

PREFACE

NATIONAL PETROLEUM COUNCIL

The sole purpose of the National Petroleum Council (NPC) is to provide advice to the federal government. At President Harry Truman's request, this federally chartered and privately funded advisory group was established by the Secretary of the Interior in 1946 to represent the oil and gas industries' views to the federal government: advising, informing, and recommending policy options. During World War II, under President Franklin Roosevelt, the federal government and the Petroleum Industry War Council had worked closely together to mobilize the oil supplies that fueled the Allied victory. President Truman's goal was to continue that successful cooperation in the uncertain postwar years. Today, the NPC is chartered by the Secretary of Energy under the Federal Advisory Committee Act of 1972.

Over time, Council membership has increased in both number and diversity. Approximately 200 in number, Council members are selected by the Secretary of Energy to assure well-balanced representation from all segments of the oil and gas industries, academic, financial, research, Native American, and public interest organizations and institutions. The Council provides a forum for informed dialogue on issues involving energy, security, the economy, and the environment in an ever-changing world. A further description of the Council and a list of members are contained in Appendix A and at www.npc.org.

STUDY REQUEST

By letter dated September 16, 2009, Secretary of Energy Steven Chu requested the National Petro-

leum Council's advice on two topics: (1) Future Transportation Fuels and (2) Prudent Development of North American Natural Gas and Oil Resources. The Secretary stated that the Council is uniquely positioned to provide advice to the Department of Energy on these important topics.

In September 2011, the Council approved and submitted to the Secretary a report entitled *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources*. This report addressed the Secretary's request to "reassess the North American natural gas and oil resources supply chain and infrastructure potential, and the contribution that natural gas can make in a transition to a lower carbon fuel mix." The report and supporting materials are available on the NPC's website at www.npc.org.

This report is the Council's response to the Secretary's request to the NPC to "conduct a study on future transportation fuels which would analyze U.S. fuels prospects through 2030 for auto, truck, air, rail, and waterborne transport," with advice sought on policy insights and technology pathways "for integrating new fuels and vehicles into the marketplace including infrastructure development."

Expanding on his September 2009 request, in a supplemental letter dated April 30, 2010, Secretary Chu further asked what actions industry and government could take to stimulate the technological advances and market conditions needed to reduce life-cycle greenhouse gas emissions in the U.S. transportation sector by 50% by 2050, relative to 2005 levels, while enhancing the nation's energy security and economic prosperity. Appendix A contains copies of both letters from the Secretary.

STUDY ORGANIZATION AND APPROACH

In response to the Secretary’s requests, the Council established a Committee on Future Transportation Fuels to study this topic and to supervise preparation of a draft report for the Council’s consideration. The Committee leadership consisted of a Chair, Government Cochair, and three subject-area Vice Chairs. The Council also established a Coordinating Subcommittee, three Task Groups, and ten Coordinating Subcommittee-level analytical and support Subgroups to assist the Committee in conducting the study. Figure 1 provides an organization chart for the study and Table 1 lists those who served as leaders of the groups that conducted the study.

Study group members were drawn from NPC members’ organizations as well as from U.S. and international vehicle manufactures, transportation services end-users, non-governmental organizations, financial institutions, consultancies, academia, and research groups. More than 300 people served on the study’s Committee, Subcommittee, Task Groups, and Subgroups. All participants have expertise relevant to the study, with significant representation from oil and natural gas companies (24%), transportation manufacturers (24%), and transportation end users (11%). This diversity of industry representation assured that the study was informed by expertise from a broad array of stakeholders in the transportation sector. Appendix B contains rosters of these study groups and Figure 2 depicts the diversity of participation in the study process.

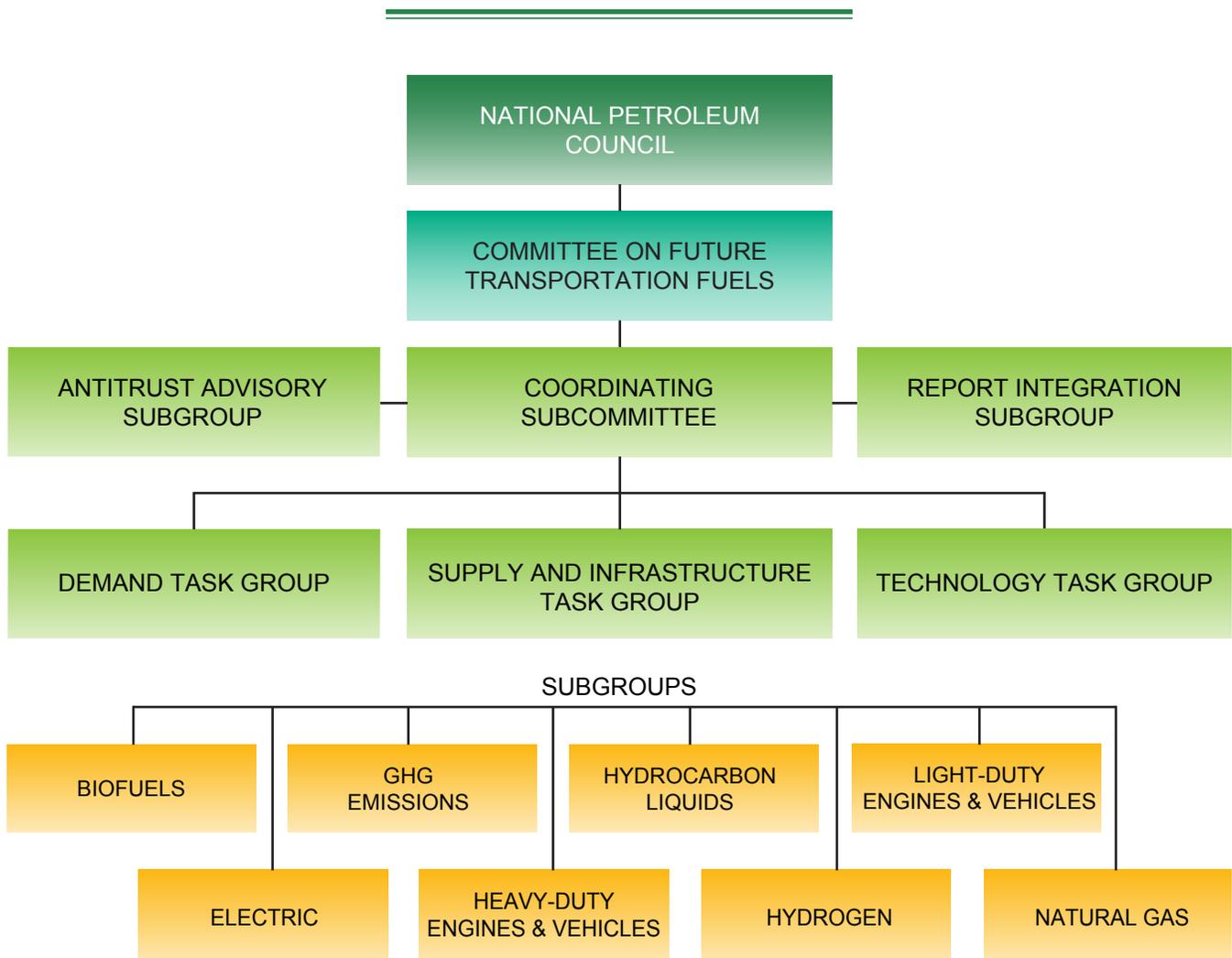


Figure 1. Structure of the Future Transportation Fuels Study Team

Chair – Committee

Clarence P. Cazalat, Jr.
 Chairman, President and Chief Executive Officer
 Marathon Oil Corporation

Government Cochair – Committee

Daniel P. Poneman
 Deputy Secretary of Energy
 U.S. Department of Energy

Vice Chair – Demand

James W. Owens
 Retired Chairman of the Board
 Caterpillar Inc.

Vice Chair – Supply & Infrastructure

John S. Watson
 Chairman of the Board and Chief Executive Officer
 Chevron Corporation

Vice Chair – Technology

John M. Deutch
 Institute Professor
 Department of Chemistry
 Massachusetts Institute of Technology

Chair – Coordinating Subcommittee

Linda A. Capuano
 Vice President
 Technology
 Marathon Oil Corporation

Government Cochair – Coordinating Subcommittee

David B. Sandalow
 Under Secretary of Energy (Acting)
 Assistant Secretary of Energy for Policy
 and International Affairs
 U.S. Department of Energy

Chair – Demand Task Group

Deanne M. Short
 Senior Economist
 Caterpillar Inc.

Chair – Supply & Infrastructure Task Group

S. Shariq Yosufzai
 Vice President
 Global Downstream LLC
 Chevron Corporation

Chair – Technology Task Group

Stephen R. Brand
 Senior Executive Advisor
 Welltec, Inc.

Note: U.S. government participants provided significant assistance in the identification and compilation of data and other information, but they did not take positions on the study's statements, findings, or recommendations.

Table 1. Future Transportation Fuels Study Leaders

Study group participants contributed in a variety of ways, ranging from full-time work in multiple study areas, to involvement on a specific topic, or by reviewing proposed materials. Involvement in these activities should not be construed as endorsement of or agreement with the statements, findings, and recommendations of this report. As a federally appointed and chartered advisory committee, the NPC is solely responsible for the final advice provided to the Secretary of Energy. However, the Council believes that the broad and diverse study group participation has informed and enhanced its study and advice. The Council is very appreciative of the commitment and contributions from all who participated in the process.

A central principle of the study was to fully comply with all regulations and laws that cover a proj-

ect of this type. For this reason, significant effort was put forth to ensure that the study group conformed to all antitrust laws and provisions as well as the Federal Advisory Committee Act. As part of the compliance effort, this study does not include a direct evaluation of commodity or fuel prices despite the important role these play in balancing supply and demand in the U.S. transportation sector. Rather, the study group adopted commodity and fuel prices put forth by the Energy Information Administration (EIA) in its Annual Energy Outlook 2010 (AEO2010). Because these projections do not cover the full study period, the study group extrapolated available EIA data out to 2050 using assumptions consistent with those used in the AEO2010.

To provide a broad review of current knowledge, the study groups examined available reports and

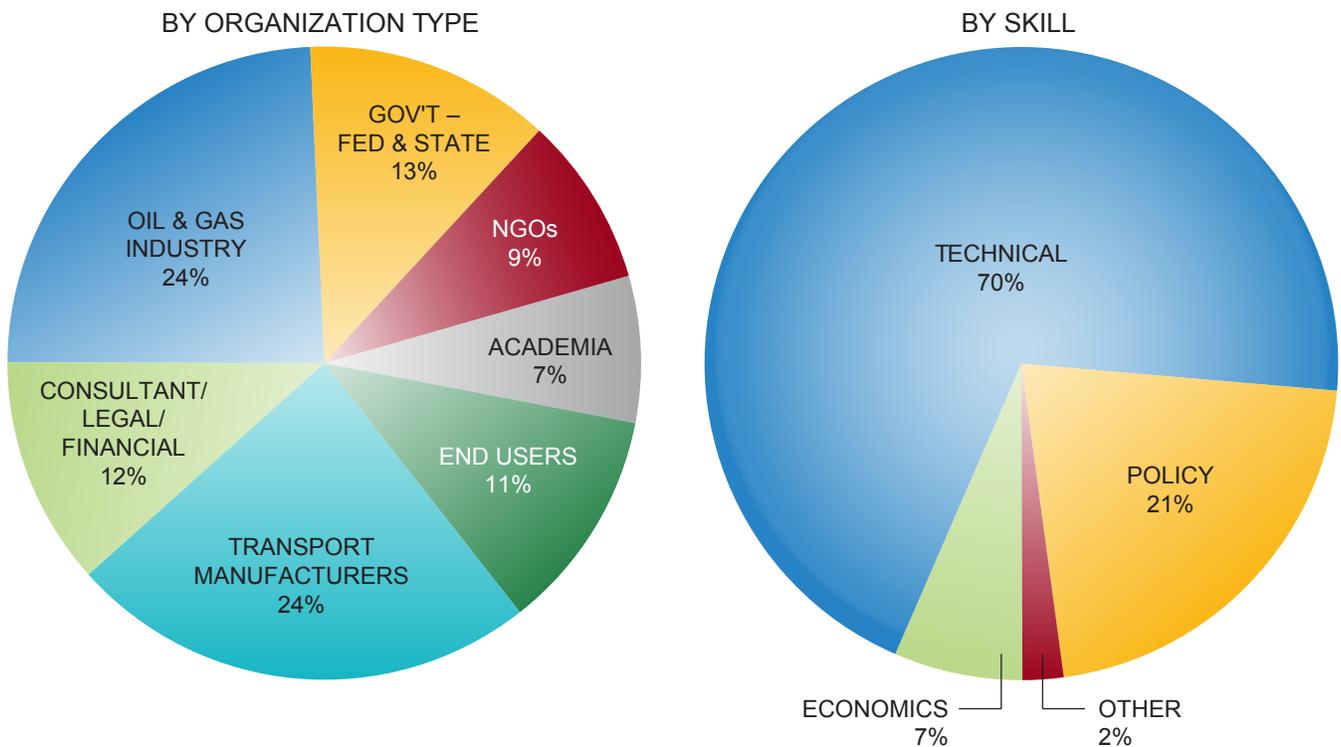


Figure 2. *Composition of the Future Transportation Fuels Study Team*

analyses on U.S. transportation demand, fuel supply and infrastructure, and potential technological advancements in the transportation sector. The varied analyses included those produced by the Energy Information Administration, National Research Council, Environmental Protection Agency, and the Department of Transportation, among others.

Through the work of the Demand Task Group, the study considered the national demand for moving passengers and freight through 2050. Concurrently, the Supply & Infrastructure Task Group conducted assessments of the possible fuel-vehicle supply chain pathways that have the potential to achieve commercial volumes by 2050. The primary focus of analysis was on light- and heavy-duty on-road vehicles, which represent nearly two-thirds of transportation energy demand. While not a primary focus, the demand for air, marine, and rail transportation was also considered.

Study subgroups were established to assess each potential fuel and vehicle pathway, which include: hydrocarbon liquids, biofuels, electric, natural gas, and hydrogen fuel cell. Light- and Heavy-Duty Engines & Vehicles Subgroups were formed to inte-

grate platform analyses across light- and heavy-duty vehicles, including spark and compression ignition engines and electric vehicles.

These subgroups reviewed published studies, providing potential future supply estimates and characteristics for each fuel-vehicle type. This work also identified potential technological hurdles that each fuel-vehicle pathway must overcome to reach commercial scale by 2050.

A separate Technology Task Group was established to (1) provide technical assistance to the individual subgroups in their evaluation of hurdles to be overcome in achieving commercial scale by 2050 and (2) provide technical peer review of the results. Subject Matter Experts were recruited and three Technology Reviews were conducted during the course of the study to provide feedback to the individual subgroups as their work progressed. An important part of this review was an assessment of the “evenness” of the relative optimism in overcoming hurdles between the fuel-vehicle pathways.

The light-duty and heavy-duty outputs from the individual fuel and vehicle pathway assessments

were then quantitatively integrated and compared using modeling tools to organize thinking, document assumptions, and ensure consistent calculations. This quantitative analysis of a subset of data provided insight into the cost of driving for light- and heavy-duty vehicles and provided a strong foundation for the broader qualitative consideration of the economic, energy security, and environmental favorability of potential fuel-vehicle portfolios in 2050.

STUDY REPORT STRUCTURE

In the interest of transparency and to help readers better understand this study, the NPC is making the study results and many of the documents developed by the study groups available to all interested parties. To provide interested parties with the ability to review this report and supporting details in different levels of detail, the report is organized in multiple layers as follows.

In Print and Online

- *Executive Summary* is the first layer and provides a broad overview of the study's principal findings and resulting recommendations.
- *Integrated Analysis Chapters* provide a more detailed discussion of the data, analyses, and additional background on the findings. These individual chapters are titled by subject area and provide supporting data and analyses for the findings presented in the Executive Summary.
- *Fuel and Vehicle System Analysis Chapters* provide in-depth, stand-alone data and analyses on the various fuels and fuel-vehicle systems covered in this study. These chapters formed the basis for the understanding of each study segment, and were heavily utilized in the development of the integrated chapters.

Online Only¹

- *Topic Papers* developed for the use of the study's Task Groups and Subgroups provide an additional level of detail for the reader. A list of short abstracts of these papers appears in Appendix C and the full papers can be viewed and downloaded from the NPC website (www.npc.org).
- *Spreadsheet Models and Supporting Documentation* used to conduct a portion of the study's light- and heavy-duty fuel and vehicle analysis have been made available for download.

All of the above materials may be individually downloaded from the NPC website. The website is located at www.npc.org, and the public is welcome and encouraged to visit the site to download the entire report or individual sections for free. Also, published copies of the report can be purchased from the NPC.

¹ The Council believes that these "Online Only" materials will be of interest to the readers of the report and will help them better understand the results. The members of the NPC were not asked to endorse or approve all of the statements and conclusions contained in these documents but, rather, to approve the publication of these materials as part of the study process.