Chapter 7 METHODOLOGY

Abstract

The global oil and gas study prepared by the National Petroleum Council (NPC) is unique in scope and participation. The complexity and scale of integrated energy markets, and the long lead-times necessary to make material changes required a study that took a long-term, comprehensive view of supply, demand, infrastructure, technology, and geopolitics. To achieve this, more than 350 expert participants from diverse backgrounds and organizations joined in a comprehensive work effort based on sound data and science. The effort included analysis of multiple public and aggregated proprietary energy outlooks, and required subgroups to address themes as diverse as deepwater exploration, renewable energy, transportation efficiency, and human resources. In addition, more than 1,000 persons and groups actively involved with energy issues provided feedback through a formal outreach program. The study includes core strategies and key recommendations for policymakers. When developing findings and recommendations, the study leadership sought to balance economic, security, and environmental perspectives.

This chapter describes how the study was organized and conducted. It describes the participants and expert task groups, identifies cross-cutting topics that emerged, details the data streams used for analyses, and explains how a data warehouse was created. An important feature of the report is a survey of 24 parallel studies that were recently published. The full report will be distributed broadly to government and public audiences.

The outline for this chapter is as follows:

- Guiding Principles
- Study Organization
  - Task Groups
  - Cross-Cutting Groups
  - Integration Team
- Information Management
  - An Analytical Approach
  - Storing Information—The Data Warehouse
  - Public Data and Information
  - Proprietary Data and Information
  - Parallel Studies
- Summary.

This report originated in late 2005, when Secretary of Energy Samuel Bodman requested that the NPC undertake a study on the ability of global oil and natural gas supply to keep pace with growing world demand. The Secretary suggested three questions that might be considered:

- What does the future hold for global oil and natural gas supply?

- Can incremental oil and natural gas supplies be brought on-line, on-time, and at a reasonable price to meet future demand without jeopardizing economic growth?
- What oil and gas supply strategies and/or demand-side strategies does the Council recommend the U.S. pursue to ensure greater economic stability and prosperity?

Accepting the Secretary's request, the NPC formed the Committee on Global Oil and Gas with Lee Raymond, former Chairman and Chief Executive Officer of Exxon Mobil Corporation, as its Chair. Clay Sell, the Deputy Secretary of Energy, was designated by Secretary Bodman to serve as the study's Government Cochair. From the 54 NPC members of the Committee on Global Oil and Gas, Mr. Raymond appointed four as Vice Chairs for specific areas of the study. These six served as an "Executive Committee" to oversee the study process. A Coordinating Subcommittee (CSC) was created to guide and focus this ambitious undertaking. Additionally, four task groups and 36 subgroups assisted in the conduct of the study. The study organization is described more fully in the Preface and is outlined in Figure 7-1. The rosters of all the study groups are in Appendix B.

The CSC included members from government, industry and non-governmental organizations to provide a wide range of skills and viewpoints, as shown in Figure 7-2.

GUIDING PRINCIPLES

The CSC's first task was to set the study's boundaries and guiding principles. First, the study leadership recognized that this undertaking would be incomplete without examining all the dimensions of the energy debate including alternative energy sources. Second, the CSC decided the study would not create a new forecast of demand, supply, or price offering yet another perspective on the uncertain energy outlook. Rather, the study would analyze existing projections and outlooks to identify underlying assumptions, understand why they differ, and thereby identify critical factors governing the future of oil and gas to 2030. Third, the CSC decided to consider and balance other points of view, including economic, environmental, and security goals. These

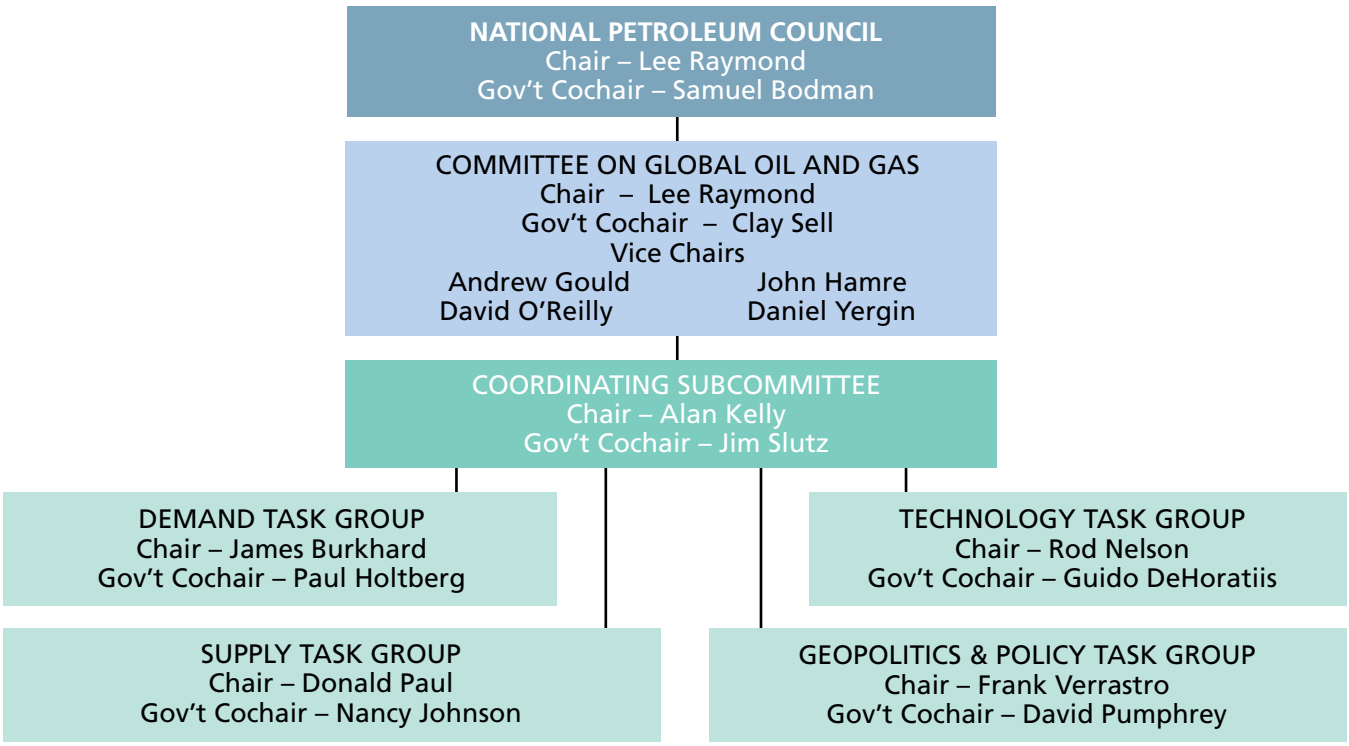

FIGURE 7-1. *Study Organization*

FIGURE 7-2. *Diverse Leadership*

three decisions enabled the NPC to create an original study with broad perspective.

The following guiding principles were pursued throughout the study:

- This is not another energy forecast of demand, supply, or price.
- Experts will gather and analyze public and aggregated proprietary data.
- Study teams will solicit input from a broad range of interested parties.
- Analyses will emphasize long-term conditions, not near-term volatility.
- Recommendations will be supported by sound data and science.
- Participants will comply fully with antitrust laws and regulations.

The study was designed in full compliance with both the letter and the spirit of all applicable laws and regulations, including but not limited to antitrust laws and the Federal Advisory Committee Act, in mind. Specifically, an independent accounting firm aggregated and removed all identifying information from all proprietary projection data provided by companies and consultants. More generally, the study was conducted in strict compliance with comprehensive antitrust guidelines governing all participants' conduct throughout all stages of the study, including data analysis, outreach sessions, meetings among the various participants, and preparation of this report. These guidelines ensured that no individually identifiable sensitive competitive information was exchanged during the study and effectively precluded any opportunities for anticompetitive agreement. An Antitrust Advisory Subgroup provided guidance to the study.

The study leadership was committed to receiving views and information from a broad range of interested parties, and focused outreach efforts to countries and organizations involved with energy. The effort included:

- More than 350 participants from diverse backgrounds
- Dialogue with more than 1,000 persons and groups with energy interests
- Department of Energy support to approach 19 key countries for information.

Figure 7-3 illustrates the diverse backgrounds of study participants.

The Coordinating Subcommittee defined a timeline for the entire study, which continued for more than 18 months. To ensure real-time communications, and to assess progress, representatives from the CSC, including Department of Energy and legal advisors, created a study website for posting all deliverables, analyses and status updates. Monthly meetings were scheduled for the CSC and Task Groups, supplemented by weekly teleconferences to review work products and commitments. The NPC Executive Committee participated in periodic reviews to receive updates and provide guidance. Finally, the CSC leadership provided regular status reports to all participants.

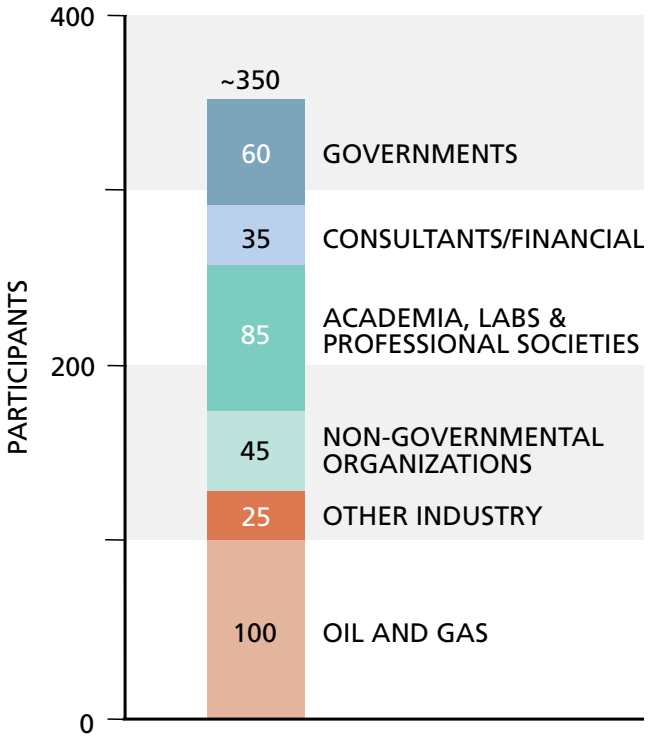

FIGURE 7-3. *Diverse Backgrounds of Participants*

STUDY ORGANIZATION

Task Groups

As the scope of the study evolved, four core groups of subject matter experts were assembled into specialized Task Groups: Demand, Supply, Technology, and Geopolitics & Policy. These Task Groups became the focus of the study's research and analytical efforts. The CSC guided the Task Groups to respond to a series of comprehensive framing questions through an extensive analysis of available reports and publications. The teams developed a broad range of integrated summary observations and findings, which eventually underpinned the agreed strategies and recommendations in the report. Supporting the Task Groups were numerous cross-cutting subgroups that examined specific topics to complement key subject areas. The membership of each of the cross-cutting groups is also found in Appendix B and a simplified diagram of Task Group interrelationships is shown in Figure 7-4.

While the four Task Groups were charged with specific, separate project objectives, the teams' efforts were fully aligned and integrated as depicted in Figure 7-4. Individual subject matter experts selected for this study were not only experienced at interpreting and analyzing Task Group-specific information, but also had sufficient breadth of knowledge to communicate and share information across the team boundaries. Extensively detailed topic papers prepared by each Task Group are also made available to supplement this report. A listing of the topic papers can be found in Appendix E.

Demand Task Group

The Demand Task Group analyzed the range of projections for world energy demand to 2030, key "drivers" underlying the demand projections such as economic activity and demographics, and the relationship of historical performance to future projections. The group analyzed the potential effect of energy efficiency measures on demand, ways that environmental concerns might alter the energy mix, and how fuel-use patterns might evolve. The group

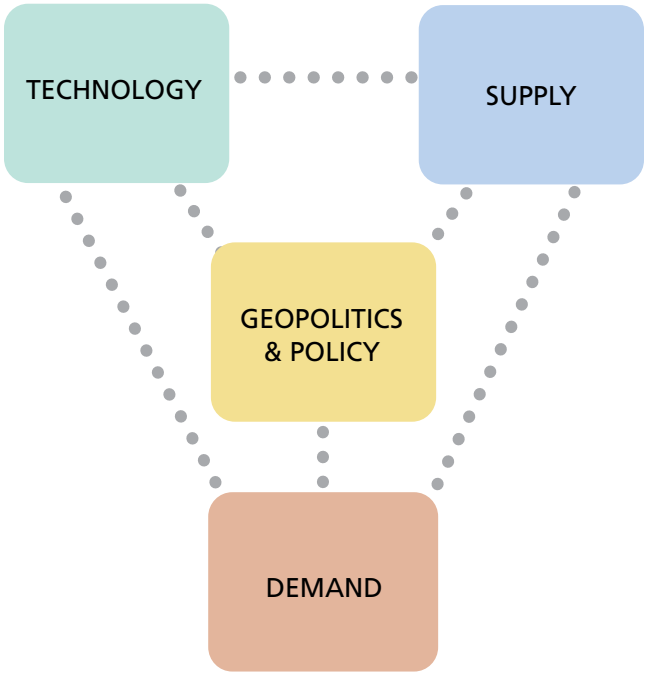

FIGURE 7-4. *Task Group Interrelationships*

also worked with the Supply Task Group to address critical infrastructure implications posed by differing fuel use.

The Demand Task Group organized its activities into six subgroups: Demand Data Evaluation, Electric Generation Efficiency, Coal Impact, Industrial Efficiency, Cultural/Social/Economic Trends, and Residential/Commercial Efficiency. The subgroups prepared topic papers that summarized input, analyses, and findings. After identifying the most significant issues, the group developed potential demand moderation strategies as a step toward formulating recommendations. The Demand Task Group's analyses and conclusions are summarized in Chapter One of this report.

Supply Task Group

To guide its assessment of the global supply of energy, the Supply Task Group considered how the energy supply/capacity mix may change and evolve over the next 25 years. The group considered a wide variety of outlooks for future oil and gas supply/capacity, and assessed the key factors that drive supply changes. The group asked what additional data could help reduce the uncertainty associated with the global energy endowment and the timing for converting it into production capacity—resource endowment, infrastructure, geopolitics, technology progress/utilization, for example. The group examined how coal might fit into the future energy mix, weighing ample supply against environmental consequences and the likely costs to address carbon constraints. Significantly, the group examined the range of outlooks for non-hydrocarbon energy supplies such as nuclear, hydro, wind, solar, biomass, and bio-liquids, noting the opportunities and challenges associated with each energy source.

The Supply Task Group formed nine subgroups organized into three functional groups to conduct its analyses: Data Interpretation/Database, Endowment, and Energy Infrastructure and Delivery. The results of the Supply Task Group's work are summarized in Chapter Two of this report.

Technology Task Group

The Technology Task Group focused on the examination of technological advances that may influence future energy use or sources. The more than 120 subject-matter experts who participated in the Technology Task Group were identified and organized into 14 subgroups around technical themes. The Technology Task Group then examined specific technical subjects as they related to these broad topics: transportation efficiency, nuclear, unconventional gas, heavy oil, coal-to-liquids/coal-to-gas, technology development and deployment, carbon management, shale oil/hydrates, exploration, deepwater, conventional/EOR/arctic, and human resources. In particular, the team was requested to address time horizons for potential technology deployment, research budgets, and the science and engineering capabilities required to support development.

The results of the discussion, debate, and insights provided by the Technology Task Group are in Chapter Three of this report and integrated with the analyses found in the Supply and Demand chapters.

Geopolitics & Policy Task Group

The Geopolitics & Policy Task Group operated as two distinct teams as the study progressed. During the study analysis phase, the Geopolitics Team assessed how sovereign national, regional, and global policy decisions might affect global supply and demand outlooks. The Geopolitics Team included

regional scholars as well as industry, academic and NGO participants. Topics addressed included broad issues such as governance, security, globalism, and climate and the environment. The Geopolitics chapter reflects the integrated content of those working documents and the discussion, debate and insights provided by the group at large.

The Policy team was formed toward the conclusion of the study and included representatives of other study teams involved in the effort as well as a contingent of outside experts drawn from the policy community. The group was used primarily to analyze and vet the various study findings and policy recommendations advanced by the Task Groups. Final selection of the most significant recommendations was performed by the CSC and working groups made up of its members.

Cross-Cutting Groups

Each Task Group began by posing a set of framing questions to guide its work. These framing questions highlighted a need for a number of cross-cutting groups to focus on topics of concurrent interest to several Task Groups. The cross-cutting groups were staffed by subject matter experts typically from two or more Task Groups. Subjects investigated included macroeconomics, gas-to-liquids/coal-to-liquids, biofuels/renewables, infrastructure, parallel studies, carbon management, refining, transportation, nuclear power, and coal.

Integration Team

The Task Groups shared information through the cross-cutting groups and by arranging overlapping membership. Even with these ongoing linkages, a broader effort was necessary to prepare integrated views of the global energy picture. An Integration Team was formed to summarize observations and findings, and to extract key conclusions. This team included members from the CSC and Task Groups, and identified the following overarching themes for review with the Policy Team and the full CSC.

- Economic growth, energy demand, and demand moderation
- Fossil energy supply and delivery
- Non-fossil energy supply and delivery
- Energy security and interdependence
- Carbon management
- Infrastructure
- Industry capacity
- Technology.

Through a process of reviews, the findings and observations were refined into the "hard truths" of this study, and formed the basis of proposed strategies and recommendations.

INFORMATION MANAGEMENT

An Analytical Approach

While the study scope was evolving, the Task Groups began assembling data for their analyses. As illustrated in Figure 7-5, the data streams used by the Task Groups for their analysis drew on public and proprietary information. In addition, a number of recent parallel studies from the energy sector were reviewed for relevant information and data.

Storing Information—The Data Warehouse

To make the study's broad-ranging and original sources easily available to all participants, a data warehouse was developed. This provided for centralized management of the multidimensional data collected. By the time it concluded, the study had compiled and used nearly 100 energy forecasts or outlooks. These forecasts and several hundreds of papers/documents on various aspects of the energy sector were used in the interpretations that formed the basis of the study findings and recommendations.

As an organizing feature, a digital survey questionnaire was developed to collect a consistent set of

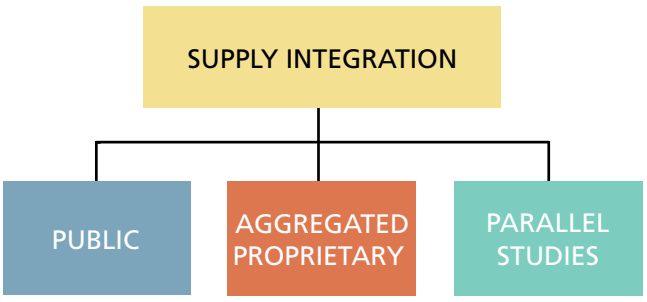

FIGURE 7-5. *Multiple Data Sources*

historical and forecast data for all data streams. The survey captured both numeric data and the assumptions used in individual energy outlooks.

The data request was very comprehensive although not all of the respondents completed all aspects of the survey. Data were requested at the world, regional and also key country levels. The regions surveyed were organized in these broad headings: North America, Central and South America, OECD, Non-OECD Europe and Asia/Oceania, the Middle East, and Africa.

The data warehouse was designed to be the main analytical tool for the Task Groups, accepting all data collected from the survey questionnaire and other data sources. As the survey data were multi-dimensional, Oracle OLAP database technology was used and the collection was organized using 7 dimensions:

1. Time *(year)*
2. Geography *(country or geographic region)*
3. Energy type *(e.g., oil, gas, coal, nuclear, renewable)*
4. Energy sector *(e.g., commercial, residential)*
5. Case type *(e.g., business as usual, alternative energy policy)*
6. Units *(applicable unit of measure)*
7. Source *(e.g., public, proprietary)*

Once in the data warehouse, selected values or ranges of values for any or all dimensions could be applied as a filter to enable analysis.

The questionnaire collected high-level assumptions, oil and natural gas endowment, oil production, natural gas production, coal energy supply, the methodology used by the different outlooks, economic/demographic information, energy prices, total energy consumption, energy production and electricity generation, and environmental information. Additional supply data were developed for liquefied natural gas and gas-to-liquids, infrastructure, and biomass/biofuels.

The review process produced supply data sets associated with the key documents that were identified and collected. These data sets cover a wide range of views, including low-end projections, mid-range and reference cases, and high-end forecasts. Each data set generated represents a unique and consistent forecast. Several organizations provided multiple scenarios, each of which was documented as a separate case for evaluation.

The contents of the Data Warehouse and a viewer application are available on the CD that accompanies this report (see Appendix E).

Public Data and Information

Each of the Task Groups searched the literature for integrated, global energy supply/demand forecasts that extended until at least 2030 and were in the public domain. Five forecasts were found that met these criteria, three from the U.S. Energy Information Administration and two from the International Energy Agency (Table 7-1).

To capture an even more comprehensive set of forecasts, the study identified a "wide net" of additional public sources. About 80 additional organizations and individuals were enlisted to participate by contributing data in a standard survey format. Among the sources for the wide-net data were: DOE, National Coal Council, OPEC, Greenpeace, Pew, SAIC, Natural Resources Defense Council, Climate Change Science Program, European Commission, and the Association for the Study of Peak Oil.

Energy Information Administration *International Energy Outlook 2006*
• Reference Case • High Case (economic growth, oil price) • Low Case (economic growth, oil price)
International Energy Agency *World Energy Outlook 2006*
• Reference Case • Alternative Policy Case

TABLE 7-1. *Integrated, Global Energy Supply/Demand Forecasts*

In addition to the data gathered from other public domain sources, Energy Secretary Bodman sent letters in October 2006 to 19 governments, advising them of the study and seeking their participation, comments, and contributions. The countries were Australia, Azerbaijan, Brazil, Canada, Peoples Republic of China, Germany, India, Indonesia, Japan, Kazakhstan, Kuwait, Mexico, Nigeria, Norway, Qatar, Russia, Saudi Arabia, United Arab Emirates, and United Kingdom.

Proprietary Data and Information

To supplement and test the major public domain projections, an analysis of aggregated proprietary information was also undertaken. The "National Petroleum Council Survey of Global Energy Supply/Demand Outlooks" was sent to 34 international oil companies and consulting groups that were believed to make this type of projection. No study participant had access to individual, proprietary survey responses or knew which organizations were among the respondents. A list of organizations to which the survey was sent is shown in Table 7-2.

In addition to quantitative data, the questionnaire also requested high-level assumptions, oil and natural gas endowment, oil production, natural gas production, coal energy supply, the methodology used by the different outlooks, economic/demographic information, energy prices, total energy consumption, energy production and electricity generation, and environmental information. Additional supply data were developed for liquefied natural gas and gas-to-liquids, infrastructure, and biomass/biofuels.

Because of the commercial value of these data, and to ensure strict compliance with all antitrust requirements, the data were collected and aggregated by an independent accounting firm, Argy, Wilze and Robinson (AWR), which was charged with maintaining the anonymity and confidentiality of the responses. No one outside this independent third-party organization had access to individual, proprietary survey responses or even knew which organizations were among the respondents.

As the aggregator of the proprietary data, AWR was tasked with:

- Receiving the survey responses from responding organizations.

International Oil Companies
BP
Chevron
ConocoPhillips
Eni S.p.A.
Exxon Mobil Corporation
Marathon Oil Company
PetroCanada
Reliance Industries Limited
Repsol
Shell
Total S.A.
Valero
Consultants and Others
Barclays Capital
Bernstein Research Group
Cambridge Energy Research Associates
Caterpillar Inc.
Chemical Data Inc.
CRA International, Inc.
Deutsche Bank
Global Insight, Inc.
Goldman, Sachs & Co.
Jacobs Consultancy Inc.
Lawrence Berkeley National Laboratory
McKinsey Global Institute
Oak Ridge National Laboratory
PFC Energy
PIRA Energy Group
Probe Economics, Inc
Purvin & Gertz, Inc.
Rocky Mountain Institute
Simmons and Company International
SRI International
Wood Mackenzie Ltd.
Ziff Energy Group

TABLE 7-2. *Recipients of the NPC Survey of Global Energy Supply/Demand Outlooks*

- Clarifying with the survey respondent any responses that appeared inconsistent or incorrectly entered. The NPC required that the aggregator also engage an independent technical expert, who operated under the same confidentiality requirements as any other employee of the aggregator, to assist in reviewing the survey responses.
- Provided that at least three responses were received from a group of respondents (i.e., International Oil Companies or Consultants), preparing a report for that group of the aggregated survey data and the individual qualitative responses after suitable editing to preclude identifying any specific response with a specific respondent.
- Submitting a draft report of the aggregated and de-identified responses to the NPC's outside antitrust counsel as an additional check to ensure compliance with the reporting guidelines.
- Following up as necessary and issuing an amended final report if the NPC requested that specific items in the report be clarified.

The data were aggregated separately for the International Oil Companies and the Consulting Companies, and again for combined groupings.

For each of the groups separately, provided at least three responses were received for each group, AWR reported:

- The highest values for each quantitative response (where at least three values were reported) and associated qualitative responses.
- The lowest values for each quantitative response (where at least three values were reported) and associated qualitative responses.
- The average values for each quantitative response (where at least three values were reported) and associated qualitative responses.

Then, for all the responses combined, AWR reported:

- For the two responses with the highest total global energy use in 2030, a report of the average of all quantitative responses where two responses were reported, and all qualitative responses.
- For the two responses with the lowest total global energy use in 2030, a report of the average of all quantitative responses where two responses were reported, and all qualitative responses.
- For all responses, a report of the average of all quantitative responses where at least two responses were reported, and all qualitative responses.

Following completion of its report, AWR was required to destroy all survey responses, working papers, notes, and any other record of the survey responses, keeping only the survey report.

As a result of the proprietary data collection, 29 cases from 21 respondents were incorporated into the 9 aggregations that now reside in the data warehouse—International Oil Companies (low, average, and high energy use); Consulting Companies (low, average, and high energy use), and the combined low, average, and high responses from all the International Oil Company and Consultant respondents. The response rate for the International Oil Companies was 75 percent or greater, with the response rate from the Consulting Companies less than 75 percent.

Parallel Studies

A parallel studies process examined numerous other recent public reports that addressed various aspects of energy policy to inform the work of the NPC study's Coordinating Subcommittee. (Appendix D provides summaries of these parallel studies.) The reports included are shown in Table 7-3.

SUMMARY

The NPC study, *Facing the Hard Truths about Energy,* differs from most of the parallel studies we reviewed by its depth of analysis, its breadth of sources and participants, and its balanced perspectives. The methodology adopted by the study team included a comprehensive review of multiple supply and demand outlooks to 2030. This effort was further extended by the Task Groups and cross-cutting groups to include assessments of technology, infrastructure, alternative energy sources, security, and the environment. This methodology enabled the team to create and recommend a core set of five strategies for the nation to pursue. Solutions to the energy challenges will depend on the cooperation of government and industry, in the United States and around the world, to create the necessary opportunities for a balanced future—including economic, security, and environmental goals.

National Commission on Energy Policy

Energy Security Leadership Council

Business Roundtable Energy Task Force

National Association of Manufacturers

Council on Foreign Relations

Alliance for Energy and Economic Growth

World Energy Council/US Energy Association

IEA World Energy Outlook 2006

U.S. DOE/EIA International Energy Annual 2006

ExxonMobil Outlook for Energy

NETL Oil Peaking Study

U.S. Government Accountability Office

American Enterprise Institute

Intergovernmental Panel on Climate Change

Stern Review Report

Global Roundtable on Climate Change

World Energy Technology Outlook – 2050

2000-2050 North American Transportation Energy Futures

UN Foundation (Scientific Expert Group)

CNA – National Security and the Threat of Climate Change

MIT – The Future of Coal in a Carbon-Constrained World

EPRINC – Ethanol and U.S. Energy Security

U.S. Climate Action Partnership

Council of the Americas – Energy Action Group

OPEC Secretariat – World Oil Outlook 2007

Energy Charter – Oil & Gas Pricing Study

TABLE 7-3. *Studies Examined*