World Energy Council

Global Energy Policy Scenarios to 2050 Study

United States Country Report

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Draft 1 –Revision One

[Not for Attribution or Citation]

Note: This draft report has been prepared for discussion with the Members of the United States Scenarios Task Force, and the Leaders and Rapporteurs of the United States Scenarios Workshop held on May 30-31, 2006. Comments from these groups will be used to prepare the next Draft of this report, which will be circulated to all U.S. workshop participants in advance of a late July 2006 follow-up meeting.

This draft report is also provided to the other World Energy Council North America Region Member Committees to support their report preparation, and also to the North America Region Scenarios Study Leader, to provide initial input for the preparation of the integrated North America Region Scenarios Report which will be presented at the 2006 Executive Assembly in Tallinn, September 6, 2006.

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A. Background [Substantially re-written]

The United States Energy Association (USEA) has embarked on an effort to support the World Energy Council's Global Energy Policy Scenarios Study. The World Energy Council (WEC) study lays out four energy policy scenarios, which provide a useful framework to consider energy resource development and utilization over five decades. This framework facilitates a discussion of how eleven critical global issues will influence the WEC goals of assuring energy Accessibility, Availability and Acceptability.

This U.S. report, when in final form, will be appended to the "North American Regional Report," as will the country reports from Canada and Mexico. This, this document will not only serve as a free-standing U.S. report, but will be utilized substantially as input to both the North American and global World Energy Council documents

These "3-A's" are defined as follows:

Accessibility: Access to affordable modern energy for all people, as distinct from dependence on "traditional" energy forms, i.e., firewood, animal waste, etc.

Availability: Reliability and security of energy supply systems once access has been achieved.

Acceptability: Avoidance of damage to the environment that could compromise current and future welfare.

The Dominant Global Issues and Concerns for Next Half Century

1. Global hydrocarbon supply challenge
2. Keeping all supply options open
3. Energy end uses, especially mobility systems
4. Global conservation ethic
5. Greenhouse gas challenge
6. Technologic challenges and opportunities
7. Global market reform
8. Financing Challenge
9. National and regional supply security
10. Global coordination and support
11. Accessibility

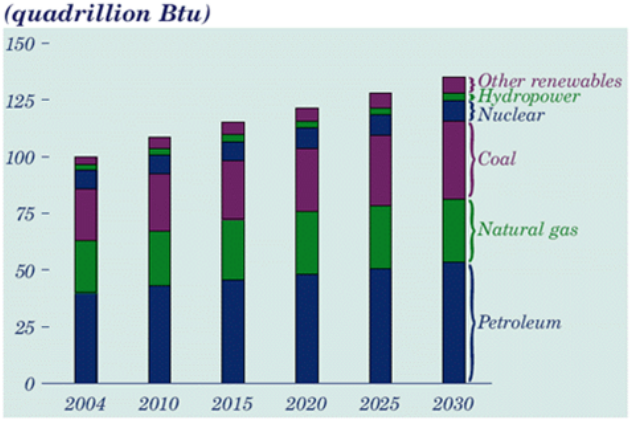
1. The U.S. Setting

The U.S. energy economy in 2006 presents an interesting example of the usefulness of the WEC scenario study. U.S. Government statistical projections go to 2030, as is common with similar efforts. Little analysis has been done with a time frame of the middle of the century, yet many experts perceive that technology development and deployment will address critical energy issues within this time frame.

The U.S. Energy Information Administration projects primary energy use to reach 134 quadrillion (quads) BTU's by 2030 up from about 100 quads today. Petroleum for transportation and coal for industrial/electric power generation drives this increase. Growth in energy demand from 2030 to 2050 is unclear; but few, if any, expect demand to fall in the United States. In fact, it is reasonable to expect that absent dramatically different price or policy signals, the 2030 to 2050 timeframe will look similar to 2005 to 2030.

Coal and Petroleum Lead Increases in Primary Energy Use

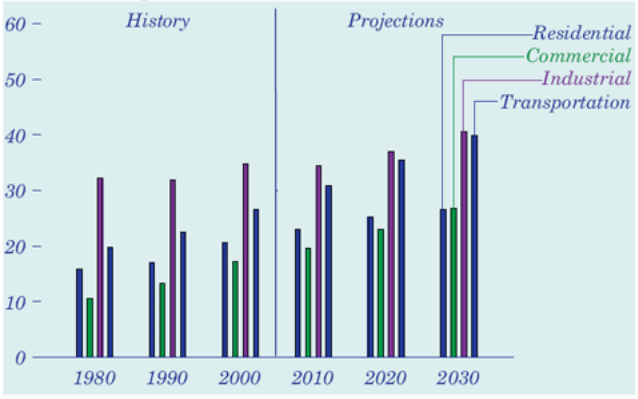
Figure 32. Primary energy use by fuel, 2004-2030 (quadrillion Btu)



U.S. Energy Information Administration

U.S. Primary Energy Use Climbs to 134 Quadrillion Btu in 2030

Figure 34. Primary energy consumption by sector, 1980-2030 (quadrillion Btu)

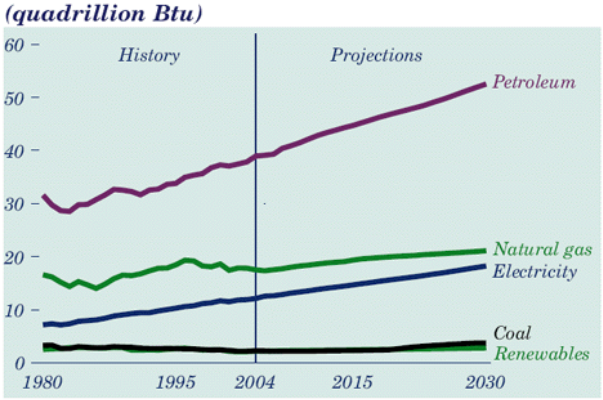


U.S. Energy Information Administration

Both petroleum and electricity consumption are expected to grow significantly, with most increased demand for crude oil and refined products to be met by imports in the 2005-2030 time frame.

Petroleum and Electricity Lead Growth in Energy Consumption

Figure 33. Delivered energy use by fuel, 1980-2030 (quadrillion Btu)

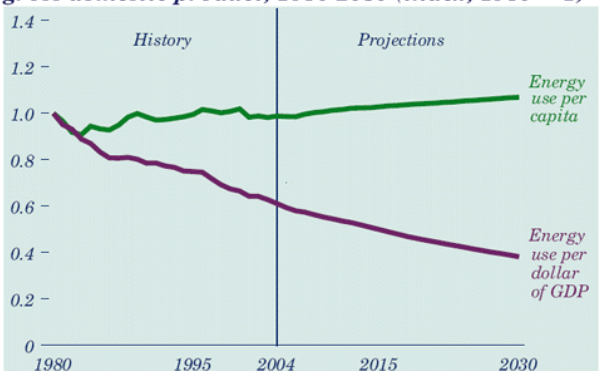


U.S. Energy Information Administration

Even though significant gains are reached in energy intensity through efficiency and productivity, the average per capita energy use increases again in the 2005 to 2030 time frame, with a 15% increase in per capita energy use for transportation between 2005 and 2030.

Average Energy Use per Person Increases Through 2030

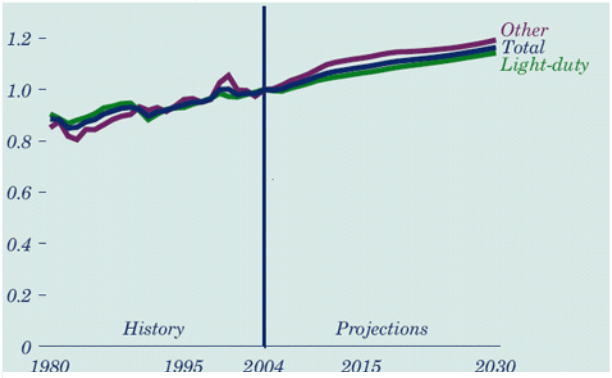
Figure 31. Energy use per capita and per dollar of gross domestic product, 1980-2030 (index, 1980 = 1)



U.S. Energy Information Administration

Transportation Energy Use Per Capita in 2030 is 15 Percent Over 2004 Level

Figure 49. Transportation energy use per capita, 1980-2030 (index, 2004 = 1)



U.S. Energy Information Administration

Investments in energy infrastructure are beginning to percolate as a direct result of the Energy Policy Act of 2005. These policy changes, coupled with the need to better balance supply and demand, are expected to lead to a significant expansion in the electric power system. Tax incentives for transmission system improvements, for new nuclear plants, for deploying clean coal technologies and for renewable energy systems should spur investments in this sector through the end of this decade and perhaps beyond.

The Energy Policy Act of 2005 did very little to facilitate domestic production of oil and gas. Additional legislation will be needed to allow exploration and production on the outer continental shelf, on federal lands in the west, particularly the Rocky Mountains, as well as in the Artic National Wildlife Refuge.

This unwillingness on the part of the legislative branch to encourage an expansion of domestic oil and gas production is occurring against a backdrop of:

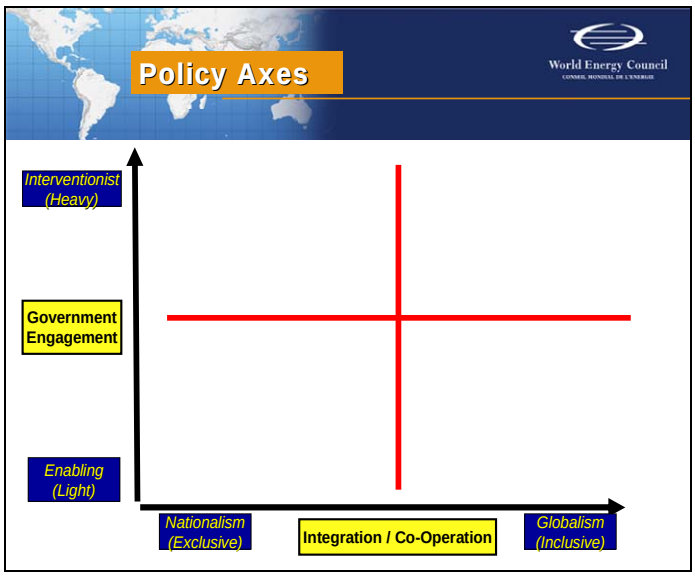
- Rising global demand for petroleum and natural gas and prices above historic norms.

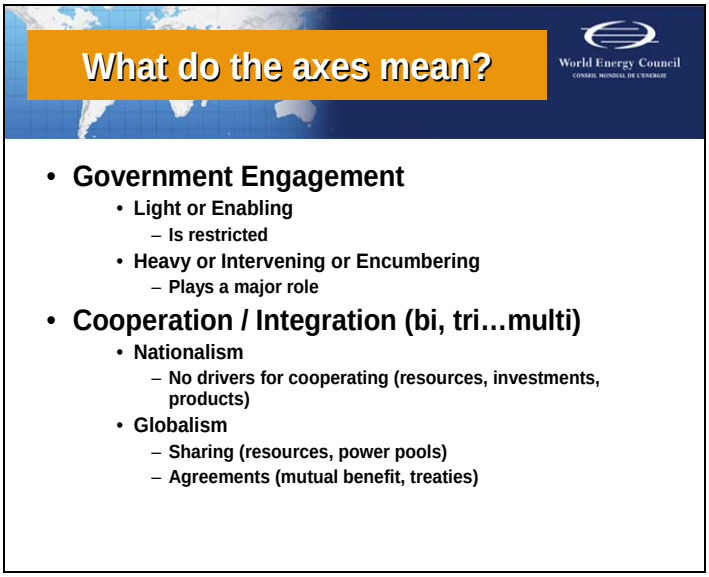
- Increasing focus on domestic energy independence, driven by national security concerns and an expectation of increased reliance on biofuels.

Hence, this is an opportune time for the United States to explore energy policy scenarios to 2050, particularly within the framework of a more or less interventionist government along a continuum of nationalism versus globalization.

2. Introduction to the Scenarios

The U.S. workshop generally accepted the descriptions of the four scenarios as framed by the WEC study and defined by the National Workshop Guidelines (May 2005) – World Energy Council. However, by the end of the workshop, it was clear that there was some confusion as to how each scenario was defined.





Globalization (high international cooperation)

- Strong support for ongoing global market reform, including stronger NAFTA, WTO and other related organizations.

- Strong committed support for future regional and global agreement which address the world's dominant energy-related issues and challenges, including global warming, energy poverty, energy supply security, technology development and transfer, etc.

- Strong support for existing global and regional institutions with energy related responsibilities, such as the UN, IMF, World Bank, Regional Banks, etc., and working proactively in strengthening existing and creating new institutional arrangements for tackling major international energy related challenges.

Nationalism (low international cooperation)

- Strong focus on national self sufficiency and national security. International commitments tend to be disregarded.

- There is no direct participation in addressing future regional and global concerns such as global warming, energy poverty, etc.

- Passive participation in the support of existing global and regional institutions, such as the UN, IMF, etc., but no commitment to their implementation.

- Strong focus on the development and deployment of technologies which utilize indigenous energy resources.

Interventionist Government (high government engagement)

- Energy is viewed by governments as being of high priority for national economic growth and development.

- Governments decide that domestic energy systems are too important to be left purely to open market processes, and thereby engage in direct intervention, including equity participation and regulation (prices, taxes, incentives).

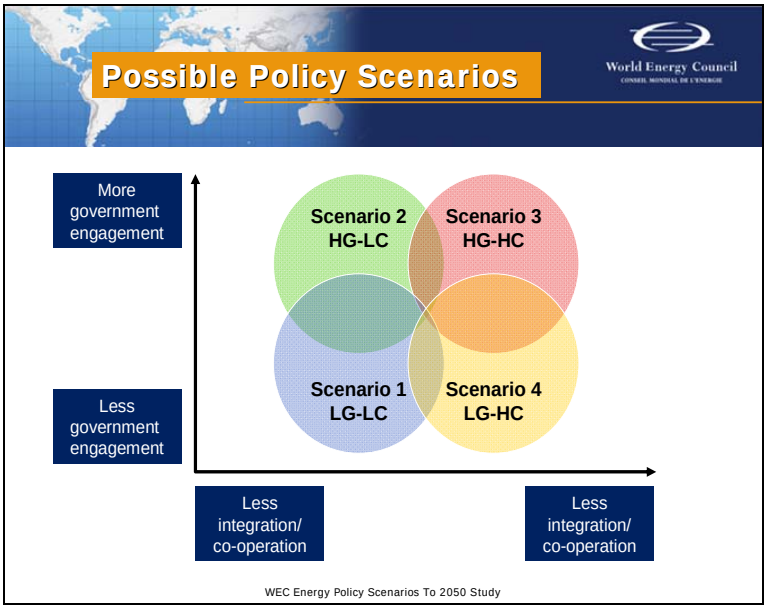
- There is a strong sustained commitment by governments to have a policy framework for the development and management of energy system.

- There is a strong regulatory environment to support energy developments.

- There are strong programs for development and deployment of new energy technologies, including "picking winners" and implementing policies that support such decisions.

Enabling Government (low government engagement)

- Overall economic development is the priority.
- Energy systems are viewed by governments as elements (albeit important) of other system, with policy frameworks not focusing specifically on energy systems as such.
- Governments enhance and promote the importance of market forces in the energy sector. The role of governments is to set the overall policy framework, with the buyers and sellers making the key investment, production and consumption decisions.
- Regulations for development of energy systems are streamlined, and only used as a last resort.
- There is cooperation on technology, but with a stronger focus on supporting and promoting RD&D initiatives by the private sector.



3. Summary of the Scenarios

Overall Commentary

- The U.S. workshop participants indicated an acceptance of WEC approach as providing a framework within which to discuss the principle issues. However, a clear consensus emerged that these axes are not drivers of major issues in the U.S. context.

- It was noted that different fuels and technologies have different realities within and among scenarios. There really is no one scenario that adequately captures the United States today. Hence, it is difficult to envision that one single scenario will apply to all fuels and all technologies by 2050. One clear example is the regulatory regime that applies to nuclear compared to solar photovoltaics.

- Also state and regional differences are significant within the U.S. This particularly applies to issues such as facility siting, power market structure and the trade-offs between economic development and environmental protection.

- A general consensus emerged that Scenario Three or Four in 2050 is likely. It is unclear if this is also desirable in that participants were not asked this question. Differences in fuels, technology and regions are likely to influence the desirability of any scenario.

- Technology development and deployment is key in all four scenarios to get to the Three A's.

- Introduction of new disruption technologies not currently utilized cannot be predicted, i.e., nano-technology, methane hydrates, etc.

- In responses to a direct question, a clear consensus emerged that in any of the four scenarios, there is zero expectation that federal or state government ownership of energy resources or facilities could increase.

All four scenarios breakout sessions reported agreement on:

- The Hydrocarbon Challenge can be managed;

- Keeping all energy options open is essential;

- The availability of finance is not a U.S. issue;

- Technology challenges and opportunities are equally critical in all scenarios;

- accessibility is not a U.S. issue.

Interesting Insights Emerging from Breakout Sessions:

- **Scenario 1 – Light Government and Nationalism**

  – This is the "business as usual" approach – Scenario 1 is where the United States is today.

  – The nationalist scenario requires movement up the vertical axis of government involvement. Nationalist policies would need to be government imposed. The "market" will lead to globalization. Nationalism is not feasible at the lowest point of vertical axis.

  Issue 1: Accepting the proposed notion of fossil fuels providing 85-90% of all U.S. energy in 2050 requires alternative fossil fuels, i.e., oil sands/shale; methane hydrates; unconventional oil and natural gas. In Scenario 1, which implies relying on domestic resources, the U.S. has inadequate domestic supplies of conventional fossil fuel resources.

  Issue 2: Keeping all supply options open is seen as critical and likely in this scenario.

  Issue 3: The workshop participants could not reach a consensus on how "end-uses" plays out in Scenario 1.

  Issue 4: The Global Conservation Ethic was rejected as an issue as being neither desirable, necessary nor relevant to Scenario 1.

  Issue 5: The Greenhouse Challenge in Scenario 1 is addressed by market-based economic/social/business pressure. Voluntary responses to climate change concerns are based on advanced technology such as carbon sequestration and nuclear power.

  Issue 6: Substantial government involvement is desirable in terms of R&D investments and incentives to deploy technologies that are in the "public good."

  Government research, development and deployment support is consistent with Scenario 1 and should be on a non-discriminatory basis, i.e., production tax credits across the spectrum of fuels and technology. In Scenario 1, the government does not pick fuel and technology winners and losers, rather the market does.

Issue 7: The participants concluded that global market reform is inconsistent and outside of Scenario 1.

It was pointed out that any nation can be highly nationalist/protectionist and still be a major global trader (i.e., mercantilism, colonization, etc). Nationalism does not automatically lead to increased barriers to international trade, while it can be interpreted to mean "no imports or exports". By definition however, it does not automatically mean this.

Issue 8: In the United States, no constraints exist on the availability of capital. It was noted that even some "bad" projects get financed.

Issue 9: In this scenario, market forces and free trade provide supply security by diversification of sources of supply, of fuel choices, and of technology.

Issue 10: Global cooperation is "defined" out of this scenario. Businesses cooperate on a voluntary basis. For this scenario to be viable in 2050, a new technology or resource must emerge.

Issue 11: Not relevant to the United States.

- **Scenario 2 – Government Intervention and Nationalism**

  - Scenario 2 suggests that the United States embarks on a very different approach to national energy policy than has historically been the case. It relies more on a "moon shot" approach rather than incremental change. This notion is that the U.S. Government, with Congressional support, makes a commitment to energy independence driven by strong government intervention in picking technology and fuel winners and losers. Government agencies are rallied to the energy independence cause in a manner reminiscent of President Kennedy's challenge in the early 1960's to put a man on the moon within a decade.

  - Imports of oil fall to 50% by 2035 and to 33% by 2050. Therefore, U.S. imports could be supplied exclusively from Canada and Mexico.

Issue 1: This scenario forces North American resource development, specifically oil shale and oil sands development. In the near term, by 2020, significant volumes of both oil and gas are delivered from Alaska, and from the outer continental shelf, as well as from federal lands in the Western U.S. Also the biofuel industry expands dramatically.

Issue 2: Scenario 2 suggests major U.S. Government-driven investments in nuclear, clean coal, renewables and electric power infrastructure. The

steps taken by the Energy Policy Act of 2005 need to be dramatically expanded and made permanent.

Issue 3: End use efficiency improvements and fuel switching, i.e., plug-in hybrids displace imported oil being led by government forcing technology deployment. This is primarily accomplished by tax policy, standards, and regulation.

Issue 4: Scenario 2 results in a nationalist conservation ethic rather than global conservation ethic. This scenario also suggests that government policy forces behavior change rather than relying on moral/social pressure.

Issue 5: Greenhouse gas concerns are secondary to energy security concerns.

Issue 6: Technology challenges are characterized by government picking winners and losers.

Issue 7: Scenario 2 discourages global market reform.

Issue 8: Not relevant to the United States.

Issue 9: Continued integration of North American markets occur.

Issue 10: Defined out of this scenario.

Issue 11: Not relevant to the United States.

Overall Comment: The realism of this scenario was challenged by the breakout session participants. They posed the question, "Can the U.S. really become energy independent?" They also questioned if this will be desirable.

- **Scenario 3 – High Government/Globalization**

Issue 1: This scenario is characterized by global competition for access to hydrocarbon supplies. The U.S. government uses a variety of tools - commercial, diplomatic and military - to secure access.

Issue 2: The United States relies on a diversity of fuel and technology in Scenario 2. All options are required to be open. Citizen concerns over energy production and transportation facility siting are overruled by government directives. The "Not In My Backyard" syndrome is overcome by governments exercising eminent domain to site energy facilities.

Issue 3: Significantly more government policy-driven changes in behavior characterizes this scenario, i.e., mass transit, urban planning, telecommunication, employment patterns. Possible de-urbanization may occur and new semi-urban communities prosper. Live where you work/work where you live becomes more common. New residential and commercial buildings are designed with significantly increased energy efficiency standards. Old, inefficient urban buildings that cannot be economically retrofitted are abandoned. In this scenario, the U.S. becomes a global leader in setting efficiency standards.

Issue 4: All Americans come under political and moral pressure to conserve energy and natural resources. Government policies force mandatory efficiency and conservation measures.

Issue 5: In a spirit of international cooperation, the United States endorses strong regulations and mandates regarding climate change – government forces domestic, non-emitting technologies, i.e., renewable, nuclear, etc. Greenhouse gas emissions are stabilized by 2050.

Issue 6: Government funding and support for research and development increases dramatically in this scenario, characterized by public-private partnerships. Global liability issues are addressed such as nuclear incidents, carbon storage, etc. Global technology cooperation is significant.

Issue 7: In this scenario the United States supports global market reform and aggressively pursues treaties and other tools to promote international trade and investment flows.

Issue 8: Availability of financing for domestic projects is not an issue in the United States.

Issue 9: This scenarios addresses security of supply by increasing imports from diverse sources. Imports of oil and gas increase significantly and concerns over security of supplies grow. U.S. military forces assure the free flow of energy resources globally.

Issue 10: The U.S. increases its financial support for technology transfer to developing countries for clean energy technologies.

Issue 11: Accessibility is not an issue in the United States as defined by the WEC.

- **Scenario 4 – Light Government - Globalization**

Issue 1: In this scenario government imposed restrictions to access to energy resources is removed, providing adequate hydrocarbons. Plentiful supplies of oil and gas exist in the outer continental shelf, on federal lands and in Alaska. Hydrocarbon dominance remains easily through the mid point of the century, although price volatility occurs.

Reduced U.S. government intervention in the energy sector, including reduced military presence, results in increased political risk for oil and gas exploration and production. The number of quality investment opportunities that have acceptable risk profiles decreases.

Issue 2: Government still has significant role as an "enabler" in helping keep all energy options open. The U.S. government also has a role as a facilitator of energy resource development by helping U.S. companies engage in other countries. This scenario relies extensively on market-based decision making – over time, markets bring supply and demand into balance, albeit, short term disruptions occur. A shortage of technical personnel will adversely impact resource development. This likely occurs as a sporadic short-term, regional specific issue because ultimately salaries will compensate for labor shortages and workers will migrate to higher paid professions and jobs. This however, will put pressure on energy prices and ultimately inflation.

Issue 3: A scenario of light government/globalization discourages efficiency. Market pricing will eventually bring supply and demand into balance, and while government policies such as building and appliance standards can contribute, but they are inconsistent with the definition of Scenario 4.

In this scenario higher prices drive "choice" - not government command and control. Americans choose to drive more efficient automobiles overall, but options remain for those individuals not sensitive to price. Americans continue to like their cars. They resist cultural changes such as using mass transit or otherwise modifying their behavior. Price rather than policy guides consumers choices.

Issue 4: The breakout group participants strongly expressed a view that for a global conservation ethic to emerge, conservation must become a "marketable" product. It must be made to be stylistic, like anti-smoking or anti-littering campaigns.

Issue 5: Scenario 4 provides little reduction in U.S. greenhouse gas emission levels by 2050. What does occur is driven by social/moral pressures.

In Scenario 4, an enabling government solves the carbon sequestration issue. This is in part due to Americans responding to international pressure and a growing sensitivity to global concerns.

Issue 6: The U.S. Government's role remains in basic R&D; protection of intellectual property rights, etc., and is vital.

Issue 7: In globalized energy markets, international investment follow market principals. "Enabling" foreign governments and proper investment frameworks will determine which countries move forward and which are left behind based in part on their ability to attract direct foreign investment. This is true also for the United States.

Issue 8: Financing is adequate to meet U.S. requirements, provided that the "enabling governments" provide for regulatory (including environmental regulation) certainty.

Issue 9: The "Not in My Backyard" syndrome constrains facility siting, ultimately putting increased pressure on price and supply.

In a scenario of light government, one appropriate role is energy market monitoring to prevent market manipulation. Security concerns are provided by diversified energy markets.

Issue 10: Government and industry work together in public-private partnerships to transfer of best practices through international voluntary partnerships. Improved international data is needed for decision and policy making. International government cooperation is critical for this to occur.

Issue 11: In this scenario energy poverty has been impacted little by 2050.

4. Comparison of the Scenarios

A. The Economy – Scenario Four is the only scenario where GDP growth is expected to increase across the 2020, 2035 and 2050 time periods.

GDP Growth

Scenario	2005	2020	2035	2050
1	Increasing	Decreasing	Neutral	Increasing
2	Increasing	Decreasing	Neutral	Increasing
3	Increasing	Neutral	Neutral	Decreasing
4	Increasing	Increasing	Increasing	Increasing

Scenarios One and Two expected demographic growth to be neutral in all time periods. Scenario Three expects an increase to 2020 and then a decrease through 2035 and 2050. Scenario Four expected an increase to 2020 and then neutral through 2035-2050.

B. Energy - Energy intensity was seen as decreasing in all time periods in Scenario One and Two. In Scenario Three, it is seen as neutral through 2020 and then declines. In Scenario Four it remains neutral in all time periods.

Primary energy mix appears to have not been consistently interpreted. Hence, the data is of little value.

C. Supply/Demand Tension

Oil	2005	2020	2035	2050
Scenario 1	Increasing	Increasing	Decreasing	Decreasing
Scenario 2	Increasing	Decreasing	Decreasing	Decreasing
Scenario 3	Increasing	Neutral	Decreasing	Decreasing
Scenario 4	Increasing	Increasing	Neutral	Decreasing

Gas	2005	2020	2035	2050
Scenario 1	Increasing	Neutral	Neutral	Decreasing
Scenario 2	Increasing	Decreasing	Decreasing	Decreasing
Scenario 3	Increasing	Decreasing	Neutral	Decreasing
Scenario 4	Increasing	Increasing	Neutral	Decreasing

Coal	2005	2020	2035	2050
Scenario 1	Increasing	Neutral	Neutral	Decreasing
Scenario 2	Increasing	Increasing	Increasing	Increasing
Scenario 3	Increasing	Increasing	Increasing	Increasing
Scenario 4	Increasing	Increasing	Neutral	Increasing

Nuclear	2005	2020	2035	2050
Scenario 1	Neutral	Neutral	Neutral	Neutral
Scenario 2	Neutral	Increasing	Increasing	Increasing
Scenario 3	Neutral	Increasing	Decreasing	Decreasing
Scenario 4	Neutral	Decreasing	Decreasing	Decreasing

Renewables	2005	2020	2035	2050
Scenario 1	Decreasing	Decreasing	Decreasing	Decreasing
Scenario 2	Decreasing	Increasing	Increasing	Increasing
Scenario 3	Decreasing	Increasing	Increasing	Decreasing
Scenario 4	Decreasing	Decreasing	Decreasing	Decreasing

Non-Commercial – Not applicable to the United States.

In examining the supply/demand tension analysis, it is not clear that consistent definitions were used in the four breakout sessions. Hence, it may be that little can be gleaned from the information collected. It may be determined that this exercise can be repeated if the results are critical.

D. Issues – Challenges & Opportunities – Areas of Agreement

All four scenarios concluded that:

Issue 1: The Hydrocarbon Resource Challenge can be met by a combination of developing non-conventional domestic resources; accessing lands currently off-limit to production and diversify sources of imports. This will require mitigating existing policies.

Issue 2: Keeping all options open is critical in each scenario. This will require mitigating existing policies.

Issue 6: Technology Challenges & Opportunities - This is critically important in all scenarios, with a significant U.S. Government role, even in the government

"light" scenarios (1 & 4). The only difference among scenarios is the degree of government engagement at the commercialization stage and the notion of governments picking winners and losers. Current policies should accommodate this in the short-term.

Issue 8: Financing challenge – does not apply in the U.S. context. Capital exists for all "good" projects, and even some "bad" projects. Current policies should accommodate this in the short-term.

Issue 11: Accessibility as defined by the World Energy Council is not a U.S. issue. (Accessibility, in the context of "access" to the outer-continental shelf for drilling is important; as is accessibility in the sense of energy security).

E. Issues & Challenges – Areas of Disagreement

Issue 3: End-Use – The scenarios of heavy government intervention (2 & 3) led to dramatic efficiency improvements; market driven/voluntary efforts (1 & 4) were not likely to have major impact.

Issue 4: Global Conservation Ethic – This was interpreted as not relevant to the nationalist scenarios (1 & 2) and was considered as likely due to government action in Scenario Three and only relevant in Scenario Four if the concept could be "marketed" better.

Issue 5: Greenhouse Gas Challenge – Action in Scenario One is driven by society pressure on business, in Scenario Two considered of secondary importance to security, in Scenario Three is driven by government regulation and mandates and in Four, minor reductions occur driven by social pressure.

Issue 6: Global Market Reform – Participants felt this was defined out of Scenario One and Two. In Scenario Three, the U.S. Government is aggressive in pursuing global market reform. In Scenario Four, pressure comes from private capitol markets rather than governments.

Issue 9: National and Regional Supply Security - Supply security is achieved in each scenario, but by different paths. In Scenario One and Four, security is achieved by market forces by way of diversification. In Scenario One and Two, diversification occurs in the North American context, and in Scenario Four, diversification occurs globally. In Scenario Three, security is achieved by diversification with the U.S. military protecting supply sources and transportation routes.

Issue 10: Global Coordination & Support – This is defined out of the scenario in One and Two, is government forced in Scenario Three and is market forced in Scenario Four.

5. The United States in 2050

Summarized below are the key characteristics of each scenario in the U.S. in 2050.

- **Scenario 1 – Enabling Government/Nationalism**

  - Different states and regions have varying degrees of cooperation, i.e., border states more cooperative with Canada and Mexico.
  - Energy producing states strive to maintain state level/regional independence.
  - Economic growth is strong. Private sector drives economic growth.
  - Market forces eventually solve supply/demand imbalances but volatility is constant issues due to market reaction lag-time.
  - Social/cultural philosophy drives nationalism rather than government policy.
  - Social pressure regarding climate change pushes carbon light technologies.
  - Military presences support energy security within the context of world oil markets.

- **Scenario 2 – Interventionist Government/Nationalism**

  - The United States has a much more comprehensive energy policy than ever before in our history. Energy policy becomes "moon shot" approach.
  - Strong government intervention in the energy sector is by way of regulation, research and development and policy formulation; not by government ownership.
  - Domestic resources dominate, oil imports by 2050 limited to 1/3, i.e., from Canada and Mexico only.
  - Behavior changes – nationalistic conservation ethic emerges.

- **Scenario 3 – Interventionist Government/Nationalism**

  - U.S. Government becomes heavily engaged in securing energy supplies through commercial, diplomatic and military channels.
  - Expanded international cooperation on hydrogen, nuclear, carbon sequestration.
  - Energy security preempts other U.S. foreign policy objectives, i.e., eliminating global poverty; promoting good governance/transparency; intellectual property rights, etc.
  - Domestic lifestyle changes are imposed by government regulation, i.e., telecommuting, shifting employment patterns, mass transit use, and land use changes.
  - Mandatory efficiency standards tightened, i.e., buildings and vehicles.
  - Moral pressure is exerted domestically and globally regarding a global conservation ethic.
  - Stronger government intervention in siting energy facilities

- **Scenario 4 –Enabling Government/Globalization**

  - Government role is to facilitate private sector action both domestically and globally.
  - Market forces determine prices – supply and demand are balanced with short term volatility.
  - Government restrictions to access domestic resources lighten.
  - International cooperation is based on public – private partnerships, transferring best practices.
  - Fossil fuels remain dominant.
  - Consumers make choices – little behavior change.
  - Social pressure results in reductions of greenhouse gas emissions.
  - Government role is crucial in monitoring energy markets.

6. Policy Elements

A review of the workshop's commentary suggests that participants found the following policy elements would mitigate the outcomes of a business as usual approach:

1. Government support for research, development, deployment and commercialization is critical in all scenarios. The level of government engagement and the degree to which the "government" or the "market" pick technology winners or losers becomes a critical factor.

2. Fossil Fuels do continue to dominate the energy mix in the United States. Policies which enable domestic production, which support cleaner fossil technologies and which support the rapid expansion of unconventional fossil fuels, coupled with the rate of advanced technology deployment, help determine which scenario evolves.

3. The United States' approach to climate is clearly differentiated by which of the four scenarios might exist, but climate change policies also influence which direction along both axes the U.S. finds itself.

4. All four breakout groups indicated that financing projects will not be an issue. This is likely true if one assumes that the current balance between the roles of the government and the market either maintain the current balance or evolve in a positive manner. However, the potential for government interference in the sector by not providing regulatory and policy stability should not be ignored. Any of the four scenarios can result in a high price environment for energy commodities and services. Government action to restrain prices to consumers (voters) could result in inadequate rates of return and cause capital flight either to other economic sectors, other countries, or both.

5. A key issue is how policy options can reduce the lag time of technology deployment. In every industry sector, alternative, advanced, cleaner energy technologies will contribute enormously to achieve the World Energy Council's Three A's: Accessibility, Availability, and Acceptability. Policies related to taxation, regulation, government investment in research, demonstration, deployment and commercialization will determine whether domestic deployment of these technologies will be sooner or later. Of equal importance, U.S. government recognition and support, including major financial support, can make the transfer and deployment of clean energy technologies to developing countries much quicker than relying exclusively on market forces.

6. Each of the workshop breakout sessions concluded that in any scenario, the U.S. would "keep all energy options open." While clearly not only desirable but critical to our future, this view is certainly not unanimous in the general public. Opponents of specific technologies and fuels not only exist but are

actively working to close the door on technologies and fuels that they oppose. Simultaneously, proponents of certain technologies and fuels are actively striving to improve their position in the market place by denigrating what they perceive to be their competitors. This later circumstance is particularly shortsighted. The U.S. workshop clearly endorsed keeping all options open and in that regard, we should remain united with the notion that both the United States and the rest of the world, will need both every unit of energy production and every unit of efficiency and conservation through 2050 that can be achieved.

7. One final policy element that warrants discussion is the difficulty that the industry has experienced in siting energy facilities. This phenomenon is not unique to the energy sector, but it is certainly widespread within the sector. We have gone from NIMBY, "Not In My Backyard" to BANANA, "Build Absolutely Nothing Anywhere Nor Anytime," to NOPE, "Not On Planet Earth", to now most recently DADA, "Design, Announce, Defend, then Abandon." Policy makers need to support a broad educational effort to explain to the citizenry what future energy options are, why they are critical and what the impact is on the economy, the environment and our collective social welfare if critical projects can not be built. Some might visualize Scenario Two, where a strong, nationalistic culture with heavy government engagement results in governmental edicts regarding where specific projects will be built and even exercising eminent domain to seize land for construction projects. This scenario is difficult to imagine in a democratic political system that is based on significant citizen involvement in public policy, such as is well developed currently in the United States.

7. Observations

A slight majority view existed at the end of the workshop that in 2050, the United States would be in Scenario 4. The others all felt that issues would drive the U.S. into a higher government involvement, i.e., Scenario 3. No one thought the U.S. would be in Scenario 1 or Scenario 2. However, these conclusions need to be tempered by two realities.

1. Some of the participants, perhaps one third, were unable to stay until the end particularly as the workshop went later than scheduled. While the workshop began with a excellent representation of the U.S. sector, no notation was made of which sub-sectors were under-represented at the end.

2. Also, there remained differences in view as to what constituted government invention, including a lack of consensus on whether "light" government meant "little" government intervention as compared with the notion of "enabling" government whose interventions are significant as well as positive and supportive.

   No effort was made to comment on which of the four scenarios is most desirable, or which offered advantages or disadvantages to the United States. Consequently, no identification occurred as to what policies would push the U.S. into one scenario versus the other. Also, no effort was made to identify strategies that would allow individual organizations to be successful in one versus the other.

   The United States energy system in 2050 looks much like the U.S. Energy Information Administration projections for 2030. In that regard, the energy resource mix is not dramatically different than in 2005. However, much progress has been made in deploying advanced, clean energy technology. Significant policy changes would be needed to cause the energy supply mix and energy consumption patterns to be radically altered.

   Several phenomenon contribute to this likelihood:

   A. The sheer size of the energy system, i.e., over one million megawatts of power generation; growth in petroleum consumption from ±20 million barrels per day in 2006 to ±28 million in 2030 to who knows what volume in 2050.

   B. The lag rate of technology deployment.

   C. The lag rate of political/regulatory policy making to stay ahead of the "curve" in a fast paced, quickly evolving industry.

However, several plausible wildcards could push policy makers, who will respond to public opinion, to aggressively pursue dramatic changes that push into one of the four scenarios. Examples include:

- A world war, with unforeseeable outcomes.

- A series of repeated terrorists strikes on the U.S. homeland that result in a "Fortress America" or a "Fortress North America" mindset, where energy independence truly becomes a national/continental mandate (Scenario 1 or Scenario 2).

- A much broader and deeper than currently held belief that climate change warrants urgent and immediate global action resulting in alternatives to fossil fuels being embraced for non-economic motivations (Scenario 3 or 4).

- A technological failure that closes off one or more energy options, i.e., oil spill, nuclear incident; genetically engineered crops for bio fuel production result in catastrophe, etc. (Scenario 2 or 3).

- A technological breakthrough that disrupts current technology deployment roadmaps, i.e., moderate breakthroughs such as improved hydrogen fuels cells; photovoltaics; electric batteries or substantial breakthroughs such as more economic oil shale production, carbon capture and storage or dramatic breakthroughs such as methane hydrates; safe carbon-eating bacteria, nuclear fusion. (Scenario 4).

The relationship between the government and the energy industry is significantly different in each of the four WEC scenarios. This remains true even though a consensus exists in the U.S. that neither of the Axes by and of themselves actually are going to drive events. Energy organizations expecting to still be operating in 2050 and can consider how their organization can be successful regardless of which (if any) of these scenarios materialize.