## Investing in American Energy: Continued Progress through Policy Technical Appendix

### **OP-NEMS**

OP-NEMS is a version of the National Energy Modeling System (NEMS) developed by the DOE Office of Policy (OP). NEMS is the primary model used for economy-wide energy system modeling for the U.S. government and is used to develop key analyses including the U.S. Energy Information Administration (EIA) Annual Energy Outlook.

Details on OP-NEMS model development can be found at <u>https://www.energy.gov/policy/office-policy-national-energy-modeling-system-op-nems</u>. Details on the NEMS framework can be found at <u>https://www.eia.gov/outlooks/aeo/nems/documentation/</u>.

Several sections of OP-NEMS are based on the DOE Office of Fossil Energy and Carbon Management (FECM-NEMS) version of NEMS developed by OnLocation, Inc, and supported by FECM. OP-NEMS represents new and modified carbon capture, transport, and storage (CCS) technologies that are not covered by the EIA NEMS model including ethanol, natural gas processing, hydrogen in refineries, and cement in industry, and biomass cofiring in power plants (BECCS). Additional applications of expanded sustainable biofuels production and use were included using inputs provided by the Office of Energy Efficiency and Renewable Energy (EERE). OP-NEMS also represents hydrogen production, transportation, and storage. Hydrogen production technologies represented include biomass with and without CCS, natural gas with and without CCS, electrolysis, and nuclear power. Additional model granularity related to building energy efficiency that were developed for the Building Technologies Office (using BTO-NEMS) were also layered on.

#### **Model Scenarios**

The analysis in this report uses two scenarios to evaluate current and potential future policies, and one scenario based on last year's <u>Investing in American Energy Report</u> as a baseline for comparison.

The **2024 Policy Baseline Scenario** represents current policies as of May 2024 and includes four sensitivities that capture different potential future macroeconomic growth trends.

- Moderate Policy and Technology Costs (2024 Moderate): A reference case representing moderate levels of Bipartisan Infrastructure Law (BIL) and Inflation Reductio Act (IRA) uptake, additional policies since the IRA, and moderate technology costs from the 2023 Annual Technology Baseline (ATB) published by the National Renewable Energy Laboratory (NREL).
- Low Oil and Gas Supply Sensitivity (2024 LOGS): A sensitivity case that assumes 50% lower oil and gas resource recovery and 50% higher drilling costs relative to the 2024 Moderate scenario.

- High Oil and Gas Supply Sensitivity (2024 HOGS): A sensitivity case that assumes 50% higher oil and gas resource recovery and 50% lower drilling costs relative to the 2024 Moderate scenario.
- Advanced Policy and Technology Costs (2024 Advanced): A sensitivity case that assumes advanced technology costs from the 2023 ATB and higher BIL and IRA uptake.

The **Enhanced Policy Scenario** represents current policies as of May 2024, potential future policies that further progress towards a clean energy economy, and two sensitivities that capture different potential future macroeconomic growth trends.

- Moderate Policy and Technology Costs (Enhanced Policy Moderate): A reference case representing moderate levels of BIL and IRA uptake, additional policies since the IRA, and moderate technology costs from the 2023 ATB published by NREL, in addition to potential future policies.
- Low Oil and Gas Supply Sensitivity (Enhanced Policy LOGS): A sensitivity case that assumes 50% lower oil and gas resource recovery and 50% higher drilling costs relative to the 2024 Enhanced Policy Moderate scenario.

The **2023 Policy Baseline Scenario** is based on the 2023 Moderate Scenario from last year's Investing in American Energy Report, and adjusted with updated macroeconomic trends and technology costs to enable comparison with the other scenarios in this report. This scenario includes policies from BIL and IRA, but does not include more recent policies in the past year such as the updated National Highway Traffic Safety Administration Corporate Average Fuel Economy standards, or the Environmental Protection Agency Greenhouse Gas Standards for fossil fuel power plants, and light-, medium-, and heavy-duty vehicles.

All of the scenarios above only include impacts on energy-related  $CO_2$  emissions. This is because the OP-NEMS modeling framework currently does not track non- $CO_2$  emissions (e.g., methane from oil and gas production). Net greenhouse gas emissions in this report are therefore drawn from the 2024 Biennial Transparency Report of the United States to the United Nations Framework Convention on Climate Change. The 2024 BTR combines energy-related  $CO_2$  emissions results from OP-NEMS with additional results from the Global Change Analysis Model (GCAM) and the U.S. Regional Energy Policy economy-wide model linked with the Regional Energy Deployment System (USREP-ReEDS). In the 2024 BTR, non-energy  $CO_2$  emissions, non- $CO_2$  emissions (including methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF<sub>6</sub>), and nitrogen trifluoride (NF<sub>3</sub>)), and changes in  $CO_2$  sequestration from land use, land use change, and forestry (LULUCF) are added to energy-related  $CO_2$  emissions using multiple additional models as described in Annex 3 of the report.

### **Policy Representation in OP-NEMS**

This analysis leverages DOE experts' best judgement on policy implementation to represent key BIL and IRA provisions and other policies. The Enhanced Policy Scenario includes policies that are not currently in place but could be considered as part of future policy decisions. The 2023 Policy Baseline and 2024 Policy Baseline follows the implementation of BIL and IRA used in the 2023 *Investing in American Energy* report, which is detailed in the accompanying <u>Technical Appendix</u>.

**Table 1.** Modeled existing policies in the 2023 Policy Baseline, 2024 Policy Baseline, and Enhanced Policy scenarios.

Policy	Section (Tax Code)	2023 Policy Baseline	2024 Policy Baseline	Enhanced Policy
Production Tax Credit for Electricity from Renewables	IRA 13101 (45)	Yes	Yes	Yes
Investment Tax Credit for Energy Property	IRA 13102 (48)	Yes	Yes	Yes
Clean Electricity Production Tax Credit	IRA 13701 (45Y)	Yes	Yes	Yes
Clean Electricity Investment Tax Credit	IRA 13702(h) (48E)	Yes	Yes	Yes
Zero-Emission Nuclear Power Production Credit	IRA 13105 (45U)	Yes	Yes	Yes
Cost Recovery for Qualified Facilities, Qualified Property, and Energy Storage Technology	IRA 13703 (168(e)(3)(B))	Yes	Yes	Yes
Electric Loans for Renewable Energy	IRA 22001	Yes	Yes	Yes
Rural Energy for America Program	IRA 22002	Yes	Yes	Yes
USDA Assistance for Rural Electric Cooperatives	IRA 22004	Yes	Yes	Yes
Energy Efficient Home Improvement Credit	IRA 13301 (25C)	Yes	Yes	Yes
Residential Clean Energy Credit	IRA 13302 (25D)	Yes	Yes	Yes
New Energy Efficient Homes Credit	IRA 13304 (45L)	Yes	Yes	Yes
Energy Efficient Commercial Buildings Deduction	IRA 13303 (179D)	Yes	Yes	Yes
Home Energy Performance Based, Whole House Rebates (HOMES)	IRA 50121	Yes	Yes	Yes
High Efficiency Electric Home Rebate Program	IRA 50122	Yes	Yes	Yes
Assistance for Latest and Zero Building Energy Code Adoption	IRA 50131	Yes	Yes	Yes
Assistance for Federal Buildings	IRA 60502	Yes	Yes	Yes
Energy Efficiency Revolving Loan Fund Capitalization Grant Program	BIL 40502	Yes	Yes	Yes
Weatherization Assistance Program	BIL 40551	Yes	Yes	Yes
State Energy Program	BIL 40109	Yes	Yes	Yes
Energy Efficiency and Conservation Block Grant Program	BIL 40552	Yes	Yes	Yes

Assisting Federal Facilities with Energy		Voo	Voo	Vee
Conservation Technologies Grant Program	DIL 40004	res	res	res
Commercial RE and CHP credits		Yes	Yes	Yes
Advanced Industrial Facilities Deployment		Voo	Voc	Yes
Program	INA 30101	165	165	
Advanced Energy Project Credit	IRA 13501 (48C)	Yes	Yes	Yes
Investment Tax Credit for Energy Property	IRA 13102 (48)	Yes	Yes	Yes
Low Carbon Transportation Materials Program	IRA 60506	Yes	Yes	Yes
Clean Hydrogen Production Tax Credit	IRA 13204 (45V)	Yes	Yes	Yes
Use of Low-Carbon Materials	IRA 60503	Yes	Yes	Yes
Four Regional Clean Direct Air Capture Hubs	BIL 40308	Yes	Yes	Yes
Clean Vehicle Credit	IRA 13401 (30D)	Yes	Yes	Yes
Commercial Clean Vehicles Credit	IRA 13403 (45W)	Yes	Yes	Yes
U.S. Postal Services Clean Fleets	IRA 70002	Yes	Yes	Yes
Grants to Reduce Air Pollution at Ports	IRA 60102	Yes	Yes	Yes
Clean Heavy-Duty Vehicles	IRA 60101	Yes	Yes	Yes
Advanced Technology Vehicle Manufacturing			N 1	
Loan Program	IRA 50142	NO	NO	Yes
Domestic Manufacturing Conversion Grants	IRA 50143	No	No	Yes
Clean School Bus Program	Section 71101	Yes	Yes	Yes
Extension of Tax Credits for Biodiesel and	IRA 13201 (40A,	Vaa	Vaa	Vaa
Renewable Diesel	6426(c),6427(e))	res	Yes	res
Extension of Second Generation Biofuel	IDA 12202 (40)	Vaa	Vaa	Voc
Incentives	INA 13202 (40)	165	165	res
Sustainable Aviation Fuel Credit	IRA 13203 (40B)	No	No	No
Clean Fuel Production Credit	IRA 13704 (45Z)	Yes	Yes	Yes
Credit for Carbon Oxide Sequestration	IRA 13104 (45Q)	Yes	Yes	Yes
Environmental and Climate Justice Block	IPA 60201	Ves	Voc	Ves
Grants	INA 00201	165	165	165
Greenhouse Gas Reduction Fund	IRA 60103	Yes	Yes	Yes
Energy Infrastructure Reinvestment Financing	IRA 50144	Yes	Yes	Yes
Offshore Oil and Gas Royalty Rates	IRA 50261	Yes	Yes	Yes
Mineral Leasing Act Modernization	IRA 50262	Yes	Yes	Yes
Carbon Dioxide Transportation Infrastructure		Voo	Voo	Voo
Finance and Innovation Program	DIL 40304	165	165	165
Carbon Capture Demonstration Projects	BIL 41004	Vec	Vec	Vec
Program	DIL 41004	165	res	res
Advanced Reactor Demonstration Program	BIL 41002	Yes	Yes	Yes
Civil Nuclear Credit Program	BIL 40323	Yes	Updated	Updated
Strategic Petroleum Reserve	N/A	Yes	Updated	Updated
DOE Appliance Standards	N/A	Yes	Updated	Updated
EPA NSPS on Oil and Gas Sector	N/A	No	No	No
NHTSA CAFE standards	N/A	Yes (2023)	Yes (2024)	Yes
EPA Emissions Standards for LMHDV	N/A	No	Yes	Yes
State ZEV mandates for LDVs	N/A	Yes	Updated	Updated
Advanced Clean Truck (ACT) rule	N/A	No	Yes	Yes

EPA Emissions Standards for Power Plants	N/A	Yes	Updated	Updated
EPA Good Neighbor NOx Rule	N/A	Yes	Updated	Updated
State RPS/CES programs	N/A	Yes	Updated	Updated
State battery storage and offshore wind mandates	N/A	Yes	Updated	Updated
DOE Distribution Transformer Standards	N/A	Yes	Updated	Updated

# Table 2. Additional potential policies included in the Enhanced Policy Scenario

Policy	Implementation
Enhanced emission standards for power plants	Accelerated phase-out of unabated coal by 2032; Includes
	standards for existing gas combustion turbines.
Enhanced incentives to reverse nuclear planned	Palisades (MI), Three Mile Island (PA), and Duane Arnold
retirements	(IA) assumed to restart operations in 2025, 2027;
	Perry (OH), Diablo Canyon 1&2 (CA) delay retirement until
	after 2050
Enhanced fuel economy standards	Increased CAFE standards 2%/yr for LDVs from 2033 to
	2040. Fuel efficiency requirements increased 5%/yr for
Enhanced emission standards for vehicles	Enhanced and extended EPA CHC standards for light
	medium- and heavy-duty-vehicles from 2033 to 2040
	including a zero-emission target by 2040 for LDVs.
Expanded Advanced Clean Trucks (ACT) for states	By 2040, 100% ZEV sales shares for class 2-6 and 7&8
	vocational, 60% for class 7&8 tractors at the national level.
Vehicle miles travelled (VMT) reduction through	Reduced LDV VMT by 2%-20% from 2027 through 2040,
investment in public transit and other options	VMT reduction remains 20% through 2050.
National low carbon fuel standard	Policy covers jet fuel, diesel and gasoline with credit trading
	cross the fuels. Starts in 2026 with CI reductions of 5% by
	2030, 17% by 2040, and 30% by 2050 based off the 2022 Cl
	value.
Regional low carbon fuel standards	Sustainable aviation fuel (SAF) counts to meet the diesel
	standard of the regional LCFS policies.
Enhanced appliance standards	Additional standards for central air conditioners, room air
	conditioners, distillate boilers, distillate furnaces, and
Building performance standards (BPS)	BPS implemented in the commercial building sector
Industrial GHG standards	GHG Standard applied to all manufacturing industries (to
	be achieved by 2035)
Extended clean electricity tax credits	Credits continue through 2050 with 15% bonus. Nuclear
	credits extended to 2050.
Extended clean vehicle credits	Credits extended through 2050.
School bus electrification	100% electric school and transit bus sales by 2030.
Cost for Differences (CfD) for industrial sector	Cost for Differences program applied to electric boilers and
	other electrification technologies.
Extended combined heat and power (CHP) tax credit	CHP investment tax credit extended to 2050.
Extended commercial renewable energy credits	Extended through 2050 with 15% bonus.
Extended residential rebate and grant programs	Extended through 2050.
Accelerated adoption of net-zero building codes	Increased shell efficiencies by 2026 for residential
	buildings.
Extended clean fuel credits	Extended through 2050.
Extended carbon sequestration credits	Extended through 2050.

Unless otherwise noted above, policy implementation is based on the 2024 Policy Baseline Advanced Policy and Technology Costs scenario.

## Comparison of 2024 Policy Baseline and Enhanced Policy results

**Table 3.** Energy-Related CO<sub>2</sub> Emissions by Sector (Direct Emissions Only), 2024 Policy Baseline vs. Enhanced Policy Scenario

		Direct Energy-Related $CO_2$ Emissions (MMT $CO_2$ )			
Year	Sector	2024 Policy	Enhanced	Enhanced	Additional
		Baseline	Policy	Policy	<b>Reductions with</b>
		(Moderate)	(Moderate)	(LOGS)	Enhanced Policy
	Transportation	1,594	1,526	1,470	68-123
	Buildings	561	561	545	0.5-17
2030	Industry	969	912	824	57-144
	Electricity	670	545	494	125-176
	Total	3,794	3,543	3,333	251-461
2035	Transportation	1,353	1,208	1,166	145-186
	Buildings	544	541	522	3-22
	Industry	987	893	794	95-193
	Electricity	456	263	199	192-256
	Total	3,339	2,905	2,682	435-657
2040	Transportation	1,142	902	871	240-271
	Buildings	527	521	503	6-25
	Industry	1,033	914	796	119-237
	Electricity	402	235	185	167-217
	Total	3,104	2,573	2,354	532-750

**Table 4.** Energy-Related CO<sub>2</sub> Emissions by Sector (Total Emissions), 2024 Policy Baseline vs. Enhanced Policy Scenario

		Total Energy-Related CO <sub>2</sub> Emissions (MMT CO <sub>2</sub> )				
Year	Sector	2024 Policy Baseline (Moderate)	Enhanced Policy (Moderate)	Enhanced Policy (LOGS)	Additional Reductions with Enhanced Policy	
2030	Transportation	1,626	1,553	1,495	73-132	
	Buildings	1,021	932	885	89-136	
	Industry	1,146	1,058	953	88-193	
	Total	3,794	3,543	3,333	251-461	
2035	Transportation	1,406	1,240	1,191	167-216	
	Buildings	834	701	640	133-194	
	Industry	1,099	964	852	135-248	
	Total	3,339	2,905	2,682	435-657	
2040	Transportation	1,213	944	904	269-309	
	Buildings	763	650	602	113-161	
	Industry	1,128	978	849	150-280	
	Total	3,104	2,573	2,354	532-750	