+02	1.28E+02	6.64E+01	1.30E+02
Construction	-	4.83E-01	4.83E-01	-	5.43E-01	5.43E-01
System Expansion: US Average Crude Oil Production and End Use	1.98E+01	8.18E+01	1.78E+01	3.73E+00	7.35E+01	1.49E+00
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	6.58E+02	6.12E+02	6.12E+02	3.75E+02	3.29E+02	3.28E+02
Upper	2.37E+01	4.14E+01	4.47E+01	2.70E+01	4.49E+01	4.39E+01
Lower	1.43E+01	1.04E+01	1.03E+01	1.58E+01	1.09E+01	1.21E+01

Exhibit E-4. Multiproduct Functional Unit in kg CO_2e – India (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.49E+01	3.49E+01	-	3.92E+01	3.92E+01
Natural Gas Pipelines to GTP	-	3.10E+00	3.10E+00	-	3.48E+00	3.48E+00
Natural Gas Processing at GTP	-	2.25E+01	2.25E+01	-	2.54E+01	2.54E+01
CO2 Compression and Sequestration	-	7.13E-01	-	-	8.02E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.38E+00	9.38E+00	-	1.06E+01	1.06E+01
Liquefaction	-	2.97E+01	2.97E+01	-	3.35E+01	3.35E+01
Ocean Transport	-	3.76E+01	3.76E+01	-	4.23E+01	4.23E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	2.54E+00	2.60E+00	2.60E+00	2.86E+00	2.93E+00	2.93E+00
Crude Oil Extraction, CO2-EOR	-	-	6.10E+00	-	-	6.87E+00
CO2-EOR Crude Oil Transport	-	-	8.01E-01	-	-	9.01E-01
Crude Oil Alaskan Pipeline Transport	1.61E+00	8.31E-01	8.31E-01	1.81E+00	9.35E-01	9.35E-01
Crude Oil Ocean Transport	8.59E-01	4.65E-01	9.14E-01	9.66E-01	5.24E-01	1.03E+00
Crude Oil Refining and End Use	1.15E+02	5.96E+01	1.17E+02	1.30E+02	6.71E+01	1.32E+02
Construction	-	4.88E-01	4.88E-01	-	5.49E-01	5.49E-01
System Expansion: US Average Crude Oil Production and End Use	1.85E+01	8.11E+01	1.65E+01	2.22E+00	7.27E+01	-
System Expansion: US Lower 48 LNG Export and End Use	5.17E+02	-	-	2.35E+02	-	-
Total	6.56E+02	6.29E+02	6.28E+02	3.73E+02	3.48E+02	3.47E+02
Upper	2.25E+01	4.79E+01	3.87E+01	2.68E+01	5.10E+01	4.64E+01
Lower	1.38E+01	1.01E+01	1.01E+01	1.56E+01	1.19E+01	1.15E+01

Exhibit E-5. Single Product Functional Unit in kg CO_2e – Japan (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.44E+01	3.44E+01	-	3.88E+01	3.88E+01
Natural Gas Pipelines to GTP	-	3.06E+00	3.06E+00	-	3.44E+00	3.44E+00
Natural Gas Processing at GTP	-	2.23E+01	2.23E+01	-	2.51E+01	2.51E+01
CO2 Compression and Sequestration	-	6.06E-01	-	-	6.81E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.27E+00	9.27E+00	-	1.04E+01	1.04E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	1.85E+01	1.85E+01	-	2.08E+01	2.08E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.82E-01	4.82E-01	-	5.42E-01	5.42E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.15E+02	-	-	2.32E+02	-	-
Total	5.15E+02	4.64E+02	4.63E+02	2.32E+02	1.80E+02	1.80E+02
Upper	1.80E+01	3.45E+01	3.15E+01	2.02E+01	2.55E+01	2.71E+01
Lower	1.16E+01	7.95E+00	7.73E+00	1.32E+01	6.52E+00	6.49E+00

Exhibit E-6. Single Product Functional Unit in kg CO_2e – South Korea (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.45E+01	3.45E+01	-	3.88E+01	3.88E+01
Natural Gas Pipelines to GTP	-	3.07E+00	3.07E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.23E+01	2.23E+01	-	2.51E+01	2.51E+01
CO2 Compression and Sequestration	-	6.07E-01	-	-	6.83E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.15E+01	2.15E+01	-	2.42E+01	2.42E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.83E-01	4.83E-01	-	5.43E-01	5.43E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	5.19E+02	4.67E+02	4.67E+02	2.37E+02	1.84E+02	1.83E+02
Upper	1.83E+01	3.10E+01	3.19E+01	2.03E+01	2.84E+01	2.42E+01
Lower	1.29E+01	8.33E+00	7.62E+00	1.39E+01	6.73E+00	6.40E+00

Exhibit E-7. Single Product Functional Unit in kg CO_2e – China (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.45E+01	3.45E+01	-	3.88E+01	3.88E+01
Natural Gas Pipelines to GTP	-	3.07E+00	3.07E+00	-	3.45E+00	3.45E+00
Natural Gas Processing at GTP	-	2.23E+01	2.23E+01	-	2.51E+01	2.51E+01
CO2 Compression and Sequestration	-	6.07E-01	-	-	6.83E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.29E+00	9.29E+00	-	1.05E+01	1.05E+01
Liquefaction	-	2.94E+01	2.94E+01	-	3.31E+01	3.31E+01
Ocean Transport	-	2.17E+01	2.17E+01	-	2.44E+01	2.44E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.83E-01	4.83E-01	-	5.43E-01	5.43E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.19E+02	-	-	2.37E+02	-	-
Total	5.19E+02	4.67E+02	4.67E+02	2.37E+02	1.84E+02	1.84E+02
Upper	1.81E+01	3.16E+01	3.41E+01	2.08E+01	2.52E+01	2.46E+01
Lower	1.27E+01	7.97E+00	7.87E+00	1.39E+01	6.13E+00	6.75E+00

Exhibit E-8. Single Product Functional Unit in kg CO_2e – India (AR6 – 100-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	3.49E+01	3.49E+01	-	3.92E+01	3.92E+01
Natural Gas Pipelines to GTP	-	3.10E+00	3.10E+00	-	3.48E+00	3.48E+00
Natural Gas Processing at GTP	-	2.25E+01	2.25E+01	-	2.54E+01	2.54E+01
CO2 Compression and Sequestration	-	6.13E-01	-	-	6.90E-01	-
Natural Gas Alaskan Pipeline Transport	-	9.38E+00	9.38E+00	-	1.06E+01	1.06E+01
Liquefaction	-	2.97E+01	2.97E+01	-	3.35E+01	3.35E+01
Ocean Transport	-	3.76E+01	3.76E+01	-	4.23E+01	4.23E+01
LNG Regasification	-	3.50E+00	3.50E+00	-	3.93E+00	3.93E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.37E+01	4.37E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.88E-01	4.88E-01	-	5.49E-01	5.49E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	5.17E+02	-	-	2.35E+02	-	-
Total	5.17E+02	4.84E+02	4.84E+02	2.35E+02	2.03E+02	2.03E+02
Upper	1.71E+01	3.68E+01	2.98E+01	2.09E+01	2.99E+01	2.71E+01
Lower	1.21E+01	7.80E+00	7.80E+00	1.37E+01	6.96E+00	6.70E+00

Exhibit E-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	5.36E-02	-	-	2.51E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	6.84E-02	7.41E-03	5.75E-09	1.59E+00
Crude Oil Ocean Transport	8.24E-01	2.38E-02	-	8.54E-07	8.48E-01
Crude Oil Refining and End Use	1.14E+02	1.92E-01	5.20E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.96E+01	4.56E-01	1.17E-02	-	2.01E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	5.06E+01	3.09E-01	1.89E-07	5.15E+02
Construction	-	-	-	-	-
Total	6.02E+02	-	-	-	6.02E+02

Exhibit E-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	5.37E-02	-	-	2.52E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	6.86E-02	7.43E-03	5.76E-09	1.59E+00
Crude Oil Ocean Transport	8.26E-01	2.39E-02	-	8.56E-07	8.50E-01
Crude Oil Refining and End Use	1.14E+02	1.92E-01	5.22E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	4.50E-01	1.15E-02	-	1.98E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	5.10E+01	3.18E-01	1.90E-07	5.19E+02
Construction	-	-	-	-	-
Total	6.05E+02	5.18E+01	3.42E-01	1.05E-06	6.57E+02

Exhibit E-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	5.37E-02	-	-	2.52E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	6.85E-02	7.43E-03	5.76E-09	1.59E+00
Crude Oil Ocean Transport	8.26E-01	2.39E-02	-	8.56E-07	8.50E-01
Crude Oil Refining and End Use	1.14E+02	1.92E-01	5.21E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.94E+01	4.51E-01	1.15E-02	-	1.98E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	5.10E+01	3.19E-01	1.90E-07	5.19E+02
Construction	-	-	-	-	-
Total	6.05E+02	5.18E+01	3.43E-01	1.05E-06	6.58E+02

Exhibit E-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.49E+00	5.43E-02	-	-	2.54E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.53E+00	6.92E-02	7.50E-03	5.82E-09	1.61E+00
Crude Oil Ocean Transport	8.34E-01	2.41E-02	-	8.65E-07	8.59E-01
Crude Oil Refining and End Use	1.15E+02	1.94E-01	5.27E-03	-	1.15E+02
System Expansion: US Average Crude Oil Production and End Use	1.81E+01	4.21E-01	1.08E-02	-	1.85E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	5.09E+01	3.15E-01	1.90E-07	5.17E+02
Construction	-	-	-	-	-
Total	6.04E+02	5.16E+01	3.39E-01	1.06E-06	6.56E+02

Exhibit E-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.59E+01	-	-	3.44E+01
Natural Gas Pipelines to GTP	2.14E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.18E+01	4.65E-01	2.48E-05	-	2.23E+01
CO2 Compression and Sequestration	6.56E-01	4.42E-02	1.42E-03	2.13E-03	7.04E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.10E+00	5.17E-07	-	9.27E+00
Liquefaction	2.25E+01	6.93E+00	-	1.37E-07	2.94E+01
Ocean Transport	1.68E+01	1.70E+00	-	-	1.85E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	1.13E+00	-	-	2.57E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.82E-01	3.54E-02	3.83E-03	2.97E-09	8.21E-01
Crude Oil Ocean Transport	4.42E-01	1.75E-02	-	6.32E-07	4.60E-01
Crude Oil Refining and End Use	5.88E+01	9.93E-02	2.69E-03	-	5.89E+01
System Expansion: US Average Crude Oil Production and End Use	8.00E+01	1.86E+00	4.77E-02	-	8.19E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	8.75E-03	2.41E-03	-	4.82E-01
Total	5.73E+02	3.58E+01	5.81E-02	2.23E-03	6.09E+02

Exhibit E-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.59E+01	-	-	3.45E+01
Natural Gas Pipelines to GTP	2.15E-03	3.06E+00	-	-	3.07E+00
Natural Gas Processing at GTP	2.18E+01	4.66E-01	2.49E-05	-	2.23E+01
CO2 Compression and Sequestration	6.58E-01	4.43E-02	1.43E-03	2.14E-03	7.05E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	-	1.38E-07	2.94E+01
Ocean Transport	1.95E+01	2.02E+00	-	-	2.15E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.13E+00	-	-	2.57E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	3.54E-02	3.84E-03	2.98E-09	8.22E-01
Crude Oil Ocean Transport	4.43E-01	1.75E-02	-	6.33E-07	4.61E-01
Crude Oil Refining and End Use	5.89E+01	9.95E-02	2.70E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	1.86E+00	4.77E-02	-	8.18E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	8.77E-03	2.41E-03	-	4.83E-01
Total	5.76E+02	3.61E+01	5.81E-02	2.23E-03	6.12E+02

Exhibit E-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.59E+01	-	-	3.45E+01
Natural Gas Pipelines to GTP	2.15E-03	3.06E+00	-	-	3.07E+00
Natural Gas Processing at GTP	2.18E+01	4.66E-01	2.49E-05	-	2.23E+01
CO2 Compression and Sequestration	6.58E-01	4.43E-02	1.43E-03	2.14E-03	7.06E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	-	1.38E-07	2.94E+01
Ocean Transport	1.96E+01	2.03E+00	-	-	2.17E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.13E+00	-	-	2.57E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	3.55E-02	3.84E-03	2.98E-09	8.23E-01
Crude Oil Ocean Transport	4.43E-01	1.75E-02	-	6.33E-07	4.61E-01
Crude Oil Refining and End Use	5.89E+01	9.95E-02	2.70E-03	-	5.90E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	1.86E+00	4.77E-02	-	8.18E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	8.77E-03	2.41E-03	-	4.83E-01
Total	5.76E+02	3.62E+01	5.81E-02	2.23E-03	6.12E+02

Exhibit E-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	1.61E+01	-	-	3.49E+01
Natural Gas Pipelines to GTP	2.17E-03	3.09E+00	-	-	3.10E+00
Natural Gas Processing at GTP	2.21E+01	4.71E-01	2.51E-05	-	2.25E+01
CO2 Compression and Sequestration	6.64E-01	4.47E-02	1.44E-03	2.16E-03	7.13E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	4.15E+00	5.24E-07	-	9.38E+00
Liquefaction	2.27E+01	7.01E+00	-	1.39E-07	2.97E+01
Ocean Transport	3.39E+01	3.74E+00	-	-	3.76E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	1.14E+00	-	-	2.60E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.91E-01	3.58E-02	3.88E-03	3.01E-09	8.31E-01
Crude Oil Ocean Transport	4.48E-01	1.77E-02	-	6.40E-07	4.65E-01
Crude Oil Refining and End Use	5.95E+01	1.01E-01	2.72E-03	-	5.96E+01
System Expansion: US Average Crude Oil Production and End Use	7.92E+01	1.84E+00	4.73E-02	-	8.11E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	8.86E-03	2.44E-03	-	4.88E-01
Total	5.91E+02	3.82E+01	5.78E-02	2.25E-03	6.29E+02

Exhibit E-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.59E+01	-	-	3.44E+01
Natural Gas Pipelines to GTP	2.14E-03	3.06E+00	-	-	3.06E+00
Natural Gas Processing at GTP	2.18E+01	4.65E-01	2.48E-05	-	2.23E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	4.10E+00	5.17E-07	-	9.27E+00
Liquefaction	2.25E+01	6.93E+00	-	1.37E-07	2.94E+01
Ocean Transport	1.68E+01	1.70E+00	-	-	1.85E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	1.13E+00	-	-	2.57E+00
Crude Oil Extraction, CO2-EOR	5.58E+00	4.01E-01	1.78E-02	2.77E-02	6.03E+00
CO2-EOR Crude Oil Transport	7.53E-01	3.41E-02	3.69E-03	2.87E-09	7.91E-01
Crude Oil Alaskan Pipeline Transport	7.82E-01	3.54E-02	3.83E-03	2.97E-09	8.21E-01
Crude Oil Ocean Transport	8.68E-01	3.43E-02	-	1.24E-06	9.03E-01
Crude Oil Refining and End Use	1.15E+02	1.95E-01	5.28E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.77E+01	4.11E-01	1.05E-02	-	1.81E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	8.75E-03	2.41E-03	-	4.82E-01
Total	5.73E+02	3.48E+01	4.36E-02	2.78E-02	6.08E+02

Exhibit E-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.59E+01	-	-	3.45E+01
Natural Gas Pipelines to GTP	2.15E-03	3.06E+00	-	-	3.07E+00
Natural Gas Processing at GTP	2.18E+01	4.66E-01	2.49E-05	-	2.23E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	-	1.38E-07	2.94E+01
Ocean Transport	1.95E+01	2.02E+00	-	-	2.15E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.13E+00	-	-	2.57E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	4.02E-01	1.79E-02	2.78E-02	6.04E+00
CO2-EOR Crude Oil Transport	7.55E-01	3.42E-02	3.70E-03	2.87E-09	7.92E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	3.54E-02	3.84E-03	2.98E-09	8.22E-01
Crude Oil Ocean Transport	8.70E-01	3.44E-02	-	1.24E-06	9.04E-01
Crude Oil Refining and End Use	1.16E+02	1.95E-01	5.29E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	4.06E-01	1.04E-02	-	1.78E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	8.77E-03	2.41E-03	-	4.83E-01
Total	5.76E+02	3.52E+01	4.35E-02	2.78E-02	6.11E+02

Exhibit E-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	1.59E+01	-	-	3.45E+01
Natural Gas Pipelines to GTP	2.15E-03	3.06E+00	-	-	3.07E+00
Natural Gas Processing at GTP	2.18E+01	4.66E-01	2.49E-05	-	2.23E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	4.10E+00	5.18E-07	-	9.29E+00
Liquefaction	2.25E+01	6.94E+00	-	1.38E-07	2.94E+01
Ocean Transport	1.96E+01	2.03E+00	-	-	2.17E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	1.13E+00	-	-	2.57E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	4.02E-01	1.79E-02	2.78E-02	6.04E+00
CO2-EOR Crude Oil Transport	7.55E-01	3.42E-02	3.70E-03	2.87E-09	7.93E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	3.55E-02	3.84E-03	2.98E-09	8.23E-01
Crude Oil Ocean Transport	8.70E-01	3.44E-02	-	1.24E-06	9.04E-01
Crude Oil Refining and End Use	1.16E+02	1.95E-01	5.30E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	4.05E-01	1.04E-02	-	1.78E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	8.77E-03	2.41E-03	-	4.83E-01
Total	5.76E+02	3.52E+01	4.35E-02	2.78E-02	6.12E+02

Exhibit E-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 100-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	1.61E+01	-	-	3.49E+01
Natural Gas Pipelines to GTP	2.17E-03	3.09E+00	-	-	3.10E+00
Natural Gas Processing at GTP	2.21E+01	4.71E-01	2.51E-05	-	2.25E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	4.15E+00	5.24E-07	-	9.38E+00
Liquefaction	2.27E+01	7.01E+00	-	1.39E-07	2.97E+01
Ocean Transport	3.39E+01	3.74E+00	-	-	3.76E+01
LNG Regasification	3.02E+00	4.77E-01	-	9.20E-05	3.50E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	1.14E+00	-	-	2.60E+00
Crude Oil Extraction, CO2-EOR	5.65E+00	4.06E-01	1.81E-02	2.80E-02	6.10E+00
CO2-EOR Crude Oil Transport	7.62E-01	3.45E-02	3.74E-03	2.90E-09	8.01E-01
Crude Oil Alaskan Pipeline Transport	7.91E-01	3.58E-02	3.88E-03	3.01E-09	8.31E-01
Crude Oil Ocean Transport	8.79E-01	3.47E-02	-	1.26E-06	9.14E-01
Crude Oil Refining and End Use	1.17E+02	1.97E-01	5.35E-03	-	1.17E+02
System Expansion: US Average Crude Oil Production and End Use	1.61E+01	3.75E-01	9.62E-03	-	1.65E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	8.86E-03	2.44E-03	-	4.88E-01
Total	5.91E+02	3.72E+01	4.31E-02	2.81E-02	6.28E+02

Exhibit E-21. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.51E+01	-4.55E-01	4.55E+01	2.94E+00	1.08E+01	1.89E+00	2.89E+01	-	2.86E-01	4.49E+01	2.92E+00	1.08E+01	1.92E+00	2.92E+01	-	-	4.49E+01
2030	-	-	2.53E+00	5.84E+01	5.29E+01	-5.55E-01	1.13E+02	1.03E+01	3.79E+01	3.67E+00	5.61E+01	-	1.94E+00	1.10E+02	1.02E+01	3.79E+01	3.89E+00	5.79E+01	-	-	1.10E+02
2031	-	-	3.75E+00	8.63E+01	1.21E+02	6.04E-01	2.12E+02	2.36E+01	8.66E+01	5.33E+00	8.16E+01	-	5.93E+00	2.03E+02	2.34E+01	8.66E+01	6.01E+00	8.68E+01	-	-	2.03E+02
2032	-	-	4.93E+00	1.13E+02	2.04E+02	3.27E+00	3.26E+02	3.98E+01	1.46E+02	6.89E+00	1.05E+02	-	1.23E+01	3.11E+02	3.95E+01	1.46E+02	8.29E+00	1.16E+02	-	-	3.10E+02
2033	-	-	6.08E+00	1.40E+02	2.95E+02	6.85E+00	4.47E+02	5.74E+01	2.11E+02	8.36E+00	1.28E+02	-	2.04E+01	4.25E+02	5.70E+01	2.11E+02	1.07E+01	1.46E+02	-	-	4.25E+02
2034	-	-	7.19E+00	1.66E+02	3.85E+02	1.04E+01	5.68E+02	7.51E+01	2.76E+02	9.73E+00	1.49E+02	-	2.91E+01	5.39E+02	7.46E+01	2.76E+02	1.30E+01	1.75E+02	-	-	5.38E+02
2035	-	-	8.27E+00	1.90E+02	4.76E+02	1.36E+01	6.88E+02	9.28E+01	3.41E+02	1.10E+01	1.69E+02	-	3.82E+01	6.52E+02	9.21E+01	3.41E+02	1.54E+01	2.03E+02	-	-	6.51E+02
2036	-	-	9.33E+00	2.15E+02	5.66E+02	1.63E+01	8.07E+02	1.10E+02	4.06E+02	1.22E+01	1.87E+02	-	4.75E+01	7.63E+02	1.10E+02	4.06E+02	1.76E+01	2.29E+02	-	-	7.62E+02
2037	-	-	1.04E+01	2.38E+02	6.57E+02	1.85E+01	9.24E+02	1.28E+02	4.71E+02	1.33E+01	2.04E+02	-	5.69E+01	8.74E+02	1.27E+02	4.71E+02	1.98E+01	2.55E+02	-	-	8.73E+02
2038	-	-	1.13E+01	2.61E+02	7.48E+02	2.05E+01	1.04E+03	1.46E+02	5.36E+02	1.44E+01	2.20E+02	-	6.65E+01	9.83E+02	1.45E+02	5.36E+02	2.20E+01	2.79E+02	-	-	9.82E+02
2039	-	-	1.23E+01	2.84E+02	8.38E+02	2.20E+01	1.16E+03	1.63E+02	6.01E+02	1.54E+01	2.35E+02	-	7.62E+01	1.09E+03	1.62E+02	6.01E+02	2.41E+01	3.03E+02	-	-	1.09E+03
2040	-	-	1.33E+01	3.05E+02	9.29E+02	2.32E+01	1.27E+03	1.81E+02	6.66E+02	1.63E+01	2.50E+02	-	8.59E+01	1.20E+03	1.80E+02	6.66E+02	2.61E+01	3.26E+02	-	-	1.20E+03
2041	-	-	1.42E+01	3.26E+02	1.02E+03	2.40E+01	1.38E+03	1.99E+02	7.31E+02	1.72E+01	2.63E+02	-	9.55E+01	1.31E+03	1.97E+02	7.31E+02	2.80E+01	3.48E+02	-	-	1.30E+03
2042	-	-	1.51E+01	3.47E+02	1.11E+03	2.45E+01	1.50E+03	2.16E+02	7.96E+02	1.80E+01	2.75E+02	-	1.05E+02	1.41E+03	2.15E+02	7.96E+02	2.99E+01	3.69E+02	-	-	1.41E+03
2043	-	-	1.59E+01	3.67E+02	1.20E+03	2.47E+01	1.61E+03	2.34E+02	8.61E+02	1.87E+01	2.87E+02	-	1.15E+02	1.52E+03	2.32E+02	8.61E+02	3.18E+01	3.89E+02	-	-	1.51E+03
2044	-	-	1.68E+01	3.86E+02	1.29E+03	2.46E+01	1.72E+03	2.52E+02	9.26E+02	1.94E+01	2.98E+02	-	1.24E+02	1.62E+03	2.50E+02	9.26E+02	3.36E+01	4.08E+02	-	-	1.62E+03
2045	-	-	1.76E+01	4.05E+02	1.38E+03	2.44E+01	1.83E+03	2.69E+02	9.91E+02	2.01E+01	3.08E+02	-	1.34E+02	1.72E+03	2.68E+02	9.91E+02	3.54E+01	4.27E+02	-	-	1.72E+03
2046	-	-	1.84E+01	4.24E+02	1.47E+03	2.41E+01	1.94E+03	2.87E+02	1.06E+03	2.07E+01	3.17E+02	-	1.44E+02	1.82E+03	2.85E+02	1.06E+03	3.71E+01	4.45E+02	-	-	1.82E+03
2047	-	-	1.92E+01	4.41E+02	1.56E+03	2.37E+01	2.05E+03	3.05E+02	1.12E+03	2.13E+01	3.26E+02	-	1.53E+02	1.93E+03	3.03E+02	1.12E+03	3.88E+01	4.62E+02	-	-	1.92E+03
2048	-	-	1.99E+01	4.59E+02	1.65E+03	2.31E+01	2.16E+03	3.22E+02	1.19E+03	2.19E+01	3.35E+02	-	1.63E+02	2.03E+03	3.20E+02	1.19E+03	4.04E+01	4.79E+02	-	-	2.03E+03
2049	-	-	2.07E+01	4.76E+02	1.74E+03	2.24E+01	2.26E+03	3.40E+02	1.25E+03	2.24E+01	3.42E+02	-	1.72E+02	2.13E+03	3.38E+02	1.25E+03	4.20E+01	4.96E+02	-	-	2.13E+03
2050	-	-	2.14E+01	4.92E+02	1.84E+03	2.16E+01	2.37E+03	3.58E+02	1.32E+03	2.29E+01	3.50E+02	-	1.82E+02	2.23E+03	3.55E+02	1.32E+03	4.36E+01	5.12E+02	-	-	2.23E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	1.93E+03	2.08E+01	2.48E+03	3.75E+02	1.38E+03	2.33E+01	3.57E+02	-	1.92E+02	2.33E+03	3.73E+02	1.38E+03	4.51E+01	5.27E+02	-	-	2.33E+03
2052	-	-	2.28E+01	5.24E+02	2.02E+03	1.98E+01	2.58E+03	3.93E+02	1.45E+03	2.37E+01	3.63E+02	-	2.01E+02	2.43E+03	3.90E+02	1.45E+03	4.66E+01	5.42E+02	-	-	2.42E+03
2053	-	-	2.34E+01	5.39E+02	2.11E+03	1.87E+01	2.69E+03	4.11E+02	1.51E+03	2.41E+01	3.69E+02	-	2.10E+02	2.52E+03	4.08E+02	1.51E+03	4.80E+01	5.56E+02	-	-	2.52E+03
2054	-	-	2.41E+01	5.54E+02	2.20E+03	1.74E+01	2.79E+03	4.28E+02	1.58E+03	2.45E+01	3.75E+02	-	2.19E+02	2.62E+03	4.25E+02	1.58E+03	4.94E+01	5.69E+02	-	-	2.62E+03
2055	-	-	2.47E+01	5.68E+02	2.29E+03	1.61E+01	2.90E+03	4.46E+02	1.64E+03	2.48E+01	3.80E+02	-	2.28E+02	2.72E+03	4.43E+02	1.64E+03	5.08E+01	5.83E+02	-	-	2.72E+03
2056	-	-	2.53E+01	5.82E+02	2.38E+03	1.48E+01	3.00E+03	4.64E+02	1.71E+03	2.52E+01	3.85E+02	-	2.37E+02	2.82E+03	4.60E+02	1.71E+03	5.21E+01	5.96E+02	-	-	2.81E+03
2057	-	-	2.59E+01	5.96E+02	2.47E+03	1.35E+01	3.11E+03	4.81E+02	1.77E+03	2.55E+01	3.90E+02	-	2.46E+02	2.91E+03	4.78E+02	1.77E+03	5.34E+01	6.08E+02	-	-	2.91E+03
2058	-	-	2.65E+01	6.10E+02	2.55E+03	1.20E+01	3.20E+03	4.97E+02	1.83E+03	2.58E+01	3.94E+02	-	2.54E+02	3.00E+03	4.94E+02	1.83E+03	5.47E+01	6.20E+02	-	-	3.00E+03
2059	-	-	2.70E+01	6.22E+02	2.62E+03	1.04E+01	3.28E+03	5.10E+02	1.87E+03	2.60E+01	3.98E+02	-	2.63E+02	3.07E+03	5.06E+02	1.87E+03	5.59E+01	6.32E+02	-	-	3.07E+03
2060	-	-	2.76E+01	6.35E+02	2.67E+03	8.65E+00	3.34E+03	5.20E+02	1.91E+03	2.63E+01	4.02E+02	-	2.71E+02	3.13E+03	5.16E+02	1.91E+03	5.71E+01	6.43E+02	-	-	3.13E+03
2061	-	-	2.81E+01	6.47E+02	2.71E+03	6.78E+00	3.39E+03	5.28E+02	1.94E+03	2.65E+01	4.05E+02	-	2.79E+02	3.18E+03	5.24E+02	1.94E+03	5.82E+01	6.53E+02	-	-	3.18E+03

Exhibit E-22. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.52E+01	-4.55E-01	4.56E+01	2.94E+00	1.09E+01	1.89E+00	2.89E+01	-	2.86E-01	4.50E+01	2.92E+00	1.09E+01	1.92E+00	2.92E+01	-	-	4.49E+01
2030	-	-	2.53E+00	5.84E+01	5.32E+01	-5.55E-01	1.13E+02	1.03E+01	3.81E+01	3.67E+00	5.61E+01	-	1.94E+00	1.10E+02	1.02E+01	3.81E+01	3.89E+00	5.79E+01	-	-	1.10E+02
2031	-	-	3.75E+00	8.63E+01	1.22E+02	6.04E-01	2.12E+02	2.36E+01	8.72E+01	5.33E+00	8.16E+01	-	5.93E+00	2.04E+02	2.34E+01	8.72E+01	6.01E+00	8.68E+01	-	-	2.03E+02
2032	-	-	4.93E+00	1.13E+02	2.05E+02	3.27E+00	3.27E+02	3.98E+01	1.47E+02	6.89E+00	1.05E+02	-	1.23E+01	3.11E+02	3.95E+01	1.47E+02	8.29E+00	1.16E+02	-	-	3.11E+02
2033	-	-	6.08E+00	1.40E+02	2.96E+02	6.85E+00	4.49E+02	5.74E+01	2.12E+02	8.36E+00	1.28E+02	-	2.04E+01	4.26E+02	5.70E+01	2.12E+02	1.07E+01	1.46E+02	-	-	4.26E+02
2034	-	-	7.19E+00	1.66E+02	3.87E+02	1.04E+01	5.70E+02	7.51E+01	2.78E+02	9.73E+00	1.49E+02	-	2.91E+01	5.41E+02	7.46E+01	2.78E+02	1.30E+01	1.75E+02	-	-	5.40E+02
2035	-	-	8.27E+00	1.90E+02	4.78E+02	1.36E+01	6.91E+02	9.28E+01	3.43E+02	1.10E+01	1.69E+02	-	3.82E+01	6.54E+02	9.21E+01	3.43E+02	1.54E+01	2.03E+02	-	-	6.53E+02
2036	-	-	9.33E+00	2.15E+02	5.70E+02	1.63E+01	8.10E+02	1.10E+02	4.09E+02	1.22E+01	1.87E+02	-	4.75E+01	7.66E+02	1.10E+02	4.09E+02	1.76E+01	2.29E+02	-	-	7.65E+02
2037	-	-	1.04E+01	2.38E+02	6.61E+02	1.85E+01	9.28E+02	1.28E+02	4.74E+02	1.33E+01	2.04E+02	-	5.69E+01	8.77E+02	1.27E+02	4.74E+02	1.98E+01	2.55E+02	-	-	8.76E+02
2038	-	-	1.13E+01	2.61E+02	7.52E+02	2.05E+01	1.04E+03	1.46E+02	5.39E+02	1.44E+01	2.20E+02	-	6.65E+01	9.86E+02	1.45E+02	5.39E+02	2.20E+01	2.79E+02	-	-	9.85E+02
2039	-	-	1.23E+01	2.84E+02	8.43E+02	2.20E+01	1.16E+03	1.63E+02	6.05E+02	1.54E+01	2.35E+02	-	7.62E+01	1.10E+03	1.62E+02	6.05E+02	2.41E+01	3.03E+02	-	-	1.09E+03
2040	-	-	1.33E+01	3.05E+02	9.34E+02	2.32E+01	1.28E+03	1.81E+02	6.70E+02	1.63E+01	2.50E+02	-	8.59E+01	1.20E+03	1.80E+02	6.70E+02	2.61E+01	3.26E+02	-	-	1.20E+03
2041	-	-	1.42E+01	3.26E+02	1.03E+03	2.40E+01	1.39E+03	1.99E+02	7.35E+02	1.72E+01	2.63E+02	-	9.55E+01	1.31E+03	1.97E+02	7.35E+02	2.80E+01	3.48E+02	-	-	1.31E+03
2042	-	-	1.51E+01	3.47E+02	1.12E+03	2.45E+01	1.50E+03	2.16E+02	8.01E+02	1.80E+01	2.75E+02	-	1.05E+02	1.42E+03	2.15E+02	8.01E+02	2.99E+01	3.69E+02	-	-	1.41E+03
2043	-	-	1.59E+01	3.67E+02	1.21E+03	2.47E+01	1.61E+03	2.34E+02	8.66E+02	1.87E+01	2.87E+02	-	1.15E+02	1.52E+03	2.32E+02	8.66E+02	3.18E+01	3.89E+02	-	-	1.52E+03
2044	-	-	1.68E+01	3.86E+02	1.30E+03	2.46E+01	1.73E+03	2.52E+02	9.32E+02	1.94E+01	2.98E+02	-	1.24E+02	1.62E+03	2.50E+02	9.32E+02	3.36E+01	4.08E+02	-	-	1.62E+03
2045	-	-	1.76E+01	4.05E+02	1.39E+03	2.44E+01	1.84E+03	2.69E+02	9.97E+02	2.01E+01	3.08E+02	-	1.34E+02	1.73E+03	2.68E+02	9.97E+02	3.54E+01	4.27E+02	-	-	1.73E+03
2046	-	-	1.84E+01	4.24E+02	1.48E+03	2.41E+01	1.95E+03	2.87E+02	1.06E+03	2.07E+01	3.17E+02	-	1.44E+02	1.83E+03	2.85E+02	1.06E+03	3.71E+01	4.45E+02	-	-	1.83E+03
2047	-	-	1.92E+01	4.41E+02	1.57E+03	2.37E+01	2.06E+03	3.05E+02	1.13E+03	2.13E+01	3.26E+02	-	1.53E+02	1.93E+03	3.03E+02	1.13E+03	3.88E+01	4.62E+02	-	-	1.93E+03
2048	-	-	1.99E+01	4.59E+02	1.66E+03	2.31E+01	2.17E+03	3.22E+02	1.19E+03	2.19E+01	3.35E+02	-	1.63E+02	2.03E+03	3.20E+02	1.19E+03	4.04E+01	4.79E+02	-	-	2.03E+03
2049	-	-	2.07E+01	4.76E+02	1.75E+03	2.24E+01	2.27E+03	3.40E+02	1.26E+03	2.24E+01	3.42E+02	-	1.72E+02	2.14E+03	3.38E+02	1.26E+03	4.20E+01	4.96E+02	-	-	2.13E+03
2050	-	-	2.14E+01	4.92E+02	1.85E+03	2.16E+01	2.38E+03	3.58E+02	1.32E+03	2.29E+01	3.50E+02	-	1.82E+02	2.24E+03	3.55E+02	1.32E+03	4.36E+01	5.12E+02	-	-	2.23E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	1.94E+03	2.08E+01	2.49E+03	3.75E+02	1.39E+03	2.33E+01	3.57E+02	-	1.92E+02	2.34E+03	3.73E+02	1.39E+03	4.51E+01	5.27E+02	-	-	2.33E+03
2052	-	-	2.28E+01	5.24E+02	2.03E+03	1.98E+01	2.59E+03	3.93E+02	1.45E+03	2.37E+01	3.63E+02	-	2.01E+02	2.44E+03	3.90E+02	1.45E+03	4.66E+01	5.42E+02	-	-	2.43E+03
2053	-	-	2.34E+01	5.39E+02	2.12E+03	1.87E+01	2.70E+03	4.11E+02	1.52E+03	2.41E+01	3.69E+02	-	2.10E+02	2.53E+03	4.08E+02	1.52E+03	4.80E+01	5.56E+02	-	-	2.53E+03
2054	-	-	2.41E+01	5.54E+02	2.21E+03	1.74E+01	2.81E+03	4.28E+02	1.59E+03	2.45E+01	3.75E+02	-	2.19E+02	2.63E+03	4.25E+02	1.59E+03	4.94E+01	5.69E+02	-	-	2.63E+03
2055	-	-	2.47E+01	5.68E+02	2.30E+03	1.61E+01	2.91E+03	4.46E+02	1.65E+03	2.48E+01	3.80E+02	-	2.28E+02	2.73E+03	4.43E+02	1.65E+03	5.08E+01	5.83E+02	-	-	2.73E+03
2056	-	-	2.53E+01	5.82E+02	2.39E+03	1.48E+01	3.01E+03	4.64E+02	1.72E+03	2.52E+01	3.85E+02	-	2.37E+02	2.83E+03	4.60E+02	1.72E+03	5.21E+01	5.96E+02	-	-	2.82E+03
2057	-	-	2.59E+01	5.96E+02	2.48E+03	1.35E+01	3.12E+03	4.81E+02	1.78E+03	2.55E+01	3.90E+02	-	2.46E+02	2.92E+03	4.78E+02	1.78E+03	5.34E+01	6.08E+02	-	-	2.92E+03
2058	-	-	2.65E+01	6.10E+02	2.56E+03	1.20E+01	3.21E+03	4.97E+02	1.84E+03	2.58E+01	3.94E+02	-	2.54E+02	3.01E+03	4.94E+02	1.84E+03	5.47E+01	6.20E+02	-	-	3.01E+03
2059	-	-	2.70E+01	6.22E+02	2.63E+03	1.04E+01	3.29E+03	5.10E+02	1.89E+03	2.60E+01	3.98E+02	-	2.63E+02	3.08E+03	5.06E+02	1.89E+03	5.59E+01	6.32E+02	-	-	3.08E+03
2060	-	-	2.76E+01	6.35E+02	2.68E+03	8.65E+00	3.35E+03	5.20E+02	1.92E+03	2.63E+01	4.02E+02	-	2.71E+02	3.14E+03	5.16E+02	1.92E+03	5.71E+01	6.43E+02	-	-	3.14E+03
2061	-	-	2.81E+01	6.47E+02	2.72E+03	6.78E+00	3.41E+03	5.28E+02	1.95E+03	2.65E+01	4.05E+02	-	2.79E+02	3.19E+03	5.24E+02	1.95E+03	5.82E+01	6.53E+02	-	-	3.19E+03

Exhibit E-23. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.52E+01	-4.55E-01	4.56E+01	2.94E+00	1.09E+01	1.89E+00	2.89E+01	-	2.86E-01	4.50E+01	2.92E+00	1.09E+01	1.93E+00	2.92E+01	-	-	4.49E+01
2030	-	-	2.53E+00	5.84E+01	5.32E+01	-5.55E-01	1.14E+02	1.03E+01	3.81E+01	3.67E+00	5.61E+01	-	1.94E+00	1.10E+02	1.02E+01	3.81E+01	3.89E+00	5.79E+01	-	-	1.10E+02
2031	-	-	3.75E+00	8.63E+01	1.22E+02	6.04E-01	2.12E+02	2.36E+01	8.72E+01	5.33E+00	8.16E+01	-	5.93E+00	2.04E+02	2.34E+01	8.72E+01	6.01E+00	8.68E+01	-	-	2.03E+02
2032	-	-	4.93E+00	1.13E+02	2.05E+02	3.27E+00	3.27E+02	3.98E+01	1.47E+02	6.89E+00	1.05E+02	-	1.23E+01	3.12E+02	3.95E+01	1.47E+02	8.30E+00	1.16E+02	-	-	3.11E+02
2033	-	-	6.08E+00	1.40E+02	2.96E+02	6.85E+00	4.49E+02	5.74E+01	2.13E+02	8.36E+00	1.28E+02	-	2.04E+01	4.27E+02	5.70E+01	2.13E+02	1.07E+01	1.46E+02	-	-	4.26E+02
2034	-	-	7.19E+00	1.66E+02	3.87E+02	1.04E+01	5.71E+02	7.51E+01	2.78E+02	9.73E+00	1.49E+02	-	2.91E+01	5.41E+02	7.46E+01	2.78E+02	1.31E+01	1.75E+02	-	-	5.40E+02
2035	-	-	8.27E+00	1.90E+02	4.79E+02	1.36E+01	6.91E+02	9.28E+01	3.43E+02	1.10E+01	1.69E+02	-	3.82E+01	6.54E+02	9.21E+01	3.43E+02	1.54E+01	2.03E+02	-	-	6.53E+02
2036	-	-	9.33E+00	2.15E+02	5.70E+02	1.63E+01	8.10E+02	1.10E+02	4.09E+02	1.22E+01	1.87E+02	-	4.75E+01	7.66E+02	1.10E+02	4.09E+02	1.76E+01	2.29E+02	-	-	7.65E+02
2037	-	-	1.04E+01	2.38E+02	6.61E+02	1.85E+01	9.28E+02	1.28E+02	4.74E+02	1.33E+01	2.04E+02	-	5.69E+01	8.77E+02	1.27E+02	4.74E+02	1.98E+01	2.55E+02	-	-	8.76E+02
2038	-	-	1.13E+01	2.61E+02	7.52E+02	2.05E+01	1.05E+03	1.46E+02	5.39E+02	1.44E+01	2.20E+02	-	6.65E+01	9.86E+02	1.45E+02	5.39E+02	2.20E+01	2.79E+02	-	-	9.86E+02
2039	-	-	1.23E+01	2.84E+02	8.43E+02	2.20E+01	1.16E+03	1.63E+02	6.05E+02	1.54E+01	2.35E+02	-	7.62E+01	1.10E+03	1.62E+02	6.05E+02	2.41E+01	3.03E+02	-	-	1.09E+03
2040	-	-	1.33E+01	3.05E+02	9.34E+02	2.32E+01	1.28E+03	1.81E+02	6.70E+02	1.63E+01	2.50E+02	-	8.59E+01	1.20E+03	1.80E+02	6.70E+02	2.61E+01	3.26E+02	-	-	1.20E+03
2041	-	-	1.42E+01	3.26E+02	1.03E+03	2.40E+01	1.39E+03	1.99E+02	7.36E+02	1.72E+01	2.63E+02	-	9.55E+01	1.31E+03	1.97E+02	7.36E+02	2.81E+01	3.48E+02	-	-	1.31E+03
2042	-	-	1.51E+01	3.47E+02	1.12E+03	2.45E+01	1.50E+03	2.16E+02	8.01E+02	1.80E+01	2.75E+02	-	1.05E+02	1.42E+03	2.15E+02	8.01E+02	3.00E+01	3.69E+02	-	-	1.41E+03
2043	-	-	1.59E+01	3.67E+02	1.21E+03	2.47E+01	1.62E+03	2.34E+02	8.66E+02	1.87E+01	2.87E+02	-	1.15E+02	1.52E+03	2.32E+02	8.66E+02	3.18E+01	3.89E+02	-	-	1.52E+03
2044	-	-	1.68E+01	3.86E+02	1.30E+03	2.46E+01	1.73E+03	2.52E+02	9.32E+02	1.94E+01	2.98E+02	-	1.24E+02	1.63E+03	2.50E+02	9.32E+02	3.36E+01	4.08E+02	-	-	1.62E+03
2045	-	-	1.76E+01	4.05E+02	1.39E+03	2.44E+01	1.84E+03	2.69E+02	9.97E+02	2.01E+01	3.08E+02	-	1.34E+02	1.73E+03	2.68E+02	9.97E+02	3.54E+01	4.27E+02	-	-	1.73E+03
2046	-	-	1.84E+01	4.24E+02	1.48E+03	2.41E+01	1.95E+03	2.87E+02	1.06E+03	2.07E+01	3.17E+02	-	1.44E+02	1.83E+03	2.85E+02	1.06E+03	3.71E+01	4.45E+02	-	-	1.83E+03
2047	-	-	1.92E+01	4.41E+02	1.57E+03	2.37E+01	2.06E+03	3.05E+02	1.13E+03	2.13E+01	3.26E+02	-	1.53E+02	1.93E+03	3.03E+02	1.13E+03	3.88E+01	4.62E+02	-	-	1.93E+03
2048	-	-	1.99E+01	4.59E+02	1.66E+03	2.31E+01	2.17E+03	3.22E+02	1.19E+03	2.19E+01	3.35E+02	-	1.63E+02	2.04E+03	3.20E+02	1.19E+03	4.04E+01	4.79E+02	-	-	2.03E+03
2049	-	-	2.07E+01	4.76E+02	1.75E+03	2.24E+01	2.27E+03	3.40E+02	1.26E+03	2.24E+01	3.42E+02	-	1.72E+02	2.14E+03	3.38E+02	1.26E+03	4.20E+01	4.96E+02	-	-	2.13E+03
2050	-	-	2.14E+01	4.92E+02	1.85E+03	2.16E+01	2.38E+03	3.58E+02	1.32E+03	2.29E+01	3.50E+02	-	1.82E+02	2.24E+03	3.55E+02	1.32E+03	4.36E+01	5.12E+02	-	-	2.23E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	1.94E+03	2.08E+01	2.49E+03	3.75E+02	1.39E+03	2.33E+01	3.57E+02	-	1.92E+02	2.34E+03	3.73E+02	1.39E+03	4.51E+01	5.27E+02	-	-	2.33E+03
2052	-	-	2.28E+01	5.24E+02	2.03E+03	1.98E+01	2.59E+03	3.93E+02	1.45E+03	2.37E+01	3.63E+02	-	2.01E+02	2.44E+03	3.90E+02	1.45E+03	4.66E+01	5.42E+02	-	-	2.43E+03
2053	-	-	2.34E+01	5.39E+02	2.12E+03	1.87E+01	2.70E+03	4.11E+02	1.52E+03	2.41E+01	3.69E+02	-	2.10E+02	2.53E+03	4.08E+02	1.52E+03	4.81E+01	5.56E+02	-	-	2.53E+03
2054	-	-	2.41E+01	5.54E+02	2.21E+03	1.74E+01	2.81E+03	4.28E+02	1.59E+03	2.45E+01	3.75E+02	-	2.19E+02	2.63E+03	4.25E+02	1.59E+03	4.94E+01	5.69E+02	-	-	2.63E+03
2055	-	-	2.47E+01	5.68E+02	2.30E+03	1.61E+01	2.91E+03	4.46E+02	1.65E+03	2.48E+01	3.80E+02	-	2.28E+02	2.73E+03	4.43E+02	1.65E+03	5.08E+01	5.83E+02	-	-	2.73E+03
2056	-	-	2.53E+01	5.82E+02	2.39E+03	1.48E+01	3.02E+03	4.64E+02	1.72E+03	2.52E+01	3.85E+02	-	2.37E+02	2.83E+03	4.60E+02	1.72E+03	5.22E+01	5.96E+02	-	-	2.82E+03
2057	-	-	2.59E+01	5.96E+02	2.48E+03	1.35E+01	3.12E+03	4.81E+02	1.78E+03	2.55E+01	3.90E+02	-	2.46E+02	2.92E+03	4.78E+02	1.78E+03	5.35E+01	6.08E+02	-	-	2.92E+03
2058	-	-	2.65E+01	6.10E+02	2.57E+03	1.20E+01	3.21E+03	4.97E+02	1.84E+03	2.58E+01	3.94E+02	-	2.54E+02	3.01E+03	4.94E+02	1.84E+03	5.47E+01	6.20E+02	-	-	3.01E+03
2059	-	-	2.70E+01	6.22E+02	2.63E+03	1.04E+01	3.29E+03	5.10E+02	1.89E+03	2.60E+01	3.98E+02	-	2.63E+02	3.08E+03	5.06E+02	1.89E+03	5.59E+01	6.32E+02	-	-	3.08E+03
2060	-	-	2.76E+01	6.35E+02	2.68E+03	8.65E+00	3.35E+03	5.20E+02	1.93E+03	2.63E+01	4.02E+02	-	2.71E+02	3.14E+03	5.16E+02	1.93E+03	5.71E+01	6.43E+02	-	-	3.14E+03
2061	-	-	2.81E+01	6.47E+02	2.72E+03	6.78E+00	3.41E+03	5.28E+02	1.95E+03	2.65E+01	4.05E+02	-	2.79E+02	3.19E+03	5.24E+02	1.95E+03	5.83E+01	6.53E+02	-	-	3.19E+03

Exhibit E-24. Cumulative Emissions Profile AR6 100-yr – NGCC without CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	1.52E+01	-4.55E-01	4.56E+01	2.94E+00	1.13E+01	1.89E+00	2.89E+01	-	2.86E-01	4.53E+01	2.92E+00	1.13E+01	1.92E+00	2.92E+01	-	-	4.53E+01
2030	-	-	2.53E+00	5.84E+01	5.31E+01	-5.55E-01	1.13E+02	1.03E+01	3.94E+01	3.67E+00	5.61E+01	-	1.94E+00	1.11E+02	1.02E+01	3.94E+01	3.89E+00	5.79E+01	-	-	1.11E+02
2031	-	-	3.75E+00	8.63E+01	1.21E+02	6.04E-01	2.12E+02	2.36E+01	9.01E+01	5.33E+00	8.16E+01	-	5.93E+00	2.06E+02	2.34E+01	9.01E+01	6.00E+00	8.68E+01	-	-	2.06E+02
2032	-	-	4.93E+00	1.13E+02	2.05E+02	3.27E+00	3.26E+02	3.97E+01	1.52E+02	6.89E+00	1.05E+02	-	1.23E+01	3.16E+02	3.95E+01	1.52E+02	8.29E+00	1.16E+02	-	-	3.16E+02
2033	-	-	6.08E+00	1.40E+02	2.96E+02	6.85E+00	4.48E+02	5.74E+01	2.20E+02	8.35E+00	1.28E+02	-	2.04E+01	4.34E+02	5.70E+01	2.20E+02	1.07E+01	1.46E+02	-	-	4.33E+02
2034	-	-	7.19E+00	1.66E+02	3.87E+02	1.04E+01	5.70E+02	7.51E+01	2.87E+02	9.73E+00	1.49E+02	-	2.91E+01	5.50E+02	7.45E+01	2.87E+02	1.30E+01	1.75E+02	-	-	5.49E+02
2035	-	-	8.27E+00	1.90E+02	4.78E+02	1.36E+01	6.90E+02	9.27E+01	3.55E+02	1.10E+01	1.69E+02	-	3.82E+01	6.65E+02	9.21E+01	3.55E+02	1.54E+01	2.03E+02	-	-	6.65E+02
2036	-	-	9.33E+00	2.15E+02	5.68E+02	1.63E+01	8.09E+02	1.10E+02	4.22E+02	1.22E+01	1.87E+02	-	4.75E+01	7.79E+02	1.10E+02	4.22E+02	1.76E+01	2.29E+02	-	-	7.79E+02
2037	-	-	1.04E+01	2.38E+02	6.59E+02	1.85E+01	9.27E+02	1.28E+02	4.90E+02	1.33E+01	2.04E+02	-	5.69E+01	8.92E+02	1.27E+02	4.90E+02	1.98E+01	2.55E+02	-	-	8.92E+02
2038	-	-	1.13E+01	2.61E+02	7.50E+02	2.05E+01	1.04E+03	1.46E+02	5.57E+02	1.44E+01	2.20E+02	-	6.65E+01	1.00E+03	1.45E+02	5.57E+02	2.20E+01	2.79E+02	-	-	1.00E+03
2039	-	-	1.23E+01	2.84E+02	8.41E+02	2.20E+01	1.16E+03	1.63E+02	6.25E+02	1.54E+01	2.35E+02	-	7.62E+01	1.12E+03	1.62E+02	6.25E+02	2.41E+01	3.03E+02	-	-	1.11E+03
2040	-	-	1.33E+01	3.05E+02	9.32E+02	2.32E+01	1.27E+03	1.81E+02	6.92E+02	1.63E+01	2.50E+02	-	8.59E+01	1.23E+03	1.80E+02	6.92E+02	2.61E+01	3.26E+02	-	-	1.22E+03
2041	-	-	1.42E+01	3.26E+02	1.02E+03	2.40E+01	1.39E+03	1.99E+02	7.60E+02	1.72E+01	2.63E+02	-	9.55E+01	1.33E+03	1.97E+02	7.60E+02	2.80E+01	3.48E+02	-	-	1.33E+03
2042	-	-	1.51E+01	3.47E+02	1.11E+03	2.45E+01	1.50E+03	2.16E+02	8.27E+02	1.80E+01	2.75E+02	-	1.05E+02	1.44E+03	2.15E+02	8.27E+02	2.99E+01	3.69E+02	-	-	1.44E+03
2043	-	-	1.59E+01	3.67E+02	1.21E+03	2.47E+01	1.61E+03	2.34E+02	8.95E+02	1.87E+01	2.87E+02	-	1.15E+02	1.55E+03	2.32E+02	8.95E+02	3.18E+01	3.89E+02	-	-	1.55E+03
2044	-	-	1.68E+01	3.86E+02	1.30E+03	2.46E+01	1.72E+03	2.52E+02	9.63E+02	1.94E+01	2.98E+02	-	1.24E+02	1.66E+03	2.50E+02	9.63E+02	3.36E+01	4.08E+02	-	-	1.65E+03
2045	-	-	1.76E+01	4.05E+02	1.39E+03	2.44E+01	1.83E+03	2.69E+02	1.03E+03	2.01E+01	3.08E+02	-	1.34E+02	1.76E+03	2.67E+02	1.03E+03	3.54E+01	4.27E+02	-	-	1.76E+03
2046	-	-	1.84E+01	4.24E+02	1.48E+03	2.41E+01	1.94E+03	2.87E+02	1.10E+03	2.07E+01	3.17E+02	-	1.44E+02	1.87E+03	2.85E+02	1.10E+03	3.71E+01	4.45E+02	-	-	1.86E+03
2047	-	-	1.92E+01	4.41E+02	1.57E+03	2.37E+01	2.05E+03	3.05E+02	1.17E+03	2.13E+01	3.26E+02	-	1.53E+02	1.97E+03	3.03E+02	1.17E+03	3.88E+01	4.62E+02	-	-	1.97E+03
2048	-	-	1.99E+01	4.59E+02	1.66E+03	2.31E+01	2.16E+03	3.22E+02	1.23E+03	2.19E+01	3.35E+02	-	1.63E+02	2.07E+03	3.20E+02	1.23E+03	4.04E+01	4.79E+02	-	-	2.07E+03
2049	-	-	2.07E+01	4.76E+02	1.75E+03	2.24E+01	2.27E+03	3.40E+02	1.30E+03	2.24E+01	3.42E+02	-	1.72E+02	2.18E+03	3.38E+02	1.30E+03	4.20E+01	4.96E+02	-	-	2.18E+03
2050	-	-	2.14E+01	4.92E+02	1.84E+03	2.16E+01	2.38E+03	3.58E+02	1.37E+03	2.28E+01	3.50E+02	-	1.82E+02	2.28E+03	3.55E+02	1.37E+03	4.36E+01	5.12E+02	-	-	2.28E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	1.93E+03	2.08E+01	2.48E+03	3.75E+02	1.44E+03	2.33E+01	3.57E+02	-	1.92E+02	2.38E+03	3.73E+02	1.44E+03	4.51E+01	5.27E+02	-	-	2.38E+03
2052	-	-	2.28E+01	5.24E+02	2.02E+03	1.98E+01	2.59E+03	3.93E+02	1.50E+03	2.37E+01	3.63E+02	-	2.01E+02	2.48E+03	3.90E+02	1.50E+03	4.66E+01	5.42E+02	-	-	2.48E+03
2053	-	-	2.34E+01	5.39E+02	2.11E+03	1.87E+01	2.70E+03	4.11E+02	1.57E+03	2.41E+01	3.69E+02	-	2.10E+02	2.58E+03	4.08E+02	1.57E+03	4.80E+01	5.56E+02	-	-	2.58E+03
2054	-	-	2.41E+01	5.54E+02	2.21E+03	1.74E+01	2.80E+03	4.28E+02	1.64E+03	2.45E+01	3.75E+02	-	2.19E+02	2.68E+03	4.25E+02	1.64E+03	4.94E+01	5.69E+02	-	-	2.68E+03
2055	-	-	2.47E+01	5.68E+02	2.30E+03	1.61E+01	2.91E+03	4.46E+02	1.71E+03	2.48E+01	3.80E+02	-	2.28E+02	2.78E+03	4.43E+02	1.71E+03	5.08E+01	5.83E+02	-	-	2.78E+03
2056	-	-	2.53E+01	5.82E+02	2.39E+03	1.48E+01	3.01E+03	4.64E+02	1.77E+03	2.52E+01	3.85E+02	-	2.37E+02	2.88E+03	4.60E+02	1.77E+03	5.21E+01	5.96E+02	-	-	2.88E+03
2057	-	-	2.59E+01	5.96E+02	2.48E+03	1.35E+01	3.11E+03	4.81E+02	1.84E+03	2.55E+01	3.90E+02	-	2.46E+02	2.98E+03	4.78E+02	1.84E+03	5.34E+01	6.08E+02	-	-	2.98E+03
2058	-	-	2.65E+01	6.10E+02	2.56E+03	1.20E+01	3.21E+03	4.97E+02	1.90E+03	2.57E+01	3.94E+02	-	2.54E+02	3.07E+03	4.94E+02	1.90E+03	5.47E+01	6.20E+02	-	-	3.07E+03
2059	-	-	2.70E+01	6.22E+02	2.63E+03	1.04E+01	3.29E+03	5.10E+02	1.95E+03	2.60E+01	3.98E+02	-	2.63E+02	3.15E+03	5.06E+02	1.95E+03	5.59E+01	6.32E+02	-	-	3.14E+03
2060	-	-	2.76E+01	6.35E+02	2.68E+03	8.65E+00	3.35E+03	5.20E+02	1.99E+03	2.63E+01	4.02E+02	-	2.71E+02	3.21E+03	5.16E+02	1.99E+03	5.71E+01	6.43E+02	-	-	3.20E+03
2061	-	-	2.81E+01	6.47E+02	2.72E+03	6.78E+00	3.40E+03	5.28E+02	2.02E+03	2.65E+01	4.05E+02	-	2.79E+02	3.26E+03	5.24E+02	2.02E+03	5.82E+01	6.53E+02	-	-	3.26E+03

Exhibit E-25. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.06E+00	-4.55E-01	3.65E+01	2.94E+00	1.81E+00	1.89E+00	2.89E+01	-	2.86E-01	3.59E+01	2.92E+00	1.81E+00	1.92E+00	2.92E+01	-	-	3.58E+01
2030	-	-	2.53E+00	5.84E+01	2.12E+01	-5.55E-01	8.15E+01	1.03E+01	6.33E+00	3.67E+00	5.61E+01	-	1.94E+00	7.84E+01	1.02E+01	6.33E+00	3.89E+00	5.79E+01	-	-	7.83E+01
2031	-	-	3.75E+00	8.63E+01	4.85E+01	6.04E-01	1.39E+02	2.36E+01	1.45E+01	5.33E+00	8.16E+01	-	5.93E+00	1.31E+02	2.34E+01	1.45E+01	6.01E+00	8.68E+01	-	-	1.31E+02
2032	-	-	4.93E+00	1.13E+02	8.18E+01	3.27E+00	2.03E+02	3.98E+01	2.44E+01	6.90E+00	1.05E+02	-	1.23E+01	1.89E+02	3.95E+01	2.44E+01	8.30E+00	1.16E+02	-	-	1.89E+02
2033	-	-	6.08E+00	1.40E+02	1.18E+02	6.85E+00	2.71E+02	5.74E+01	3.52E+01	8.36E+00	1.28E+02	-	2.04E+01	2.49E+02	5.70E+01	3.52E+01	1.07E+01	1.46E+02	-	-	2.49E+02
2034	-	-	7.19E+00	1.66E+02	1.55E+02	1.04E+01	3.38E+02	7.51E+01	4.61E+01	9.74E+00	1.49E+02	-	2.91E+01	3.09E+02	7.46E+01	4.61E+01	1.31E+01	1.75E+02	-	-	3.09E+02
2035	-	-	8.27E+00	1.90E+02	1.91E+02	1.36E+01	4.03E+02	9.28E+01	5.69E+01	1.10E+01	1.69E+02	-	3.82E+01	3.68E+02	9.21E+01	5.69E+01	1.54E+01	2.03E+02	-	-	3.67E+02
2036	-	-	9.33E+00	2.15E+02	2.27E+02	1.63E+01	4.68E+02	1.10E+02	6.78E+01	1.22E+01	1.87E+02	-	4.75E+01	4.25E+02	1.10E+02	6.78E+01	1.76E+01	2.29E+02	-	-	4.24E+02
2037	-	-	1.04E+01	2.38E+02	2.64E+02	1.85E+01	5.31E+02	1.28E+02	7.86E+01	1.34E+01	2.04E+02	-	5.69E+01	4.81E+02	1.27E+02	7.86E+01	1.98E+01	2.55E+02	-	-	4.80E+02
2038	-	-	1.13E+01	2.61E+02	3.00E+02	2.05E+01	5.93E+02	1.46E+02	8.95E+01	1.44E+01	2.20E+02	-	6.65E+01	5.37E+02	1.45E+02	8.95E+01	2.20E+01	2.79E+02	-	-	5.36E+02
2039	-	-	1.23E+01	2.84E+02	3.36E+02	2.20E+01	6.54E+02	1.63E+02	1.00E+02	1.54E+01	2.35E+02	-	7.62E+01	5.91E+02	1.62E+02	1.00E+02	2.41E+01	3.03E+02	-	-	5.90E+02
2040	-	-	1.33E+01	3.05E+02	3.73E+02	2.32E+01	7.14E+02	1.81E+02	1.11E+02	1.63E+01	2.50E+02	-	8.59E+01	6.44E+02	1.80E+02	1.11E+02	2.61E+01	3.26E+02	-	-	6.43E+02
2041	-	-	1.42E+01	3.26E+02	4.09E+02	2.40E+01	7.74E+02	1.99E+02	1.22E+02	1.72E+01	2.63E+02	-	9.55E+01	6.96E+02	1.97E+02	1.22E+02	2.81E+01	3.48E+02	-	-	6.95E+02
2042	-	-	1.51E+01	3.47E+02	4.45E+02	2.45E+01	8.32E+02	2.16E+02	1.33E+02	1.80E+01	2.75E+02	-	1.05E+02	7.48E+02	2.15E+02	1.33E+02	3.00E+01	3.69E+02	-	-	7.46E+02
2043	-	-	1.59E+01	3.67E+02	4.82E+02	2.47E+01	8.89E+02	2.34E+02	1.44E+02	1.88E+01	2.87E+02	-	1.15E+02	7.98E+02	2.32E+02	1.44E+02	3.18E+01	3.89E+02	-	-	7.97E+02
2044	-	-	1.68E+01	3.86E+02	5.18E+02	2.46E+01	9.46E+02	2.52E+02	1.55E+02	1.95E+01	2.98E+02	-	1.24E+02	8.48E+02	2.50E+02	1.55E+02	3.36E+01	4.08E+02	-	-	8.46E+02
2045	-	-	1.76E+01	4.05E+02	5.55E+02	2.44E+01	1.00E+03	2.69E+02	1.65E+02	2.01E+01	3.08E+02	-	1.34E+02	8.97E+02	2.68E+02	1.65E+02	3.54E+01	4.27E+02	-	-	8.95E+02
2046	-	-	1.84E+01	4.24E+02	5.91E+02	2.41E+01	1.06E+03	2.87E+02	1.76E+02	2.07E+01	3.17E+02	-	1.44E+02	9.45E+02	2.85E+02	1.76E+02	3.71E+01	4.45E+02	-	-	9.43E+02
2047	-	-	1.92E+01	4.41E+02	6.27E+02	2.37E+01	1.11E+03	3.05E+02	1.87E+02	2.13E+01	3.26E+02	-	1.53E+02	9.93E+02	3.03E+02	1.87E+02	3.88E+01	4.62E+02	-	-	9.91E+02
2048	-	-	1.99E+01	4.59E+02	6.64E+02	2.31E+01	1.17E+03	3.22E+02	1.98E+02	2.19E+01	3.35E+02	-	1.63E+02	1.04E+03	3.20E+02	1.98E+02	4.04E+01	4.79E+02	-	-	1.04E+03
2049	-	-	2.07E+01	4.76E+02	7.00E+02	2.24E+01	1.22E+03	3.40E+02	2.09E+02	2.24E+01	3.42E+02	-	1.72E+02	1.09E+03	3.38E+02	2.09E+02	4.20E+01	4.96E+02	-	-	1.08E+03
2050	-	-	2.14E+01	4.92E+02	7.36E+02	2.16E+01	1.27E+03	3.58E+02	2.20E+02	2.29E+01	3.50E+02	-	1.82E+02	1.13E+03	3.55E+02	2.20E+02	4.36E+01	5.12E+02	-	-	1.13E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	7.73E+02	2.08E+01	1.32E+03	3.75E+02	2.30E+02	2.33E+01	3.57E+02	-	1.92E+02	1.18E+03	3.73E+02	2.30E+02	4.51E+01	5.27E+02	-	-	1.18E+03
2052	-	-	2.28E+01	5.24E+02	8.09E+02	1.98E+01	1.38E+03	3.93E+02	2.41E+02	2.37E+01	3.63E+02	-	2.01E+02	1.22E+03	3.90E+02	2.41E+02	4.66E+01	5.42E+02	-	-	1.22E+03
2053	-	-	2.34E+01	5.39E+02	8.45E+02	1.87E+01	1.43E+03	4.11E+02	2.52E+02	2.41E+01	3.69E+02	-	2.10E+02	1.27E+03	4.08E+02	2.52E+02	4.80E+01	5.56E+02	-	-	1.26E+03
2054	-	-	2.41E+01	5.54E+02	8.82E+02	1.74E+01	1.48E+03	4.28E+02	2.63E+02	2.45E+01	3.75E+02	-	2.19E+02	1.31E+03	4.25E+02	2.63E+02	4.94E+01	5.69E+02	-	-	1.31E+03
2055	-	-	2.47E+01	5.68E+02	9.18E+02	1.61E+01	1.53E+03	4.46E+02	2.74E+02	2.49E+01	3.80E+02	-	2.28E+02	1.35E+03	4.43E+02	2.74E+02	5.08E+01	5.83E+02	-	-	1.35E+03
2056	-	-	2.53E+01	5.82E+02	9.54E+02	1.48E+01	1.58E+03	4.64E+02	2.85E+02	2.52E+01	3.85E+02	-	2.37E+02	1.40E+03	4.61E+02	2.85E+02	5.21E+01	5.96E+02	-	-	1.39E+03
2057	-	-	2.59E+01	5.96E+02	9.91E+02	1.35E+01	1.63E+03	4.82E+02	2.96E+02	2.55E+01	3.90E+02	-	2.46E+02	1.44E+03	4.78E+02	2.96E+02	5.35E+01	6.08E+02	-	-	1.44E+03
2058	-	-	2.65E+01	6.10E+02	1.02E+03	1.20E+01	1.67E+03	4.97E+02	3.05E+02	2.58E+01	3.94E+02	-	2.54E+02	1.48E+03	4.94E+02	3.05E+02	5.47E+01	6.20E+02	-	-	1.47E+03
2059	-	-	2.70E+01	6.22E+02	1.05E+03	1.04E+01	1.71E+03	5.10E+02	3.13E+02	2.60E+01	3.98E+02	-	2.63E+02	1.51E+03	5.06E+02	3.13E+02	5.59E+01	6.32E+02	-	-	1.51E+03
2060	-	-	2.76E+01	6.35E+02	1.07E+03	8.65E+00	1.74E+03	5.20E+02	3.19E+02	2.63E+01	4.02E+02	-	2.71E+02	1.54E+03	5.16E+02	3.19E+02	5.71E+01	6.43E+02	-	-	1.54E+03
2061	-	-	2.81E+01	6.47E+02	1.09E+03	6.78E+00	1.77E+03	5.28E+02	3.24E+02	2.65E+01	4.05E+02	-	2.79E+02	1.56E+03	5.25E+02	3.24E+02	5.82E+01	6.53E+02	-	-	1.56E+03

Exhibit E-26. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.16E+00	-4.55E-01	3.66E+01	2.94E+00	1.89E+00	1.89E+00	2.89E+01	-	2.86E-01	3.60E+01	2.92E+00	1.89E+00	1.92E+00	2.92E+01	-	-	3.59E+01
2030	-	-	2.53E+00	5.84E+01	2.16E+01	-5.55E-01	8.19E+01	1.03E+01	6.63E+00	3.67E+00	5.61E+01	-	1.94E+00	7.87E+01	1.02E+01	6.63E+00	3.89E+00	5.79E+01	-	-	7.86E+01
2031	-	-	3.75E+00	8.63E+01	4.93E+01	6.04E-01	1.40E+02	2.36E+01	1.52E+01	5.33E+00	8.16E+01	-	5.93E+00	1.32E+02	2.34E+01	1.52E+01	6.01E+00	8.68E+01	-	-	1.31E+02
2032	-	-	4.93E+00	1.13E+02	8.32E+01	3.27E+00	2.05E+02	3.98E+01	2.56E+01	6.89E+00	1.05E+02	-	1.23E+01	1.90E+02	3.95E+01	2.56E+01	8.29E+00	1.16E+02	-	-	1.90E+02
2033	-	-	6.08E+00	1.40E+02	1.20E+02	6.85E+00	2.73E+02	5.74E+01	3.69E+01	8.36E+00	1.28E+02	-	2.04E+01	2.51E+02	5.70E+01	3.69E+01	1.07E+01	1.46E+02	-	-	2.51E+02
2034	-	-	7.19E+00	1.66E+02	1.57E+02	1.04E+01	3.40E+02	7.51E+01	4.83E+01	9.74E+00	1.49E+02	-	2.91E+01	3.11E+02	7.46E+01	4.83E+01	1.31E+01	1.75E+02	-	-	3.11E+02
2035	-	-	8.27E+00	1.90E+02	1.94E+02	1.36E+01	4.06E+02	9.28E+01	5.97E+01	1.10E+01	1.69E+02	-	3.82E+01	3.70E+02	9.21E+01	5.97E+01	1.54E+01	2.03E+02	-	-	3.70E+02
2036	-	-	9.33E+00	2.15E+02	2.31E+02	1.63E+01	4.71E+02	1.10E+02	7.10E+01	1.22E+01	1.87E+02	-	4.75E+01	4.28E+02	1.10E+02	7.10E+01	1.76E+01	2.29E+02	-	-	4.28E+02
2037	-	-	1.04E+01	2.38E+02	2.68E+02	1.85E+01	5.35E+02	1.28E+02	8.24E+01	1.34E+01	2.04E+02	-	5.69E+01	4.85E+02	1.27E+02	8.24E+01	1.98E+01	2.55E+02	-	-	4.84E+02
2038	-	-	1.13E+01	2.61E+02	3.05E+02	2.05E+01	5.98E+02	1.46E+02	9.38E+01	1.44E+01	2.20E+02	-	6.65E+01	5.41E+02	1.45E+02	9.38E+01	2.20E+01	2.79E+02	-	-	5.40E+02
2039	-	-	1.23E+01	2.84E+02	3.42E+02	2.20E+01	6.60E+02	1.63E+02	1.05E+02	1.54E+01	2.35E+02	-	7.62E+01	5.96E+02	1.62E+02	1.05E+02	2.41E+01	3.03E+02	-	-	5.95E+02
2040	-	-	1.33E+01	3.05E+02	3.79E+02	2.32E+01	7.21E+02	1.81E+02	1.16E+02	1.63E+01	2.50E+02	-	8.59E+01	6.49E+02	1.80E+02	1.16E+02	2.61E+01	3.26E+02	-	-	6.48E+02
2041	-	-	1.42E+01	3.26E+02	4.16E+02	2.40E+01	7.80E+02	1.99E+02	1.28E+02	1.72E+01	2.63E+02	-	9.55E+01	7.02E+02	1.97E+02	1.28E+02	2.81E+01	3.48E+02	-	-	7.01E+02
2042	-	-	1.51E+01	3.47E+02	4.53E+02	2.45E+01	8.39E+02	2.16E+02	1.39E+02	1.80E+01	2.75E+02	-	1.05E+02	7.54E+02	2.15E+02	1.39E+02	3.00E+01	3.69E+02	-	-	7.53E+02
2043	-	-	1.59E+01	3.67E+02	4.90E+02	2.47E+01	8.97E+02	2.34E+02	1.51E+02	1.88E+01	2.87E+02	-	1.15E+02	8.05E+02	2.32E+02	1.51E+02	3.18E+01	3.89E+02	-	-	8.04E+02
2044	-	-	1.68E+01	3.86E+02	5.27E+02	2.46E+01	9.54E+02	2.52E+02	1.62E+02	1.95E+01	2.98E+02	-	1.24E+02	8.55E+02	2.50E+02	1.62E+02	3.36E+01	4.08E+02	-	-	8.54E+02
2045	-	-	1.76E+01	4.05E+02	5.64E+02	2.44E+01	1.01E+03	2.69E+02	1.73E+02	2.01E+01	3.08E+02	-	1.34E+02	9.05E+02	2.68E+02	1.73E+02	3.54E+01	4.27E+02	-	-	9.03E+02
2046	-	-	1.84E+01	4.24E+02	6.01E+02	2.41E+01	1.07E+03	2.87E+02	1.85E+02	2.07E+01	3.17E+02	-	1.44E+02	9.53E+02	2.85E+02	1.85E+02	3.71E+01	4.45E+02	-	-	9.52E+02
2047	-	-	1.92E+01	4.41E+02	6.38E+02	2.37E+01	1.12E+03	3.05E+02	1.96E+02	2.13E+01	3.26E+02	-	1.53E+02	1.00E+03	3.03E+02	1.96E+02	3.88E+01	4.62E+02	-	-	1.00E+03
2048	-	-	1.99E+01	4.59E+02	6.75E+02	2.31E+01	1.18E+03	3.22E+02	2.07E+02	2.19E+01	3.35E+02	-	1.63E+02	1.05E+03	3.20E+02	2.07E+02	4.04E+01	4.79E+02	-	-	1.05E+03
2049	-	-	2.07E+01	4.76E+02	7.11E+02	2.24E+01	1.23E+03	3.40E+02	2.19E+02	2.24E+01	3.42E+02	-	1.72E+02	1.10E+03	3.38E+02	2.19E+02	4.20E+01	4.96E+02	-	-	1.09E+03
2050	-	-	2.14E+01	4.92E+02	7.48E+02	2.16E+01	1.28E+03	3.58E+02	2.30E+02	2.29E+01	3.50E+02	-	1.82E+02	1.14E+03	3.55E+02	2.30E+02	4.36E+01	5.12E+02	-	-	1.14E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	7.85E+02	2.08E+01	1.34E+03	3.75E+02	2.41E+02	2.33E+01	3.57E+02	-	1.92E+02	1.19E+03	3.73E+02	2.41E+02	4.51E+01	5.27E+02	-	-	1.19E+03
2052	-	-	2.28E+01	5.24E+02	8.22E+02	1.98E+01	1.39E+03	3.93E+02	2.53E+02	2.37E+01	3.63E+02	-	2.01E+02	1.23E+03	3.90E+02	2.53E+02	4.66E+01	5.42E+02	-	-	1.23E+03
2053	-	-	2.34E+01	5.39E+02	8.59E+02	1.87E+01	1.44E+03	4.11E+02	2.64E+02	2.41E+01	3.69E+02	-	2.10E+02	1.28E+03	4.08E+02	2.64E+02	4.80E+01	5.56E+02	-	-	1.28E+03
2054	-	-	2.41E+01	5.54E+02	8.96E+02	1.74E+01	1.49E+03	4.28E+02	2.76E+02	2.45E+01	3.75E+02	-	2.19E+02	1.32E+03	4.25E+02	2.76E+02	4.94E+01	5.69E+02	-	-	1.32E+03
2055	-	-	2.47E+01	5.68E+02	9.33E+02	1.61E+01	1.54E+03	4.46E+02	2.87E+02	2.49E+01	3.80E+02	-	2.28E+02	1.37E+03	4.43E+02	2.87E+02	5.08E+01	5.83E+02	-	-	1.36E+03
2056	-	-	2.53E+01	5.82E+02	9.70E+02	1.48E+01	1.59E+03	4.64E+02	2.98E+02	2.52E+01	3.85E+02	-	2.37E+02	1.41E+03	4.61E+02	2.98E+02	5.21E+01	5.96E+02	-	-	1.41E+03
2057	-	-	2.59E+01	5.96E+02	1.01E+03	1.35E+01	1.64E+03	4.82E+02	3.10E+02	2.55E+01	3.90E+02	-	2.46E+02	1.45E+03	4.78E+02	3.10E+02	5.35E+01	6.08E+02	-	-	1.45E+03
2058	-	-	2.65E+01	6.10E+02	1.04E+03	1.20E+01	1.69E+03	4.97E+02	3.20E+02	2.58E+01	3.94E+02	-	2.54E+02	1.49E+03	4.94E+02	3.20E+02	5.47E+01	6.20E+02	-	-	1.49E+03
2059	-	-	2.70E+01	6.22E+02	1.07E+03	1.04E+01	1.73E+03	5.10E+02	3.28E+02	2.60E+01	3.98E+02	-	2.63E+02	1.52E+03	5.06E+02	3.28E+02	5.59E+01	6.32E+02	-	-	1.52E+03
2060	-	-	2.76E+01	6.35E+02	1.09E+03	8.65E+00	1.76E+03	5.20E+02	3.35E+02	2.63E+01	4.02E+02	-	2.71E+02	1.55E+03	5.16E+02	3.35E+02	5.71E+01	6.43E+02	-	-	1.55E+03
2061	-	-	2.81E+01	6.47E+02	1.10E+03	6.78E+00	1.79E+03	5.28E+02	3.40E+02	2.65E+01	4.05E+02	-	2.79E+02	1.58E+03	5.25E+02	3.40E+02	5.82E+01	6.53E+02	-	-	1.58E+03

Exhibit E-27. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.16E+00	-4.55E-01	3.66E+01	2.94E+00	1.90E+00	1.89E+00	2.89E+01	-	2.86E-01	3.60E+01	2.92E+00	1.90E+00	1.92E+00	2.92E+01	-	-	3.59E+01
2030	-	-	2.53E+00	5.84E+01	2.16E+01	-5.55E-01	8.19E+01	1.03E+01	6.64E+00	3.67E+00	5.61E+01	-	1.94E+00	7.87E+01	1.02E+01	6.64E+00	3.89E+00	5.79E+01	-	-	7.86E+01
2031	-	-	3.75E+00	8.63E+01	4.93E+01	6.04E-01	1.40E+02	2.36E+01	1.52E+01	5.33E+00	8.16E+01	-	5.93E+00	1.32E+02	2.34E+01	1.52E+01	6.01E+00	8.68E+01	-	-	1.31E+02
2032	-	-	4.93E+00	1.13E+02	8.32E+01	3.27E+00	2.05E+02	3.98E+01	2.56E+01	6.89E+00	1.05E+02	-	1.23E+01	1.90E+02	3.95E+01	2.56E+01	8.29E+00	1.16E+02	-	-	1.90E+02
2033	-	-	6.08E+00	1.40E+02	1.20E+02	6.85E+00	2.73E+02	5.74E+01	3.70E+01	8.36E+00	1.28E+02	-	2.04E+01	2.51E+02	5.70E+01	3.70E+01	1.07E+01	1.46E+02	-	-	2.51E+02
2034	-	-	7.19E+00	1.66E+02	1.57E+02	1.04E+01	3.40E+02	7.51E+01	4.84E+01	9.74E+00	1.49E+02	-	2.91E+01	3.11E+02	7.46E+01	4.84E+01	1.31E+01	1.75E+02	-	-	3.11E+02
2035	-	-	8.27E+00	1.90E+02	1.94E+02	1.36E+01	4.07E+02	9.28E+01	5.98E+01	1.10E+01	1.69E+02	-	3.82E+01	3.70E+02	9.21E+01	5.98E+01	1.54E+01	2.03E+02	-	-	3.70E+02
2036	-	-	9.33E+00	2.15E+02	2.31E+02	1.63E+01	4.72E+02	1.10E+02	7.12E+01	1.22E+01	1.87E+02	-	4.75E+01	4.28E+02	1.10E+02	7.12E+01	1.76E+01	2.29E+02	-	-	4.28E+02
2037	-	-	1.04E+01	2.38E+02	2.68E+02	1.85E+01	5.35E+02	1.28E+02	8.26E+01	1.34E+01	2.04E+02	-	5.69E+01	4.85E+02	1.27E+02	8.26E+01	1.98E+01	2.55E+02	-	-	4.84E+02
2038	-	-	1.13E+01	2.61E+02	3.05E+02	2.05E+01	5.98E+02	1.46E+02	9.40E+01	1.44E+01	2.20E+02	-	6.65E+01	5.41E+02	1.45E+02	9.40E+01	2.20E+01	2.79E+02	-	-	5.40E+02
2039	-	-	1.23E+01	2.84E+02	3.42E+02	2.20E+01	6.60E+02	1.63E+02	1.05E+02	1.54E+01	2.35E+02	-	7.62E+01	5.96E+02	1.62E+02	1.05E+02	2.41E+01	3.03E+02	-	-	5.95E+02
2040	-	-	1.33E+01	3.05E+02	3.79E+02	2.32E+01	7.21E+02	1.81E+02	1.17E+02	1.63E+01	2.50E+02	-	8.59E+01	6.50E+02	1.80E+02	1.17E+02	2.61E+01	3.26E+02	-	-	6.49E+02
2041	-	-	1.42E+01	3.26E+02	4.16E+02	2.40E+01	7.81E+02	1.99E+02	1.28E+02	1.72E+01	2.63E+02	-	9.55E+01	7.02E+02	1.97E+02	1.28E+02	2.81E+01	3.48E+02	-	-	7.01E+02
2042	-	-	1.51E+01	3.47E+02	4.53E+02	2.45E+01	8.40E+02	2.16E+02	1.40E+02	1.80E+01	2.75E+02	-	1.05E+02	7.54E+02	2.15E+02	1.40E+02	3.00E+01	3.69E+02	-	-	7.53E+02
2043	-	-	1.59E+01	3.67E+02	4.90E+02	2.47E+01	8.98E+02	2.34E+02	1.51E+02	1.88E+01	2.87E+02	-	1.15E+02	8.05E+02	2.32E+02	1.51E+02	3.18E+01	3.89E+02	-	-	8.04E+02
2044	-	-	1.68E+01	3.86E+02	5.27E+02	2.46E+01	9.55E+02	2.52E+02	1.62E+02	1.95E+01	2.98E+02	-	1.24E+02	8.55E+02	2.50E+02	1.62E+02	3.36E+01	4.08E+02	-	-	8.54E+02
2045	-	-	1.76E+01	4.05E+02	5.64E+02	2.44E+01	1.01E+03	2.69E+02	1.74E+02	2.01E+01	3.08E+02	-	1.34E+02	9.05E+02	2.68E+02	1.74E+02	3.54E+01	4.27E+02	-	-	9.03E+02
2046	-	-	1.84E+01	4.24E+02	6.01E+02	2.41E+01	1.07E+03	2.87E+02	1.85E+02	2.07E+01	3.17E+02	-	1.44E+02	9.54E+02	2.85E+02	1.85E+02	3.71E+01	4.45E+02	-	-	9.52E+02
2047	-	-	1.92E+01	4.41E+02	6.38E+02	2.37E+01	1.12E+03	3.05E+02	1.96E+02	2.13E+01	3.26E+02	-	1.53E+02	1.00E+03	3.03E+02	1.96E+02	3.88E+01	4.62E+02	-	-	1.00E+03
2048	-	-	1.99E+01	4.59E+02	6.75E+02	2.31E+01	1.18E+03	3.22E+02	2.08E+02	2.19E+01	3.35E+02	-	1.63E+02	1.05E+03	3.20E+02	2.08E+02	4.04E+01	4.79E+02	-	-	1.05E+03
2049	-	-	2.07E+01	4.76E+02	7.12E+02	2.24E+01	1.23E+03	3.40E+02	2.19E+02	2.24E+01	3.42E+02	-	1.72E+02	1.10E+03	3.38E+02	2.19E+02	4.20E+01	4.96E+02	-	-	1.09E+03
2050	-	-	2.14E+01	4.92E+02	7.49E+02	2.16E+01	1.28E+03	3.58E+02	2.31E+02	2.29E+01	3.50E+02	-	1.82E+02	1.14E+03	3.55E+02	2.31E+02	4.36E+01	5.12E+02	-	-	1.14E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	7.86E+02	2.08E+01	1.34E+03	3.75E+02	2.42E+02	2.33E+01	3.57E+02	-	1.92E+02	1.19E+03	3.73E+02	2.42E+02	4.51E+01	5.27E+02	-	-	1.19E+03
2052	-	-	2.28E+01	5.24E+02	8.23E+02	1.98E+01	1.39E+03	3.93E+02	2.53E+02	2.37E+01	3.63E+02	-	2.01E+02	1.23E+03	3.90E+02	2.53E+02	4.66E+01	5.42E+02	-	-	1.23E+03
2053	-	-	2.34E+01	5.39E+02	8.60E+02	1.87E+01	1.44E+03	4.11E+02	2.65E+02	2.41E+01	3.69E+02	-	2.10E+02	1.28E+03	4.08E+02	2.65E+02	4.80E+01	5.56E+02	-	-	1.28E+03
2054	-	-	2.41E+01	5.54E+02	8.97E+02	1.74E+01	1.49E+03	4.28E+02	2.76E+02	2.45E+01	3.75E+02	-	2.19E+02	1.32E+03	4.25E+02	2.76E+02	4.94E+01	5.69E+02	-	-	1.32E+03
2055	-	-	2.47E+01	5.68E+02	9.34E+02	1.61E+01	1.54E+03	4.46E+02	2.88E+02	2.49E+01	3.80E+02	-	2.28E+02	1.37E+03	4.43E+02	2.88E+02	5.08E+01	5.83E+02	-	-	1.36E+03
2056	-	-	2.53E+01	5.82E+02	9.71E+02	1.48E+01	1.59E+03	4.64E+02	2.99E+02	2.52E+01	3.85E+02	-	2.37E+02	1.41E+03	4.61E+02	2.99E+02	5.21E+01	5.96E+02	-	-	1.41E+03
2057	-	-	2.59E+01	5.96E+02	1.01E+03	1.35E+01	1.64E+03	4.82E+02	3.10E+02	2.55E+01	3.90E+02	-	2.46E+02	1.45E+03	4.78E+02	3.10E+02	5.35E+01	6.08E+02	-	-	1.45E+03
2058	-	-	2.65E+01	6.10E+02	1.04E+03	1.20E+01	1.69E+03	4.97E+02	3.21E+02	2.58E+01	3.94E+02	-	2.54E+02	1.49E+03	4.94E+02	3.21E+02	5.47E+01	6.20E+02	-	-	1.49E+03
2059	-	-	2.70E+01	6.22E+02	1.07E+03	1.04E+01	1.73E+03	5.10E+02	3.29E+02	2.60E+01	3.98E+02	-	2.63E+02	1.53E+03	5.06E+02	3.29E+02	5.59E+01	6.32E+02	-	-	1.52E+03
2060	-	-	2.76E+01	6.35E+02	1.09E+03	8.65E+00	1.76E+03	5.20E+02	3.35E+02	2.63E+01	4.02E+02	-	2.71E+02	1.55E+03	5.16E+02	3.35E+02	5.71E+01	6.43E+02	-	-	1.55E+03
2061	-	-	2.81E+01	6.47E+02	1.11E+03	6.78E+00	1.79E+03	5.28E+02	3.40E+02	2.65E+01	4.05E+02	-	2.79E+02	1.58E+03	5.25E+02	3.40E+02	5.82E+01	6.53E+02	-	-	1.58E+03

Exhibit E-28. Cumulative Emissions Profile AR6 100-yr – NGCC with CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.29E+00	2.96E+01	6.13E+00	-4.55E-01	3.66E+01	2.94E+00	2.35E+00	1.89E+00	2.89E+01	-	2.86E-01	3.64E+01	2.92E+00	2.35E+00	1.92E+00	2.92E+01	-	-	3.64E+01
2030	-	-	2.53E+00	5.84E+01	2.14E+01	-5.55E-01	8.18E+01	1.03E+01	8.22E+00	3.67E+00	5.61E+01	-	1.94E+00	8.03E+01	1.02E+01	8.22E+00	3.89E+00	5.79E+01	-	-	8.02E+01
2031	-	-	3.75E+00	8.63E+01	4.90E+01	6.04E-01	1.40E+02	2.36E+01	1.88E+01	5.33E+00	8.16E+01	-	5.93E+00	1.35E+02	2.34E+01	1.88E+01	6.01E+00	8.68E+01	-	-	1.35E+02
2032	-	-	4.93E+00	1.13E+02	8.27E+01	3.27E+00	2.04E+02	3.98E+01	3.17E+01	6.89E+00	1.05E+02	-	1.23E+01	1.96E+02	3.95E+01	3.17E+01	8.29E+00	1.16E+02	-	-	1.96E+02
2033	-	-	6.08E+00	1.40E+02	1.19E+02	6.85E+00	2.72E+02	5.74E+01	4.58E+01	8.36E+00	1.28E+02	-	2.04E+01	2.60E+02	5.70E+01	4.58E+01	1.07E+01	1.46E+02	-	-	2.59E+02
2034	-	-	7.19E+00	1.66E+02	1.56E+02	1.04E+01	3.39E+02	7.51E+01	5.99E+01	9.73E+00	1.49E+02	-	2.91E+01	3.23E+02	7.46E+01	5.99E+01	1.31E+01	1.75E+02	-	-	3.22E+02
2035	-	-	8.27E+00	1.90E+02	1.93E+02	1.36E+01	4.05E+02	9.28E+01	7.39E+01	1.10E+01	1.69E+02	-	3.82E+01	3.85E+02	9.21E+01	7.39E+01	1.54E+01	2.03E+02	-	-	3.84E+02
2036	-	-	9.33E+00	2.15E+02	2.30E+02	1.63E+01	4.70E+02	1.10E+02	8.80E+01	1.22E+01	1.87E+02	-	4.75E+01	4.45E+02	1.10E+02	8.80E+01	1.76E+01	2.29E+02	-	-	4.45E+02
2037	-	-	1.04E+01	2.38E+02	2.66E+02	1.85E+01	5.34E+02	1.28E+02	1.02E+02	1.34E+01	2.04E+02	-	5.69E+01	5.05E+02	1.27E+02	1.02E+02	1.98E+01	2.55E+02	-	-	5.04E+02
2038	-	-	1.13E+01	2.61E+02	3.03E+02	2.05E+01	5.96E+02	1.46E+02	1.16E+02	1.44E+01	2.20E+02	-	6.65E+01	5.63E+02	1.45E+02	1.16E+02	2.20E+01	2.79E+02	-	-	5.62E+02
2039	-	-	1.23E+01	2.84E+02	3.40E+02	2.20E+01	6.58E+02	1.63E+02	1.30E+02	1.54E+01	2.35E+02	-	7.62E+01	6.21E+02	1.62E+02	1.30E+02	2.41E+01	3.03E+02	-	-	6.20E+02
2040	-	-	1.33E+01	3.05E+02	3.77E+02	2.32E+01	7.18E+02	1.81E+02	1.44E+02	1.63E+01	2.50E+02	-	8.59E+01	6.77E+02	1.80E+02	1.44E+02	2.61E+01	3.26E+02	-	-	6.76E+02
2041	-	-	1.42E+01	3.26E+02	4.14E+02	2.40E+01	7.78E+02	1.99E+02	1.58E+02	1.72E+01	2.63E+02	-	9.55E+01	7.33E+02	1.97E+02	1.58E+02	2.81E+01	3.48E+02	-	-	7.32E+02
2042	-	-	1.51E+01	3.47E+02	4.50E+02	2.45E+01	8.37E+02	2.16E+02	1.73E+02	1.80E+01	2.75E+02	-	1.05E+02	7.87E+02	2.15E+02	1.73E+02	3.00E+01	3.69E+02	-	-	7.86E+02
2043	-	-	1.59E+01	3.67E+02	4.87E+02	2.47E+01	8.94E+02	2.34E+02	1.87E+02	1.87E+01	2.87E+02	-	1.15E+02	8.41E+02	2.32E+02	1.87E+02	3.18E+01	3.89E+02	-	-	8.40E+02
2044	-	-	1.68E+01	3.86E+02	5.24E+02	2.46E+01	9.51E+02	2.52E+02	2.01E+02	1.95E+01	2.98E+02	-	1.24E+02	8.94E+02	2.50E+02	2.01E+02	3.36E+01	4.08E+02	-	-	8.92E+02
2045	-	-	1.76E+01	4.05E+02	5.61E+02	2.44E+01	1.01E+03	2.69E+02	2.15E+02	2.01E+01	3.08E+02	-	1.34E+02	9.46E+02	2.68E+02	2.15E+02	3.54E+01	4.27E+02	-	-	9.45E+02
2046	-	-	1.84E+01	4.24E+02	5.97E+02	2.41E+01	1.06E+03	2.87E+02	2.29E+02	2.07E+01	3.17E+02	-	1.44E+02	9.98E+02	2.85E+02	2.29E+02	3.71E+01	4.45E+02	-	-	9.96E+02
2047	-	-	1.92E+01	4.41E+02	6.34E+02	2.37E+01	1.12E+03	3.05E+02	2.43E+02	2.13E+01	3.26E+02	-	1.53E+02	1.05E+03	3.03E+02	2.43E+02	3.88E+01	4.62E+02	-	-	1.05E+03
2048	-	-	1.99E+01	4.59E+02	6.71E+02	2.31E+01	1.17E+03	3.22E+02	2.57E+02	2.19E+01	3.35E+02	-	1.63E+02	1.10E+03	3.20E+02	2.57E+02	4.04E+01	4.79E+02	-	-	1.10E+03
2049	-	-	2.07E+01	4.76E+02	7.08E+02	2.24E+01	1.23E+03	3.40E+02	2.71E+02	2.24E+01	3.42E+02	-	1.72E+02	1.15E+03	3.38E+02	2.71E+02	4.20E+01	4.96E+02	-	-	1.15E+03
2050	-	-	2.14E+01	4.92E+02	7.44E+02	2.16E+01	1.28E+03	3.58E+02	2.85E+02	2.29E+01	3.50E+02	-	1.82E+02	1.20E+03	3.55E+02	2.85E+02	4.36E+01	5.12E+02	-	-	1.20E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.21E+01	5.08E+02	7.81E+02	2.08E+01	1.33E+03	3.75E+02	2.99E+02	2.33E+01	3.57E+02	-	1.92E+02	1.25E+03	3.73E+02	2.99E+02	4.51E+01	5.27E+02	-	-	1.24E+03
2052	-	-	2.28E+01	5.24E+02	8.18E+02	1.98E+01	1.38E+03	3.93E+02	3.13E+02	2.37E+01	3.63E+02	-	2.01E+02	1.29E+03	3.90E+02	3.13E+02	4.66E+01	5.42E+02	-	-	1.29E+03
2053	-	-	2.34E+01	5.39E+02	8.55E+02	1.87E+01	1.44E+03	4.11E+02	3.27E+02	2.41E+01	3.69E+02	-	2.10E+02	1.34E+03	4.08E+02	3.27E+02	4.80E+01	5.56E+02	-	-	1.34E+03
2054	-	-	2.41E+01	5.54E+02	8.91E+02	1.74E+01	1.49E+03	4.28E+02	3.42E+02	2.45E+01	3.75E+02	-	2.19E+02	1.39E+03	4.25E+02	3.42E+02	4.94E+01	5.69E+02	-	-	1.39E+03
2055	-	-	2.47E+01	5.68E+02	9.28E+02	1.61E+01	1.54E+03	4.46E+02	3.56E+02	2.48E+01	3.80E+02	-	2.28E+02	1.43E+03	4.43E+02	3.56E+02	5.08E+01	5.83E+02	-	-	1.43E+03
2056	-	-	2.53E+01	5.82E+02	9.65E+02	1.48E+01	1.59E+03	4.64E+02	3.70E+02	2.52E+01	3.85E+02	-	2.37E+02	1.48E+03	4.61E+02	3.70E+02	5.21E+01	5.96E+02	-	-	1.48E+03
2057	-	-	2.59E+01	5.96E+02	1.00E+03	1.35E+01	1.64E+03	4.81E+02	3.84E+02	2.55E+01	3.90E+02	-	2.46E+02	1.53E+03	4.78E+02	3.84E+02	5.34E+01	6.08E+02	-	-	1.52E+03
2058	-	-	2.65E+01	6.10E+02	1.03E+03	1.20E+01	1.68E+03	4.97E+02	3.96E+02	2.58E+01	3.94E+02	-	2.54E+02	1.57E+03	4.94E+02	3.96E+02	5.47E+01	6.20E+02	-	-	1.57E+03
2059	-	-	2.70E+01	6.22E+02	1.06E+03	1.04E+01	1.72E+03	5.10E+02	4.07E+02	2.60E+01	3.98E+02	-	2.63E+02	1.60E+03	5.06E+02	4.07E+02	5.59E+01	6.32E+02	-	-	1.60E+03
2060	-	-	2.76E+01	6.35E+02	1.08E+03	8.65E+00	1.75E+03	5.20E+02	4.15E+02	2.63E+01	4.02E+02	-	2.71E+02	1.63E+03	5.16E+02	4.15E+02	5.71E+01	6.43E+02	-	-	1.63E+03
2061	-	-	2.81E+01	6.47E+02	1.10E+03	6.78E+00	1.78E+03	5.28E+02	4.21E+02	2.65E+01	4.05E+02	-	2.79E+02	1.66E+03	5.24E+02	4.21E+02	5.82E+01	6.53E+02	-	-	1.66E+03

Exhibit E-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.08E+02	6.11E+02	6.12E+02	6.28E+02
Lower GOR	6.09E+02	6.12E+02	6.12E+02	6.29E+02
Higher GOR	6.08E+02	6.11E+02	6.11E+02	6.28E+02

Exhibit E-30. CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 100-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.08E+02	6.11E+02	6.12E+02	6.28E+02
Decrease in Methane Emissions	6.06E+02	6.10E+02	6.10E+02	6.27E+02
Increase in Methane Emissions	6.10E+02	6.13E+02	6.13E+02	6.30E+02

Appendix F: AR6 20-yr Results

The following tables have been prepared to give additional insights into the effects of alternative GWP methods on the results displayed in the main report.

- Multiproduct Functional Unit – Japan (AR6 – 20-yr)
- Multiproduct Functional Unit – South Korea (AR6 – 20-yr)
- Multiproduct Functional Unit – China (AR6 – 20-yr)
- Multiproduct Functional Unit – India (AR6 – 20-yr)
- Single Product Functional Unit in kg CO2e – Japan (AR6 – 20-yr)
- Single Product Functional Unit in kg CO2e – South Korea (AR6 – 20-yr)
- Single Product Functional Unit in kg CO2e – China (AR6 – 20-yr)
- Single Product Functional Unit in kg CO2e – India (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 20-yr)
- Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 20-yr)
- Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 20-yr)
- Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to Japan (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to South Korea (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to China (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC without CCS to India (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to Japan (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to South Korea (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to China (AR6 – 20-yr)
- Cumulative Emissions Profile – NGCC with CCS to India (AR6 – 20-yr)
- GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR6 – 20-yr)
- CH_4 Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO2e (AR6 – 20-yr)

Exhibit F-1. Multiproduct Functional Unit in kg CO_2e – Japan (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.25E+01	6.25E+01	-	7.03E+01	7.03E+01
Natural Gas Pipelines to GTP	-	8.47E+00	8.47E+00	-	9.53E+00	9.53E+00
Natural Gas Processing at GTP	-	2.31E+01	2.31E+01	-	2.60E+01	2.60E+01
CO2 Compression and Sequestration	-	7.82E-01	-	-	8.80E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.16E+01	4.16E+01	-	4.69E+01	4.69E+01
Ocean Transport	-	2.15E+01	2.15E+01	-	2.42E+01	2.42E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	2.61E+00	4.56E+00	4.56E+00	2.93E+00	5.13E+00	5.13E+00
Crude Oil Extraction, CO2-EOR	-	-	6.73E+00	-	-	7.58E+00
CO2-EOR Crude Oil Transport	-	-	8.51E-01	-	-	9.58E-01
Crude Oil Alaskan Pipeline Transport	1.71E+00	8.83E-01	8.83E-01	1.92E+00	9.94E-01	9.94E-01
Crude Oil Ocean Transport	8.90E-01	4.91E-01	9.63E-01	1.00E+00	5.52E-01	1.08E+00
Crude Oil Refining and End Use	1.14E+02	5.91E+01	1.16E+02	1.29E+02	6.65E+01	1.31E+02
Construction	-	4.97E-01	4.97E-01	-	5.60E-01	5.60E-01
System Expansion: US Average Crude Oil Production and End Use	2.09E+01	8.52E+01	1.88E+01	4.14E+00	7.66E+01	1.86E+00
System Expansion: US Lower 48 LNG Export and End Use	6.04E+02	-	-	3.33E+02	-	-
Total	7.44E+02	6.72E+02	6.70E+02	4.72E+02	3.96E+02	3.93E+02
Upper	3.75E+01	6.68E+01	5.99E+01	4.10E+01	6.88E+01	7.33E+01
Lower	2.20E+01	1.85E+01	1.84E+01	2.48E+01	2.12E+01	2.13E+01

Exhibit F-2. Multiproduct Functional Unit in kg CO_2e – South Korea (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.26E+01	6.26E+01	-	7.05E+01	7.05E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.55E+00	9.55E+00
Natural Gas Processing at GTP	-	2.31E+01	2.31E+01	-	2.60E+01	2.60E+01
CO2 Compression and Sequestration	-	7.83E-01	-	-	8.81E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.69E+01	4.69E+01
Ocean Transport	-	2.51E+01	2.51E+01	-	2.82E+01	2.82E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	2.61E+00	4.57E+00	4.57E+00	2.94E+00	5.14E+00	5.14E+00
Crude Oil Extraction, CO2-EOR	-	-	6.75E+00	-	-	7.59E+00
CO2-EOR Crude Oil Transport	-	-	8.53E-01	-	-	9.60E-01
Crude Oil Alaskan Pipeline Transport	1.71E+00	8.85E-01	8.85E-01	1.93E+00	9.96E-01	9.96E-01
Crude Oil Ocean Transport	8.92E-01	4.92E-01	9.65E-01	1.00E+00	5.53E-01	1.09E+00
Crude Oil Refining and End Use	1.14E+02	5.92E+01	1.16E+02	1.29E+02	6.66E+01	1.31E+02
Construction	-	4.98E-01	4.98E-01	-	5.61E-01	5.61E-01
System Expansion: US Average Crude Oil Production and End Use	2.06E+01	8.51E+01	1.86E+01	3.85E+00	7.64E+01	1.57E+00
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	7.49E+02	6.76E+02	6.74E+02	4.77E+02	4.00E+02	3.98E+02
Upper	3.74E+01	5.91E+01	5.92E+01	4.31E+01	7.75E+01	6.58E+01
Lower	2.38E+01	1.98E+01	1.82E+01	2.48E+01	2.11E+01	2.04E+01

Exhibit F-3. Multiproduct Functional Unit in kg CO_2e – China (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.26E+01	6.26E+01	-	7.05E+01	7.05E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.55E+00	9.55E+00
Natural Gas Processing at GTP	-	2.31E+01	2.31E+01	-	2.60E+01	2.60E+01
CO2 Compression and Sequestration	-	7.83E-01	-	-	8.82E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.70E+01	4.70E+01
Ocean Transport	-	2.53E+01	2.53E+01	-	2.84E+01	2.84E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	2.61E+00	4.57E+00	4.57E+00	2.94E+00	5.14E+00	5.14E+00
Crude Oil Extraction, CO2-EOR	-	-	6.75E+00	-	-	7.59E+00
CO2-EOR Crude Oil Transport	-	-	8.53E-01	-	-	9.60E-01
Crude Oil Alaskan Pipeline Transport	1.71E+00	8.85E-01	8.85E-01	1.93E+00	9.96E-01	9.96E-01
Crude Oil Ocean Transport	8.92E-01	4.92E-01	9.65E-01	1.00E+00	5.53E-01	1.09E+00
Crude Oil Refining and End Use	1.14E+02	5.92E+01	1.16E+02	1.29E+02	6.66E+01	1.31E+02
Construction	-	4.98E-01	4.98E-01	-	5.61E-01	5.61E-01
System Expansion: US Average Crude Oil Production and End Use	2.06E+01	8.51E+01	1.85E+01	3.88E+00	7.64E+01	1.55E+00
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	7.49E+02	6.76E+02	6.74E+02	4.77E+02	4.00E+02	3.98E+02
Upper	3.76E+01	5.90E+01	6.53E+01	4.23E+01	6.93E+01	6.66E+01
Lower	2.24E+01	1.89E+01	1.89E+01	2.50E+01	2.07E+01	2.12E+01

Exhibit F-4. Multiproduct Functional Unit in kg CO_2e – India (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.32E+01	6.32E+01	-	7.12E+01	7.12E+01
Natural Gas Pipelines to GTP	-	8.57E+00	8.57E+00	-	9.64E+00	9.64E+00
Natural Gas Processing at GTP	-	2.34E+01	2.34E+01	-	2.63E+01	2.63E+01
CO2 Compression and Sequestration	-	7.91E-01	-	-	8.90E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.67E+01	1.67E+01	-	1.88E+01	1.88E+01
Liquefaction	-	4.21E+01	4.21E+01	-	4.74E+01	4.74E+01
Ocean Transport	-	4.42E+01	4.42E+01	-	4.98E+01	4.98E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	2.64E+00	4.61E+00	4.61E+00	2.97E+00	5.19E+00	5.19E+00
Crude Oil Extraction, CO2-EOR	-	-	6.82E+00	-	-	7.67E+00
CO2-EOR Crude Oil Transport	-	-	8.62E-01	-	-	9.70E-01
Crude Oil Alaskan Pipeline Transport	1.73E+00	8.94E-01	8.94E-01	1.95E+00	1.01E+00	1.01E+00
Crude Oil Ocean Transport	9.01E-01	4.97E-01	9.75E-01	1.01E+00	5.59E-01	1.10E+00
Crude Oil Refining and End Use	1.16E+02	5.98E+01	1.17E+02	1.30E+02	6.73E+01	1.32E+02
Construction	-	5.03E-01	5.03E-01	-	5.66E-01	5.66E-01
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	8.44E+01	1.72E+01	2.31E+00	7.56E+01	-
System Expansion: US Lower 48 LNG Export and End Use	6.07E+02	-	-	3.36E+02	-	-
Total	7.47E+02	6.97E+02	6.94E+02	4.75E+02	4.23E+02	4.21E+02
Upper	3.58E+01	7.31E+01	5.55E+01	4.19E+01	7.49E+01	6.82E+01
Lower	2.22E+01	1.88E+01	1.87E+01	2.45E+01	2.16E+01	2.07E+01

Exhibit F-5. Single Product Functional Unit in kg CO_2e – Japan (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.25E+01	6.25E+01	-	7.03E+01	7.03E+01
Natural Gas Pipelines to GTP	-	8.47E+00	8.47E+00	-	9.53E+00	9.53E+00
Natural Gas Processing at GTP	-	2.31E+01	2.31E+01	-	2.60E+01	2.60E+01
CO2 Compression and Sequestration	-	6.72E-01	-	-	7.57E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.16E+01	4.16E+01	-	4.69E+01	4.69E+01
Ocean Transport	-	2.15E+01	2.15E+01	-	2.42E+01	2.42E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.97E-01	4.97E-01	-	5.60E-01	5.60E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.04E+02	-	-	3.33E+02	-	-
Total	6.04E+02	5.22E+02	5.21E+02	3.33E+02	2.46E+02	2.45E+02
Upper	3.13E+01	5.19E+01	4.66E+01	3.50E+01	4.27E+01	4.57E+01
Lower	2.03E+01	1.43E+01	1.43E+01	2.29E+01	1.32E+01	1.33E+01

Exhibit F-6.Single Product Functional Unit in kg CO_2e – South Korea (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.26E+01	6.26E+01	-	7.05E+01	7.05E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.55E+00	9.55E+00
Natural Gas Processing at GTP	-	2.31E+01	2.31E+01	-	2.60E+01	2.60E+01
CO2 Compression and Sequestration	-	6.74E-01	-	-	7.58E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.69E+01	4.69E+01
Ocean Transport	-	2.51E+01	2.51E+01	-	2.82E+01	2.82E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.98E-01	4.98E-01	-	5.61E-01	5.61E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	6.09E+02	5.26E+02	5.25E+02	3.38E+02	2.50E+02	2.50E+02
Upper	3.17E+01	4.59E+01	4.61E+01	3.59E+01	4.85E+01	4.13E+01
Lower	2.22E+01	1.54E+01	1.41E+01	2.29E+01	1.32E+01	1.28E+01

Exhibit F-7.Single Product Functional Unit in kg CO_2e – China (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.26E+01	6.26E+01	-	7.05E+01	7.05E+01
Natural Gas Pipelines to GTP	-	8.48E+00	8.48E+00	-	9.55E+00	9.55E+00
Natural Gas Processing at GTP	-	2.31E+01	2.31E+01	-	2.60E+01	2.60E+01
CO2 Compression and Sequestration	-	6.74E-01	-	-	7.58E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.65E+01	1.65E+01	-	1.86E+01	1.86E+01
Liquefaction	-	4.17E+01	4.17E+01	-	4.70E+01	4.70E+01
Ocean Transport	-	2.53E+01	2.53E+01	-	2.84E+01	2.84E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	4.98E-01	4.98E-01	-	5.61E-01	5.61E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.09E+02	-	-	3.38E+02	-	-
Total	6.09E+02	5.26E+02	5.25E+02	3.38E+02	2.51E+02	2.50E+02
Upper	3.18E+01	4.59E+01	5.09E+01	3.58E+01	4.33E+01	4.18E+01
Lower	2.07E+01	1.47E+01	1.47E+01	2.31E+01	1.30E+01	1.33E+01

Exhibit F-8. Single Product Functional Unit in kg CO_2e – India (AR6 – 20-yr)

	NGCC without CCS			NGCC with CCS		
	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR	Scenario 1: BAU, US Lower 48 LNG	Scenario 2: AK LNG + CCS	Scenario 3: AK LNG + CO2-EOR
Natural Gas Extraction, Associated	-	6.32E+01	6.32E+01	-	7.12E+01	7.12E+01
Natural Gas Pipelines to GTP	-	8.57E+00	8.57E+00	-	9.64E+00	9.64E+00
Natural Gas Processing at GTP	-	2.34E+01	2.34E+01	-	2.63E+01	2.63E+01
CO2 Compression and Sequestration	-	6.80E-01	-	-	7.66E-01	-
Natural Gas Alaskan Pipeline Transport	-	1.67E+01	1.67E+01	-	1.88E+01	1.88E+01
Liquefaction	-	4.21E+01	4.21E+01	-	4.74E+01	4.74E+01
Ocean Transport	-	4.42E+01	4.42E+01	-	4.98E+01	4.98E+01
LNG Regasification	-	4.34E+00	4.34E+00	-	4.88E+00	4.88E+00
Power Plant Operations	-	3.42E+02	3.42E+02	-	4.43E+01	4.43E+01
Crude Oil Extraction, Associated	-	-	-	-	-	-
Crude Oil Extraction, CO2-EOR	-	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	-	-	-	-	-	-
Crude Oil Ocean Transport	-	-	-	-	-	-
Crude Oil Refining and End Use	-	-	-	-	-	-
Construction	-	5.03E-01	5.03E-01	-	5.66E-01	5.66E-01
System Expansion: US Average Crude Oil Production and End Use	-	-	-	-	-	-
System Expansion: US Lower 48 LNG Export and End Use	6.07E+02	-	-	3.36E+02	-	-
Total	6.07E+02	5.46E+02	5.46E+02	3.36E+02	2.74E+02	2.73E+02
Upper	3.02E+01	5.73E+01	4.36E+01	3.56E+01	4.84E+01	4.42E+01
Lower	2.05E+01	1.47E+01	1.47E+01	2.26E+01	1.39E+01	1.34E+01

Exhibit F-9. Speciated Emission Results for Scenario 1 – NGCC without CCS to Japan (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.48E-01	-	-	2.61E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	1.89E-01	7.41E-03	4.28E-09	1.71E+00
Crude Oil Ocean Transport	8.24E-01	6.60E-02	-	6.36E-07	8.90E-01
Crude Oil Refining and End Use	1.14E+02	5.32E-01	5.20E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.96E+01	1.26E+00	1.17E-02	-	2.09E+01
System Expansion: US Lower 48 export and End Use	4.64E+02	1.40E+02	3.09E-01	1.41E-07	6.04E+02
Construction	-	-	-	-	-
Total	6.02E+02	-	-	-	6.02E+02

Exhibit F-10. Speciated Emission Results for Scenario 1 – NGCC without CCS to South Korea (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.49E-01	-	-	2.61E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	1.90E-01	7.43E-03	4.29E-09	1.71E+00
Crude Oil Ocean Transport	8.26E-01	6.61E-02	-	6.38E-07	8.92E-01
Crude Oil Refining and End Use	1.14E+02	5.33E-01	5.22E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.93E+01	1.25E+00	1.15E-02	-	2.06E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.41E+02	3.18E-01	1.41E-07	6.09E+02
Construction	-	-	-	-	-
Total	6.05E+02	1.43E+02	3.42E-01	7.83E-07	7.49E+02

Exhibit F-11. Speciated Emission Results for Scenario 1 – NGCC without CCS to China (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.46E+00	1.49E-01	-	-	2.61E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.51E+00	1.90E-01	7.43E-03	4.29E-09	1.71E+00
Crude Oil Ocean Transport	8.26E-01	6.61E-02	-	6.37E-07	8.92E-01
Crude Oil Refining and End Use	1.14E+02	5.33E-01	5.21E-03	-	1.14E+02
System Expansion: US Average Crude Oil Production and End Use	1.94E+01	1.25E+00	1.15E-02	-	2.06E+01
System Expansion: US Lower 48 export and End Use	4.67E+02	1.41E+02	3.19E-01	1.41E-07	6.09E+02
Construction	-	-	-	-	-
Total	6.05E+02	1.44E+02	3.43E-01	7.83E-07	7.49E+02

Exhibit F-12. Speciated Emission Results for Scenario 1 – NGCC without CCS to India (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	-	-	-	-	-
Natural Gas Pipelines to GTP	-	-	-	-	-
Natural Gas Processing at GTP	-	-	-	-	-
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	-	-	-	-	-
Liquefaction	-	-	-	-	-
Ocean Transport	-	-	-	-	-
LNG Regasification	-	-	-	-	-
Power Plant Operations	-	-	-	-	-
Crude Oil Extraction, Associated	2.49E+00	1.50E-01	-	-	2.64E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	1.53E+00	1.92E-01	7.50E-03	4.34E-09	1.73E+00
Crude Oil Ocean Transport	8.34E-01	6.68E-02	-	6.44E-07	9.01E-01
Crude Oil Refining and End Use	1.15E+02	5.38E-01	5.27E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.81E+01	1.17E+00	1.08E-02	-	1.93E+01
System Expansion: US Lower 48 export and End Use	4.66E+02	1.41E+02	3.15E-01	1.41E-07	6.07E+02
Construction	-	-	-	-	-
Total	6.04E+02	1.43E+02	3.39E-01	7.89E-07	7.47E+02

Exhibit F-13. Speciated Emission Results for Scenario 2 – NGCC without CCS to Japan (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.39E+01	-	-	6.25E+01
Natural Gas Pipelines to GTP	2.14E-03	8.46E+00	-	-	8.47E+00
Natural Gas Processing at GTP	2.18E+01	1.29E+00	2.48E-05	-	2.31E+01
CO2 Compression and Sequestration	6.56E-01	1.22E-01	1.42E-03	1.59E-03	7.82E-01
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.13E+01	5.17E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	-	1.02E-07	4.16E+01
Ocean Transport	1.68E+01	4.69E+00	-	-	2.15E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	3.11E+00	-	-	4.56E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.82E-01	9.79E-02	3.83E-03	2.21E-09	8.83E-01
Crude Oil Ocean Transport	4.42E-01	4.84E-02	-	4.71E-07	4.91E-01
Crude Oil Refining and End Use	5.88E+01	2.75E-01	2.69E-03	-	5.91E+01
System Expansion: US Average Crude Oil Production and End Use	8.00E+01	5.16E+00	4.77E-02	-	8.52E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	2.42E-02	2.41E-03	-	4.97E-01
Total	5.73E+02	9.90E+01	5.81E-02	1.66E-03	6.72E+02

Exhibit F-14. Speciated Emission Results for Scenario 2 – NGCC without CCS to South Korea (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.40E+01	-	-	6.26E+01
Natural Gas Pipelines to GTP	2.15E-03	8.48E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.18E+01	1.29E+00	2.49E-05	-	2.31E+01
CO2 Compression and Sequestration	6.58E-01	1.23E-01	1.43E-03	1.59E-03	7.83E-01
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	-	1.02E-07	4.17E+01
Ocean Transport	1.95E+01	5.59E+00	-	-	2.51E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.12E+00	-	-	4.57E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	9.81E-02	3.84E-03	2.22E-09	8.85E-01
Crude Oil Ocean Transport	4.43E-01	4.85E-02	-	4.72E-07	4.92E-01
Crude Oil Refining and End Use	5.89E+01	2.75E-01	2.70E-03	-	5.92E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	5.15E+00	4.77E-02	-	8.51E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.43E-02	2.41E-03	-	4.98E-01
Total	5.76E+02	1.00E+02	5.81E-02	1.66E-03	6.76E+02

Exhibit F-15. Speciated Emission Results for Scenario 2 – NGCC without CCS to China (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.40E+01	-	-	6.26E+01
Natural Gas Pipelines to GTP	2.15E-03	8.48E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.18E+01	1.29E+00	2.49E-05	-	2.31E+01
CO2 Compression and Sequestration	6.58E-01	1.23E-01	1.43E-03	1.59E-03	7.83E-01
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	-	1.02E-07	4.17E+01
Ocean Transport	1.96E+01	5.63E+00	-	-	2.53E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.12E+00	-	-	4.57E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.83E-01	9.81E-02	3.84E-03	2.22E-09	8.85E-01
Crude Oil Ocean Transport	4.43E-01	4.85E-02	-	4.72E-07	4.92E-01
Crude Oil Refining and End Use	5.89E+01	2.75E-01	2.70E-03	-	5.92E+01
System Expansion: US Average Crude Oil Production and End Use	7.99E+01	5.15E+00	4.77E-02	-	8.51E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.43E-02	2.41E-03	-	4.98E-01
Total	5.76E+02	1.00E+02	5.81E-02	1.66E-03	6.76E+02

Exhibit F-16. Speciated Emission Results for Scenario 2 – NGCC without CCS to India (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	4.44E+01	-	-	6.32E+01
Natural Gas Pipelines to GTP	2.17E-03	8.57E+00	-	-	8.57E+00
Natural Gas Processing at GTP	2.21E+01	1.30E+00	2.51E-05	-	2.34E+01
CO2 Compression and Sequestration	6.64E-01	1.24E-01	1.44E-03	1.61E-03	7.91E-01
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.15E+01	5.24E-07	-	1.67E+01
Liquefaction	2.27E+01	1.94E+01	-	1.03E-07	4.21E+01
Ocean Transport	3.39E+01	1.04E+01	-	-	4.42E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	3.15E+00	-	-	4.61E+00
Crude Oil Extraction, CO2-EOR	-	-	-	-	-
CO2-EOR Crude Oil Transport	-	-	-	-	-
Crude Oil Alaskan Pipeline Transport	7.91E-01	9.91E-02	3.88E-03	2.24E-09	8.94E-01
Crude Oil Ocean Transport	4.48E-01	4.90E-02	-	4.76E-07	4.97E-01
Crude Oil Refining and End Use	5.95E+01	2.78E-01	2.72E-03	-	5.98E+01
System Expansion: US Average Crude Oil Production and End Use	7.92E+01	5.10E+00	4.73E-02	-	8.44E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	2.45E-02	2.44E-03	-	5.03E-01
Total	5.91E+02	1.06E+02	5.78E-02	1.68E-03	6.97E+02

Exhibit F-17. Speciated Emission Results for Scenario 3 – NGCC without CCS to Japan (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.39E+01	-	-	6.25E+01
Natural Gas Pipelines to GTP	2.14E-03	8.46E+00	-	-	8.47E+00
Natural Gas Processing at GTP	2.18E+01	1.29E+00	2.48E-05	-	2.31E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.17E+00	1.13E+01	5.17E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	-	1.02E-07	4.16E+01
Ocean Transport	1.68E+01	4.69E+00	-	-	2.15E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.44E+00	3.11E+00	-	-	4.56E+00
Crude Oil Extraction, CO2-EOR	5.58E+00	1.11E+00	1.78E-02	2.06E-02	6.73E+00
CO2-EOR Crude Oil Transport	7.53E-01	9.44E-02	3.69E-03	2.13E-09	8.51E-01
Crude Oil Alaskan Pipeline Transport	7.82E-01	9.79E-02	3.83E-03	2.21E-09	8.83E-01
Crude Oil Ocean Transport	8.68E-01	9.50E-02	-	9.24E-07	9.63E-01
Crude Oil Refining and End Use	1.15E+02	5.40E-01	5.28E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.77E+01	1.14E+00	1.05E-02	-	1.88E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.71E-01	2.42E-02	2.41E-03	-	4.97E-01
Total	5.73E+02	9.64E+01	4.36E-02	2.07E-02	6.70E+02

Exhibit F-18. Speciated Emission Results for Scenario 3 – NGCC without CCS to South Korea (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.40E+01	-	-	6.26E+01
Natural Gas Pipelines to GTP	2.15E-03	8.48E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.18E+01	1.29E+00	2.49E-05	-	2.31E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.18E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	-	1.02E-07	4.17E+01
Ocean Transport	1.95E+01	5.59E+00	-	-	2.51E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.12E+00	-	-	4.57E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	1.11E+00	1.79E-02	2.07E-02	6.75E+00
CO2-EOR Crude Oil Transport	7.55E-01	9.46E-02	3.70E-03	2.14E-09	8.53E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	9.81E-02	3.84E-03	2.22E-09	8.85E-01
Crude Oil Ocean Transport	8.70E-01	9.52E-02	-	9.26E-07	9.65E-01
Crude Oil Refining and End Use	1.16E+02	5.41E-01	5.29E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	1.12E+00	1.04E-02	-	1.86E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.43E-02	2.41E-03	-	4.98E-01
Total	5.76E+02	9.75E+01	4.35E-02	2.07E-02	6.74E+02

Exhibit F-19. Speciated Emission Results for Scenario 3 – NGCC without CCS to China (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.86E+01	4.40E+01	-	-	6.26E+01
Natural Gas Pipelines to GTP	2.15E-03	8.48E+00	-	-	8.48E+00
Natural Gas Processing at GTP	2.18E+01	1.29E+00	2.49E-05	-	2.31E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.19E+00	1.14E+01	5.18E-07	-	1.65E+01
Liquefaction	2.25E+01	1.92E+01	-	1.02E-07	4.17E+01
Ocean Transport	1.96E+01	5.63E+00	-	-	2.53E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.45E+00	3.12E+00	-	-	4.57E+00
Crude Oil Extraction, CO2-EOR	5.60E+00	1.11E+00	1.79E-02	2.07E-02	6.75E+00
CO2-EOR Crude Oil Transport	7.55E-01	9.46E-02	3.70E-03	2.14E-09	8.53E-01
Crude Oil Alaskan Pipeline Transport	7.83E-01	9.81E-02	3.84E-03	2.22E-09	8.85E-01
Crude Oil Ocean Transport	8.70E-01	9.52E-02	-	9.26E-07	9.65E-01
Crude Oil Refining and End Use	1.16E+02	5.41E-01	5.30E-03	-	1.16E+02
System Expansion: US Average Crude Oil Production and End Use	1.74E+01	1.12E+00	1.04E-02	-	1.85E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.72E-01	2.43E-02	2.41E-03	-	4.98E-01
Total	5.76E+02	9.75E+01	4.35E-02	2.07E-02	6.74E+02

Exhibit F-20. Speciated Emission Results for Scenario 3 – NGCC without CCS to India (AR6 – 20-yr)

	CO_2, kg CO_2e	CH_4, kg CO_2e	N_2O, kg CO_2e	SF_6, kg CO_2e	Total
Natural Gas Extraction, Associated	1.88E+01	4.44E+01	-	-	6.32E+01
Natural Gas Pipelines to GTP	2.17E-03	8.57E+00	-	-	8.57E+00
Natural Gas Processing at GTP	2.21E+01	1.30E+00	2.51E-05	-	2.34E+01
CO2 Compression and Sequestration	-	-	-	-	-
Natural Gas Alaskan Pipeline Transport	5.24E+00	1.15E+01	5.24E-07	-	1.67E+01
Liquefaction	2.27E+01	1.94E+01	-	1.03E-07	4.21E+01
Ocean Transport	3.39E+01	1.04E+01	-	-	4.42E+01
LNG Regasification	3.02E+00	1.32E+00	-	6.85E-05	4.34E+00
Power Plant Operations	3.42E+02	-	-	-	3.42E+02
Crude Oil Extraction, Associated	1.46E+00	3.15E+00	-	-	4.61E+00
Crude Oil Extraction, CO2-EOR	5.65E+00	1.12E+00	1.81E-02	2.09E-02	6.82E+00
CO2-EOR Crude Oil Transport	7.62E-01	9.55E-02	3.74E-03	2.16E-09	8.62E-01
Crude Oil Alaskan Pipeline Transport	7.91E-01	9.91E-02	3.88E-03	2.24E-09	8.94E-01
Crude Oil Ocean Transport	8.79E-01	9.61E-02	-	9.35E-07	9.75E-01
Crude Oil Refining and End Use	1.17E+02	5.46E-01	5.35E-03	-	1.17E+02
System Expansion: US Average Crude Oil Production and End Use	1.61E+01	1.04E+00	9.62E-03	-	1.72E+01
System Expansion: US Lower 48 export and End Use	-	-	-	-	-
Construction	4.76E-01	2.45E-02	2.44E-03	-	5.03E-01
Total	5.91E+02	1.03E+02	4.31E-02	2.09E-02	6.94E+02

Exhibit F-21. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	1.77E+01	-4.74E-01	4.83E+01	4.54E+00	1.09E+01	2.91E+00	2.90E+01	-	2.98E-01	4.77E+01	4.52E+00	1.09E+01	2.95E+00	2.93E+01	-	-	4.77E+01
2030	-	-	2.67E+00	5.85E+01	6.21E+01	-5.78E-01	1.23E+02	1.59E+01	3.83E+01	5.65E+00	5.63E+01	-	2.02E+00	1.18E+02	1.58E+01	3.83E+01	5.90E+00	5.80E+01	-	-	1.18E+02
2031	-	-	3.94E+00	8.66E+01	1.42E+02	6.29E-01	2.33E+02	3.64E+01	8.75E+01	8.22E+00	8.18E+01	-	6.17E+00	2.20E+02	3.62E+01	8.75E+01	8.96E+00	8.71E+01	-	-	2.20E+02
2032	-	-	5.19E+00	1.14E+02	2.39E+02	3.41E+00	3.62E+02	6.13E+01	1.48E+02	1.06E+01	1.06E+02	-	1.28E+01	3.38E+02	6.10E+01	1.48E+02	1.22E+01	1.17E+02	-	-	3.38E+02
2033	-	-	6.39E+00	1.40E+02	3.46E+02	7.13E+00	5.00E+02	8.86E+01	2.13E+02	1.29E+01	1.28E+02	-	2.12E+01	4.64E+02	8.82E+01	2.13E+02	1.54E+01	1.46E+02	-	-	4.63E+02
2034	-	-	7.57E+00	1.66E+02	4.52E+02	1.08E+01	6.37E+02	1.16E+02	2.79E+02	1.50E+01	1.49E+02	-	3.03E+01	5.90E+02	1.15E+02	2.79E+02	1.87E+01	1.75E+02	-	-	5.88E+02
2035	-	-	8.71E+00	1.91E+02	5.59E+02	1.41E+01	7.72E+02	1.43E+02	3.45E+02	1.70E+01	1.69E+02	-	3.98E+01	7.14E+02	1.42E+02	3.45E+02	2.18E+01	2.03E+02	-	-	7.12E+02
2036	-	-	9.81E+00	2.15E+02	6.65E+02	1.69E+01	9.07E+02	1.70E+02	4.10E+02	1.88E+01	1.88E+02	-	4.94E+01	8.36E+02	1.70E+02	4.10E+02	2.48E+01	2.30E+02	-	-	8.35E+02
2037	-	-	1.09E+01	2.39E+02	7.71E+02	1.93E+01	1.04E+03	1.98E+02	4.76E+02	2.06E+01	2.05E+02	-	5.92E+01	9.58E+02	1.97E+02	4.76E+02	2.78E+01	2.56E+02	-	-	9.56E+02
2038	-	-	1.19E+01	2.62E+02	8.78E+02	2.13E+01	1.17E+03	2.25E+02	5.42E+02	2.22E+01	2.21E+02	-	6.92E+01	1.08E+03	2.24E+02	5.42E+02	3.06E+01	2.80E+02	-	-	1.08E+03
2039	-	-	1.30E+01	2.84E+02	9.84E+02	2.29E+01	1.30E+03	2.52E+02	6.07E+02	2.37E+01	2.36E+02	-	7.92E+01	1.20E+03	2.51E+02	6.07E+02	3.33E+01	3.04E+02	-	-	1.20E+03
2040	-	-	1.40E+01	3.06E+02	1.09E+03	2.41E+01	1.43E+03	2.79E+02	6.73E+02	2.51E+01	2.50E+02	-	8.93E+01	1.32E+03	2.78E+02	6.73E+02	3.60E+01	3.27E+02	-	-	1.31E+03
2041	-	-	1.49E+01	3.27E+02	1.20E+03	2.50E+01	1.56E+03	3.07E+02	7.38E+02	2.65E+01	2.64E+02	-	9.94E+01	1.43E+03	3.05E+02	7.38E+02	3.85E+01	3.49E+02	-	-	1.43E+03
2042	-	-	1.59E+01	3.48E+02	1.30E+03	2.55E+01	1.69E+03	3.34E+02	8.04E+02	2.77E+01	2.76E+02	-	1.09E+02	1.55E+03	3.32E+02	8.04E+02	4.10E+01	3.70E+02	-	-	1.55E+03
2043	-	-	1.68E+01	3.68E+02	1.41E+03	2.56E+01	1.82E+03	3.61E+02	8.70E+02	2.89E+01	2.88E+02	-	1.19E+02	1.67E+03	3.59E+02	8.70E+02	4.34E+01	3.90E+02	-	-	1.66E+03
2044	-	-	1.77E+01	3.87E+02	1.52E+03	2.56E+01	1.95E+03	3.89E+02	9.35E+02	3.00E+01	2.98E+02	-	1.29E+02	1.78E+03	3.87E+02	9.35E+02	4.57E+01	4.09E+02	-	-	1.78E+03
2045	-	-	1.85E+01	4.06E+02	1.62E+03	2.54E+01	2.07E+03	4.16E+02	1.00E+03	3.10E+01	3.09E+02	-	1.39E+02	1.90E+03	4.14E+02	1.00E+03	4.79E+01	4.28E+02	-	-	1.89E+03
2046	-	-	1.94E+01	4.25E+02	1.73E+03	2.51E+01	2.20E+03	4.43E+02	1.07E+03	3.20E+01	3.18E+02	-	1.49E+02	2.01E+03	4.41E+02	1.07E+03	5.01E+01	4.46E+02	-	-	2.00E+03
2047	-	-	2.02E+01	4.43E+02	1.84E+03	2.46E+01	2.32E+03	4.70E+02	1.13E+03	3.29E+01	3.27E+02	-	1.59E+02	2.12E+03	4.68E+02	1.13E+03	5.22E+01	4.64E+02	-	-	2.12E+03
2048	-	-	2.10E+01	4.60E+02	1.94E+03	2.40E+01	2.45E+03	4.98E+02	1.20E+03	3.37E+01	3.36E+02	-	1.69E+02	2.23E+03	4.95E+02	1.20E+03	5.43E+01	4.81E+02	-	-	2.23E+03
2049	-	-	2.17E+01	4.77E+02	2.05E+03	2.33E+01	2.57E+03	5.25E+02	1.26E+03	3.45E+01	3.43E+02	-	1.79E+02	2.35E+03	5.22E+02	1.26E+03	5.63E+01	4.97E+02	-	-	2.34E+03
2050	-	-	2.25E+01	4.94E+02	2.15E+03	2.25E+01	2.69E+03	5.52E+02	1.33E+03	3.52E+01	3.51E+02	-	1.89E+02	2.46E+03	5.49E+02	1.33E+03	5.82E+01	5.13E+02	-	-	2.45E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	2.26E+03	2.16E+01	2.82E+03	5.79E+02	1.39E+03	3.59E+01	3.58E+02	-	1.99E+02	2.57E+03	5.76E+02	1.39E+03	6.01E+01	5.28E+02	-	-	2.56E+03
2052	-	-	2.39E+01	5.26E+02	2.37E+03	2.06E+01	2.94E+03	6.07E+02	1.46E+03	3.66E+01	3.64E+02	-	2.09E+02	2.68E+03	6.04E+02	1.46E+03	6.19E+01	5.43E+02	-	-	2.67E+03
2053	-	-	2.46E+01	5.41E+02	2.47E+03	1.94E+01	3.06E+03	6.34E+02	1.53E+03	3.72E+01	3.70E+02	-	2.18E+02	2.79E+03	6.31E+02	1.53E+03	6.37E+01	5.57E+02	-	-	2.78E+03
2054	-	-	2.53E+01	5.56E+02	2.58E+03	1.81E+01	3.18E+03	6.61E+02	1.59E+03	3.77E+01	3.76E+02	-	2.28E+02	2.89E+03	6.58E+02	1.59E+03	6.54E+01	5.71E+02	-	-	2.89E+03
2055	-	-	2.60E+01	5.70E+02	2.69E+03	1.67E+01	3.30E+03	6.88E+02	1.66E+03	3.83E+01	3.81E+02	-	2.37E+02	3.00E+03	6.85E+02	1.66E+03	6.71E+01	5.84E+02	-	-	2.99E+03
2056	-	-	2.66E+01	5.84E+02	2.79E+03	1.54E+01	3.42E+03	7.16E+02	1.72E+03	3.88E+01	3.86E+02	-	2.46E+02	3.11E+03	7.12E+02	1.72E+03	6.87E+01	5.97E+02	-	-	3.10E+03
2057	-	-	2.72E+01	5.98E+02	2.90E+03	1.41E+01	3.54E+03	7.43E+02	1.79E+03	3.93E+01	3.91E+02	-	2.56E+02	3.22E+03	7.39E+02	1.79E+03	7.03E+01	6.10E+02	-	-	3.21E+03
2058	-	-	2.79E+01	6.11E+02	2.99E+03	1.25E+01	3.65E+03	7.67E+02	1.85E+03	3.97E+01	3.95E+02	-	2.64E+02	3.31E+03	7.63E+02	1.85E+03	7.18E+01	6.22E+02	-	-	3.30E+03
2059	-	-	2.84E+01	6.24E+02	3.07E+03	1.08E+01	3.73E+03	7.87E+02	1.89E+03	4.01E+01	3.99E+02	-	2.73E+02	3.39E+03	7.83E+02	1.89E+03	7.33E+01	6.34E+02	-	-	3.38E+03
2060	-	-	2.90E+01	6.37E+02	3.13E+03	9.00E+00	3.81E+03	8.03E+02	1.93E+03	4.05E+01	4.03E+02	-	2.82E+02	3.46E+03	7.98E+02	1.93E+03	7.47E+01	6.45E+02	-	-	3.45E+03
2061	-	-	2.96E+01	6.49E+02	3.18E+03	7.06E+00	3.87E+03	8.15E+02	1.96E+03	4.08E+01	4.07E+02	-	2.90E+02	3.52E+03	8.11E+02	1.96E+03	7.60E+01	6.55E+02	-	-	3.50E+03

Exhibit F-22. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	1.78E+01	-4.74E-01	4.84E+01	4.54E+00	1.10E+01	2.91E+00	2.90E+01	-	2.98E-01	4.78E+01	4.52E+00	1.10E+01	2.95E+00	2.93E+01	-	-	4.78E+01
2030	-	-	2.67E+00	5.85E+01	6.24E+01	-5.78E-01	1.23E+02	1.59E+01	3.86E+01	5.65E+00	5.63E+01	-	2.02E+00	1.18E+02	1.58E+01	3.86E+01	5.90E+00	5.80E+01	-	-	1.18E+02
2031	-	-	3.94E+00	8.66E+01	1.43E+02	6.29E-01	2.34E+02	3.64E+01	8.82E+01	8.22E+00	8.18E+01	-	6.17E+00	2.21E+02	3.62E+01	8.82E+01	8.96E+00	8.71E+01	-	-	2.20E+02
2032	-	-	5.19E+00	1.14E+02	2.41E+02	3.41E+00	3.63E+02	6.13E+01	1.49E+02	1.06E+01	1.06E+02	-	1.28E+01	3.39E+02	6.10E+01	1.49E+02	1.22E+01	1.17E+02	-	-	3.39E+02
2033	-	-	6.39E+00	1.40E+02	3.48E+02	7.13E+00	5.02E+02	8.86E+01	2.15E+02	1.29E+01	1.28E+02	-	2.12E+01	4.66E+02	8.82E+01	2.15E+02	1.54E+01	1.46E+02	-	-	4.65E+02
2034	-	-	7.57E+00	1.66E+02	4.55E+02	1.08E+01	6.39E+02	1.16E+02	2.81E+02	1.50E+01	1.49E+02	-	3.03E+01	5.92E+02	1.15E+02	2.81E+02	1.87E+01	1.75E+02	-	-	5.90E+02
2035	-	-	8.71E+00	1.91E+02	5.62E+02	1.41E+01	7.76E+02	1.43E+02	3.47E+02	1.70E+01	1.69E+02	-	3.98E+01	7.16E+02	1.42E+02	3.47E+02	2.18E+01	2.03E+02	-	-	7.15E+02
2036	-	-	9.81E+00	2.15E+02	6.69E+02	1.69E+01	9.11E+02	1.70E+02	4.13E+02	1.88E+01	1.88E+02	-	4.94E+01	8.40E+02	1.70E+02	4.13E+02	2.48E+01	2.30E+02	-	-	8.38E+02
2037	-	-	1.09E+01	2.39E+02	7.76E+02	1.93E+01	1.04E+03	1.98E+02	4.80E+02	2.06E+01	2.05E+02	-	5.92E+01	9.62E+02	1.97E+02	4.80E+02	2.78E+01	2.56E+02	-	-	9.60E+02
2038	-	-	1.19E+01	2.62E+02	8.83E+02	2.13E+01	1.18E+03	2.25E+02	5.46E+02	2.22E+01	2.21E+02	-	6.92E+01	1.08E+03	2.24E+02	5.46E+02	3.06E+01	2.80E+02	-	-	1.08E+03
2039	-	-	1.30E+01	2.84E+02	9.90E+02	2.29E+01	1.31E+03	2.52E+02	6.12E+02	2.37E+01	2.36E+02	-	7.92E+01	1.20E+03	2.51E+02	6.12E+02	3.33E+01	3.04E+02	-	-	1.20E+03
2040	-	-	1.40E+01	3.06E+02	1.10E+03	2.41E+01	1.44E+03	2.79E+02	6.78E+02	2.51E+01	2.50E+02	-	8.93E+01	1.32E+03	2.78E+02	6.78E+02	3.60E+01	3.27E+02	-	-	1.32E+03
2041	-	-	1.49E+01	3.27E+02	1.20E+03	2.50E+01	1.57E+03	3.07E+02	7.44E+02	2.65E+01	2.64E+02	-	9.94E+01	1.44E+03	3.05E+02	7.44E+02	3.85E+01	3.49E+02	-	-	1.44E+03
2042	-	-	1.59E+01	3.48E+02	1.31E+03	2.55E+01	1.70E+03	3.34E+02	8.10E+02	2.77E+01	2.76E+02	-	1.09E+02	1.56E+03	3.32E+02	8.10E+02	4.10E+01	3.70E+02	-	-	1.55E+03
2043	-	-	1.68E+01	3.68E+02	1.42E+03	2.56E+01	1.83E+03	3.61E+02	8.77E+02	2.89E+01	2.88E+02	-	1.19E+02	1.67E+03	3.59E+02	8.77E+02	4.34E+01	3.90E+02	-	-	1.67E+03
2044	-	-	1.77E+01	3.87E+02	1.52E+03	2.56E+01	1.96E+03	3.89E+02	9.43E+02	3.00E+01	2.98E+02	-	1.29E+02	1.79E+03	3.87E+02	9.43E+02	4.57E+01	4.09E+02	-	-	1.78E+03
2045	-	-	1.85E+01	4.06E+02	1.63E+03	2.54E+01	2.08E+03	4.16E+02	1.01E+03	3.10E+01	3.09E+02	-	1.39E+02	1.90E+03	4.14E+02	1.01E+03	4.79E+01	4.28E+02	-	-	1.90E+03
2046	-	-	1.94E+01	4.25E+02	1.74E+03	2.51E+01	2.21E+03	4.43E+02	1.08E+03	3.20E+01	3.18E+02	-	1.49E+02	2.02E+03	4.41E+02	1.08E+03	5.01E+01	4.46E+02	-	-	2.01E+03
2047	-	-	2.02E+01	4.43E+02	1.85E+03	2.46E+01	2.33E+03	4.70E+02	1.14E+03	3.29E+01	3.27E+02	-	1.59E+02	2.13E+03	4.68E+02	1.14E+03	5.22E+01	4.64E+02	-	-	2.13E+03
2048	-	-	2.10E+01	4.60E+02	1.95E+03	2.40E+01	2.46E+03	4.98E+02	1.21E+03	3.37E+01	3.36E+02	-	1.69E+02	2.24E+03	4.95E+02	1.21E+03	5.43E+01	4.81E+02	-	-	2.24E+03
2049	-	-	2.17E+01	4.77E+02	2.06E+03	2.33E+01	2.58E+03	5.25E+02	1.27E+03	3.45E+01	3.43E+02	-	1.79E+02	2.36E+03	5.22E+02	1.27E+03	5.63E+01	4.97E+02	-	-	2.35E+03
2050	-	-	2.25E+01	4.94E+02	2.17E+03	2.25E+01	2.71E+03	5.52E+02	1.34E+03	3.52E+01	3.51E+02	-	1.89E+02	2.47E+03	5.49E+02	1.34E+03	5.82E+01	5.13E+02	-	-	2.46E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	2.27E+03	2.16E+01	2.83E+03	5.79E+02	1.41E+03	3.59E+01	3.58E+02	-	1.99E+02	2.58E+03	5.76E+02	1.41E+03	6.01E+01	5.28E+02	-	-	2.57E+03
2052	-	-	2.39E+01	5.26E+02	2.38E+03	2.06E+01	2.95E+03	6.07E+02	1.47E+03	3.66E+01	3.64E+02	-	2.09E+02	2.69E+03	6.04E+02	1.47E+03	6.19E+01	5.43E+02	-	-	2.68E+03
2053	-	-	2.46E+01	5.41E+02	2.49E+03	1.94E+01	3.07E+03	6.34E+02	1.54E+03	3.72E+01	3.70E+02	-	2.18E+02	2.80E+03	6.31E+02	1.54E+03	6.37E+01	5.57E+02	-	-	2.79E+03
2054	-	-	2.53E+01	5.56E+02	2.59E+03	1.81E+01	3.19E+03	6.61E+02	1.60E+03	3.77E+01	3.76E+02	-	2.28E+02	2.91E+03	6.58E+02	1.60E+03	6.54E+01	5.71E+02	-	-	2.90E+03
2055	-	-	2.60E+01	5.70E+02	2.70E+03	1.67E+01	3.31E+03	6.88E+02	1.67E+03	3.83E+01	3.81E+02	-	2.37E+02	3.02E+03	6.85E+02	1.67E+03	6.71E+01	5.84E+02	-	-	3.01E+03
2056	-	-	2.66E+01	5.84E+02	2.81E+03	1.54E+01	3.43E+03	7.16E+02	1.74E+03	3.88E+01	3.86E+02	-	2.46E+02	3.12E+03	7.12E+02	1.74E+03	6.87E+01	5.97E+02	-	-	3.11E+03
2057	-	-	2.72E+01	5.98E+02	2.92E+03	1.41E+01	3.55E+03	7.43E+02	1.80E+03	3.93E+01	3.91E+02	-	2.56E+02	3.23E+03	7.39E+02	1.80E+03	7.03E+01	6.10E+02	-	-	3.22E+03
2058	-	-	2.79E+01	6.11E+02	3.01E+03	1.25E+01	3.66E+03	7.67E+02	1.86E+03	3.97E+01	3.95E+02	-	2.64E+02	3.33E+03	7.63E+02	1.86E+03	7.18E+01	6.22E+02	-	-	3.32E+03
2059	-	-	2.84E+01	6.24E+02	3.09E+03	1.08E+01	3.75E+03	7.87E+02	1.91E+03	4.01E+01	3.99E+02	-	2.73E+02	3.41E+03	7.83E+02	1.91E+03	7.33E+01	6.34E+02	-	-	3.40E+03
2060	-	-	2.90E+01	6.37E+02	3.15E+03	9.00E+00	3.82E+03	8.03E+02	1.95E+03	4.05E+01	4.03E+02	-	2.82E+02	3.48E+03	7.98E+02	1.95E+03	7.47E+01	6.45E+02	-	-	3.47E+03
2061	-	-	2.96E+01	6.49E+02	3.20E+03	7.06E+00	3.88E+03	8.15E+02	1.98E+03	4.08E+01	4.07E+02	-	2.90E+02	3.53E+03	8.11E+02	1.98E+03	7.60E+01	6.55E+02	-	-	3.52E+03

Exhibit F-23. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	1.78E+01	-4.74E-01	4.84E+01	4.54E+00	1.10E+01	2.91E+00	2.90E+01	-	2.98E-01	4.78E+01	4.52E+00	1.10E+01	2.95E+00	2.93E+01	-	-	4.78E+01
2030	-	-	2.67E+00	5.85E+01	6.24E+01	-5.78E-01	1.23E+02	1.59E+01	3.86E+01	5.65E+00	5.63E+01	-	2.02E+00	1.18E+02	1.58E+01	3.86E+01	5.90E+00	5.80E+01	-	-	1.18E+02
2031	-	-	3.94E+00	8.66E+01	1.43E+02	6.29E-01	2.34E+02	3.64E+01	8.82E+01	8.22E+00	8.18E+01	-	6.17E+00	2.21E+02	3.62E+01	8.82E+01	8.97E+00	8.71E+01	-	-	2.20E+02
2032	-	-	5.19E+00	1.14E+02	2.41E+02	3.41E+00	3.63E+02	6.13E+01	1.49E+02	1.06E+01	1.06E+02	-	1.28E+01	3.39E+02	6.10E+01	1.49E+02	1.22E+01	1.17E+02	-	-	3.39E+02
2033	-	-	6.39E+00	1.40E+02	3.48E+02	7.13E+00	5.02E+02	8.86E+01	2.15E+02	1.29E+01	1.28E+02	-	2.12E+01	4.66E+02	8.82E+01	2.15E+02	1.55E+01	1.46E+02	-	-	4.65E+02
2034	-	-	7.57E+00	1.66E+02	4.55E+02	1.08E+01	6.39E+02	1.16E+02	2.81E+02	1.50E+01	1.49E+02	-	3.03E+01	5.92E+02	1.15E+02	2.81E+02	1.87E+01	1.75E+02	-	-	5.91E+02
2035	-	-	8.71E+00	1.91E+02	5.62E+02	1.41E+01	7.76E+02	1.43E+02	3.47E+02	1.70E+01	1.69E+02	-	3.98E+01	7.16E+02	1.42E+02	3.47E+02	2.18E+01	2.03E+02	-	-	7.15E+02
2036	-	-	9.81E+00	2.15E+02	6.69E+02	1.69E+01	9.11E+02	1.70E+02	4.14E+02	1.88E+01	1.88E+02	-	4.94E+01	8.40E+02	1.70E+02	4.14E+02	2.48E+01	2.30E+02	-	-	8.38E+02
2037	-	-	1.09E+01	2.39E+02	7.76E+02	1.93E+01	1.05E+03	1.98E+02	4.80E+02	2.06E+01	2.05E+02	-	5.92E+01	9.62E+02	1.97E+02	4.80E+02	2.78E+01	2.56E+02	-	-	9.60E+02
2038	-	-	1.19E+01	2.62E+02	8.83E+02	2.13E+01	1.18E+03	2.25E+02	5.46E+02	2.22E+01	2.21E+02	-	6.92E+01	1.08E+03	2.24E+02	5.46E+02	3.06E+01	2.80E+02	-	-	1.08E+03
2039	-	-	1.30E+01	2.84E+02	9.90E+02	2.29E+01	1.31E+03	2.52E+02	6.12E+02	2.37E+01	2.36E+02	-	7.92E+01	1.20E+03	2.51E+02	6.12E+02	3.33E+01	3.04E+02	-	-	1.20E+03
2040	-	-	1.40E+01	3.06E+02	1.10E+03	2.41E+01	1.44E+03	2.79E+02	6.78E+02	2.51E+01	2.50E+02	-	8.93E+01	1.32E+03	2.78E+02	6.78E+02	3.60E+01	3.27E+02	-	-	1.32E+03
2041	-	-	1.49E+01	3.27E+02	1.20E+03	2.50E+01	1.57E+03	3.07E+02	7.45E+02	2.65E+01	2.64E+02	-	9.94E+01	1.44E+03	3.05E+02	7.45E+02	3.85E+01	3.49E+02	-	-	1.44E+03
2042	-	-	1.59E+01	3.48E+02	1.31E+03	2.55E+01	1.70E+03	3.34E+02	8.11E+02	2.77E+01	2.76E+02	-	1.09E+02	1.56E+03	3.32E+02	8.11E+02	4.10E+01	3.70E+02	-	-	1.55E+03
2043	-	-	1.68E+01	3.68E+02	1.42E+03	2.56E+01	1.83E+03	3.61E+02	8.77E+02	2.89E+01	2.88E+02	-	1.19E+02	1.67E+03	3.59E+02	8.77E+02	4.34E+01	3.90E+02	-	-	1.67E+03
2044	-	-	1.77E+01	3.87E+02	1.52E+03	2.56E+01	1.96E+03	3.89E+02	9.43E+02	3.00E+01	2.98E+02	-	1.29E+02	1.79E+03	3.87E+02	9.43E+02	4.57E+01	4.09E+02	-	-	1.78E+03
2045	-	-	1.85E+01	4.06E+02	1.63E+03	2.54E+01	2.08E+03	4.16E+02	1.01E+03	3.10E+01	3.09E+02	-	1.39E+02	1.90E+03	4.14E+02	1.01E+03	4.79E+01	4.28E+02	-	-	1.90E+03
2046	-	-	1.94E+01	4.25E+02	1.74E+03	2.51E+01	2.21E+03	4.43E+02	1.08E+03	3.20E+01	3.18E+02	-	1.49E+02	2.02E+03	4.41E+02	1.08E+03	5.01E+01	4.46E+02	-	-	2.01E+03
2047	-	-	2.02E+01	4.43E+02	1.85E+03	2.46E+01	2.33E+03	4.70E+02	1.14E+03	3.29E+01	3.27E+02	-	1.59E+02	2.13E+03	4.68E+02	1.14E+03	5.22E+01	4.64E+02	-	-	2.13E+03
2048	-	-	2.10E+01	4.60E+02	1.95E+03	2.40E+01	2.46E+03	4.98E+02	1.21E+03	3.37E+01	3.36E+02	-	1.69E+02	2.24E+03	4.95E+02	1.21E+03	5.43E+01	4.81E+02	-	-	2.24E+03
2049	-	-	2.17E+01	4.77E+02	2.06E+03	2.33E+01	2.58E+03	5.25E+02	1.27E+03	3.45E+01	3.43E+02	-	1.79E+02	2.36E+03	5.22E+02	1.27E+03	5.63E+01	4.97E+02	-	-	2.35E+03
2050	-	-	2.25E+01	4.94E+02	2.17E+03	2.25E+01	2.71E+03	5.52E+02	1.34E+03	3.52E+01	3.51E+02	-	1.89E+02	2.47E+03	5.49E+02	1.34E+03	5.82E+01	5.13E+02	-	-	2.46E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	2.27E+03	2.16E+01	2.83E+03	5.79E+02	1.41E+03	3.59E+01	3.58E+02	-	1.99E+02	2.58E+03	5.76E+02	1.41E+03	6.01E+01	5.28E+02	-	-	2.57E+03
2052	-	-	2.39E+01	5.26E+02	2.38E+03	2.06E+01	2.95E+03	6.07E+02	1.47E+03	3.66E+01	3.64E+02	-	2.09E+02	2.69E+03	6.04E+02	1.47E+03	6.20E+01	5.43E+02	-	-	2.68E+03
2053	-	-	2.46E+01	5.41E+02	2.49E+03	1.94E+01	3.07E+03	6.34E+02	1.54E+03	3.72E+01	3.70E+02	-	2.18E+02	2.80E+03	6.31E+02	1.54E+03	6.37E+01	5.57E+02	-	-	2.79E+03
2054	-	-	2.53E+01	5.56E+02	2.59E+03	1.81E+01	3.19E+03	6.61E+02	1.60E+03	3.77E+01	3.76E+02	-	2.28E+02	2.91E+03	6.58E+02	1.60E+03	6.54E+01	5.71E+02	-	-	2.90E+03
2055	-	-	2.60E+01	5.70E+02	2.70E+03	1.67E+01	3.31E+03	6.88E+02	1.67E+03	3.83E+01	3.81E+02	-	2.37E+02	3.02E+03	6.85E+02	1.67E+03	6.71E+01	5.84E+02	-	-	3.01E+03
2056	-	-	2.66E+01	5.84E+02	2.81E+03	1.54E+01	3.44E+03	7.16E+02	1.74E+03	3.88E+01	3.86E+02	-	2.46E+02	3.12E+03	7.12E+02	1.74E+03	6.87E+01	5.97E+02	-	-	3.12E+03
2057	-	-	2.72E+01	5.98E+02	2.92E+03	1.41E+01	3.56E+03	7.43E+02	1.80E+03	3.93E+01	3.91E+02	-	2.56E+02	3.23E+03	7.39E+02	1.80E+03	7.03E+01	6.10E+02	-	-	3.22E+03
2058	-	-	2.79E+01	6.11E+02	3.01E+03	1.25E+01	3.66E+03	7.67E+02	1.86E+03	3.97E+01	3.95E+02	-	2.64E+02	3.33E+03	7.63E+02	1.86E+03	7.18E+01	6.22E+02	-	-	3.32E+03
2059	-	-	2.84E+01	6.24E+02	3.09E+03	1.08E+01	3.75E+03	7.87E+02	1.91E+03	4.01E+01	3.99E+02	-	2.73E+02	3.41E+03	7.83E+02	1.91E+03	7.33E+01	6.34E+02	-	-	3.40E+03
2060	-	-	2.90E+01	6.37E+02	3.15E+03	9.00E+00	3.83E+03	8.03E+02	1.95E+03	4.05E+01	4.03E+02	-	2.82E+02	3.48E+03	7.98E+02	1.95E+03	7.47E+01	6.45E+02	-	-	3.47E+03
2061	-	-	2.96E+01	6.49E+02	3.20E+03	7.06E+00	3.89E+03	8.15E+02	1.98E+03	4.08E+01	4.07E+02	-	2.90E+02	3.53E+03	8.11E+02	1.98E+03	7.61E+01	6.55E+02	-	-	3.52E+03

Exhibit F-24. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	1.78E+01	-4.74E-01	4.84E+01	4.54E+00	1.15E+01	2.91E+00	2.90E+01	-	2.98E-01	4.83E+01	4.52E+00	1.15E+01	2.95E+00	2.93E+01	-	-	4.82E+01
2030	-	-	2.67E+00	5.85E+01	6.23E+01	-5.78E-01	1.23E+02	1.59E+01	4.02E+01	5.65E+00	5.63E+01	-	2.02E+00	1.20E+02	1.58E+01	4.02E+01	5.90E+00	5.80E+01	-	-	1.20E+02
2031	-	-	3.94E+00	8.66E+01	1.42E+02	6.29E-01	2.34E+02	3.64E+01	9.18E+01	8.21E+00	8.18E+01	-	6.17E+00	2.24E+02	3.62E+01	9.18E+01	8.96E+00	8.71E+01	-	-	2.24E+02
2032	-	-	5.19E+00	1.14E+02	2.40E+02	3.41E+00	3.63E+02	6.13E+01	1.55E+02	1.06E+01	1.06E+02	-	1.28E+01	3.45E+02	6.10E+01	1.55E+02	1.22E+01	1.17E+02	-	-	3.45E+02
2033	-	-	6.39E+00	1.40E+02	3.47E+02	7.13E+00	5.01E+02	8.86E+01	2.24E+02	1.29E+01	1.28E+02	-	2.12E+01	4.75E+02	8.82E+01	2.24E+02	1.54E+01	1.46E+02	-	-	4.74E+02
2034	-	-	7.57E+00	1.66E+02	4.54E+02	1.08E+01	6.38E+02	1.16E+02	2.93E+02	1.50E+01	1.49E+02	-	3.03E+01	6.03E+02	1.15E+02	2.93E+02	1.87E+01	1.75E+02	-	-	6.02E+02
2035	-	-	8.71E+00	1.91E+02	5.61E+02	1.41E+01	7.75E+02	1.43E+02	3.62E+02	1.70E+01	1.69E+02	-	3.98E+01	7.30E+02	1.42E+02	3.62E+02	2.18E+01	2.03E+02	-	-	7.29E+02
2036	-	-	9.81E+00	2.15E+02	6.67E+02	1.69E+01	9.10E+02	1.70E+02	4.30E+02	1.88E+01	1.88E+02	-	4.94E+01	8.57E+02	1.70E+02	4.30E+02	2.48E+01	2.30E+02	-	-	8.55E+02
2037	-	-	1.09E+01	2.39E+02	7.74E+02	1.93E+01	1.04E+03	1.98E+02	4.99E+02	2.06E+01	2.05E+02	-	5.92E+01	9.81E+02	1.97E+02	4.99E+02	2.78E+01	2.56E+02	-	-	9.79E+02
2038	-	-	1.19E+01	2.62E+02	8.81E+02	2.13E+01	1.18E+03	2.25E+02	5.68E+02	2.22E+01	2.21E+02	-	6.92E+01	1.11E+03	2.24E+02	5.68E+02	3.06E+01	2.80E+02	-	-	1.10E+03
2039	-	-	1.30E+01	2.84E+02	9.88E+02	2.29E+01	1.31E+03	2.52E+02	6.37E+02	2.37E+01	2.36E+02	-	7.92E+01	1.23E+03	2.51E+02	6.37E+02	3.33E+01	3.04E+02	-	-	1.23E+03
2040	-	-	1.40E+01	3.06E+02	1.09E+03	2.41E+01	1.44E+03	2.79E+02	7.06E+02	2.51E+01	2.50E+02	-	8.93E+01	1.35E+03	2.78E+02	7.06E+02	3.60E+01	3.27E+02	-	-	1.35E+03
2041	-	-	1.49E+01	3.27E+02	1.20E+03	2.50E+01	1.57E+03	3.07E+02	7.75E+02	2.65E+01	2.64E+02	-	9.94E+01	1.47E+03	3.05E+02	7.75E+02	3.85E+01	3.49E+02	-	-	1.47E+03
2042	-	-	1.59E+01	3.48E+02	1.31E+03	2.55E+01	1.70E+03	3.34E+02	8.44E+02	2.77E+01	2.76E+02	-	1.09E+02	1.59E+03	3.32E+02	8.44E+02	4.10E+01	3.70E+02	-	-	1.59E+03
2043	-	-	1.68E+01	3.68E+02	1.41E+03	2.56E+01	1.83E+03	3.61E+02	9.12E+02	2.89E+01	2.88E+02	-	1.19E+02	1.71E+03	3.59E+02	9.12E+02	4.34E+01	3.90E+02	-	-	1.71E+03
2044	-	-	1.77E+01	3.87E+02	1.52E+03	2.56E+01	1.95E+03	3.89E+02	9.81E+02	3.00E+01	2.98E+02	-	1.29E+02	1.83E+03	3.87E+02	9.81E+02	4.57E+01	4.09E+02	-	-	1.82E+03
2045	-	-	1.85E+01	4.06E+02	1.63E+03	2.54E+01	2.08E+03	4.16E+02	1.05E+03	3.10E+01	3.09E+02	-	1.39E+02	1.94E+03	4.14E+02	1.05E+03	4.79E+01	4.28E+02	-	-	1.94E+03
2046	-	-	1.94E+01	4.25E+02	1.74E+03	2.51E+01	2.20E+03	4.43E+02	1.12E+03	3.20E+01	3.18E+02	-	1.49E+02	2.06E+03	4.41E+02	1.12E+03	5.01E+01	4.46E+02	-	-	2.06E+03
2047	-	-	2.02E+01	4.43E+02	1.84E+03	2.46E+01	2.33E+03	4.70E+02	1.19E+03	3.29E+01	3.27E+02	-	1.59E+02	2.18E+03	4.68E+02	1.19E+03	5.22E+01	4.64E+02	-	-	2.17E+03
2048	-	-	2.10E+01	4.60E+02	1.95E+03	2.40E+01	2.45E+03	4.98E+02	1.26E+03	3.37E+01	3.36E+02	-	1.69E+02	2.29E+03	4.95E+02	1.26E+03	5.43E+01	4.81E+02	-	-	2.29E+03
2049	-	-	2.17E+01	4.77E+02	2.06E+03	2.33E+01	2.58E+03	5.25E+02	1.33E+03	3.45E+01	3.43E+02	-	1.79E+02	2.41E+03	5.22E+02	1.33E+03	5.63E+01	4.97E+02	-	-	2.40E+03
2050	-	-	2.25E+01	4.94E+02	2.16E+03	2.25E+01	2.70E+03	5.52E+02	1.39E+03	3.52E+01	3.51E+02	-	1.89E+02	2.52E+03	5.49E+02	1.39E+03	5.82E+01	5.13E+02	-	-	2.51E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	2.27E+03	2.16E+01	2.82E+03	5.79E+02	1.46E+03	3.59E+01	3.58E+02	-	1.99E+02	2.64E+03	5.76E+02	1.46E+03	6.01E+01	5.28E+02	-	-	2.63E+03
2052	-	-	2.39E+01	5.26E+02	2.38E+03	2.06E+01	2.95E+03	6.07E+02	1.53E+03	3.66E+01	3.64E+02	-	2.09E+02	2.75E+03	6.04E+02	1.53E+03	6.19E+01	5.43E+02	-	-	2.74E+03
2053	-	-	2.46E+01	5.41E+02	2.48E+03	1.94E+01	3.07E+03	6.34E+02	1.60E+03	3.72E+01	3.70E+02	-	2.18E+02	2.86E+03	6.31E+02	1.60E+03	6.37E+01	5.57E+02	-	-	2.85E+03
2054	-	-	2.53E+01	5.56E+02	2.59E+03	1.81E+01	3.19E+03	6.61E+02	1.67E+03	3.77E+01	3.76E+02	-	2.28E+02	2.97E+03	6.58E+02	1.67E+03	6.54E+01	5.71E+02	-	-	2.96E+03
2055	-	-	2.60E+01	5.70E+02	2.70E+03	1.67E+01	3.31E+03	6.88E+02	1.74E+03	3.83E+01	3.81E+02	-	2.37E+02	3.08E+03	6.85E+02	1.74E+03	6.71E+01	5.84E+02	-	-	3.08E+03
2056	-	-	2.66E+01	5.84E+02	2.80E+03	1.54E+01	3.43E+03	7.16E+02	1.81E+03	3.88E+01	3.86E+02	-	2.46E+02	3.19E+03	7.12E+02	1.81E+03	6.87E+01	5.97E+02	-	-	3.19E+03
2057	-	-	2.72E+01	5.98E+02	2.91E+03	1.41E+01	3.55E+03	7.43E+02	1.88E+03	3.92E+01	3.91E+02	-	2.56E+02	3.31E+03	7.39E+02	1.88E+03	7.03E+01	6.10E+02	-	-	3.30E+03
2058	-	-	2.79E+01	6.11E+02	3.01E+03	1.25E+01	3.66E+03	7.67E+02	1.94E+03	3.97E+01	3.95E+02	-	2.64E+02	3.40E+03	7.63E+02	1.94E+03	7.18E+01	6.22E+02	-	-	3.40E+03
2059	-	-	2.84E+01	6.24E+02	3.08E+03	1.08E+01	3.75E+03	7.87E+02	1.99E+03	4.01E+01	3.99E+02	-	2.73E+02	3.49E+03	7.83E+02	1.99E+03	7.33E+01	6.34E+02	-	-	3.48E+03
2060	-	-	2.90E+01	6.37E+02	3.14E+03	9.00E+00	3.82E+03	8.03E+02	2.03E+03	4.05E+01	4.03E+02	-	2.82E+02	3.55E+03	7.98E+02	2.03E+03	7.47E+01	6.45E+02	-	-	3.54E+03
2061	-	-	2.96E+01	6.49E+02	3.19E+03	7.06E+00	3.88E+03	8.15E+02	2.06E+03	4.08E+01	4.07E+02	-	2.90E+02	3.61E+03	8.11E+02	2.06E+03	7.60E+01	6.55E+02	-	-	3.60E+03

Exhibit F-25. Cumulative Emissions Profile AR6 20-yr – NGCC with CCS to Japan (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	8.69E+00	-4.74E-01	3.92E+01	4.54E+00	1.94E+00	2.92E+00	2.90E+01	-	2.98E-01	3.87E+01	4.52E+00	1.94E+00	2.95E+00	2.93E+01	-	-	3.87E+01
2030	-	-	2.67E+00	5.85E+01	3.04E+01	-5.78E-01	9.10E+01	1.59E+01	6.78E+00	5.66E+00	5.63E+01	-	2.02E+00	8.67E+01	1.58E+01	6.78E+00	5.90E+00	5.80E+01	-	-	8.65E+01
2031	-	-	3.94E+00	8.66E+01	6.95E+01	6.29E-01	1.61E+02	3.64E+01	1.55E+01	8.22E+00	8.18E+01	-	6.17E+00	1.48E+02	3.62E+01	1.55E+01	8.97E+00	8.71E+01	-	-	1.48E+02
2032	-	-	5.19E+00	1.14E+02	1.17E+02	3.41E+00	2.40E+02	6.14E+01	2.61E+01	1.06E+01	1.06E+02	-	1.28E+01	2.17E+02	6.10E+01	2.61E+01	1.22E+01	1.17E+02	-	-	2.16E+02
2033	-	-	6.39E+00	1.40E+02	1.69E+02	7.13E+00	3.23E+02	8.86E+01	3.78E+01	1.29E+01	1.28E+02	-	2.12E+01	2.89E+02	8.82E+01	3.78E+01	1.55E+01	1.46E+02	-	-	2.88E+02
2034	-	-	7.57E+00	1.66E+02	2.21E+02	1.08E+01	4.06E+02	1.16E+02	4.94E+01	1.50E+01	1.49E+02	-	3.03E+01	3.60E+02	1.15E+02	4.94E+01	1.87E+01	1.75E+02	-	-	3.59E+02
2035	-	-	8.71E+00	1.91E+02	2.74E+02	1.41E+01	4.87E+02	1.43E+02	6.10E+01	1.70E+01	1.69E+02	-	3.98E+01	4.30E+02	1.42E+02	6.10E+01	2.18E+01	2.03E+02	-	-	4.28E+02
2036	-	-	9.81E+00	2.15E+02	3.26E+02	1.69E+01	5.68E+02	1.70E+02	7.26E+01	1.88E+01	1.88E+02	-	4.94E+01	4.99E+02	1.70E+02	7.26E+01	2.48E+01	2.30E+02	-	-	4.97E+02
2037	-	-	1.09E+01	2.39E+02	3.78E+02	1.93E+01	6.47E+02	1.98E+02	8.42E+01	2.06E+01	2.05E+02	-	5.92E+01	5.67E+02	1.97E+02	8.42E+01	2.78E+01	2.56E+02	-	-	5.64E+02
2038	-	-	1.19E+01	2.62E+02	4.30E+02	2.13E+01	7.25E+02	2.25E+02	9.59E+01	2.22E+01	2.21E+02	-	6.92E+01	6.33E+02	2.24E+02	9.59E+01	3.06E+01	2.80E+02	-	-	6.31E+02
2039	-	-	1.30E+01	2.84E+02	4.82E+02	2.29E+01	8.02E+02	2.52E+02	1.07E+02	2.37E+01	2.36E+02	-	7.92E+01	6.99E+02	2.51E+02	1.07E+02	3.33E+01	3.04E+02	-	-	6.96E+02
2040	-	-	1.40E+01	3.06E+02	5.34E+02	2.41E+01	8.78E+02	2.79E+02	1.19E+02	2.51E+01	2.50E+02	-	8.93E+01	7.63E+02	2.78E+02	1.19E+02	3.60E+01	3.27E+02	-	-	7.60E+02
2041	-	-	1.49E+01	3.27E+02	5.86E+02	2.50E+01	9.53E+02	3.07E+02	1.31E+02	2.65E+01	2.64E+02	-	9.94E+01	8.27E+02	3.05E+02	1.31E+02	3.85E+01	3.49E+02	-	-	8.23E+02
2042	-	-	1.59E+01	3.48E+02	6.38E+02	2.55E+01	1.03E+03	3.34E+02	1.42E+02	2.77E+01	2.76E+02	-	1.09E+02	8.89E+02	3.32E+02	1.42E+02	4.10E+01	3.70E+02	-	-	8.85E+02
2043	-	-	1.68E+01	3.68E+02	6.90E+02	2.56E+01	1.10E+03	3.61E+02	1.54E+02	2.89E+01	2.88E+02	-	1.19E+02	9.51E+02	3.59E+02	1.54E+02	4.34E+01	3.90E+02	-	-	9.47E+02
2044	-	-	1.77E+01	3.87E+02	7.43E+02	2.56E+01	1.17E+03	3.89E+02	1.66E+02	3.00E+01	2.98E+02	-	1.29E+02	1.01E+03	3.87E+02	1.66E+02	4.57E+01	4.09E+02	-	-	1.01E+03
2045	-	-	1.85E+01	4.06E+02	7.95E+02	2.54E+01	1.24E+03	4.16E+02	1.77E+02	3.10E+01	3.09E+02	-	1.39E+02	1.07E+03	4.14E+02	1.77E+02	4.79E+01	4.28E+02	-	-	1.07E+03
2046	-	-	1.94E+01	4.25E+02	8.47E+02	2.51E+01	1.32E+03	4.43E+02	1.89E+02	3.20E+01	3.18E+02	-	1.49E+02	1.13E+03	4.41E+02	1.89E+02	5.01E+01	4.46E+02	-	-	1.13E+03
2047	-	-	2.02E+01	4.43E+02	8.99E+02	2.46E+01	1.39E+03	4.70E+02	2.00E+02	3.29E+01	3.27E+02	-	1.59E+02	1.19E+03	4.68E+02	2.00E+02	5.22E+01	4.64E+02	-	-	1.18E+03
2048	-	-	2.10E+01	4.60E+02	9.51E+02	2.40E+01	1.46E+03	4.98E+02	2.12E+02	3.37E+01	3.36E+02	-	1.69E+02	1.25E+03	4.95E+02	2.12E+02	5.43E+01	4.81E+02	-	-	1.24E+03
2049	-	-	2.17E+01	4.77E+02	1.00E+03	2.33E+01	1.53E+03	5.25E+02	2.24E+02	3.45E+01	3.43E+02	-	1.79E+02	1.31E+03	5.22E+02	2.24E+02	5.63E+01	4.97E+02	-	-	1.30E+03
2050	-	-	2.25E+01	4.94E+02	1.06E+03	2.25E+01	1.59E+03	5.52E+02	2.35E+02	3.52E+01	3.51E+02	-	1.89E+02	1.36E+03	5.49E+02	2.35E+02	5.82E+01	5.13E+02	-	-	1.36E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	1.11E+03	2.16E+01	1.66E+03	5.79E+02	2.47E+02	3.59E+01	3.58E+02	-	1.99E+02	1.42E+03	5.76E+02	2.47E+02	6.01E+01	5.28E+02	-	-	1.41E+03
2052	-	-	2.39E+01	5.26E+02	1.16E+03	2.06E+01	1.73E+03	6.07E+02	2.59E+02	3.66E+01	3.64E+02	-	2.09E+02	1.47E+03	6.04E+02	2.59E+02	6.19E+01	5.43E+02	-	-	1.47E+03
2053	-	-	2.46E+01	5.41E+02	1.21E+03	1.94E+01	1.80E+03	6.34E+02	2.70E+02	3.72E+01	3.70E+02	-	2.18E+02	1.53E+03	6.31E+02	2.70E+02	6.37E+01	5.57E+02	-	-	1.52E+03
2054	-	-	2.53E+01	5.56E+02	1.26E+03	1.81E+01	1.86E+03	6.61E+02	2.82E+02	3.78E+01	3.76E+02	-	2.28E+02	1.58E+03	6.58E+02	2.82E+02	6.54E+01	5.71E+02	-	-	1.58E+03
2055	-	-	2.60E+01	5.70E+02	1.32E+03	1.67E+01	1.93E+03	6.88E+02	2.93E+02	3.83E+01	3.81E+02	-	2.37E+02	1.64E+03	6.85E+02	2.93E+02	6.71E+01	5.84E+02	-	-	1.63E+03
2056	-	-	2.66E+01	5.84E+02	1.37E+03	1.54E+01	1.99E+03	7.16E+02	3.05E+02	3.88E+01	3.86E+02	-	2.46E+02	1.69E+03	7.12E+02	3.05E+02	6.87E+01	5.97E+02	-	-	1.68E+03
2057	-	-	2.72E+01	5.98E+02	1.42E+03	1.41E+01	2.06E+03	7.43E+02	3.17E+02	3.93E+01	3.91E+02	-	2.56E+02	1.75E+03	7.39E+02	3.17E+02	7.03E+01	6.10E+02	-	-	1.74E+03
2058	-	-	2.79E+01	6.11E+02	1.47E+03	1.25E+01	2.12E+03	7.67E+02	3.27E+02	3.97E+01	3.95E+02	-	2.64E+02	1.79E+03	7.64E+02	3.27E+02	7.18E+01	6.22E+02	-	-	1.78E+03
2059	-	-	2.84E+01	6.24E+02	1.50E+03	1.08E+01	2.17E+03	7.87E+02	3.35E+02	4.01E+01	3.99E+02	-	2.73E+02	1.84E+03	7.83E+02	3.35E+02	7.33E+01	6.34E+02	-	-	1.83E+03
2060	-	-	2.90E+01	6.37E+02	1.53E+03	9.00E+00	2.21E+03	8.03E+02	3.42E+02	4.05E+01	4.03E+02	-	2.82E+02	1.87E+03	7.99E+02	3.42E+02	7.47E+01	6.45E+02	-	-	1.86E+03
2061	-	-	2.96E+01	6.49E+02	1.56E+03	7.06E+00	2.24E+03	8.15E+02	3.47E+02	4.09E+01	4.07E+02	-	2.90E+02	1.90E+03	8.11E+02	3.47E+02	7.61E+01	6.55E+02	-	-	1.89E+03

Exhibit F-26. Cumulative Emissions Profile AR6 20-yr – NGCC with CCS to South Korea (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	8.80E+00	-4.74E-01	3.94E+01	4.54E+00	2.04E+00	2.92E+00	2.90E+01	-	2.98E-01	3.88E+01	4.52E+00	2.04E+00	2.95E+00	2.93E+01	-	-	3.88E+01
2030	-	-	2.67E+00	5.85E+01	3.08E+01	-5.78E-01	9.14E+01	1.59E+01	7.14E+00	5.66E+00	5.63E+01	-	2.02E+00	8.70E+01	1.58E+01	7.14E+00	5.90E+00	5.80E+01	-	-	8.69E+01
2031	-	-	3.94E+00	8.66E+01	7.04E+01	6.29E-01	1.62E+02	3.64E+01	1.63E+01	8.22E+00	8.18E+01	-	6.17E+00	1.49E+02	3.62E+01	1.63E+01	8.97E+00	8.71E+01	-	-	1.49E+02
2032	-	-	5.19E+00	1.14E+02	1.19E+02	3.41E+00	2.41E+02	6.14E+01	2.75E+01	1.06E+01	1.06E+02	-	1.28E+01	2.18E+02	6.10E+01	2.75E+01	1.22E+01	1.17E+02	-	-	2.17E+02
2033	-	-	6.39E+00	1.40E+02	1.72E+02	7.13E+00	3.25E+02	8.86E+01	3.98E+01	1.29E+01	1.28E+02	-	2.12E+01	2.91E+02	8.82E+01	3.98E+01	1.55E+01	1.46E+02	-	-	2.90E+02
2034	-	-	7.57E+00	1.66E+02	2.24E+02	1.08E+01	4.09E+02	1.16E+02	5.20E+01	1.50E+01	1.49E+02	-	3.03E+01	3.63E+02	1.15E+02	5.20E+01	1.87E+01	1.75E+02	-	-	3.61E+02
2035	-	-	8.71E+00	1.91E+02	2.77E+02	1.41E+01	4.91E+02	1.43E+02	6.43E+01	1.70E+01	1.69E+02	-	3.98E+01	4.33E+02	1.42E+02	6.43E+01	2.18E+01	2.03E+02	-	-	4.32E+02
2036	-	-	9.81E+00	2.15E+02	3.30E+02	1.69E+01	5.72E+02	1.70E+02	7.65E+01	1.88E+01	1.88E+02	-	4.94E+01	5.03E+02	1.70E+02	7.65E+01	2.48E+01	2.30E+02	-	-	5.01E+02
2037	-	-	1.09E+01	2.39E+02	3.83E+02	1.93E+01	6.52E+02	1.98E+02	8.87E+01	2.06E+01	2.05E+02	-	5.92E+01	5.71E+02	1.97E+02	8.87E+01	2.78E+01	2.56E+02	-	-	5.69E+02
2038	-	-	1.19E+01	2.62E+02	4.36E+02	2.13E+01	7.31E+02	2.25E+02	1.01E+02	2.22E+01	2.21E+02	-	6.92E+01	6.38E+02	2.24E+02	1.01E+02	3.06E+01	2.80E+02	-	-	6.36E+02
2039	-	-	1.30E+01	2.84E+02	4.89E+02	2.29E+01	8.09E+02	2.52E+02	1.13E+02	2.37E+01	2.36E+02	-	7.92E+01	7.05E+02	2.51E+02	1.13E+02	3.33E+01	3.04E+02	-	-	7.02E+02
2040	-	-	1.40E+01	3.06E+02	5.41E+02	2.41E+01	8.86E+02	2.79E+02	1.25E+02	2.51E+01	2.50E+02	-	8.93E+01	7.70E+02	2.78E+02	1.25E+02	3.60E+01	3.27E+02	-	-	7.66E+02
2041	-	-	1.49E+01	3.27E+02	5.94E+02	2.50E+01	9.61E+02	3.07E+02	1.38E+02	2.65E+01	2.64E+02	-	9.94E+01	8.34E+02	3.05E+02	1.38E+02	3.85E+01	3.49E+02	-	-	8.30E+02
2042	-	-	1.59E+01	3.48E+02	6.47E+02	2.55E+01	1.04E+03	3.34E+02	1.50E+02	2.77E+01	2.76E+02	-	1.09E+02	8.97E+02	3.32E+02	1.50E+02	4.10E+01	3.70E+02	-	-	8.93E+02
2043	-	-	1.68E+01	3.68E+02	7.00E+02	2.56E+01	1.11E+03	3.61E+02	1.62E+02	2.89E+01	2.88E+02	-	1.19E+02	9.59E+02	3.59E+02	1.62E+02	4.34E+01	3.90E+02	-	-	9.55E+02
2044	-	-	1.77E+01	3.87E+02	7.53E+02	2.56E+01	1.18E+03	3.89E+02	1.74E+02	3.00E+01	2.98E+02	-	1.29E+02	1.02E+03	3.87E+02	1.74E+02	4.57E+01	4.09E+02	-	-	1.02E+03
2045	-	-	1.85E+01	4.06E+02	8.05E+02	2.54E+01	1.26E+03	4.16E+02	1.87E+02	3.10E+01	3.09E+02	-	1.39E+02	1.08E+03	4.14E+02	1.87E+02	4.79E+01	4.28E+02	-	-	1.08E+03
2046	-	-	1.94E+01	4.25E+02	8.58E+02	2.51E+01	1.33E+03	4.43E+02	1.99E+02	3.20E+01	3.18E+02	-	1.49E+02	1.14E+03	4.41E+02	1.99E+02	5.01E+01	4.46E+02	-	-	1.14E+03
2047	-	-	2.02E+01	4.43E+02	9.11E+02	2.46E+01	1.40E+03	4.70E+02	2.11E+02	3.29E+01	3.27E+02	-	1.59E+02	1.20E+03	4.68E+02	2.11E+02	5.22E+01	4.64E+02	-	-	1.20E+03
2048	-	-	2.10E+01	4.60E+02	9.64E+02	2.40E+01	1.47E+03	4.98E+02	2.23E+02	3.37E+01	3.36E+02	-	1.69E+02	1.26E+03	4.95E+02	2.23E+02	5.43E+01	4.81E+02	-	-	1.25E+03
2049	-	-	2.17E+01	4.77E+02	1.02E+03	2.33E+01	1.54E+03	5.25E+02	2.36E+02	3.45E+01	3.43E+02	-	1.79E+02	1.32E+03	5.22E+02	2.36E+02	5.63E+01	4.97E+02	-	-	1.31E+03
2050	-	-	2.25E+01	4.94E+02	1.07E+03	2.25E+01	1.61E+03	5.52E+02	2.48E+02	3.52E+01	3.51E+02	-	1.89E+02	1.38E+03	5.49E+02	2.48E+02	5.82E+01	5.13E+02	-	-	1.37E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	1.12E+03	2.16E+01	1.68E+03	5.79E+02	2.60E+02	3.59E+01	3.58E+02	-	1.99E+02	1.43E+03	5.76E+02	2.60E+02	6.01E+01	5.28E+02	-	-	1.43E+03
2052	-	-	2.39E+01	5.26E+02	1.18E+03	2.06E+01	1.75E+03	6.07E+02	2.72E+02	3.66E+01	3.64E+02	-	2.09E+02	1.49E+03	6.04E+02	2.72E+02	6.19E+01	5.43E+02	-	-	1.48E+03
2053	-	-	2.46E+01	5.41E+02	1.23E+03	1.94E+01	1.81E+03	6.34E+02	2.85E+02	3.72E+01	3.70E+02	-	2.18E+02	1.54E+03	6.31E+02	2.85E+02	6.37E+01	5.57E+02	-	-	1.54E+03
2054	-	-	2.53E+01	5.56E+02	1.28E+03	1.81E+01	1.88E+03	6.61E+02	2.97E+02	3.78E+01	3.76E+02	-	2.28E+02	1.60E+03	6.58E+02	2.97E+02	6.54E+01	5.71E+02	-	-	1.59E+03
2055	-	-	2.60E+01	5.70E+02	1.33E+03	1.67E+01	1.95E+03	6.88E+02	3.09E+02	3.83E+01	3.81E+02	-	2.37E+02	1.65E+03	6.85E+02	3.09E+02	6.71E+01	5.84E+02	-	-	1.65E+03
2056	-	-	2.66E+01	5.84E+02	1.39E+03	1.54E+01	2.01E+03	7.16E+02	3.21E+02	3.88E+01	3.86E+02	-	2.46E+02	1.71E+03	7.12E+02	3.21E+02	6.87E+01	5.97E+02	-	-	1.70E+03
2057	-	-	2.72E+01	5.98E+02	1.44E+03	1.41E+01	2.08E+03	7.43E+02	3.34E+02	3.93E+01	3.91E+02	-	2.56E+02	1.76E+03	7.39E+02	3.34E+02	7.03E+01	6.10E+02	-	-	1.75E+03
2058	-	-	2.79E+01	6.11E+02	1.49E+03	1.25E+01	2.14E+03	7.67E+02	3.45E+02	3.97E+01	3.95E+02	-	2.64E+02	1.81E+03	7.64E+02	3.45E+02	7.18E+01	6.22E+02	-	-	1.80E+03
2059	-	-	2.84E+01	6.24E+02	1.52E+03	1.08E+01	2.19E+03	7.87E+02	3.53E+02	4.01E+01	3.99E+02	-	2.73E+02	1.85E+03	7.83E+02	3.53E+02	7.33E+01	6.34E+02	-	-	1.84E+03
2060	-	-	2.90E+01	6.37E+02	1.55E+03	9.00E+00	2.23E+03	8.03E+02	3.60E+02	4.05E+01	4.03E+02	-	2.82E+02	1.89E+03	7.99E+02	3.60E+02	7.47E+01	6.45E+02	-	-	1.88E+03
2061	-	-	2.96E+01	6.49E+02	1.58E+03	7.06E+00	2.26E+03	8.15E+02	3.66E+02	4.09E+01	4.07E+02	-	2.90E+02	1.92E+03	8.11E+02	3.66E+02	7.61E+01	6.55E+02	-	-	1.91E+03

Exhibit F-27. Cumulative Emissions Profile AR6 20-yr – NGCC without CCS to China (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	8.81E+00	-4.74E-01	3.94E+01	4.54E+00	2.04E+00	2.92E+00	2.90E+01	-	2.98E-01	3.88E+01	4.52E+00	2.04E+00	2.95E+00	2.93E+01	-	-	3.88E+01
2030	-	-	2.67E+00	5.85E+01	3.08E+01	-5.78E-01	9.14E+01	1.59E+01	7.16E+00	5.66E+00	5.63E+01	-	2.02E+00	8.70E+01	1.58E+01	7.16E+00	5.90E+00	5.80E+01	-	-	8.69E+01
2031	-	-	3.94E+00	8.66E+01	7.05E+01	6.29E-01	1.62E+02	3.64E+01	1.64E+01	8.22E+00	8.18E+01	-	6.17E+00	1.49E+02	3.62E+01	1.64E+01	8.97E+00	8.71E+01	-	-	1.49E+02
2032	-	-	5.19E+00	1.14E+02	1.19E+02	3.41E+00	2.41E+02	6.14E+01	2.76E+01	1.06E+01	1.06E+02	-	1.28E+01	2.18E+02	6.10E+01	2.76E+01	1.22E+01	1.17E+02	-	-	2.18E+02
2033	-	-	6.39E+00	1.40E+02	1.72E+02	7.13E+00	3.26E+02	8.86E+01	3.99E+01	1.29E+01	1.28E+02	-	2.12E+01	2.91E+02	8.82E+01	3.99E+01	1.55E+01	1.46E+02	-	-	2.90E+02
2034	-	-	7.57E+00	1.66E+02	2.25E+02	1.08E+01	4.09E+02	1.16E+02	5.21E+01	1.50E+01	1.49E+02	-	3.03E+01	3.63E+02	1.15E+02	5.21E+01	1.87E+01	1.75E+02	-	-	3.61E+02
2035	-	-	8.71E+00	1.91E+02	2.77E+02	1.41E+01	4.91E+02	1.43E+02	6.44E+01	1.70E+01	1.69E+02	-	3.98E+01	4.33E+02	1.42E+02	6.44E+01	2.18E+01	2.03E+02	-	-	4.32E+02
2036	-	-	9.81E+00	2.15E+02	3.30E+02	1.69E+01	5.72E+02	1.70E+02	7.67E+01	1.88E+01	1.88E+02	-	4.94E+01	5.03E+02	1.70E+02	7.67E+01	2.48E+01	2.30E+02	-	-	5.01E+02
2037	-	-	1.09E+01	2.39E+02	3.83E+02	1.93E+01	6.52E+02	1.98E+02	8.90E+01	2.06E+01	2.05E+02	-	5.92E+01	5.71E+02	1.97E+02	8.90E+01	2.78E+01	2.56E+02	-	-	5.69E+02
2038	-	-	1.19E+01	2.62E+02	4.36E+02	2.13E+01	7.31E+02	2.25E+02	1.01E+02	2.22E+01	2.21E+02	-	6.92E+01	6.39E+02	2.24E+02	1.01E+02	3.06E+01	2.80E+02	-	-	6.36E+02
2039	-	-	1.30E+01	2.84E+02	4.89E+02	2.29E+01	8.09E+02	2.52E+02	1.13E+02	2.37E+01	2.36E+02	-	7.92E+01	7.05E+02	2.51E+02	1.13E+02	3.33E+01	3.04E+02	-	-	7.02E+02
2040	-	-	1.40E+01	3.06E+02	5.42E+02	2.41E+01	8.86E+02	2.79E+02	1.26E+02	2.51E+01	2.50E+02	-	8.93E+01	7.70E+02	2.78E+02	1.26E+02	3.60E+01	3.27E+02	-	-	7.67E+02
2041	-	-	1.49E+01	3.27E+02	5.95E+02	2.50E+01	9.62E+02	3.07E+02	1.38E+02	2.65E+01	2.64E+02	-	9.94E+01	8.34E+02	3.05E+02	1.38E+02	3.85E+01	3.49E+02	-	-	8.31E+02
2042	-	-	1.59E+01	3.48E+02	6.47E+02	2.55E+01	1.04E+03	3.34E+02	1.50E+02	2.77E+01	2.76E+02	-	1.09E+02	8.97E+02	3.32E+02	1.50E+02	4.10E+01	3.70E+02	-	-	8.93E+02
2043	-	-	1.68E+01	3.68E+02	7.00E+02	2.56E+01	1.11E+03	3.61E+02	1.63E+02	2.89E+01	2.88E+02	-	1.19E+02	9.60E+02	3.59E+02	1.63E+02	4.34E+01	3.90E+02	-	-	9.55E+02
2044	-	-	1.77E+01	3.87E+02	7.53E+02	2.56E+01	1.18E+03	3.89E+02	1.75E+02	3.00E+01	2.98E+02	-	1.29E+02	1.02E+03	3.87E+02	1.75E+02	4.57E+01	4.09E+02	-	-	1.02E+03
2045	-	-	1.85E+01	4.06E+02	8.06E+02	2.54E+01	1.26E+03	4.16E+02	1.87E+02	3.10E+01	3.09E+02	-	1.39E+02	1.08E+03	4.14E+02	1.87E+02	4.79E+01	4.28E+02	-	-	1.08E+03
2046	-	-	1.94E+01	4.25E+02	8.59E+02	2.51E+01	1.33E+03	4.43E+02	1.99E+02	3.20E+01	3.18E+02	-	1.49E+02	1.14E+03	4.41E+02	1.99E+02	5.01E+01	4.46E+02	-	-	1.14E+03
2047	-	-	2.02E+01	4.43E+02	9.12E+02	2.46E+01	1.40E+03	4.70E+02	2.12E+02	3.29E+01	3.27E+02	-	1.59E+02	1.20E+03	4.68E+02	2.12E+02	5.22E+01	4.64E+02	-	-	1.20E+03
2048	-	-	2.10E+01	4.60E+02	9.65E+02	2.40E+01	1.47E+03	4.98E+02	2.24E+02	3.37E+01	3.36E+02	-	1.69E+02	1.26E+03	4.95E+02	2.24E+02	5.43E+01	4.81E+02	-	-	1.25E+03
2049	-	-	2.17E+01	4.77E+02	1.02E+03	2.33E+01	1.54E+03	5.25E+02	2.36E+02	3.45E+01	3.43E+02	-	1.79E+02	1.32E+03	5.22E+02	2.36E+02	5.63E+01	4.97E+02	-	-	1.31E+03
2050	-	-	2.25E+01	4.94E+02	1.07E+03	2.25E+01	1.61E+03	5.52E+02	2.48E+02	3.52E+01	3.51E+02	-	1.89E+02	1.38E+03	5.49E+02	2.48E+02	5.82E+01	5.13E+02	-	-	1.37E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	1.12E+03	2.16E+01	1.68E+03	5.79E+02	2.61E+02	3.59E+01	3.58E+02	-	1.99E+02	1.43E+03	5.76E+02	2.61E+02	6.01E+01	5.28E+02	-	-	1.43E+03
2052	-	-	2.39E+01	5.26E+02	1.18E+03	2.06E+01	1.75E+03	6.07E+02	2.73E+02	3.66E+01	3.64E+02	-	2.09E+02	1.49E+03	6.04E+02	2.73E+02	6.19E+01	5.43E+02	-	-	1.48E+03
2053	-	-	2.46E+01	5.41E+02	1.23E+03	1.94E+01	1.81E+03	6.34E+02	2.85E+02	3.72E+01	3.70E+02	-	2.18E+02	1.55E+03	6.31E+02	2.85E+02	6.37E+01	5.57E+02	-	-	1.54E+03
2054	-	-	2.53E+01	5.56E+02	1.28E+03	1.81E+01	1.88E+03	6.61E+02	2.98E+02	3.78E+01	3.76E+02	-	2.28E+02	1.60E+03	6.58E+02	2.98E+02	6.54E+01	5.71E+02	-	-	1.59E+03
2055	-	-	2.60E+01	5.70E+02	1.33E+03	1.67E+01	1.95E+03	6.88E+02	3.10E+02	3.83E+01	3.81E+02	-	2.37E+02	1.65E+03	6.85E+02	3.10E+02	6.71E+01	5.84E+02	-	-	1.65E+03
2056	-	-	2.66E+01	5.84E+02	1.39E+03	1.54E+01	2.01E+03	7.16E+02	3.22E+02	3.88E+01	3.86E+02	-	2.46E+02	1.71E+03	7.12E+02	3.22E+02	6.87E+01	5.97E+02	-	-	1.70E+03
2057	-	-	2.72E+01	5.98E+02	1.44E+03	1.41E+01	2.08E+03	7.43E+02	3.34E+02	3.93E+01	3.91E+02	-	2.56E+02	1.76E+03	7.39E+02	3.34E+02	7.03E+01	6.10E+02	-	-	1.75E+03
2058	-	-	2.79E+01	6.11E+02	1.49E+03	1.25E+01	2.14E+03	7.67E+02	3.45E+02	3.97E+01	3.95E+02	-	2.64E+02	1.81E+03	7.64E+02	3.45E+02	7.18E+01	6.22E+02	-	-	1.80E+03
2059	-	-	2.84E+01	6.24E+02	1.53E+03	1.08E+01	2.19E+03	7.87E+02	3.54E+02	4.01E+01	3.99E+02	-	2.73E+02	1.85E+03	7.83E+02	3.54E+02	7.33E+01	6.34E+02	-	-	1.84E+03
2060	-	-	2.90E+01	6.37E+02	1.56E+03	9.00E+00	2.23E+03	8.03E+02	3.61E+02	4.05E+01	4.03E+02	-	2.82E+02	1.89E+03	7.99E+02	3.61E+02	7.47E+01	6.45E+02	-	-	1.88E+03
2061	-	-	2.96E+01	6.49E+02	1.58E+03	7.06E+00	2.27E+03	8.15E+02	3.67E+02	4.09E+01	4.07E+02	-	2.90E+02	1.92E+03	8.11E+02	3.67E+02	7.61E+01	6.55E+02	-	-	1.91E+03

Exhibit F-28. Cumulative Emissions Profile AR6 20-yr – NGCC with CCS to India (MMT CO_2e)

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2029	-	-	1.35E+00	2.97E+01	8.76E+00	-4.74E-01	3.93E+01	4.54E+00	2.58E+00	2.92E+00	2.90E+01	-	2.98E-01	3.94E+01	4.52E+00	2.58E+00	2.95E+00	2.93E+01	-	-	3.93E+01
2030	-	-	2.67E+00	5.85E+01	3.07E+01	-5.78E-01	9.13E+01	1.59E+01	9.03E+00	5.66E+00	5.63E+01	-	2.02E+00	8.89E+01	1.58E+01	9.03E+00	5.90E+00	5.80E+01	-	-	8.88E+01
2031	-	-	3.94E+00	8.66E+01	7.01E+01	6.29E-01	1.61E+02	3.64E+01	2.07E+01	8.22E+00	8.18E+01	-	6.17E+00	1.53E+02	3.62E+01	2.07E+01	8.97E+00	8.71E+01	-	-	1.53E+02
2032	-	-	5.19E+00	1.14E+02	1.18E+02	3.41E+00	2.41E+02	6.13E+01	3.48E+01	1.06E+01	1.06E+02	-	1.28E+01	2.25E+02	6.10E+01	3.48E+01	1.22E+01	1.17E+02	-	-	2.25E+02
2033	-	-	6.39E+00	1.40E+02	1.71E+02	7.13E+00	3.25E+02	8.86E+01	5.03E+01	1.29E+01	1.28E+02	-	2.12E+01	3.01E+02	8.82E+01	5.03E+01	1.55E+01	1.46E+02	-	-	3.00E+02
2034	-	-	7.57E+00	1.66E+02	2.23E+02	1.08E+01	4.08E+02	1.16E+02	6.58E+01	1.50E+01	1.49E+02	-	3.03E+01	3.76E+02	1.15E+02	6.58E+01	1.87E+01	1.75E+02	-	-	3.75E+02
2035	-	-	8.71E+00	1.91E+02	2.76E+02	1.41E+01	4.90E+02	1.43E+02	8.13E+01	1.70E+01	1.69E+02	-	3.98E+01	4.50E+02	1.42E+02	8.13E+01	2.18E+01	2.03E+02	-	-	4.49E+02
2036	-	-	9.81E+00	2.15E+02	3.29E+02	1.69E+01	5.71E+02	1.70E+02	9.68E+01	1.88E+01	1.88E+02	-	4.94E+01	5.23E+02	1.70E+02	9.68E+01	2.48E+01	2.30E+02	-	-	5.21E+02
2037	-	-	1.09E+01	2.39E+02	3.81E+02	1.93E+01	6.50E+02	1.98E+02	1.12E+02	2.06E+01	2.05E+02	-	5.92E+01	5.95E+02	1.97E+02	1.12E+02	2.78E+01	2.56E+02	-	-	5.92E+02
2038	-	-	1.19E+01	2.62E+02	4.34E+02	2.13E+01	7.29E+02	2.25E+02	1.28E+02	2.22E+01	2.21E+02	-	6.92E+01	6.65E+02	2.24E+02	1.28E+02	3.06E+01	2.80E+02	-	-	6.62E+02
2039	-	-	1.30E+01	2.84E+02	4.86E+02	2.29E+01	8.07E+02	2.52E+02	1.43E+02	2.37E+01	2.36E+02	-	7.92E+01	7.35E+02	2.51E+02	1.43E+02	3.33E+01	3.04E+02	-	-	7.32E+02
2040	-	-	1.40E+01	3.06E+02	5.39E+02	2.41E+01	8.83E+02	2.79E+02	1.59E+02	2.51E+01	2.50E+02	-	8.93E+01	8.03E+02	2.78E+02	1.59E+02	3.60E+01	3.27E+02	-	-	8.00E+02
2041	-	-	1.49E+01	3.27E+02	5.91E+02	2.50E+01	9.59E+02	3.07E+02	1.74E+02	2.65E+01	2.64E+02	-	9.94E+01	8.70E+02	3.05E+02	1.74E+02	3.85E+01	3.49E+02	-	-	8.67E+02
2042	-	-	1.59E+01	3.48E+02	6.44E+02	2.55E+01	1.03E+03	3.34E+02	1.90E+02	2.77E+01	2.76E+02	-	1.09E+02	9.37E+02	3.32E+02	1.90E+02	4.10E+01	3.70E+02	-	-	9.33E+02
2043	-	-	1.68E+01	3.68E+02	6.97E+02	2.56E+01	1.11E+03	3.61E+02	2.05E+02	2.89E+01	2.88E+02	-	1.19E+02	1.00E+03	3.59E+02	2.05E+02	4.34E+01	3.90E+02	-	-	9.98E+02
2044	-	-	1.77E+01	3.87E+02	7.49E+02	2.56E+01	1.18E+03	3.89E+02	2.21E+02	3.00E+01	2.98E+02	-	1.29E+02	1.07E+03	3.87E+02	2.21E+02	4.57E+01	4.09E+02	-	-	1.06E+03
2045	-	-	1.85E+01	4.06E+02	8.02E+02	2.54E+01	1.25E+03	4.16E+02	2.36E+02	3.10E+01	3.09E+02	-	1.39E+02	1.13E+03	4.14E+02	2.36E+02	4.79E+01	4.28E+02	-	-	1.13E+03
2046	-	-	1.94E+01	4.25E+02	8.54E+02	2.51E+01	1.32E+03	4.43E+02	2.52E+02	3.20E+01	3.18E+02	-	1.49E+02	1.19E+03	4.41E+02	2.52E+02	5.01E+01	4.46E+02	-	-	1.19E+03
2047	-	-	2.02E+01	4.43E+02	9.07E+02	2.46E+01	1.39E+03	4.70E+02	2.67E+02	3.29E+01	3.27E+02	-	1.59E+02	1.26E+03	4.68E+02	2.67E+02	5.22E+01	4.64E+02	-	-	1.25E+03
2048	-	-	2.10E+01	4.60E+02	9.60E+02	2.40E+01	1.46E+03	4.98E+02	2.83E+02	3.37E+01	3.36E+02	-	1.69E+02	1.32E+03	4.95E+02	2.83E+02	5.43E+01	4.81E+02	-	-	1.31E+03
2049	-	-	2.17E+01	4.77E+02	1.01E+03	2.33E+01	1.53E+03	5.25E+02	2.98E+02	3.45E+01	3.43E+02	-	1.79E+02	1.38E+03	5.22E+02	2.98E+02	5.63E+01	4.97E+02	-	-	1.37E+03
2050	-	-	2.25E+01	4.94E+02	1.06E+03	2.25E+01	1.60E+03	5.52E+02	3.14E+02	3.52E+01	3.51E+02	-	1.89E+02	1.44E+03	5.49E+02	3.14E+02	5.82E+01	5.13E+02	-	-	1.43E+03

	Scenario 1							Scenario 2							Scenario 3						
Year	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total	Natural Gas Production, Transport and Liquefaction	Natural Gas Ocean Transport, Regasification, and Power Plant	Crude Oil Production and Transport to Lower 48 US	Crude Oil Refining and End use	System Expansion: US Lower 48 LNG Export and End Use	System Expansion: US Average Crude Oil Production and End Use	Total
2051	-	-	2.32E+01	5.10E+02	1.12E+03	2.16E+01	1.67E+03	5.79E+02	3.29E+02	3.59E+01	3.58E+02	-	1.99E+02	1.50E+03	5.76E+02	3.29E+02	6.01E+01	5.28E+02	-	-	1.49E+03
2052	-	-	2.39E+01	5.26E+02	1.17E+03	2.06E+01	1.74E+03	6.07E+02	3.45E+02	3.66E+01	3.64E+02	-	2.09E+02	1.56E+03	6.04E+02	3.45E+02	6.19E+01	5.43E+02	-	-	1.55E+03
2053	-	-	2.46E+01	5.41E+02	1.22E+03	1.94E+01	1.81E+03	6.34E+02	3.60E+02	3.72E+01	3.70E+02	-	2.18E+02	1.62E+03	6.31E+02	3.60E+02	6.37E+01	5.57E+02	-	-	1.61E+03
2054	-	-	2.53E+01	5.56E+02	1.27E+03	1.81E+01	1.87E+03	6.61E+02	3.76E+02	3.78E+01	3.76E+02	-	2.28E+02	1.68E+03	6.58E+02	3.76E+02	6.54E+01	5.71E+02	-	-	1.67E+03
2055	-	-	2.60E+01	5.70E+02	1.33E+03	1.67E+01	1.94E+03	6.88E+02	3.91E+02	3.83E+01	3.81E+02	-	2.37E+02	1.74E+03	6.85E+02	3.91E+02	6.71E+01	5.84E+02	-	-	1.73E+03
2056	-	-	2.66E+01	5.84E+02	1.38E+03	1.54E+01	2.01E+03	7.16E+02	4.07E+02	3.88E+01	3.86E+02	-	2.46E+02	1.79E+03	7.12E+02	4.07E+02	6.87E+01	5.97E+02	-	-	1.78E+03
2057	-	-	2.72E+01	5.98E+02	1.43E+03	1.41E+01	2.07E+03	7.43E+02	4.22E+02	3.93E+01	3.91E+02	-	2.56E+02	1.85E+03	7.39E+02	4.22E+02	7.03E+01	6.10E+02	-	-	1.84E+03
2058	-	-	2.79E+01	6.11E+02	1.48E+03	1.25E+01	2.13E+03	7.67E+02	4.36E+02	3.97E+01	3.95E+02	-	2.64E+02	1.90E+03	7.64E+02	4.36E+02	7.18E+01	6.22E+02	-	-	1.89E+03
2059	-	-	2.84E+01	6.24E+02	1.52E+03	1.08E+01	2.18E+03	7.87E+02	4.47E+02	4.01E+01	3.99E+02	-	2.73E+02	1.95E+03	7.83E+02	4.47E+02	7.33E+01	6.34E+02	-	-	1.94E+03
2060	-	-	2.90E+01	6.37E+02	1.55E+03	9.00E+00	2.22E+03	8.03E+02	4.56E+02	4.05E+01	4.03E+02	-	2.82E+02	1.98E+03	7.99E+02	4.56E+02	7.47E+01	6.45E+02	-	-	1.97E+03
2061	-	-	2.96E+01	6.49E+02	1.57E+03	7.06E+00	2.26E+03	8.15E+02	4.63E+02	4.08E+01	4.07E+02	-	2.90E+02	2.02E+03	8.11E+02	4.63E+02	7.60E+01	6.55E+02	-	-	2.01E+03

Exhibit F-29. GOR Sensitivity Analysis – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.70E+02	6.74E+02	6.74E+02	6.94E+02
Lower GOR	6.71E+02	6.75E+02	6.75E+02	6.96E+02
Higher GOR	6.69E+02	6.73E+02	6.73E+02	6.93E+02

Exhibit F-30. CH_4 Sensitivity – Scenario 3 NGCC without CCS in kg CO_2e (AR6 – 20-yr)

	Japan	South Korea	China	India
Multiproduct Functional Unit Result	6.70E+02	6.74E+02	6.74E+02	6.94E+02
Decrease in Methane Emissions	6.65E+02	6.69E+02	6.69E+02	6.89E+02
Increase in Methane Emissions	6.75E+02	6.79E+02	6.79E+02	6.99E+02

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