APPENDIX D
PARALLEL STUDIES

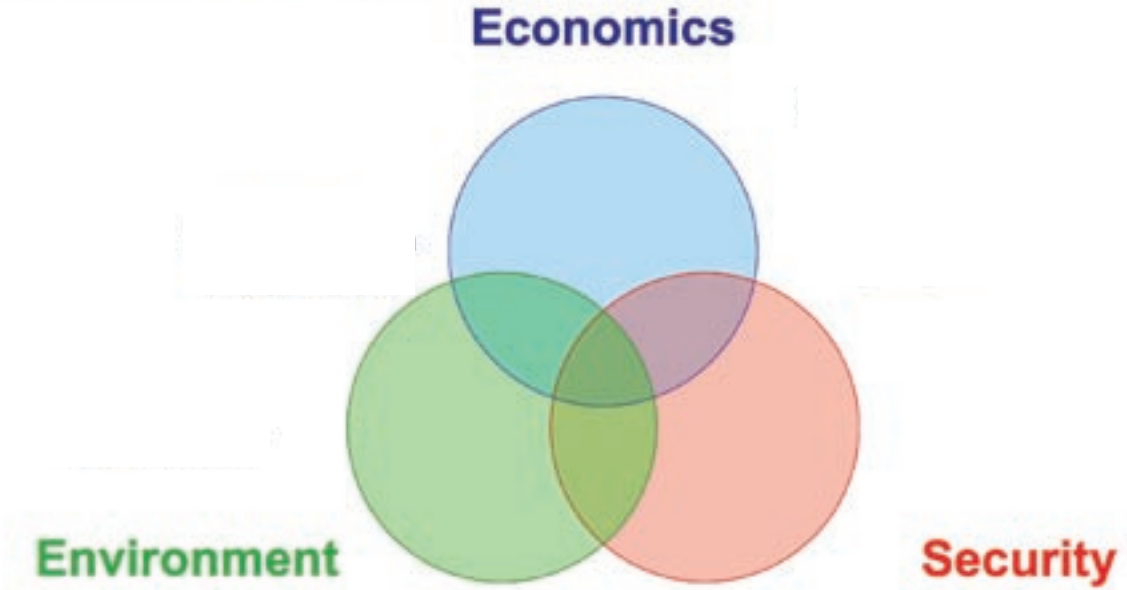
PROCESS AND SUMMARIES

The summaries in this appendix were prepared by the NPC based on studies authored or published by other organizations, and are used with permission. To obtain a complete version of any study, readers should contact the study's sponsoring organization. Contact information is included in each summary. Nothing in this appendix should be understood as indicating endorsement or sponsorship by any other organization or the NPC.

Parallel Studies

A Parallel Studies process, which examined numerous recent reports regarding aspects of energy policy, was employed to inform the work of the NPC study's Coordinating Subcommittee. This process found that:

- Most current energy studies tend to be dominated by one or at most two of the three key concerns that we believe are critical to a complete understanding of global oil and natural gas.
- The best energy strategies for the U.S. to pursue to ensure greater economic stability and prosperity are likely to be found at the intersection of these three circles.



Reports Examined

Overall Findings of Policy Studies

General Agreement on Policy Objectives

- Encourage Market Solutions
- Increase Energy Efficiency
- Ensure Access to Supplies
- Encourage Fuel Diversity
- Reduce Price and Supply Volatility
- Strengthen Energy Infrastructure
- Develop New Energy Technologies
- Protect the Environment

Overall Findings of Policy Studies

Diversity of Policies and Concerns

- CAFE standards
- Carbon taxes, caps, regulations
- Subsidies for alternate fuels
- Limits to imports / or to demand growth
- Efficiency standards
- Peak oil
- Data transparency
- Market imperfections / Over-regulation

NATIONAL COMMISSION ON ENERGY POLICY

National Commission on Energy Policy

- A consensus set of recommendations that aims to enhance American national security, strengthen the US economy, and protect the global environment and public health.

Leadership: John Holdren (Harvard University & Woods Hole Research Center)
William Reilly (Aqua Int'l Partners, formerly US EPA)
John Rowe (Exelon Corporation)

Structure: A bipartisan group of 20 energy experts – representing the senior ranks of industry, government, academia, labor, consumer and environmental protection organizations, with more than a dozen experienced analytical staff.

Timelines: Main study published in December 2004: Ending the Energy Stalemate:
Key recommendations at http://www.energycommission.org/files/finalReport/O82F4692.pdf

Updated recommendations published April 2007

Other reports/workshops include:
- US Energy Infrastructure Vulnerability (June 2006)
- Design Issues in Market-based Greenhouse Gas Reduction Strategies (Feb 2006)
- Oil Shockwave – An Oil Crisis Executive Simulation (June 2005)

- Recommendations considered a thoughtful set of policies. Has made modest progress in a highly partisan Congressional atmosphere. Latest proposals include (1) increased auto efficiency standards, (2) interim nuclear waste storage, (3) deployment of carbon capture and storage technologies, and (5) a national renewable energy standard.

Website: **http://www.energycommission.org/**

NATIONAL COMMISSION ON ENERGY POLICY

National Commission on Energy Policy

KEY RECOMMENDATIONS

1. ENHANCING OIL SECURITY

• Establish a national average new-vehicle fuel-economy improvement target of 4%/yr, while retaining the full discretionary authority of the National Highway Traffic Safety Administration (NHTSA) to modify the presumptive target up or down if safety, technology, or economic considerations warrant.
• Encourage and empower NHTSA to implement reforms aimed at making the existing CAFE program more cost-effective, market-oriented, and responsive to the jobs and competitiveness concerns of the automobile industry.
• Provide targeted consumer and manufacturer incentives to promote the domestic development, production, and deployment of advanced automotive technologies such as hybrid, plug-in hybrid, and advanced diesel vehicles.
• Pursue cost-effective opportunities to further reduce transportation energy use by improving heavy-truck fuel economy and by adopting efficiency standards for light-duty vehicle replacement tires.

2. REDUCING RISKS FROM CLIMATE CHANGE

• Adopt legislation this Congress to implement a mandatory, market-based program to limit economy-wide U.S. greenhouse gas emissions.
• Strengthen key parameters of the original NCEP climate proposal, including:
  -defining targets to aim for stabilizing emissions at current (2006) levels by 2020 and reducing emissions 15% below current levels by 2030;
  -raising the starting price of the safety valve to $10 per ton of carbon-dioxide equivalent emissions; and
  -increasing the rate of escalation in the safety-valve price to 5 percent per year in real (rather than nominal) terms.
• Address other program design issues by (1) allocating emission allowances in a manner that effectively directs substantial resources to aid in the transition to a low-carbon economy and that fairly compensates major affected industries for short-term economic dislocations incurred as a result of the policy, while also avoiding the potential for significant windfall gains; (2) placing the compliance obligation (point of regulation) at or near primary energy suppliers; and (3) including a well-designed offsets provision.
• Create stronger incentives for comparable action on the part of key trading partners by providing technical and financial resources for the transfer of low-carbon technology, by signaling that the United States will work with other countries to forcefully address trade and competitiveness concerns in the event other major emitting nations fail to take action within a reasonable timeframe, and by linking future U.S. emission-reduction commitments to progress in the international arena.

3. INCREASING ENERGY EFFICIENCY

• Enhance and extend tax incentives for efficiency investments introduced under the Energy Policy Act of 2005 (EPAct05).
• Ensure that the Department of Energy (DOE) follows through on its recent commitment to issue efficiency standards for 22 categories of appliances and equipment that capture all cost-effective and technically feasible energy savings.

NATIONAL COMMISSION ON ENERGY POLICY

National Commission on Energy Policy

KEY RECOMMENDATIONS (continued)

4. NATURAL GAS/ COAL / NUCLEAR

• Continue to focus on assuring future supply adequacy by following through on EPAct05 commitments with respect to the Alaska pipeline, LNG infrastructure, market transparency, and permitting and leasing. The Commission reiterates its call for a comprehensive inventory of on- and off-shore resources to inform future policy decisions and urges Congress to address concerns about the adequacy of related provisions in EPAct05 (both in terms of the relatively short timeframe specified for completing the inventory and in terms of constraints on the use of federal resources to conduct inventory-related activities in certain areas).

• Direct greater resources toward accelerating the commercialization of carbon capture and storage (CCS) by providing substantial deployment incentives. Specifically, the Commission believes CCS projects should be eligible for bonus allowances under a greenhouse gas trading program that are at least equal in value to incentives provided under the renewable energy production tax credit.

• Condition eligibility for public funding or subsidies on the actual inclusion of CCS with any new IGCC and other advanced coal projects going forward. CCS must be included from the outset in any taxpayer supported efforts to develop coal-to-liquids technology.

• Explore carbon capture options for non-IGCC plants.

• Ensure that the U.S. Environmental Protection Agency (EPA) completes a rigorous, formal public process to formulate effective regulatory protocols governing long-term carbon storage as soon as possible (recognizing that midcourse corrections will likely be needed as experience is gained).

• Ensure that new coal plants built without CCS are not "grandfathered" (i.e., awarded free allowances) in any future regulatory program to limit greenhouse gas emissions.

• Take action to address the current impasse on nuclear waste disposal, while reaffirming the ultimate objective of siting and developing one or more secure geologic disposal facilities, by amending the Nuclear Waste Policy Act (NWPA) to:

- Align its requirements with human engineering and scientific capabilities, while adequately protecting public health and safety and the environment.
- Require DOE to site and operate consolidated national or regional interim storage options.
- Undertake R&D to explore technological alternatives to the direct geologic disposal of waste from a once-through cycle that meet commercial requirements and non-proliferation objectives, reduce the challenge of waste disposal, ensure adequate protection of public health and safety, and extend fuel supply.
- Codify that interim storage and federal responsibility for disposal of nuclear waste is sufficient to satisfy the Nuclear Regulatory Commission's waste confidence requirement.
- Require the Secretary of Energy to take possession of and/or remove fuel from reactor sites that have been, or are in the process of being fully decommissioned.

NATIONAL COMMISSION ON ENERGY POLICY

National Commission on Energy Policy

KEY RECOMMENDATIONS (continued)

5. RENEWABLE ENERGY & BIOFUELS

- Continue to provide investment certainty by extending the eligibility period for federal production tax credits in five-year increments.
- Adopt a federal renewable portfolio standard to increase the share of electricity generated by renewable resources nationwide to at least 15% by 2020.
- Re-evaluate ethanol subsidies and tariffs in light of current fuel mandates and rationalize existing policies to direct a greater share of public resources to more promising options, such as cellulosic ethanol; biobutanol; and clean, high-quality diesel fuel from organic wastes.
- Address other hurdles to biofuels deployment, including hurdles related to the deployment of critical supporting infrastructures (including gathering systems, distribution systems, and refueling facilities) and compatible vehicle technologies.
- Take steps to ensure that policies aimed at reducing U.S. oil dependence do not promote environmentally unsustainable fuel alternatives. The Commission believes that California's recently introduced low-carbon fuel standard suggests a useful direction for future policy and deserves consideration at the national level.

6. ENERGY TECHNOLOGY INNOVATION

- Double annual direct federal expenditures on energy-technology research, development, and demonstration, corrected for inflation, with increases emphasizing public-private partnerships, international cooperation, and energy-technologies that offer high potential leverage against multiple challenges. Substantially increasing public investment in energy technology innovation is critical to the achievement of oil security and climate change objectives and can be funded using revenues generated by the proposed greenhouse-gas trading program.
- Triple federal funding specifically for cooperative international efforts in energy research, development, and deployment (where this proposed increase is within the overall expansion of federal expenditures recommended above).

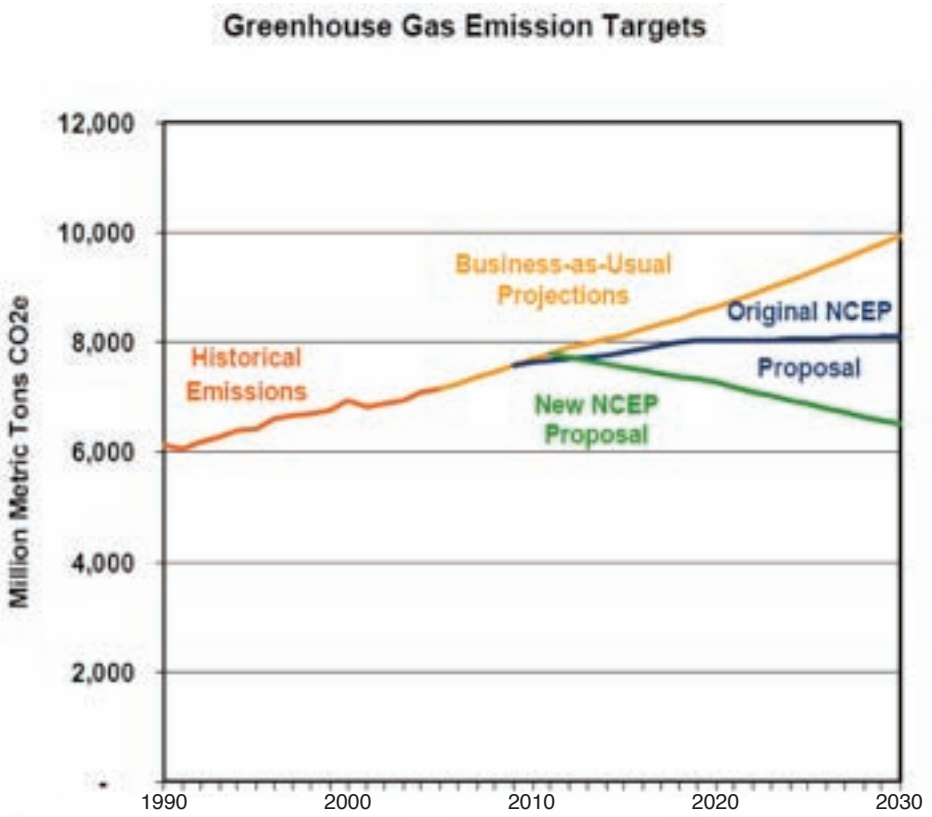
NATIONAL COMMISSION ON ENERGY POLICY

National Commission on Energy Policy

GHG PROPOSAL REVISED

While strengthening the overall stringency of its Greenhouse Gas (GHG) mitigation proposal, the new Commission proposal continues to rely on the core program elements first articulated in its 2004 report, especially: emission targets within a cap and trade system; providing market-based incentives for deployment of low-carbon technologies; linkage to greenhouse gas mitigation action by major U.S. trading partners, including China and India; and a cost-containment mechanism to prevent undue harm to the U.S. economy.

The reductions in greenhouse gas (GHG) emissions would result from a series of new policies proposed by the Commission, beginning with a revision of key elements of its initial cap and trade proposal for mitigating U.S. emissions. The proposal announced today increases the proposed "safety valve" or "cost cap" of the NCEP program from $7 to $10 per ton of carbon-dioxide equivalent emissions, and would increase the safety valve price by 5 percent above inflation per year. In addition, the Commission's new carbon cap does not rely on an "emissions intensity" metric, but instead calls for specific numerical reductions in greenhouse gas emissions for a given year.



The Commission's original proposal envisioned an initial ten-year implementation period during which program targets would first aim to slow the rate of growth in US emissions before proceeding to "stop" and "reverse" phases in which emissions would stabilize and then begin to decline. The Commission's new proposal strengthens the program targets to begin emissions reductions immediately upon implementation and achieve a 15% reduction below current emissions levels by 2030.

Business-as-usual projections for greenhouse gas emissions are taken from the Energy Information Administration's Annual Energy Outlook 2006.

Energy Security Leadership Council

The Council, a project of Securing America's Future Energy (SAFE), is led by Co-Chairmen Frederick W. Smith, Chairman and CEO of FedEx Corporation, and General P.X. Kelley (Ret.), former Marine Corps Commandant and member of the Joint Chiefs of Staff. The Energy Security Leadership Council includes prominent business and military leaders who support a comprehensive, long-term policy to reduce US oil dependence and improve energy security. The Council will work aggressively to build bipartisan support. SAFE is committed to reducing America's dependence on oil in order to improve our national security and strengthen the economy, while increasing US exports, protecting the environment, and creating US jobs.

Other members include Admiral Dennis Blair, USN (Ret.), CIC, US PACOM; Admiral Vern Clark, USN (Ret), former Chief of Naval Operations; Michael L. Eskew, Chairman and CEO, UPS, Inc; Adam Goldstein, President, Royal Caribbean International; General John A. Gordon, USAF (Ret.), former Homeland Security Advisor to the President; Maurice Greenberg, Chairman and CEO, C.V. Starr & Co., Inc.; Admiral Gregory Johnson, USN (Ret.), Commander, US Naval Forces, Europe; Robert Hormats, Vice Chairman, Goldman Sachs International; Herbert Kelleher, Exec.Chairman, Southwest Airlines; John F. Lehman, former Secretary of the US Navy; Andrew Liveris, CEO, The Dow Chemical Company; General Michael E. Ryan, USAF (Ret.), 16th Chief of Staff, USAF; David P. Steiner, CEO, Waste Management, Inc.; and General Charles F. Wald, USAF (Ret.), Former Deputy Commander, US European Command, Edgar M. Bronfman, Retired Chairman, The Seagram Company Ltd.; Jeffrey C. Sprecher, Chairman, IntercontinentalExchange (ICE); Josh S. Weston, Honorary Chairman, Automatic Data Processing, Inc.

SAFE has produced:

- **The Wescott Report:** This report gives an overview of the broad economic effects of a scenario in which oil prices surge to $120 a barrel due to coordinated terrorist attacks on global oil transportation infrastructure. The scenario was the basis for a simulation exercise conducted at the World Economic Forum Annual Meeting 2006 in Davos, Switzerland.

- **Oil ShockWave:** A scenario exercise developed by SAFE and the National Commission on Energy Policy (NCEP). This half-day simulation provided participants and observers with an opportunity to think through simulated emergency situations--in this case involving oil supply disruptions. (June 2005)

- Recommendations to the Nation on Reducing US Oil Dependence: December 2006

Website: **http://www.secureenergy.org/**

ENERGY SECURITY LEADERSHIP COUNCIL

Energy Security Leadership Council

Securing America's Future Energy

Recommendations to the Nation on Reducing US Oil Dependence: December 2006

I. REDUCE OIL CONSUMPTION

A. Significantly reform and then annually strengthen fuel efficiency standards for passenger cars and light-duty trucks.

— Reform the Corporate Average Fuel Economy (CAFE) system in order to make it more market-, size-, and attribute-based and to allow for the application of different but increasingly stringent standards.

— Set a target of 4% for annual increases in fuel efficiency of all passenger cars and light-duty trucks weighing up to 10,000 lbs.

— Allow "off-ramps" if 4% is technically infeasible, unsafe, or not cost-effective for a given year.

B. Fund significant financial incentives for the domestic production and purchase of highly fuel efficient vehicles.

— Lift the current 60,000 vehicle-per-manufacturer cap on tax incentives for the purchase of advanced technology effi cient vehicles.

— Link the tax credit to the miles-per-gallon performance of the vehicles.

— Provide tax incentives for retooling to all manufacturers with existing U.S. facilities.

Projected savings: 4.3 million barrels of oil per day (mbd)

II. PROVIDE ALTERNATIVES

A. Grow the supply and demand sides of the biofuels market by creating incentives and obligations for infrastructure deployment, requiring increasing production of Flexible Fuel Vehicles (FFVs), and increasing federal assistance available for "first-mover" production of cellulosic ethanol and other promising large-volume biofuels.

— Create obligations and provide tax credits for installing ethanol fuel pumps and related infrastructure. Limit the credit for corporate-owned and branded stations when oil prices are high.

— Require 10% annual increases in the production of FFVs so that all major production models are compatible with rich ethanol blends by 2015.

— Establish a competitive program employing a variety of financial tools—grants, tax credits, direct loans, and loan guarantees—for federal assistance to six or more biorefineries employing a variety of feedstocks and located in various regions of the country.

Projected ethanol output: 30 billion gallons per year ≈ 2.0 mbd

ENERGY SECURITY LEADERSHIP COUNCIL

Energy Security Leadership Council

Securing America's Future Energy

Recommendations to the Nation on Reducing US Oil Dependence: December 2006 (continued)

III. EXPAND SUPPLY

A. Increase access to U.S. oil and natural gas reserves on the Outer Continental Shelf (OCS) with sharply increased and expanded environmental protections.

— Increase access to OCS oil and natural gas reserves with appropriate third-party monitoring, increased surety bond requirements, clear penalties for environmental damages to avoid protracted litigation, stronger administration of the current leasing program, and protection of coastal vistas.

Projected production: 1.0–2.0 mbd

B. Employ federal funds to accelerate the development and deployment of Enhanced Oil Recovery (EOR) techniques.

Projected production: 1.0 mbd

C. Make investment access a high profile aspect of U.S. trade negotiations and diplomatic efforts with oil-producing nations.

IV. MANAGE RISKS

A. In light of military threats to the global oil infrastructure, the U.S. should, where appropriate:

— Encourage burden sharing with U.S. allies and partners, including producing and consuming nations, in defense of global oil flows;

— Foster formal and informal security arrangements on multilateral, regional, and bilateral bases, capitalizing on the U.S.'s unique ability to arrange international security efforts;

— Provide diplomatic support as well as counter-terrorism training and military aid so that oil-producing nations can better assist in protecting petroleum supplies;

— Offer assistance to producing countries in their efforts to develop attractive investment climates backed by stable civil societies; and

B. Reassess the multiple dimensions of strategic reserves policy within the U.S. and at the International Energy Agency (IEA). In addition, revise the 1974 Organization for Economic Cooperation and Development (OECD) agreement to allow China and India to join the IEA and participate in updated global strategic petroleum reserve arrangements.

ENERGY SECURITY LEADERSHIP COUNCIL

Energy Security Leadership Council

Securing America's Future Energy

Corollary Recommendations (December 2006)

I. REDUCE OIL CONSUMPTION

A. Extend federal subsidies for hybrid medium-duty vehicles (Classes 3–6) to 2012 and remove the cap on the number of eligible vehicles. Set and then annually increase fuel efficiency standards for medium-duty vehicles. Set the standards consistent with the energy efficiency benefits of hybridization. Projected savings: 0.2 mbd

B. Set and then annually strengthen fuel efficiency standards for heavy-duty vehicles (Class 7 and 8), employing federal subsidies as suitable. Projected savings: 0.9 mbd

C. Increase allowable weight to 97,000 lbs. gross vehicle weight for tractor-trailer trucks that have a supplementary sixth axle installed but which replicate current stopping distances and do not fundamentally alter current truck architecture. Further study the safety impacts of significantly longer and heavier tractor-trailers used in conjunction with slower speed limits. If safety can be proven, implementation could generate major efficiencies while simultaneously reducing road congestion and other non-fuel costs. Projected savings: will vary with extent of implementation

D. Require the Federal Aviation Administration (FAA) to implement improvements to commercial air traffic routing in order to increase safety and decrease fuel consumption. Projected savings: 0.4 mbd

II. PROVIDE ALTERNATIVES

A. Reform current ethanol per gallon subsidies to encourage private-sector investment in domestic ethanol and alternative biofuels production and infrastructure. "Smart subsidies" will secure the industry against short-term oil price drops, minimize the cost to the U.S. Treasury, and distinguish between feedstock technologies. Balance the benefits of domestic production capability with the advantages of environmentally responsible development of an international biofuels trade.

B. Grow the biodiesel market, while ensuring a biodiesel standard that mandates quality and reliability to satisfy the operational standards of users and also includes clear and consistent labeling of biodiesel blend ratios. Projected output: 3.3 billion gallons per year ≈ 0.2 mbd

C. Support federal investment in research, development, and commercialization of carbon sequestration technologies that can limit the adverse emissions impacts of oil shale, oil sands, and coal-to-liquids (CTL) production.

III. EXPAND SUPPLY and MANAGE RISKS

A. Increase access to U.S. reserves in Alaska. Increase access to Alaskan reserves with appropriate third-party monitoring, increased surety bond requirements, clear penalties for environmental damages to avoid protracted litigation, and stronger administration of the current leasing program. Projected production: 0.9 mbd

B. Evaluate policy approaches to expand the ability of U.S. refineries to process a wider variety of crude stocks and to make U.S. refining less vulnerable to extreme weather. Work to expand total U.S. capacity or to ensure that the U.S. will have secure access to product produced overseas.

Business Roundtable

- The Business Roundtable is an association of 160 chief executive officers of leading US companies that comprise nearly a third of the total value of the US stock market. The Energy Task Force was created in early 2006 to address the impact of higher energy costs on economic growth. CEOs report that rising energy costs are one of the top two cost pressures on their businesses and, as such, are committed to identifying solutions. Roundtable launched a comprehensive energy report publicly on June 6, 2007.

- Leadership: Michael G. Morris, CEO, American Electric Power Company,
coordinated by Tony Kavanagh, AEP, and Marian Hopkins, Director - Public Policy, Business Roundtable

More Diverse, More Domestic, More Efficient: A Vision for America's Energy Future

Improving Energy Efficiency in the Commercial, Residential and Electric Power Sectors

The United States should reduce energy intensity by at least 25 percent above the anticipated business-as-usual rate by:

- Substantially boosting the efficiency of new and existing commercial and residential buildings
- Deploying a broad portfolio of energy efficient technologies for building operations and appliances
- Increasing the efficiency of the transmission and distribution system
- Optimizing the power grid with new or advanced technologies to save energy and improve reliability
- Encouraging smart metering and other strategies that reduce peak period demand on the grid
- Improving the efficiency of the nation's power plant fleet through upgrades at existing units and by constructing new advanced technology units
- Accelerating the deployment of wind and solar-thermal power generation
- Increasing reliance on efficient combined heat and power (CHP) units at industrial facilities
- Challenging individual companies to set and meet ambitious energy efficiency goals

Increasing Energy Security in the Transportation Sector

The United States should aggressively reduce transportation fuel demand and diversify supply by:

- Developing and deploying energy efficient vehicle technologies to the maximum extent feasible
- Enhancing conventional domestic oil production by raising refinery output and expanding access to currently off-limit petroleum reserves, including reserves in Alaska
- Scaling up to 10% ethanol in gasoline as quickly as possible, undertaking intensive R&D on advanced biofuels such as biobutanol and cellulosic ethanol, and expanding their presence in fuel supply as warranted by technology advances in the vehicles and fuels sectors
- Increasing production of transportation fuels from unconventional sources like shale oil and coal-to-liquids processes
- Moderating fuel demand by adopting policies that reduce vehicle congestion and idling, and growth in vehicle miles traveled per capita
- Maintaining access to the world's energy resources by preserving the integrity of free markets and opportunities for robust foreign investment by our energy industry

Achieving a Better Supply/Demand Balance in Natural Gas Markets

The United States should provide stable and affordable supplies of natural gas over the long-term by:

- Increasing domestic production through expanded access to natural gas supplies in the Rocky Mountains, the Atlantic and Pacific Coasts, Alaska and the Eastern Gulf of Mexico
- Augmenting conventional natural gas supplies through gasification of coal and bio-mass
- Expanding our liquefied natural gas import and pipeline infrastructure
- Moderating demand through energy efficiency in the power distribution and home heating sectors

Maintaining a Viable and Growing Nuclear Power Sector

The United States should maintain a viable and growing nuclear power sector by:

- Establishing an efficient, predictable licensing system for new nuclear power plants
- Providing effective financial incentives for new plants
- Implementing a workable and effective program for the management and disposal of spent nuclear fuel

Website: **http://www.businessroundtable.org/pdf/Energy/Business_Roundtable_Energy_Report_06062007.pdf**

National Association of Manufacturers

Resources and Environmental Policy Department

Congressional Checklist:

- Reduce Energy Intensity: Establish a national goal for decreasing the energy intensity of the U.S. economy by 30 percent by 2021.
- Strengthen and Make Permanent the R&D Tax Credit: The credit is now set to expire for the thirteenth time. To stay competitive, Congress must encourage U.S.-based R&D activities.
- Fund a New Office Within the Department of Education: The office would promote increased visibility of energy concepts within primary and secondary education curricula.
- Establish a New Office of Federal Lands Energy Project Streamlining: This office should be within the Executive Office of the President.
- Codify and Enhance Two Major Clean Air Act Regulations: The Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule.
- Fully Fund All Federal Energy Research Authorized by EPAct 2005.
- Fund Nuclear Research: Congress should authorize $100 million for new university-based nuclear physics programs.
- Permanently Reauthorize the Price-Anderson Act: To assure compensation to the public in the event of a nuclear accident and appropriately limit private- sector liability.
- Authorize Interim Storage of Spent Fuel: Congress should allow temporary storage at existing DOE facilities and other sites approved by a state legislature and governor.
- Fund Fuel Research: Authorize $500 million annually for research and development in advanced fuel cycles and reprocessing/recycling of spent nuclear fuel.
- Authorize Reverse Auctions: Allow a system of reverse auctions for awarding federal assistance to solar, ethanol, organic municipal solid waste and silvicultural cellulose material plants.
- Address ANWR: Authorize the U.S. Department of Interior to begin leasing activities in ANWR.
- Address OCS: Lift moratoria and reverse withdrawals for oil and gas production in the Outer Continental Shelf.
- Update EPAct 2005: Extend EPAct 2005 refinery expensing for oil shales to 2020 and make coal liquefaction facilities eligible for the same treatment.
- Fund R&D Initiatives: Authorize $1 billion annually for R&D in oil shales, coal liquefaction and production of natural gas from methane hydrate formations, while providing incentives for the production of petroleum from oil shales and transportation fuels from coal liquefaction.
- Set Standards: Establish uniform standards for the production of biodiesel and ethanol.

Website: http://www.nam.org

Affordable and reliable energy is essential to the long-term health of the U.S. economy and its citizens. Lower energy prices mean greater take-home pay for American workers, and access to competitively priced energy enables domestic producers of chemicals, plastics, fertilizers, paper goods, glass, metals and food products to effectively compete in the global economy.

Impressively, energy efficiency in the United States has doubled since 1970. But, our country's need for energy has risen 47 percent due to a growing economy. While investing in new energy sources and continuing to boost efficiency gains will play critical roles in meeting our country's energy demands in the future, increasing access to domestic sources of reliable energy will be essential to the long-term health of U.S. industry as well as the American worker.

A robust, comprehensive and forward-looking energy policy must consist of five crucial elements:

- **Making a national commitment to further reducing the energy intensity of the U.S. economy and educating consumers;**
- **Strengthening and focusing on public-private research and development efforts;**
- **Making existing statutes and regulations rational;**
- **Increasing domestic power generation; and**
- **Increasing domestic energy supply.**

COUNCIL ON FOREIGN RELATIONS

A Nonpartisan Resource for Information and Analysis

CFR

The Council on Foreign Relations is an independent, national membership organization and a nonpartisan center for scholars dedicated to producing and disseminating ideas so that members, as well as policymakers, journalists, students, and interested citizens in the US and other countries, can better understand world and foreign policy choices.

Task Force Leadership: John Deutch and Jim Schlesinger, co-chairs; David Victor, Project Director

Other Participants: Graham Allison, Belfer Center; Norman Augustine, Lockheed Martin; Robert Belfer, Belfer Management; Steven Bosworth, The Fletcher School; Helima Croft, Lehman Brothers; Charles DiBona, Sentient Council; Jessica Einhorn, SAIS; Martin Feldstein; NBER; David Goldwyn, Goldwyn Int'l; Michael Granoff, Pomona Capital; Bennett Johnston; Johnston & Assoc; Arnold Kanter, The Scowcroft Group; Karin Lissakers, Soros Fund; Walter Massey, Morehouse College; Ernest Moniz, MIT; William Reilly, Aqua Int'l; Peter Schwartz, Global Business Network; Philip Sharp, RFF; James Steinberg, LBJ School; Linda Stuntz, Stuntz, Davis & Staffier; James Sweeney, Stanford Univ; Frank Verrastro, CSIS; J. Robinson West, PFC Energy

Recommends, "the adoption of incentives to slow and eventually reverse the growth in consumption of petroleum products, especially transportation fuels such as motor gasoline," and offers three options: a tax on gasoline; stricter and broader mandated Corporate Average Fuel Economy (CAFE) standards; and the use of tradable gasoline permits that would cap the total level of gasoline consumed in the economy.

Other recommendations include:

- Encourage supply of oil from all sources while recognizing that the world cannot "drill its way out of this problem."
- US should take a more active role in international arrangements to manage the revenues from oil in a more transparent way in oil-producing nations.
- Remove the protectionist tariff on imported ethanol. Increase efficiency of oil and gas use in the United States and elsewhere.
- Switch from oil-derived products to alternatives. Biofuels have significant potential.
- The Task Force favors greater use of nuclear power today and notes that over time electricity can replace liquid fuels for transportation.
- Make the oil and gas infrastructure more efficient and secure. Reexamine the management of the US SPR.
- Increase investment in new energy technologies. Promote the proper functioning and efficiency of energy markets.
- US should help improve efficiency in NOCs. Revitalize international institutions such as the International Energy Agency (IEA).
- Establish an energy security directorate within the National Security staff.
- Engage the Secretary of Energy in any foreign policy deliberations that involve energy issues.
- Include energy security considerations in all planning studies at the National Security Council, Defense and State departments, and the intelligence community.

Website: http://www.cfr.org/energy

Alliance for ENERGY & ECONOMIC GROWTH
Energy to secure America's future.

Alliance for Energy & Economic Growth

The Alliance for Energy and Economic Growth was formed in 2001 to build support for the adoption and implementation of a comprehensive, market-based energy policy that uses all forms of energy to meet consumer demand for reliable energy at reasonable prices, while at the same time ensuring the quality of the environment. The Alliance is a broad-based coalition of more than 1,200 members who develop, deliver, or consume energy from all sources.

The US Chamber of Commerce and the Nuclear Energy Institute (as founding sponsors) hosted an Energy Summit in July, 2006, "An Open National Discussion on US Energy Policy" Featuring: Samuel Bodman, Secretary of Energy, Dirk Kempthorne, Secretary of the Interior, Joseph T. Kelliher, FERC Chairman.

http://www.uschamber.com/issues/index/energy/060719_energyagenda.htm

Key policy recommendations include:

- ❑ Increase energy efficiency and conservation
- ❑ Ensure adequate energy supplies and generation
- ❑ Renew and expand the energy infrastructure
- ❑ Encourage investment in new energy technologies
- ❑ Provide energy assistance to low-income households
- ❑ Ensure appropriate consideration of the impact of regulatory policies on energy

The Alliance adopted a supplemental set of principles to help guide the debate on climate change:

- ❑ Promote the accelerated development, demonstration, and cost-effective commercial deployment of climate friendly technologies to reduce, avoid, or sequester greenhouse gas emissions
- ❑ Address barriers to the development, financing, regulation, storage, and use of domestic climate-friendly fuel sources
- ❑ Promote energy conservation and efficiency
- ❑ Preserve American jobs and the competitiveness of U.S. industry
- ❑ Minimize economic disruptions and disproportionate impacts on specific sectors or regions of the economy
- ❑ Permit maximum flexibility in achieving energy and environmental goals
- ❑ Recognize the economy-wide and international dimensions of the challenge
- ❑ Facilitate technology transfer to emerging economies to reduce the fastest growing emission sources globally and to include the participation of developing nations such as China and India

Website: **http://www.yourenergyfuture.org/**

World Energy Council

USEA
United States Energy Association

World Energy Council
US Energy Association

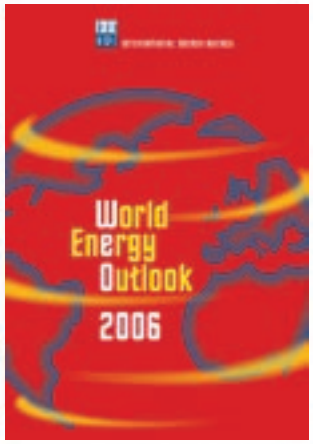
- **The World Energy Council** (WEC) covers all types of energy, including coal, oil, natural gas, nuclear, hydro, and renewables, and is UN-accredited, non-governmental, non-commercial and non-aligned. WEC is headquartered in London with member committees in 90 countries. Its goals include promoting research into the means of supplying and using energy having, short and long term, the greatest social benefit and the least harmful impact on the natural environment, and publishing or otherwise disseminating the results; holding of Congresses, workshops and seminars, to facilitate such supply and use of energy; and collaborating with other organizations in the energy sector.
  Website: http://www.worldenergy.org/wec-geis/default.asp

- **The United States Energy Association** (USEA) is the US member committee of the WEC. USEA is an association of public and private energy-related organizations. USEA sponsors policy reports and conferences dealing with global and domestic energy issues, as well as trade and educational exchange visits with other countries. The USEA published "Toward a National Energy Strategy" in February 2001 (and 10 other assessments of US Energy Policy. The policy recommendations were based on the results of workshops on key energy issues and a working group representing all sectors of the industry under the leadership of Richard Lawson, Chairman of its National Energy Policy Committee. Project was directed by Guy Caruso (now the head of the EIA at the US DOE).
  Website: http://www.usea.org

- **Recommendations include:**

  - Encourage energy supply expansion
  - Allow environmentally sound access to domestic resources
  - Implement tax policies to spur capital investment
  - Government policies should promote energy efficiency
  - Encourage competitive markets regarding pricing and selection of fuels and energy suppliers
  - Increase funding for the low-income home energy assistance program and weatherization
  - Promote US leadership in energy development
  - Eliminate tax rules the discourage foreign investment
  - Advocate market-based energy policies for foreign nations
  - Foster more open legal and institutional structures overseas
  - Avoid unilateral trade and economic sanctions
  - Focus R&D on a 20-30 year horizon
  - Education programs to explain the importance of energy to economic security and development
  - Government programs should avoid favoring selective fuels or technologies
  - Improve the US energy transportation infrastructure
  - Regulatory predictability to stabilize investment decisions
  - Comprehensive electric industry restructuring should promote efficient competition

International Energy Agency



World Energy Outlook 2006 published November 2006

Reference Scenario: No new government policies are adopted

Alternative Policy Scenario: Energy-security & climate-change policies now under consideration are adopted

Focus on Special Issues:
- Impact of higher energy prices
- Current oil and gas investment trends
- Outlook for nuclear power & biofuels
- Energy for cooking in developing countries (http://www.iea.org/textbase/weo/cooking.pdf)
- Brazil's energy outlook (http://www.worldenergyoutlook.org/Brazil.pdf)

The world is facing twin energy threats:

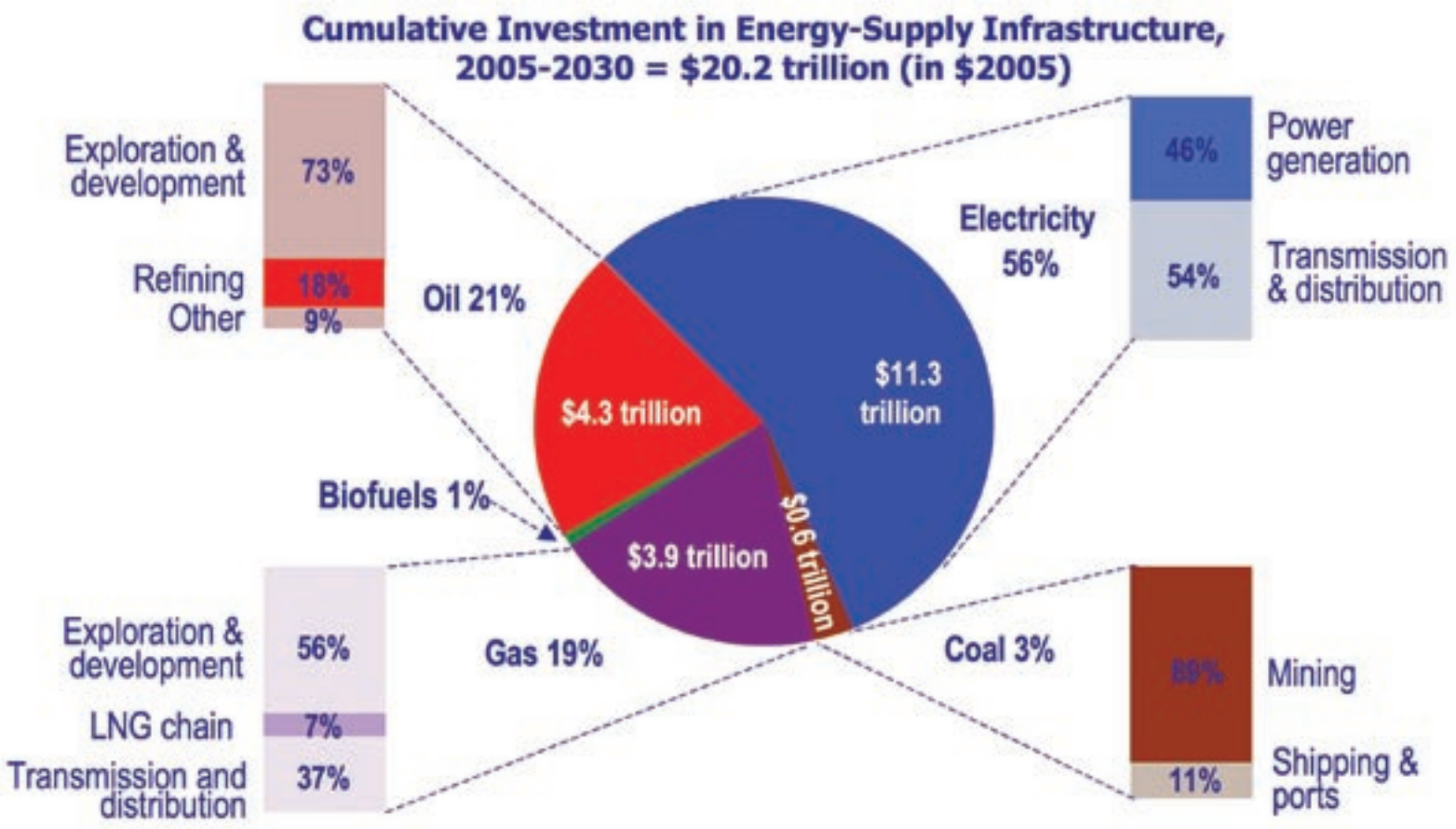
Inadequate and insecure supplies at affordable prices

Environmental damage, including climate change

- ❑ Global energy system is on an unsustainable path
- ❑ Need to diversify energy sources & mitigate emissions is critical
- ❑ Urgent need to curb the growth in fossil-fuel demand & related emissions
- ❑ Strong new policies could sharply reduce the rate of increase in demand & emissions
- ❑ Economic cost of these policies would be more than outweighed by the economic benefits alone
- ❑ Governments need to tackle market barriers to ensure investment is forthcoming
- ❑ Considerable political will is needed to push policies through
- ❑ Rich countries need to help developing countries address energy poverty
- ❑ In the longer term, technology *development* will be critical to a sustainable energy system

Website: **http://www.worldenergyoutlook.org**

International Energy Agency



Source: IEA, World Energy Outlook 2006.

Energy Information Administration

Official Energy Statistics from the U.S. Government

International Energy Outlook 2007

The Energy Information Administration (EIA) publishes its annual assessment of long-term world energy markets in its International Energy Outlook (IEO). The IEO2007 is the latest edition of this report and was released in May 2007; the NPC study, which was conducted prior to the IEO2007 release, is based upon the previous edition of this report, supplemented by projections from the Annual Energy Outlook 2007—the long-term outlook for U.S. energy markets. The report includes regional projections of world marketed energy use by fuel type (petroleum and other liquid fuels, natural gas, coal, nuclear power, and hydroelectricity and other renewable energy sources) and energy-related carbon dioxide emissions to the year 2030.

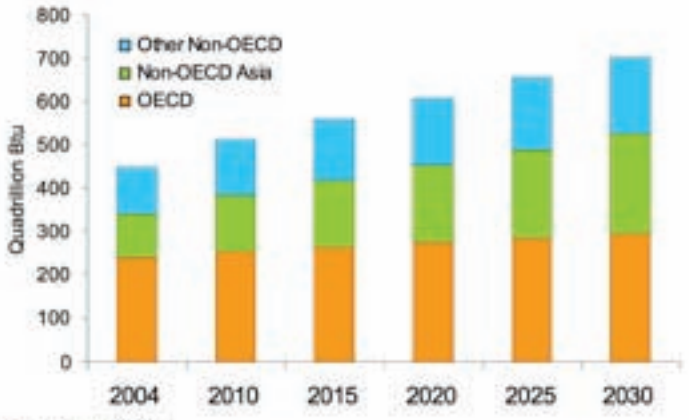
The projections in the IEO2007 provide an objective, policy-neutral reference case that can be used to analyze international energy markets. Models are abstractions of energy production and consumption activities, regulatory activities, and producer and consumer behavior. As a policy-neutral statistics and analysis organization, EIA does not propose, advocate, or speculate on future legislative and regulatory changes. Trends depicted in the analysis are indicative of tendencies in the real world rather than representations of specific real-world outcomes.

Highlights from the 2007 IEO include:

- In the IEO2007 reference case, world energy consumption is projected to increase by 57 percent between 2004 and 2030, rising to 702 quadrillion British thermal units (Btu).
- Much of the growth in worldwide energy use is projected for the non-OECD economies; energy use in the non-OECD exceeds that of the OECD by 2010.
- Non-OECD Asia (including China and India) accounts for half of the world's increase in marketed energy use in the IEO2007 reference case.
- World marketed energy consumption is projected to grow by 57 percent between 2004 and 2030, according to the reference case projection from the International Energy Outlook 2007 (IEO2007) released today by the Energy Information Administration (EIA). The IEO2007 shows the most rapid growth in energy demand for nations outside the Organization for Economic Cooperation and Development (OECD), especially in non-OECD Asia, where strong projected economic growth drives the increase in energy use.

Website: http://www.eia.doe.gov/oiaf/ieo

World Marketed Energy Consumption by Region



Source: EIA, IEO2007

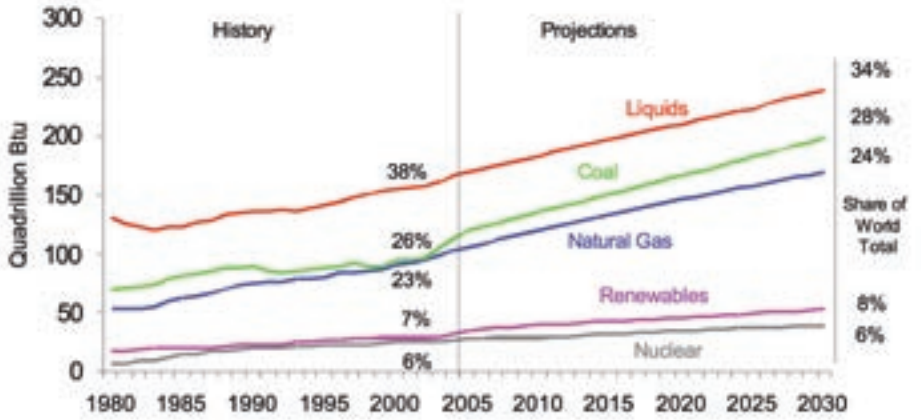
Energy Information Administration

Official Energy Statistics from the U.S. Government

International Energy Outlook 2007

- Petroleum and other liquid fuels remain the dominant energy source worldwide through 2030, though relatively high world oil prices in the mid-term erode their share of total energy use from 38 percent in 2004 to 34 percent in 2030.
- Coal is the fastest-growing energy source, increasing by 2.2 percent per year over the projection period.
- Higher fossil fuel prices, energy security concerns, improved reactor designs, and environmental considerations are expected to improve prospects for nuclear power capacity in many parts of the world, and a number of countries are expected to build new nuclear power plants. World nuclear capacity is projected to rise from 368 gigawatts in 2004 to 481 gigawatts in 2030. Declines in nuclear capacity are projected only in OECD Europe, where several countries (including Germany and Belgium) have either plans or mandates to phase out nuclear power, and where some old reactors are expected to be retired and not replaced.
- Higher fuel prices—especially for natural gas in the power sector, along with government policies and programs to support renewable energy, allow renewable fuels to compete economically. The renewable share of total world energy use increases from 7 percent in 2004 to 8 percent in 2030.

World Marketed Energy Use by Fuel Type



Source: EIA, IEO2007

World Energy Consumption by Fuel, 2004 -2030

(Quadrillion Btu)

	2004	2015	2030	Average Annual Percent Change 2004-2030
Liquids	168.2	197.6	238.9	1.4
Natural Gas	103.4	134.3	170.4	1.9
Coal	114.4	151.6	199.1	2.2
Nuclear	27.5	32.5	39.7	1.4
Renewables	33.2	43.4	53.5	1.9
Total	**446.7**	**559.4**	**701.6**	**1.8**

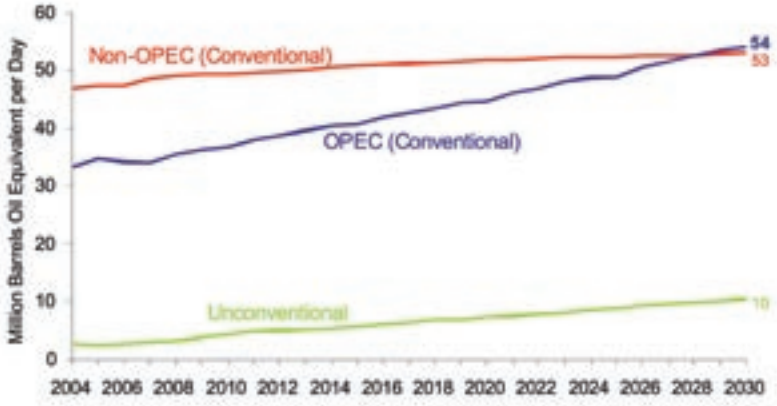
Energy Information Administration

Official Energy Statistics from the U.S. Government

International Energy Outlook 2007

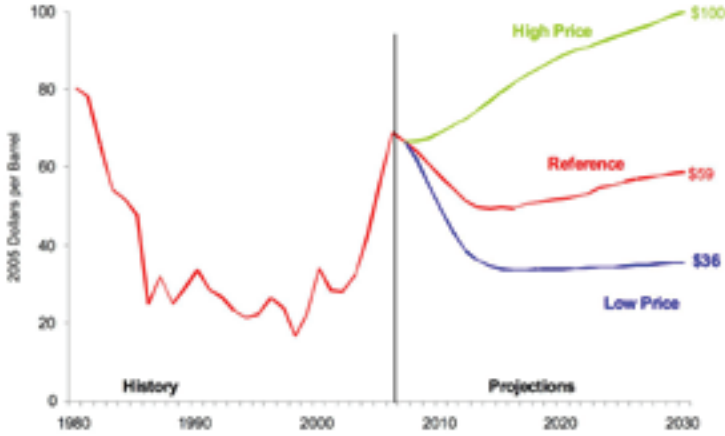
- In the IEO2007 reference case, world oil prices decline from $68 per barrel in 2006 (in real 2005 U.S. dollars) to $49 per barrel in 2014, then rise to $59 per barrel in 2030 ($95 per barrel on a nominal basis).
- High and low world oil price cases reflect the substantial degree of uncertainty about future oil prices. In 2030, prices range from $36 per barrel to $100 per barrel (real 2005 dollars) and the respective liquids demand ranges from 134 million barrels per day to 103 million barrels per day.

Worldwide Liquids Production



Source: EIA, IEO2007

World Oil Prices in Three Cases



Source: EIA, IEO2007

- To meet the increment in world liquids demand in the reference case, total supply in 2030 is projected to be 35 million barrels per day higher than the 2004 level of 83 million barrels per day.
- OPEC conventional production contributes about 21 million barrels per day to the total increase in supply; non-OPEC conventional another 6 million barrels per day to the increase.
- Unconventional resources (including biofuels, coal-to-liquids, and gas-to-liquids) are expected to become increasingly competitive and account for 9 percent of total world liquids supply in 2030, on an oil equivalent basis.

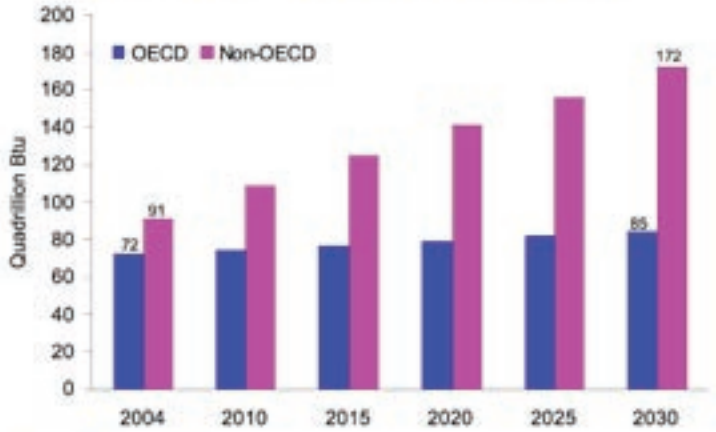
Energy Information Administration

Official Energy Statistics from the U.S. Government

International Energy Outlook 2007

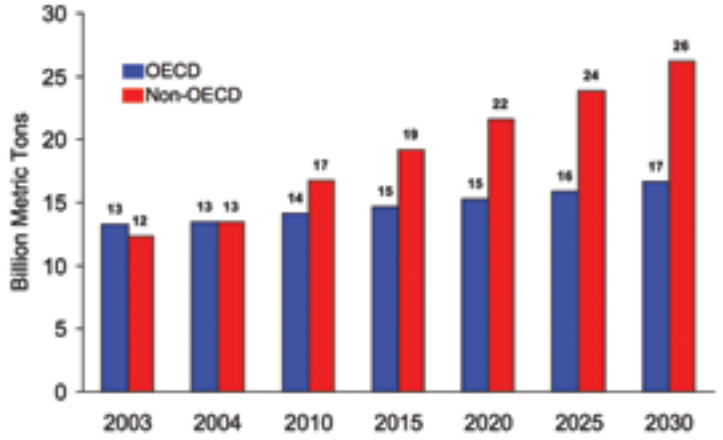
- The IEO2007 includes regional projections of delivered energy at the end use sector. In 2004 the OECD accounted for 44 percent of the world's industrial sector energy use; that share declines to 33 percent in 2030.
- Industrial sector energy use—driven by energy intensive industries—expands more rapidly in the non-OECD countries where investors are attracted by lower costs and fewer environmental constraints, than in the OECD countries.

Industrial Sector Energy Consumption



Source: EIA, IEO2007

Energy-Related World Carbon Dioxide Emissions



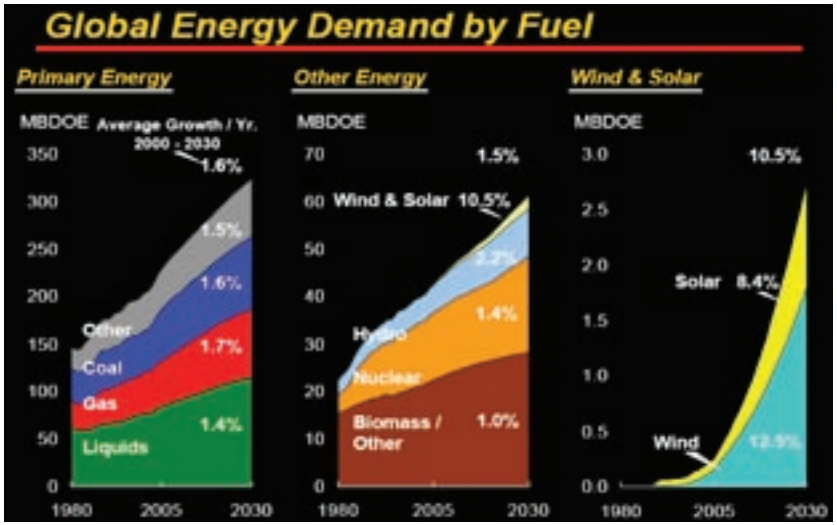
Source: EIA, IEO2007

- In the IEO2007 reference case, which does not include specific policies to limit greenhouse gas emissions, energy-related carbon dioxide emissions are projected to rise from 26.9 billion metric tons in 2004 to 33.9 billion metric tons in 2015 and 42.9 billion metric tons in 2030.
- From 2003 to 2004, carbon dioxide emissions from the non-OECD countries grew by almost 10 percent, while emissions in the OECD countries grew by less than 2 percent. The result of the large increase in non-OECD emissions was that 2004 marked the first time in history that emissions from the non-OECD exceeded those from the OECD countries.
- Because of the expectation that non-OECD countries will rely on fossil fuels to supply much of their future energy demand growth, carbon dioxide emissions from the non-OECD countries in 2030 are projected to exceed those from the OECD by 57 percent.

ExxonMobil

Taking on the world's toughest energy challenges.

The 2006 Outlook for Energy
A View to 2030



- Reflecting global population and GDP gains, we expect energy demand to rise by an average of 1.6% each year through 2030, reaching close to 325 million barrels per day of oil-equivalent (MBDOE). That's 60% higher than in 2000. Energy demand will rise fastest in non-OECD nations, which will account for approximately 80% of the global increase.
- A wide range of energy sources will contribute to meeting this growing global energy demand. Wind and solar energy, for example, are expected to grow at a rate of about 10 percent per year. But even at that rate, by 2030 they will likely still provide less than 1 percent of the world's total energy needs.

- Most of the world's growing energy needs through 2030 will continue to be met by oil, gas and coal. Today, fossil fuels account for 80% of energy usage, and that percentage is expected to remain stable through 2030.
- Driven by increasing needs in non-OECD countries, global liquids demand for transportation is expected to outpace gains in industrial and residential/commercial demand. Total liquids demand for transportation in 2030 will be about 65 million barrels a day, or about 50% higher than today.
- Ongoing access to affordable, reliable energy supplies is the foundation for future growth and prosperity around the globe.
- Meeting the world's growing energy needs will depend, as it has in the past, on advances in technology. Technology not only expands the range of where we produce, but it also extends the types of supplies available to meet demand. Many of the world's largest exploration and production projects are made possible by recent advances in technology.

Website: http://www.exxonmobil.com/Corporate/Citizenship/Imports/EnergyOutlook06/index.html

ExxonMobil

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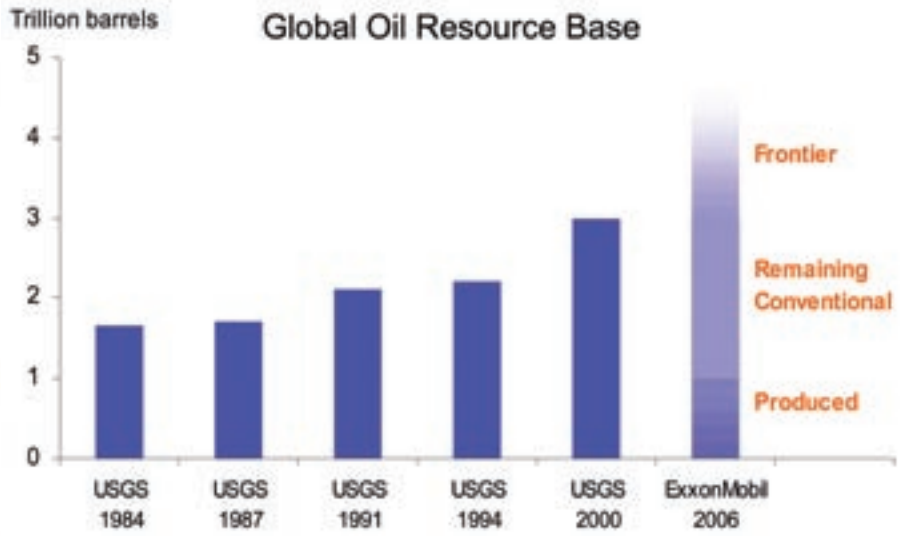
The 2006 Outlook for Energy
A View to 2030

- Technology (and prices) can impact estimates of oil resources. Global projections of the level of ultimately recoverable reserves for oil have grown over time.

- In 1984, the US Geological Survey (USGS) estimated that there were less than 2 trillion barrels of conventional oil that could be recovered globally. But that estimate has grown steadily, to more than 3 trillion barrels, as new technologies have expanded the possibilities for exploration and production.



- The ExxonMobil "2006 Outlook for Energy" adds estimated "frontier" resources (such as heavy oil and shale oil) to "conventional" oil and estimates the world's recoverable oil base is over 4 trillion barrels. Since only about 1 trillion barrels of the world's conventional oil has been produced so far, we see ample resources available to meet growing demand for oil through 2030.

- Looking to 2030, we expect global liquids trade will increase more than 50%. Globally, more volume will originate from the Middle East and Russia/Caspian regions. Also significant will be increased flows to Europe and Asia Pacific.

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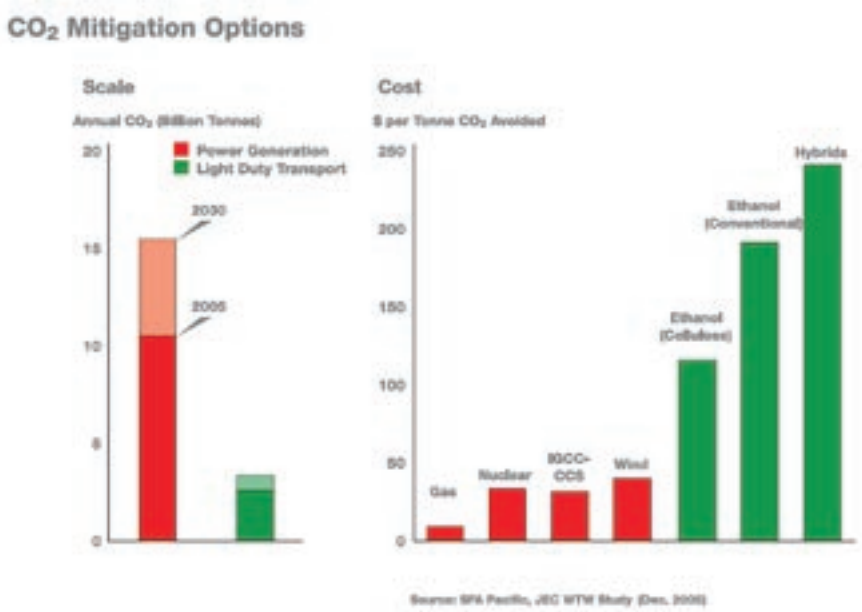
Taking on the world's toughest energy challenges.

The 2006 Outlook for Energy
A View to 2030

- We expect global CO2 emissions to increase by 1.6%/yr through 2030, in line with overall energy growth and the expected uses of oil, gas and coal that result in CO2 emissions. Most of that growth will occur in the non-OECD countries, where strong energy demand growth along with heavy reliance on coal will drive CO2 emissions up by 2.6%/yr.

- Many options exist that will help mitigate CO2 emissions. Nuclear power is clearly an option, though it carries issues regarding new plant siting and waste management. Clean coal technology – where carbon is captured and sequestered – is another option, albeit a costly one. Other sectors are important too, including transportation, where we expect better vehicle technologies, including HCCI and hybrids, as well as cleaner fuels.



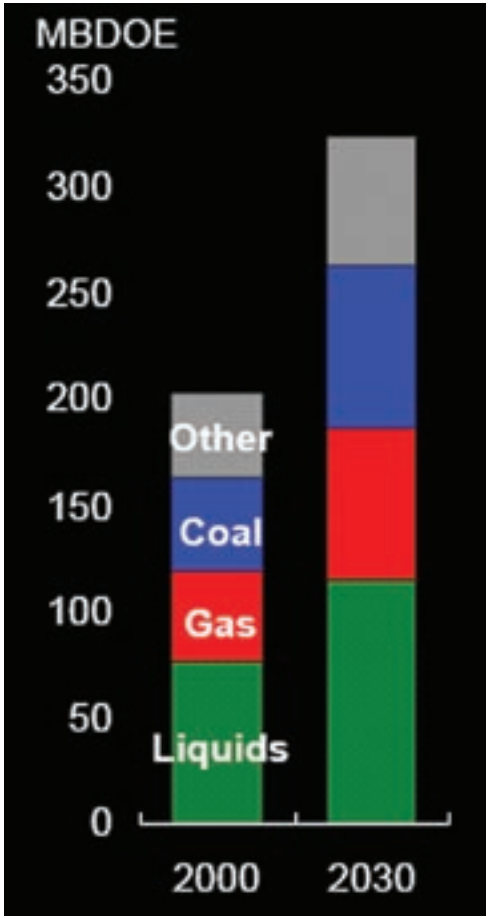
- In terms of scale, power generation is the single largest source of CO2 emissions. CO2 emissions from this sector now total 10 billion tonnes per year, and by 2030 are likely to exceed 15 billion tonnes, or 40% of energy-related CO2 emissions. CO2 emissions from light-duty vehicle transportation are also significant, but far smaller.

- In the case of power generation, the lowest-cost mitigation option involves the use of natural gas to generate power compared to a conventional coal-fired power plant, while the highest-cost option shown above is wind power. In the middle-cost range are nuclear and clean-coal technologies with carbon capture and sequestration.

ExxonMobil

Taking on the world's toughest energy challenges.

The 2006 Outlook for Energy
A View to 2030

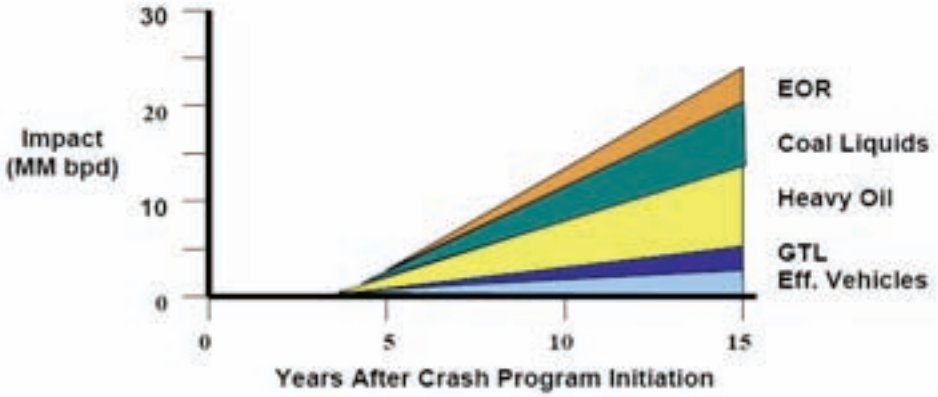


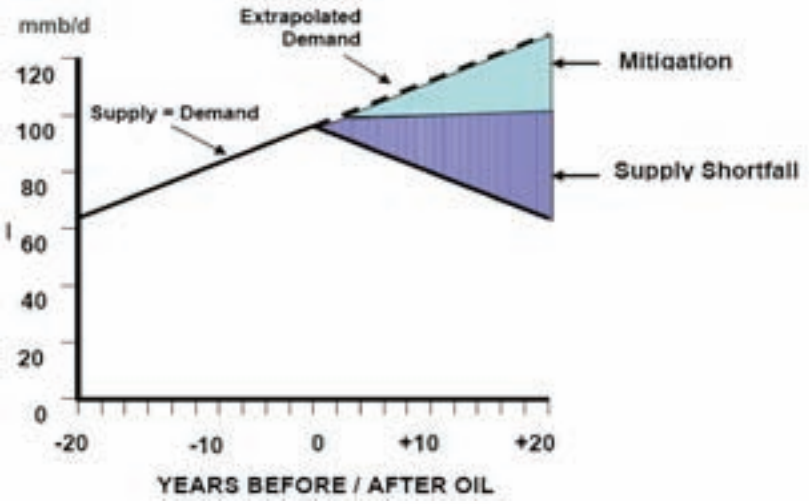
- By 2030, energy demand will increase by about 60% compared to 2000, driven by population growth and economic progress. While the vast majority of this increase will occur in non-OECD nations, efficiency gains throughout the world will remain important.
- The global energy mix will look very similar 25 years from now. Oil, gas and coal will be predominant.
- Resources are adequate to support global demand growth. However, access to these resources and large, timely investments will be needed to ensure people have access to reliable energy supplies. Global trade, particularly for oil and natural gas, will continue to grow.
- Providing this energy is not easy or automatic. Fortunately, many approaches exist which, working together, can help address these challenges. These include:
  - Supporting free and open markets to enable consumers to access the energy they need, and to spur continued innovation
  - Wise and efficient use of energy to help conserve global energy supplies and reduce greenhouse gas emissions
  - Technology advances to extend supplies and make the use of energy more efficient
  - Securing the benefits of energy trade in international markets to help ensure reliable and affordable supplies to meet growing demand

THE ONLY U.S. NATIONAL LABORATORY
DEVOTED TO FOSSIL ENERGY TECHNOLOGY

PEAKING OF WORLD OIL PRODUCTION
IMPACTS, MITIGATION, & RISK MANAGEMENT

- The peaking of world oil production presents the US and the world with an unprecedented risk management problem. As peaking is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking.
- A unique aspect of the world oil peaking problem is that its timing is uncertain, because of inadequate and potentially biased reserves data from elsewhere around the world. In addition, the onset of peaking may be obscured by the volatile nature of oil prices.
- Oil peaking will create a severe liquid fuels problem for the transportation sector, not an energy crisis in the usual sense that term has been used.
- Waiting until world oil production peaks before initiating crash program mitigation leaves the world with a significant liquid fuel deficit for more than two decades.
- Initiating a mitigation crash program 20 years before peaking offers the possibility of avoiding a world liquid fuels shortfall for the forecast period.
- If mitigation were to be too little, too late, world supply/demand balance will be achieved through massive demand destruction (shortages), which would translate to significant economic hardship. With adequate, timely mitigation, the costs of peaking can be minimized.





Website:

http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf

US Government Accountability Office

The Government Accountability Office, the audit, evaluation and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government. The GAO has published reports on a number of key energy issues and is currently working many on others. Among GAO's views, the agency recommends investigation of topics such as:

Ensure the Adequacy of National Energy Supplies and Related Infrastructure: Meeting rising demand could require significant investments into infrastructure such as power plants, transmission lines, refineries, and other key equipment and technologies.

Key Topics Needing Congressional Oversight

- Evaluate the risks, benefits, and implications for national security of investments that deepen US ties to international energy markets (e.g. overseas refineries, oil imports).
- Examine the Nuclear Regulatory Commission's licensing process for new power plants.
- Examine the implications of the Department of Energy's R&D portfolio.
- Assess development of evolving renewable energy markets.
- Evaluate programs that encourage energy efficiency and reduced energy demand.

Selected GAO Products

- Peak Oil GAO-07-283, February 2007
- Impact of petroleum inventories and refining capacity on refined product prices and price volatility (expected 2007)
- Strategic Petroleum Reserve. GAO-06-872, August 2006
- Issues Related to Potential Reductions in Venezuelan Oil Production. GAO-06-668, June 2006
- Natural Gas: Factors Affecting Prices and Potential Impacts on Consumers. GAO-06-420T. February 2006.
- Electricity Restructuring: Key Challenges Remain. GAO-06-237. November 2005.
- Meeting Energy Demand in the 21st Century: Many Challenges and Key Questions. GAO-05-414T. March 2005.

Website: **http://www.gao.gov**

GAO
Accountability • Integrity • Reliability

Peak Oil Study

Uncertainty about Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production

What GAO Found

Most studies estimate that oil production will peak sometime between now and 2040. This range of estimates is wide because the timing of the peak depends on multiple, uncertain factors that will help determine how quickly the oil remaining in the ground is used, including the amount of oil still in the ground; how much of that oil can ultimately be produced given technological, cost, and environmental challenges as well as potentially unfavorable political and investment conditions in some countries where oil is located; and future global demand for oil. Demand for oil will, in turn, be influenced by global economic growth and may be affected by government policies on the environment and climate change and consumer choices about conservation.

In the US, alternative fuels and transportation technologies face challenges that could impede their ability to mitigate the consequences of a peak and decline in oil production, unless sufficient time and effort are brought to bear. For example, although corn ethanol production is technically feasible, it is more expensive to produce than gasoline and will require costly investments in infrastructure, such as pipelines and storage tanks, before it can become widely available as a primary fuel. Key alternative technologies currently supply the equivalent of only about 1% of US consumption of petroleum products, and the Department of Energy (DOE) projects that even by 2015, they could displace only the equivalent of 4% projected US annual consumption. In such circumstances, an imminent peak and sharp decline in oil production could cause a worldwide recession. If the peak is delayed, however, these technologies have a greater potential to mitigate the consequences. DOE projects that the technologies could displace up to 34% of US consumption in the 2025 through 2030 time frame. The level of effort dedicated to overcoming challenges will depend in part on sustained high oil prices to encourage sufficient investment in and demand for alternatives.

Federal agency efforts that could reduce uncertainty about the timing of peak oil production or mitigate its consequences are spread across multiple agencies and are generally not focused explicitly on peak oil. Federally sponsored studies have expressed concern over the potential for a peak, and agency officials have identified actions that could be taken to address this issue. For example, DOE and United States Geological Survey officials said uncertainty about the peak's timing could be reduced through better information about worldwide demand and supply, and agency officials said they could step up efforts to promote alternative fuels and transportation technologies. However, there is no coordinated federal strategy for reducing uncertainty about the peak's timing or mitigating its consequences.

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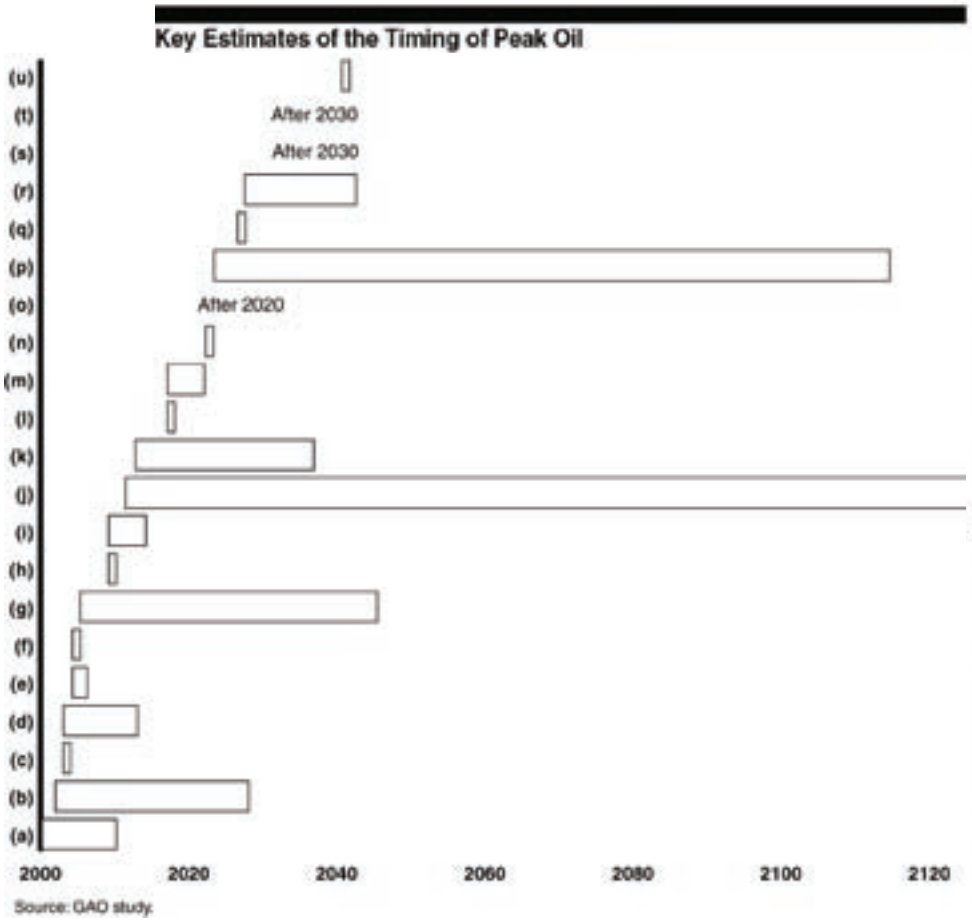
Peak Oil Study



Note: These studies are listed in appendix II of the GAO report. Estimates of 90 percent confidence intervals using two different reserves data sources are provided for study g. One additional study that is not represented in this figure, referenced as study v, states that the timing of the peak is "unknowable."

Why GAO Did This Study: The US economy depends heavily on oil, particularly in the transportation sector. World oil production has been running at near capacity to meet demand, pushing prices upward. Concerns about meeting increasing demand with finite resources have renewed interest in an old question: How long can the oil supply expand before reaching a maximum level of production—a peak—from which it can only decline?

How GAO Performed the Analysis: (1) examined when oil production could peak, (2) assessed the potential for transportation technologies to mitigate the consequences of a peak in oil production, and (3) examined federal agency efforts that could reduce uncertainty about the timing of a peak or mitigate the consequences. To address these objectives, GAO reviewed studies, convened an expert panel, and consulted agency officials.

What GAO Recommends: To better prepare for a peak in oil production, GAO recommends that the Secretary of Energy work with other agencies to establish a strategy to coordinate and prioritize federal agency efforts to reduce uncertainty about the likely timing of a peak and to advise Congress on how best to mitigate consequences.

American Enterprise Institute for Public Policy Research

AMERICAN ENTERPRISE INSTITUTE

The American Enterprise Institute for Public Policy Research is a private, nonpartisan, not-for-profit institution dedicated to research and education on issues of government, politics, economics, and social welfare. AEI sponsors research and conferences and publishes books, monographs, and periodicals. Its website, www.aei.org, posts its publications, videos and transcripts of its conferences, biographies of its scholars and fellows, and schedules of upcoming events. A number of these postings relate to energy policy:

Strategic Options for Bush Administration Climate Policy (November 2006) book

Lee Lane, the executive director of the Climate Policy Center, explores options that policymakers might consider, as well as the costs and benefits of current policies. His conclusions will surprise many environmental advocates: President Bush was right to reject the Kyoto Protocol and should continue to reject calls for "cap-and-trade" programs modeled on Kyoto. Emissions trading would be expensive and ineffective; the costs would be significant but the environmental benefits would be negligible. With the threat of Kyoto-style cap-and-trade programs looming larger with each passing year, Lane argues that the Bush administration should consider adopting a modest carbon tax. This would be vastly more efficient than emissions trading and would cut off the growing political momentum towards reengaging with the Kyoto system. (At the very least, a cap should include a "safety valve," providing an unlimited supply of affordable credits, essentially transforming the trading program into a tax.) Lane also argues that greater attention should be paid to ambitious approaches to climate change such as geo-engineering and the development of breakthrough clean-energy technologies that could reduce emissions enough to curtail projected warming. Costly cap-and-trade programs that produce trivial reductions in greenhouse gas emissions are simply a waste of money; our resources should focus instead on actual solutions, not ineffective interim steps.

What Would a Rational Energy Tax Policy Look Like (November 2006) article

Kevin Hassett and Gilbert Metcalf explore tax policy options for energy, arguing that US energy tax policy is misguided in at least three ways. First, a policy to promote energy independence through reduced oil imports is based on a fundamental misunderstanding of how energy markets function. A policy that attempts to establish energy independence by promoting domestic fossil fuel production is especially misguided. Second, our policy relies heavily on energy subsidies, most of which are socially wasteful, inefficient, and driven by political rather than energy considerations. Third, current energy taxes are deficient on a number of levels. If one accepts the view that U.S. reliance on oil is a problem, then we can do much better than the policies mentioned above. A rational U.S. energy tax policy would include (1) an end to energy supply subsidies; (2) a green tax swap; (3) an end to the gas guzzler tax loophole and possible use of "feebates"; and (4) conservation incentive programs. Ending subsidies for fossil fuel production would level the playing field among energy sources and shift us from a policy of promoting fossil fuel supply to encouraging a reduction in fossil fuel consumption. It would also move us away from a woefully inefficient reliance on corn-based ethanol. A green tax swap uses revenue from environmentally motivated taxes to lower other taxes in a revenue-neutral reform. For example, Congress could reduce reliance on oil and other polluting sources of energy by implementing a carbon tax. The revenue could be used to finance corporate tax reform or reductions in the payroll tax.

Website: **http://www.aei.org**

American Enterprise Institute for Public Policy Research

AMERICAN ENTERPRISE INSTITUTE

Climate Change: Caps vs. Taxes

Kenneth P. Green, Steven F. Hayward, Kevin A. Hassett. As the Kyoto Protocol's 2012 expiration date draws near, a general theme dominates the global conversation: leadership and participation by the United States are critical to the success of whatever climate policy regime succeeds the Kyoto Protocol. Two general policy approaches stand out in the current discussion. The first is national and international greenhouse gas (GHG) emissions trading, often referred to as "cap-and-trade." Cap-and-trade is the most popular idea at present, with several bills circulating in Congress to begin a cap-and-trade program of some kind. The second idea is a program of carbon-centered tax reform–for example, the imposition of an excise tax based on the carbon emissions of energy sources (such as coal, oil, and gasoline), offset by reductions in other taxes. In this paper we address the strengths and weaknesses of both ideas and the framework by which legislators should evaluate them.
http://www.aei.org/publications/filter.all,pubID.26286/pub_detail.asp

Website: **http://www.aei.org**

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

The Intergovernmental Panel on Climate Change (IPCC) has been established by WMO and UNEP to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts, and options for adaptation and mitigation. It is currently finalizing its Fourth Assessment Report "Climate Change 2007".

The Panel meets in plenary sessions about once a year. It accepts/approves/adopts IPCC reports, decides on the mandates and work plans of the Working Groups and the Task Force, the structure and outlines of its reports. A main activity of the IPCC is to provide in regular intervals an assessment of the state of knowledge on climate change. The reports by the three Working Groups provide a comprehensive and up-to-date assessment of the current state of knowledge on climate change.

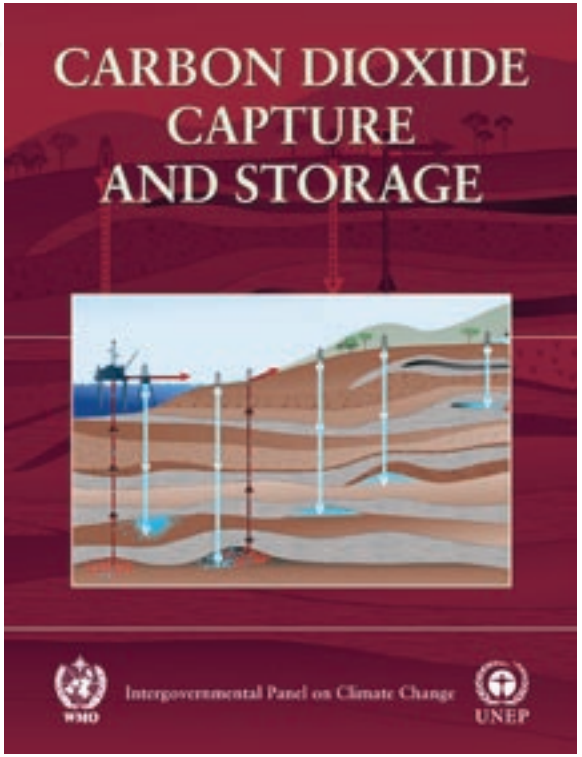
The IPCC has three Working Groups:

- Working Group I assesses the scientific aspects of the climate system and climate change. Report published February 2007
- Working Group II assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. Report published April 2007
- Working Group III assesses options for limiting greenhouse gas emissions and otherwise mitigating climate change. Report published May 2007

The Synthesis Report for the Fourth Assessment Report will be released in November 2007. This will provide the key findings of all three Working Groups of the IPCC Fourth Assessment Report.

Website: http://www.ipcc.ch

The graphic on this page depicts one of the many Special Reports undertaken by the IPCC.



WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

CLIMATE CHANGE 2007

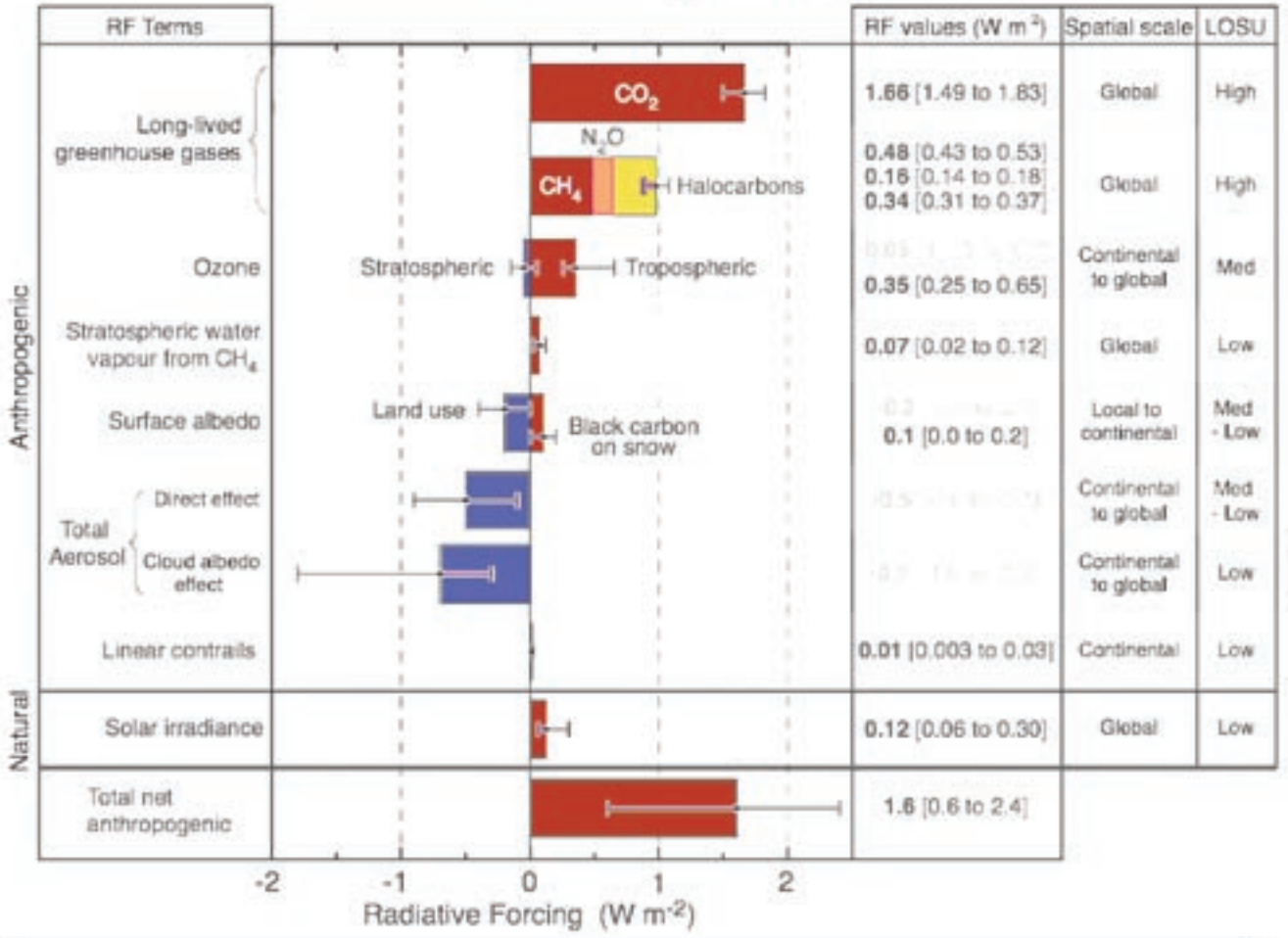
The Physical Science Basis

Working Group I

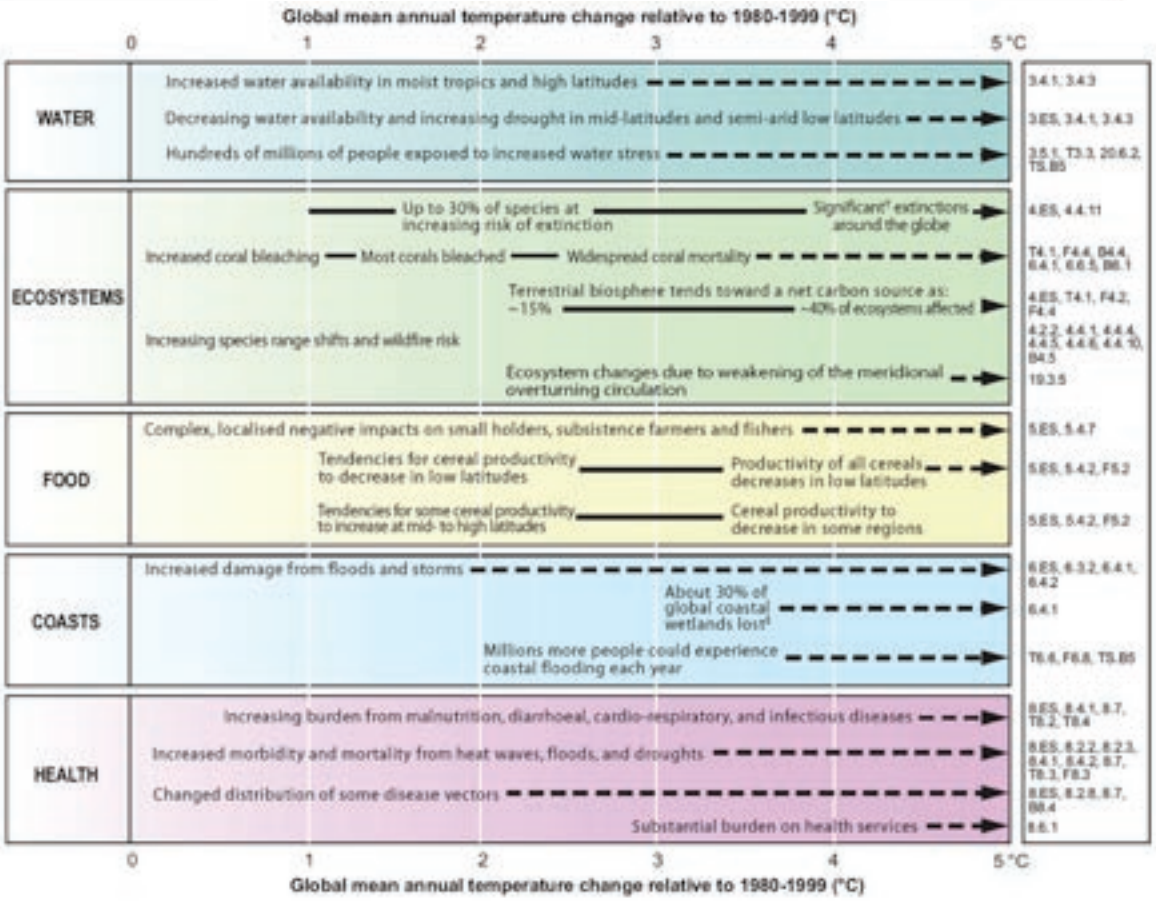
Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land-use change, while those of methane and nitrous oxide are primarily due to agriculture.

The understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to very high confidence that the globally averaged net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W m^{-2}.

Radiative Forcing Components



WMO
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
UNEP



Key impacts as a function of increasing global average temperature change

Working Group II

Illustrative examples of global impacts are projected for climate changes (and sea-level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century.

The black lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left hand side of text indicates approximate onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of Special Report on Scenarios (SRES) scenarios A1FI, A2, B1 and B2.

Adaptation to climate change is not included in these estimations. All entries are from published studies recorded in the chapters of the Assessment. Sources are given in the right hand column of the Table. Confidence levels for all statements are high.

Sector	Key mitigation technologies and practices currently commercially available.	Key mitigation technologies and practices projected to be commercialized before 2030.
Energy Supply [4.3, 4.4]	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of CCS (e.g. storage of removed CO_2 from natural gas)	Carbon Capture and Storage (CCS) for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including tidal and waves energy, concentrating solar, and solar PV
Transport [5.4]	More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; model shifts from road transport to rail and public transport systems; non-motorised transports (cycling, walking); land-use and transport planning	Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries
Buildings [6.5]	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulations; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycle of fluorinated gases	Integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control; solar PV integrated in buildings
Industry [7.5]	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO_2 gas emissions; and a wide array of process-specific technologies	Advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture
Agriculture [8.4]	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertilizer application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improve energy efficiency	Improvements of crops yields
Forestry/forests [9.4]	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use	Tree species improvements to increase biomass productivity and carbon sequestration. Improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential and mapping land use change
Waste [10.4]	Landfill methane recovery; waste incineration with energy recovery; composting of organic waste; controlled waste water treatment; recycling and waste minimization	Biocovers and biofilters to optimize CH_4 oxidation

WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

Mitigation of Climate Change Working Group III

A wide variety of national policies and instruments are available to governments to create the incentives for mitigation action. Their applicability depends on national circumstances and an understanding of their interactions, but experience from implementation in various countries and sectors shows there are advantages and disadvantages for any given instrument (high agreement, much evidence). Four main criteria are used to evaluate policies and instruments: environmental effectiveness, cost effectiveness, distributional effects including equity, and institutional feasibility.

General findings about the performance of policies are:

- Integrating climate policies in broader development policies makes implementation and overcoming barriers easier.
- Regulations and standards generally provide some certainty about emission levels. They may be preferable to other instruments when information or other barriers prevent producers and consumers from responding to price signals. However, they may not induce innovations and more advanced technologies.
- Taxes and charges can set a price for carbon, but cannot guarantee a particular level of emissions. Literature identifies taxes as an efficient way of internalizing costs of GHG emissions.
- Tradable permits will establish a carbon price. The volume of allowed emissions determines their environmental effectiveness, while the allocation of permits has distributional consequences. Fluctuation in the price of carbon makes it difficult to estimate the total cost of complying with emission permits.
- Financial incentives (subsidies and tax credits) are frequently used by governments to stimulate the development and diffusion of new technologies. While economic costs are generally higher than for the instruments listed above, they are often critical to overcome barriers.
- Voluntary agreements between industry and governments are politically attractive, raise awareness among stakeholders, and have played a role in the evolution of many national policies. The majority of agreements has not achieved significant emissions reductions beyond business as usual. However, some recent agreements, in a few countries, have accelerated the application of best available technology and led to measurable emission reductions.
- Information instruments (e.g. awareness campaigns) may positively affect environmental quality by promoting informed choices and possibly contributing to behavioural change, however, their impact on emissions has not been measured yet.
- RD&D can stimulate technological advances, reduce costs, and enable progress toward stabilization.

Global Warming Debate: Skepticism persists but science has improved

Comments below courtesy Wikipedia, The Free Encyclopedia

Material excerpted from entry titled "Global cooling" available at http://en.wikipedia.org/wiki/Global_cooling#_note-16

Wikipedia's informative entry titled "Global warming" available at http://en.wikipedia.org/wiki/Global_warming

1975 Newsweek article

April 28, 1975 article in Newsweek magazine: Titled "The Cooling World," it pointed to "ominous signs that the Earth's weather patterns have begun to change" and pointed to "a drop of half a degree [Fahrenheit] in average ground temperatures in the Northern Hemisphere between 1945 and 1968." The article claimed "The evidence in support of these predictions [of global cooling] has now begun to accumulate so massively that meteorologists are hard-pressed to keep up with it." The Newsweek article did not state the cause of cooling; it stated that "what causes the onset of major and minor ice ages remains a mystery" and cited the NAS conclusion that "not only are the basic scientific questions largely unanswered, but in many cases we do not yet know enough to pose the key questions."

The article mentioned the alternative solutions of "melting the Arctic ice cap by covering it with black soot or diverting arctic rivers" but conceded these were not feasible. The Newsweek article concluded by criticizing government leaders: "But the scientists see few signs that government leaders anywhere are even prepared to take the simple measures of stockpiling food or of introducing the variables of climatic uncertainty into economic projections of future food supplies...The longer the planners (politicians) delay, the more difficult will they find it to cope with climatic change once the results become grim reality." The article emphasized sensational and largely unsourced consequences - "resulting famines could be catastrophic", "drought and desolation," "the most devastating outbreak of tornadoes ever recorded", "droughts, floods, extended dry spells, long freezes, delayed monsoons," "impossible for starving peoples to migrate," "the present decline has taken the planet about a sixth of the way toward the Ice Age."

On October 23, 2006, Newsweek issued a correction, over 31 years after the original article, stating that it had been "so spectacularly wrong about the near-term future" (though editor Jerry Adler claimed that the article was not "inaccurate" in a journalistic sense).

Present level of knowledge

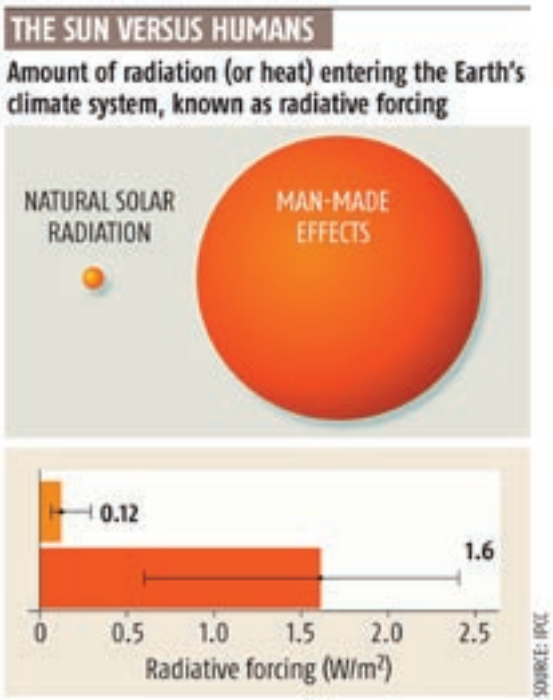
Thirty years later, the concern that the cooler temperatures would continue, and perhaps at a faster rate, can now be observed to have been incorrect. More has to be learned about climate, but the growing records have shown the cooling concerns of 1975 to have been simplistic and not borne out.

Climate science has improved

Scientific knowledge regarding climate change was more uncertain [in the 1970s] than it is today. At the time that Rasool and Schneider wrote their paper (published in the journal *Science* in July 1971), climatologists had not yet recognized the significance of greenhouse gases other than water vapor and carbon dioxide, such as methane, nitrous oxide and chlorofluorocarbons. Early in that decade, carbon dioxide was the only widely studied human-influenced greenhouse gas. The attention drawn to atmospheric gases in the 1970s stimulated many discoveries in future decades. As the temperature pattern changed, global cooling was of waning interest by 1979.

The Solar Effect

NewScientist



Note: The "circles" graphic is an amended version of the original appearing in *NewScientist* -- to show the estimated contributions as equal areas and not equal diameters.

It is one of the few areas where the sceptics' argument has had some force. What role has the sun played in recent climate change? As if to underline the controversy, [the IPCC] debate on this issue lasted some 10 hours.

The scientists wanted to halve their previous estimate of the maximum possible solar influence on warming over the past 250 years, from 40 percent to 20 percent. Government delegations from China and Saudi Arabia refused to accept that, based on new ideas about cosmic rays from outer space.

Cosmic rays ionise the atmosphere, which could, the theory goes, create clouds. Thus, anything that reduces the amount of cosmic rays could diminish cloud cover and so warm the Earth's surface. An increase in solar activity would do just that - by deflecting cosmic rays away from Earth. China and Saudi Arabia were buoyed by claims that small changes in radiation from the sun could be amplified by their potential effect on clouds. Thus, they said, the sun could have a greater effect than the scientists claimed.

Most climate scientists are unconvinced. "Right now there is no evidence," says IPCC author Piers Forster of the University of Leeds, UK. In any case, IPCC scientists believe, most of today's warming can be explained by man-made influences (see Charts). But with a book due from solar-radiation proponent Henrik Svensmark of the Danish National Space Center, this may not be the end of the matter.

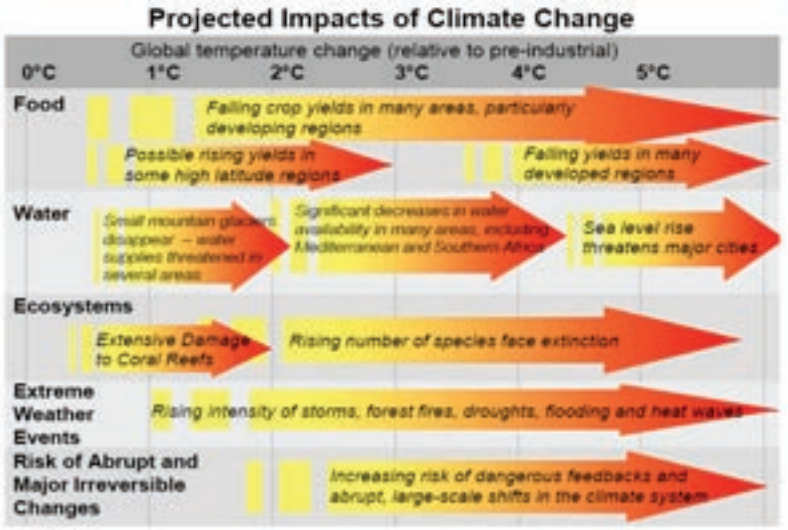
Source: ***NewScientist* magazine, 10 February 2007**

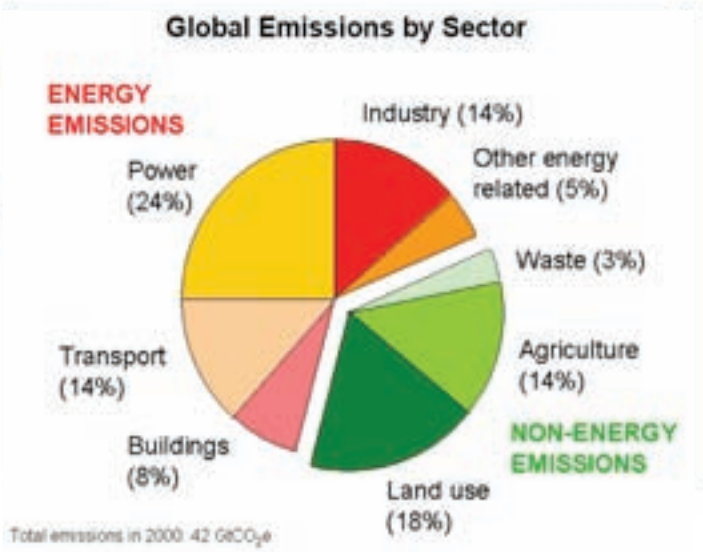
Website: **http://www.newscientist.com**

Stern Review on The Economics of Climate Change

- There is still time to avoid the worst impacts of climate change, if we take strong action now.
- Climate change could have very serious impacts on growth and development.
- The costs of stabilising the climate are significant but manageable; delay would be dangerous and much more costly.
- Action on climate change is required across all countries, and it need not cap the aspirations for growth of rich or poor countries.
- A range of options exists to cut emissions; strong, deliberate policy action is required to motivate their take-up.
- Climate change demands an international response, based on a shared understanding of long-term goals and agreement on frameworks for action.

Website:
http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm





Stern Review on The Economics of Climate Change

Key elements of future international frameworks should include:

- **Establishing a carbon price, through tax, trading or regulation is an essential foundation for climate change policy**
- **Emissions trading:** Expanding and linking the growing number of emissions trading schemes around the world is a powerful way to promote cost-effective reductions in emissions and to bring forward action in developing countries. Strong targets in rich countries could drive flows amounting to tens of billions of dollars each year to support the transition to low-carbon development paths.
- **Technology cooperation:** Informal co-ordination as well as formal agreements can boost the effectiveness of investments in innovation around the world. Globally, support for energy R&D should at least double, and support for the deployment of new low-carbon technologies should increase up to five-fold. International cooperation on product standards is a powerful way to boost energy efficiency.
- **Action to reduce deforestation:** The loss of natural forests around the world contributes more to global emissions each year than the transport sector.
- **Curbing deforestation** is a highly cost-effective way to reduce emissions; large scale international pilot programmes to explore the best ways to do this could get underway very quickly.
- **Adaptation:** The poorest countries are most vulnerable to climate change. It is essential that climate change be fully integrated into development policy, and that rich countries honour their pledges to increase support through overseas development assistance. International funding should also support improved regional information on climate change impacts, and research into new crop varieties that will be more resilient to drought and flood.

GLOBAL ROUNDTABLE ON CLIMATE CHANGE

Global Roundtable on Climate Change

The Earth Institute AT COLUMBIA UNIVERSITY

Statement Executive Summary

Climate change is an urgent problem requiring global action to reduce emissions of carbon dioxide (CO2) and other greenhouse gases (GHGs). Energy use is vital for a modern economy. Burning fossil fuels produces CO2. Thus, confronting climate change depends, in many ways, on adopting new and sustainable energy strategies that can meet growing global energy needs while allowing for the stabilization of atmospheric CO2 concentrations at safe levels.

- The world's governments should set scientifically informed targets, including an ambitious but achievable interim, mid-century target for global CO2 concentrations, for "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system," in accordance with the stated objective of the Framework Convention on Climate Change (UNFCCC).
- All countries should be party to this accord, which should include specific near- and long-term commitments for action in pursuit of the agreed targets. Commitments for actions by individual countries should reflect differences in levels of economic development and GHG emission patterns and the principles of equity and common but differentiated responsibilities.
- Clear, efficient mechanisms should be established to place a market price on carbon emissions that is reasonably consistent worldwide and across sectors in order to reward efficiency and emission avoidance, encourage innovation, and maintain a level playing field among possible technological options.
- Government policy initiatives should address energy efficiency and de-carbonization in all sectors, allow businesses to choose among a range of options as they strive to minimize GHG emissions and costs, encourage the development and rapid deployment of low-emitting and zero-emitting energy and transportation technologies, and provide incentives to reduce emissions from deforestation and harmful land management practices.
- Governments, the private sector, trade unions, and other sectors of civil society should undertake efforts to prepare for and adapt to the impacts of climate change, since climate change will occur even in the context of highly effective mitigation efforts.
- Signatories to this statement will support scientific processes including the Intergovernmental Panel on Climate Change (IPCC); work to increase public awareness of climate change risks and solutions; report information on their GHG emissions; engage in GHG emissions mitigation, which can include emissions trading schemes; champion demonstration projects; and support public policy efforts to mitigate climate change and its impacts.

Website: http://www.earthinstitute.columbia.edu/grocc/grocc4_statement.html

GLOBAL ROUNDTABLE ON CLIMATE CHANGE

Global Roundtable on Climate Change

The Earth Institute AT COLUMBIA UNIVERSITY

Management:

Jeffrey Sachs: Chair, Global Roundtable on Climate Change; Director, The Earth Institute at Columbia University; Quetelet Professor of Sustainable Development and Professor of Health Policy and Management, Columbia University.

David Downie: Director, Global Roundtable on Climate Change. Associate Director, Graduate Program in Climate and Society. Dr. Downie's research focuses on the creation, content, and implementation of international environmental policy.

Kate Brash: Assistant Director, Global Roundtable on Climate Change, The Earth Institute at Columbia University

Lyndon Valicenti: Program Coordinator, Global Roundtable on Climate Change, The Earth Institute at Columbia University

In addition, the Earth Institute's full time events staff in information technology, communications and events-planning facilitates the day-to-day operations of the Roundtable and all Roundtable and Working Group meetings. To contact the Roundtable, please send email to grocc@ei.columbia.edu.

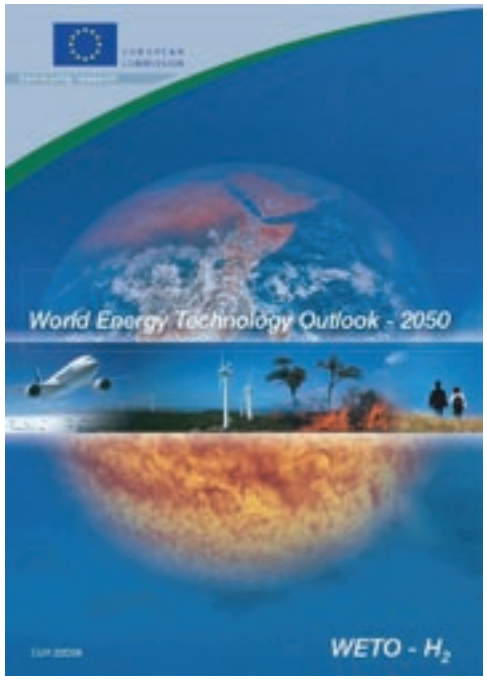
Released February 20, 2007

The Path to Climate Sustainability:
A Joint Statement by the Global Roundtable on Climate Change

The signatories include Air France, Alcoa, Allianz, American Electric Power, Bayer, China Renewable Energy Industry Association, Citigroup, DuPont, Electricity Generating Authority of Thailand, ENDESA, Eni, Eskom, FPL Group, General Electric, Iberdrola, ING, Interface, Marsh & McLennan Companies, Munich Re, NRG Energy, Patagonia, Ricoh, Rolls Royce, Stora Enso North America, Suntech Power, Swiss Re, Vattenfall, Volvo, World Council of Churches, World Petroleum Council, and many others.

European Commission

World Energy Technology Outlook - 2050



European Commission
Directorate-General for Research
Information and Communication Unit
B-1049 Brussels
Internet:
http://ec.europa.eu/research/energy/pdf/weto-h2_en.pdf

The WETO-H2 study has developed a Reference projection of the world energy system to test different scenarios for technology and climate policies in the next half-century. It has a particular focus on the diffusion of hydrogen as a fuel. This Reference projection adopts exogenous forecasts for population and economic growth in the different world regions and it makes consistent assumptions for the availability of fossil energy resources and for the costs and performances of future technologies. It uses a world energy sector simulation model – the POLES model – to describe the development to 2050 of the national and regional energy systems and of their interactions through international energy markets, under constraints on resources and from climate policy.

Conclusions

- In the Reference Case, by 2050 the "size" of the world energy system and corresponding CO2 emissions will be twice that of today.
- Relative scarcity of oil and gas ("plateau"): Coal comes to be increasingly the swing primary source in the world energy balance, which aggravates the problem raised by the energy-related CO2 emissions.
- Two alternative policy scenarios have been elaborated: A "Carbon Constraint Case" (CCC) and the "Hydrogen Scenario" (H2).
- The CCC scenario expects a very high carbon value (up to 200 €/tCO2 for Europe by 2050) to achieve a "factor two" reduction of emissions in the industrialised countries and progressive efforts from developing countries in order to get a stabilisation of emissions. In the CCC, there is important penetration of: (1) Carbon capture and storage (50% of thermal electricity in Europe), (2) Nuclear and renewables (75% of electricity), and (3) Low and very low energy buildings and vehicles (40%).
- The H2 scenario assumes technological breakthroughs in clusters of technologies concerning hydrogen production, distribution, storage, and end-use technologies. It has a substantial impact on transportation since by 2050 nearly 30% of total passenger cars run on hydrogen.

Annex

- Mean-variance portfolio (MVP) theory can help provide new insights to energy investment strategies. It demonstrates the range of possible mixes with technology shares that are +/- 20% from the POLES Reference. This enables policy makers to compare alternative 2050 outcomes, which may present more desirable CO2, energy diversity and other characteristics.
- The challenge of this research has been to merge the technically rich descriptive power of POLES with the ability of portfolio analysis to trade-off risk and reward. Optimisation identifies portfolios with better balances of cost and risk and other improved characteristics.
- The optimised mixes show improvements that may be attainable and which lie within close to the Reference. The remaining challenge is to identify policy changes that produce such optimised outcomes, a task to which the POLES simulation is ideally suited.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

2000 - 2050 North American Transportation Energy Futures

Future US Highway Energy Use: A Fifty Year Perspective - May 2001

In the summer of 2000, the transportation program within the US Department of Energy launched its effort to analyze the long-term (to 2050) energy future of highway transportation in the US, with a focus on fuel supply and demand. The initial report examined the potential for efficient technologies to reduce demand. In working on this report, it became apparent that within a couple of decades the US will probably need to begin to transition away from conventional oil use in general and in the transportation sector in particular, because world conventional oil production will peak within that time frame.

Philip Patterson, US DOE David Greene, Oak Ridge National Laboratory
Elyse Steiner, National Renewable Energy Laboratory
Steve Plotkin, Margaret Singh, Anant Vyas, Marianne Mintz,
Dan Santini, and Steve Folga, Argonne National Laboratory
Jim Moore, TA Engineering, Inc.
Peter Reilly-Roe, Kevin Cliffe, Ruth Talbot, Paul Khanna, and
Vernel Stanciulescu, Natural Resources Canada

Features
- Six strategies to reduce oil use and carbon emissions were compared
- Light vehicle oil use in 2050 dramatically less than the base case across all strategies
- No costs estimated for strategies; feedback between US and world oil markets not considered
- Estimates the energy, oil, carbon and cost implications of alternative transportation futures

2000 - 2050 North American Transportation Energy Futures, the second phase (completed in the spring of 2003) , is a joint study by the US Department of Energy and Natural Resources Canada on the evolution of transportation fuels and vehicle technologies under three North American transportation scenarios over a fifty year time period. It expands on the work done by DOE for Future US Highway Energy Use: A Fifty Year Perspective by adding a Canadian perspective to the analysis, including vehicle and fuel costs, and by developing a world oil market model. The goals of the study were to: (a) develop and understand the evolution of the North American transportation sector to 2050 under various scenarios; (b) identify the technology and fuel options that may be important to these evolutions; and (c) analyze the costs and potential energy consumption, especially of petroleum, and the environmental impacts of the scenarios relative to a base case. The major focus of the study is on-road transport due to its dominant share of the North American transportation market and its nearly exclusive dependence on petroleum-based fuels.

The study sought to explore the following questions:
- How can North America manage the predicted decline of conventional oil supplies during this time period?
- What are the implications, economic and otherwise, of a transition from conventional oil to alternative feedstocks and/or energy carriers?
- What options are available to minimize North America's reliance on imported oil?
- In light of the above issues, how can North America achieve lower greenhouse gas emission levels that might be required in the future?

Among the study's conclusions were the following:
- World conventional oil production peaks before 2050 in all scenarios.
- Oil from Canadian oil sands will be an important contributor to future North American supply, but considerable uncertainty remains – especially about long-term costs and the potential for large increases in production.
- Even in the most optimistic scenario, oil continues to dominate highway transportation energy use.
- Still, hydrogen and ethanol can play major roles, though transitions to them as postulated in the scenarios examined will require large early capital investments.
- Oil reduction can be achieved with changes in behavior and/or with technological advances.
- For different environmentally-driven scenarios – different views of what the future will look like – there is similar potential for reducing North American oil use and greenhouse gas emissions at relatively similar total costs, but through different means and with different timing of benefits."

Tools of the Study
- Scenarios of possible futures using rate of innovation, environmental responsiveness and degree of North American energy market integration as drivers
- Models for analysis of energy demand, greenhouse gas emissions, oil markets and costs
- Resource Papers on key topics to provide context, technical detail and cost data

Website: http://www.eere.energy.gov

UNITED NATIONS FOUNDATION

SIGMA XI
THE SCIENTIFIC RESEARCH SOCIETY

Confronting Climate Change

Website: http://www.unfoundation.org/SEG

The United Nations Department of Economic and Social Affairs (DESA) seeks to facilitate contributions by the scientific community to the work of the UN Commission on Sustainable Development. Accordingly, DESA invited Sigma Xi, the Scientific Research Society, to convene an international panel of scientific experts to prepare a report outlining the best measures for mitigating and adapting to global warming for submission to the CSD. **The UN Foundation was funded by the Turner Gift.**

To carry out this task, the Scientific Expert Group on Climate Change and Sustainable Development (SEG) was formed and is comprised of 18 distinguished international scientists. The panel was asked to consider innovative approaches for mitigating and/or adapting to projected climate changes, and to anticipate the relationship of response measures to sustainable development.

Highlights of the resulting report include:

To avoid a entering a regime of sharply rising danger of intolerable impacts on humans, policy makers should limit temperature increases from global warming to 2-2.5°C above the 1750 pre-industrial level. It is still possible to avoid unmanageable changes in the future, but the time for action is now. Avoiding temperature increases greater than 2-2.5°C would require very rapid success in reducing emissions of methane and black soot worldwide, and global carbon dioxide emissions must level off by 2015 or 2020 at not much above their current amount, before beginning a decline to no more than a third of that level by 2100.

• **The technology exists to seize significant opportunities around the globe to reduce emissions and provide other economic, environmental and social benefits**, including meeting the United Nations' Millennium Development Goals. To do so, policy makers must immediately act to reduce emissions by: (1) Improving efficiency in the transportation sector through measures such as vehicle efficiency standards, fuel taxes, and registration fees/rebates that favor purchase of efficient and alternative fuel vehicles. (2) Improving design and efficiency of commercial and residential buildings through building codes, standards for equipment and appliances, incentives for property developers and landlords to build and manage properties efficiently, and financing for energy-efficiency investments. (3) Expanding the use of biofuels through energy portfolio standards and incentives to growers and consumers. (4) Beginning immediately, designing and deploying only coal-fired power plants that will be capable of cost-effective and environmentally-sound retrofits for capture and sequestration of their carbon emissions.

• **Some level of climate change and impacts from it is already unavoidable.** Societies must do more to adapt to ongoing and unavoidable changes in the Earth's climate system by: (5) Improving preparedness/response strategies and management of natural resources to cope with future climatic conditions that will be. fundamentally different than those experienced for the last 100 years. (6) Addressing the adaptation needs of the poorest and most vulnerable nations, which will bear the brunt of climate change impacts. (7) Planning and building climate resilient cities. (8) Strengthening international, national, and regional institutions to cope with weather-related disasters and an increasing number of climate change refugees.

• **The international community, through the UN and related multilateral institutions, can play a crucial role in advancing action** to manage the unavoidable and avoid the unmanageable by: (9) Helping developing countries and countries with economies in transition to finance and deploy energy efficient and new energy technologies. 10) Accelerating negotiations to develop a successor international framework for addressing climate change and sustainable development. (11) Educating all about the opportunities to adopt mitigation and adaptation measures.

National Security and the Threat of Climate Change

The CNA Corporation

Global climate change presents a serious national security threat which could impact Americans at home, impact United States military operations and heighten global tensions, according to a new study released by a blue-ribbon panel of retired admirals and generals from all branches of the armed services.

The CNA Corporation (CNA) is a non-profit organization that provides research and analysis to inform public sector leaders. CNA brought together eleven retired senior admirals and generals to provide advice, expertise and perspective on the impact of climate change. CNA writers and researchers compiled the report under the board's direction and review. The study, "National Security and the Threat of Climate Change," explores ways projected climate change is a threat multiplier in already fragile regions, exacerbating conditions that lead to failed states — the breeding grounds for extremism and terrorism.

FINDINGS

- Projected climate change poses a serious threat to America's national security
- Climate change acts as a threat multiplier for instability in some of the most volatile regions of the world
- Projected climate change will add to tensions even in stable regions of the world
- Climate change, national security and energy dependence are a related set of global challenges

RECOMMENDATIONS

- The national security consequences of climate change should be fully integrated into national security and national defense strategies.
- The US should commit to a stronger national and international role to help stabilize climate changes at levels that will avoid significant disruption to global security and stability.
- The US should commit to global partnerships that help less developed nations build the capacity and resiliency to better manage climate impacts.
- The Department of Defense should enhance its operational capability by accelerating the adoption of improved business processes and innovative technologies that result in improved US combat power through energy efficiency.
- The Department of Defense should conduct an assessment of the impact on US military installations worldwide of rising sea levels, extreme weather events, and other possible climate change impacts over the next thirty to forty years.

Website: http://securityandclimate.cna.org

The Future of Coal

Massachusetts Institute of Technology

Leading academics from an interdisciplinary Massachusetts Institute of Technology (MIT) team issued a report that seeks to examine how the world can continue to use coal, an abundant and inexpensive fuel, in a way that mitigates, instead of worsens, the global warming crisis.

The goal of this MIT energy study, one of a series, was to evaluate the performance of different technologies, which in combination with policy and technology innovations, will reduce global emissions of CO2 and other greenhouse gases by mid-century.

Given that coal is likely to remain an important source of energy in any conceivable future energy scenario.

In particular, the focus is on carbon capture and sequestration (CCS) — the separation of the CO2 combustion product that is produced in conjunction with the generation of electricity from coal and the transportation of the separated CO2 to a site where the CO2 is sequestered from the atmosphere.

Website: http://web.mit.edu/coal/The_Future_of_Coal_Summary_Report.pdf

BOX 1 ILLUSTRATING THE CHALLENGE OF SCALE FOR CARBON CAPTURE

- Today fossil sources account for 80% of energy demand: Coal (25%), natural gas (21%), petroleum (34%), nuclear (6.5%), hydro (2.2%), and biomass and waste (11%). Only 0.4% of global energy demand is met by geothermal, solar and wind.[1]
- 50% of the electricity generated in the U.S. is from coal.[2]
- There are the equivalent of more than five hundred, 500 megawatt, coal-fired power plants in the United States with and average age of 35 years.[2]
- China is currently constructing the equivalent of two, 500 megawatt, coal-fired power plants per week in a capacity comparable to the entire UK power grid each year.[3]
- One 500 megawatt coal-fired power plant produces approximately 3 million tons/year of carbon dioxide (CO_2).[3]
- The United States produces about 1.5 billion tons per year of CO_2 from coal-burning power plants.
- If all of this CO_2 is transported from sequestration, the quantity is equivalent to three times the weight and, under typical operating conditions, one-third of the annual volume of natural gas transported by the U.S. gas pipeline system.
- If 60% of the CO_2 produced from U.S. coal-based power generation were to be captured and compressed to a liquid for geologic sequestration, its volume would about equal the total U.S. oil consumption of 20 million barrels per day.
- At present the largest sequestration project is injecting one million tons/year of carbon dioxide (CO_2) from the Sleipner gas field into a saline aquifer under the North Sea.[3]

1 IEA Key World Statistics (2006)
2 EIA 2005 annual statistics (www.eia.doe.gov)
3 Derived from the MIT Coal Study

The Future of Coal

Massachusetts Institute of Technology

Key Findings

- Coal is a low-cost, per BTU, mainstay of both the developed and developing world, and its use is projected to increase. Because of coal's high carbon content, increasing use will exacerbate the problem of climate change unless coal plants are deployed with very high efficiency and large scale CCS is implemented.

- CCS is the critical enabling technology because it allows significant reduction in CO2 emissions while allowing coal to meet future energy needs.

Table 1 Exajoules of Coal Use (EJ) and Global CO_2 Emissions (Gt/yr) in 2000 and 2050 with and without Carbon Capture and Storage*

	BUSINESS AS USUAL		LIMITED NUCLEAR 2050		EXPANDED NUCLEAR 2050	
	2000	2050	WITH CCS	WITHOUT CCS	WITH CCS	WITHOUT CCS
Coal Use: Global	100	448	161	116	121	78
U.S.	24	58	40	28	25	13
China	27	88	39	24	31	17
Global CO_2 Emissions	24	62	28	32	26	29
CO_2 Emissions from Coal	9	32	5	9	3	6

** Universal, simultaneous participation, High CO_2 prices and EPPA-Ref gas prices.*

- A significant charge on carbon emissions is needed in the relatively near term to increase the economic attractiveness of new technologies that avoid carbon emissions and specifically to lead to large-scale CCS in the coming decades. We need large-scale demonstration projects of the technical, economic and environmental performance of integrated CCS systems.

- The U.S. government should provide assistance only to coal projects with CO2 capture in order to demonstrate technical, economic and environmental performance.

- Today, IGCC appears to be the economic choice for new coal plants with CCS. However, this could change with further RD&D, so it is not appropriate to pick a single technology winner at this time, especially in light of the variability in coal type, access to sequestration sites, and other factors. The government should provide assistance to several "first of a kind" coal utilization demonstration plants, but only with carbon capture.

- Congress should remove any expectation that construction of new coal plants without CO2 capture will be "grandfathered" and granted emission allowances in the event of future regulation. This is a perverse incentive to build coal plants without CO2 capture today.

- Emissions will be stabilized only through global adherence to CO2 emission constraints. China and India are unlikely to adopt carbon constraints unless the U.S. does so and leads the way in the development of CCS technology.

- Key changes must be made to the current Department of Energy RD&D program to successfully promote CCS technologies.

EPRINC
formerly PIRINC

Is a Home-Grown Fuel Policy Undermining US Energy Security?

The Energy Policy Research Foundation, Inc. (EPRINC), formerly PIRINC is a not-for-profit organization that studies energy economics with special emphasis on oil.

In a recently published report, EPRINC examines the viability of a proposal that calls for the use of 35 billion-gallons/year of renewable fuels (primarily ethanol) by 2017.

Key Findings of the Ethanol Study

During the 1990's, the most commonly used gasoline oxygenate was MTBE. But due to concerns over MTBE contaminating the ground water, its phase-out in early 2006 created an opportunity for ethanol. Rapid growth in use during 2006 saw ethanol end the year at an annualized consumption rate of about 6 billion gallons, much higher than the 4 billion gallon estimate under the renewable fuel mandate - EPAct 05.

This success suggested that policy makers may have underestimated ethanol's inherent potential which led to the new proposal by President Bush, calling for the use of 35 billion-gallons/year of renewable fuels (primarily ethanol) by 2017.

But numerous challenges must be overcome before this much ethanol could be integrated into the US fuel supply.

Website: http://www.eprinc.org

Table 1:
Renewable Fuel Mandate — EPAct 05

YEAR	BILLION GAL.
2006	4.0
2007	4.7
2008	5.4
2009	6.1
2010	6.8
2011	7.4
2012	7.5

EPRINC
formerly PIRINC

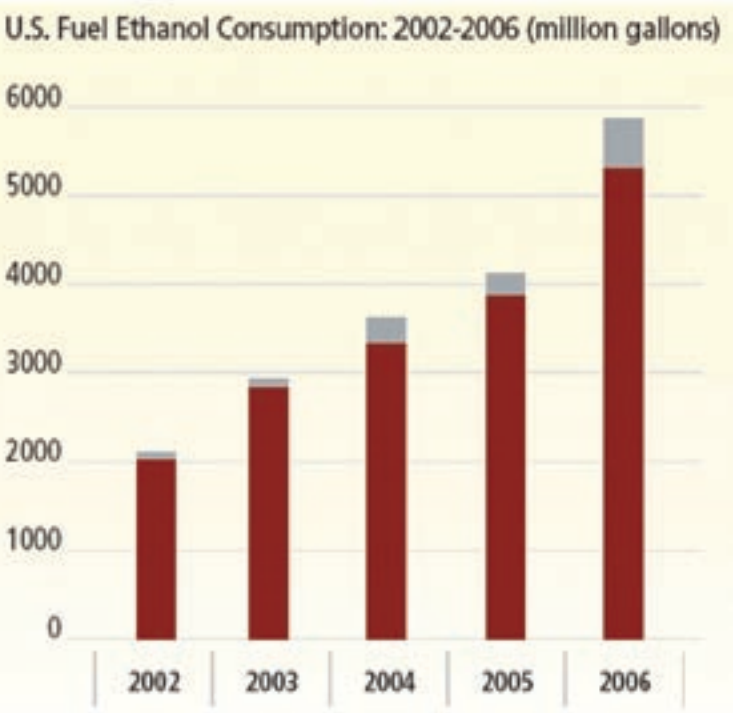
Challenges Ahead: Ethanol

- Ethanol's limited availability, higher cost, and incompatibility with existing petroleum fuels.
- Ethanol transportation costs around 15 cents/gallon compared with just a few cents for gasoline.
- Lack of a robust transport system to provide universal distribution
- The availability of an estimated 13 billion bushels of corn to manufacture this amount of ethanol
- A needed technology breakthrough to manufacture ethanol from cellulosic plant material.
- A sustained rise in grain prices driven by ethanol feedstock demand could lead to higher US and world food prices.

Ethanol contains one-third less energy per unit of volume than gasoline. If the president's proposal is to be realized, the limited availability of E-85 ethanol (only 1158 retail outlets carry E-85), a limited supply of attractive FFV vehicles (despite Corporate Average Fuel Economy (CAFE) credits for manufacturers), and general disinterest among would-be fleet operators are factors that must be overcome.

Additionally, as new ethanol plants come on line, they appear to be driving ethanol prices down—and corn prices up—creating an adverse set of economics for this new industry.

Challenges Ahead: Ethanol



OTHER EPRINC STUDIES OF INTEREST http://www.eprinc.org/publications.html

Why Do Oil Prices Jump So High When Supply Glitches Occur? November 2006

Does the Hubbert Method Provide a Reliable Means of Predicting Future Oil Production? October 2006

US Climate Action Partnership

Six Design Principles

Account for the global dimensions of climate change

Create incentives for technology innovation

Be environmentally effective

Create economic opportunity and advantage

Be fair to sectors disproportionately impacted

Reward early action

Website: http://www.us-cap.org

United States Climate Action Partnership (USCAP) is a group of businesses and leading environmental organizations that have come together to call on the federal government to quickly enact strong national legislation to require significant reductions of greenhouse gas emissions. USCAP has issued a landmark set of principles and recommendations to underscore the urgent need for a policy framework on climate change.

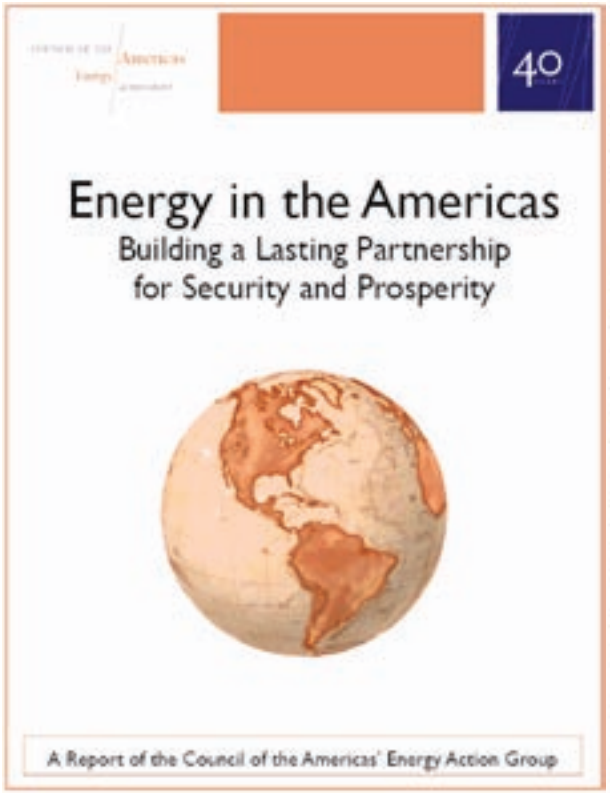
USCAP Members Include: Alcan Inc., Alcoa, American International Group, Inc., Boston Scientific Corporation, BP America Inc., Caterpillar Inc., Chrysler Group, ConocoPhillips, Deere & Company, The Dow Chemical Company, Duke Energy, DuPont, Environmental Defense, Ford Motor Company, FPL Group, Inc., General Electric, General Motors Corp., Johnson & Johnson, Marsh, Inc., National Wildlife Federation, Natural Resources Defense Council, The Nature Conservancy, NRG Energy, Inc., PepsiCo, Pew Center on Global Climate Change, PG&E Corporation, PNM Resources, Shell, Siemens Corporation, World Resources Institute, Xerox Corporation.

USCAP offers the following interconnected set of recommendations for the general structure and key elements of climate protection legislation that we urge Congress to enact as quickly as possible. The legislation should require actions to be implemented on a fast track while a cap and trade program is put in place. We recommend these fast track actions begin within one year of enactment.

- Take a stepwise cost-effective approach
- Cap and Trade is essential
- Establish short and mid-term GHG emission targets
- GHG inventory and registry
- Credit for early action
- Aggressive technology research and development
- Policies to discourage new investments in high-emitting facilities
- Accelerated deployment of zero and low-emitting technologies and energy efficiency

Council of the Americas

Energy Action Group



Website:
http://www.councilofthеamericas.org/

The Energy Action Group works to identify financial, macroeconomic, industry and business specific issues of concern and solutions. It addresses the security of the energy supply; improvement of the investment climate for energy and development; North American energy integration; energy supply to the region; and alternative energy sources such as Liquefied Natural Gas. As a key part of this initiative, the Council of the Americas leads ongoing discussions with diplomats, visiting dignitaries and senior policy officials to create an open forum for energy issues.

Energy Action Group Themes:

Security of Energy Supply — Oil and gas supplies in the Western Hemisphere are very important to the United States and the region. Current political situations in several countries make this a crucial and on-going issue.

Energy Industry Investment Issues — Topics including investment climate safety, security of commitments, and investment dispute resolution will be discussed.

North American Energy Integration — We are working to advance the North American energy integration dialogue, in conjunction with the Mexico-US (MEXUS) Business Committee, a committee of the Council of the Americas. Through MEXUS, we bring together energy companies of NAFTA countries to promote one agenda to policy makers.

Supplying Energy to the Region — As industrialization continues in the Western Hemisphere, there will be a larger demand for reliable production and transmission of electricity. Historically, energy consumption increases at twice the rate of GDP growth. If this trend continues, the region's largest economies will not be able to meet demand.

Alternate Energy Sources — As the United States and the rest of the Western Hemisphere look to broaden their energy sources, they have begun to look at alternative sources of power. Among them are Liquefied Natural Gas (LNG), Hydroelectric Power, and Solar Energy.

Setting An Agenda — EAG members play an active role in setting the agenda for the group. By keeping the Council and the rest of the EAG informed of current issues, we are working together to promote discussion, advancement, and favorable resolutions.

http://www.americas-society.org/coa/events/2006events/2005/October/EnergyReport/FINAL%20-%20COA%20Energy%20Action%20Group%20Report.pdf

OPEC *Organization of the Petroleum Exporting Countries*

World Oil Outlook 2007

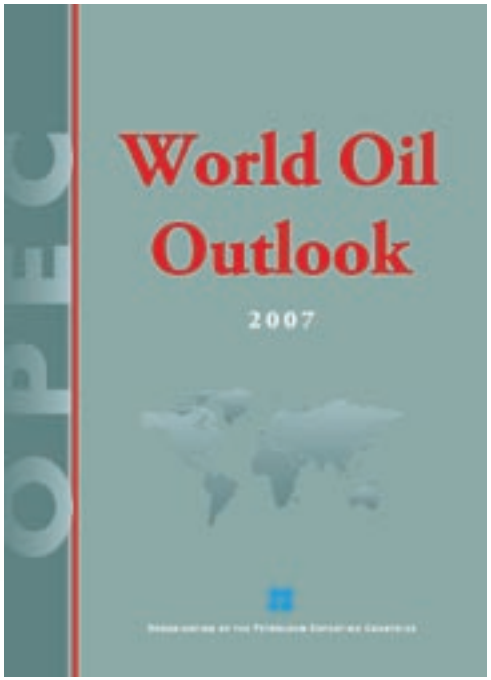
- **The OPEC Secretariat** has, for many years, produced a medium- to long-term outlook of the global oil scene. Results and analysis have offered insights into many important issues that producing countries and the oil industry have been, and may be confronted with in the future.

- In our reference case, with an average global economic growth rate of 3.5% per annum (purchasing power parity basis), and oil prices assumed to remain in the $50-60/b range in nominal terms for much of the projection period, oil demand is set to rise from the 2005 level of 83 mb/d to 118 mb/d by 2030. This also assumes that no particular departure in trends for energy policies and technologies takes place. This is a very important caveat for there are inherent downside risks to demand, something that is specifically addressed in this outlook.

- The transportation sector will be the main source of future oil demand increases. Of the non-transportation oil use, the main expected source of increase will be in the industrial and residential sectors of developing countries, which see a combined growth to 2030 of over 11 mboe/d in the reference case.

- Initial increases in both crude and non-crude supply pushes total non-OPEC supply up to 54 mb/d in 2010. This is 5 mb/d higher than in 2005. After 2010, non-OPEC crude supply, including NGLs, stabilises, then eventually falls. Yet with non-conventional oil supply increasing at strong rates, over the entire projection period, total non-OPEC supply actually continues to rise.

- The amount of crude oil supply expected from OPEC increases post-2010, rising, in this reference case, to 38 mb/d by 2020 and 49 mb/d by 2030.



- There is a great deal of uncertainty over future demand and non-OPEC supply, which translates into large uncertainties over the amount of oil that OPEC Member Countries will eventually need to supply. Investment requirements are very large, and subject to considerably long lead-times and pay-back periods. It is therefore essential to explore these uncertainties in the context of alternative scenarios.

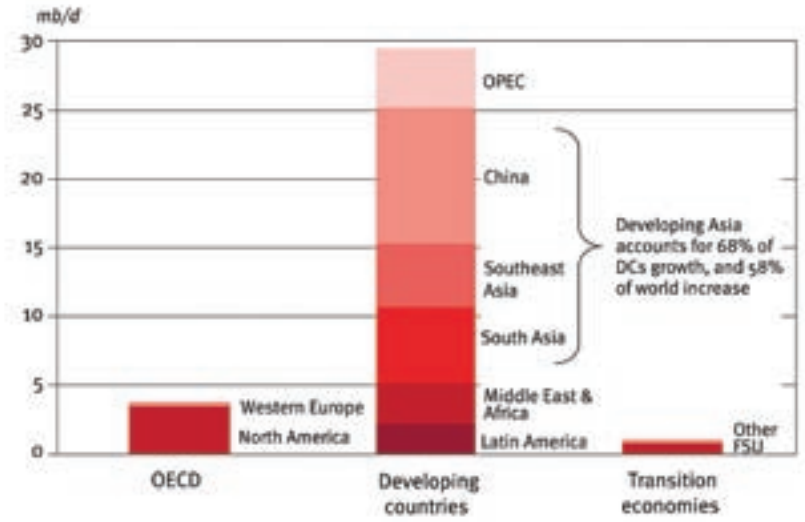
- Taking into account the most likely changes in the future supply and demand structures and their quality specifications, the global downstream sector will require in the period 2006–2020, 13 mb/d of additional distillation capacity, around 7.5 mb/d of combined upgrading capacity, 18 mb/d of desulphurisation capacity and 2 mb/d of capacity for other supporting processes, such as alkylation, isomerisation and reforming.

Website: http://www.opec.org/library/World%20Oil%20Outlook/pdf/WorldOilOutlook.pdf

OPEC *Organization of the Petroleum Exporting Countries*

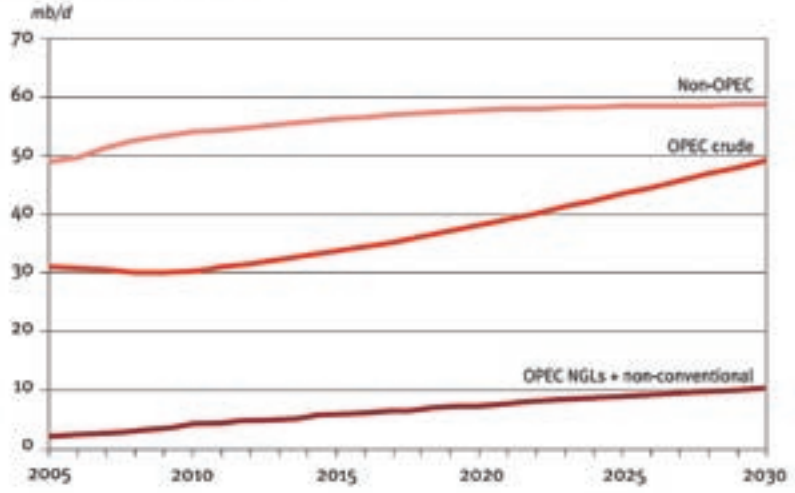
World Oil Outlook 2007

Annual growth in oil demand, 2005–2030



OECD countries, currently accounting for close to 60% of world oil demand, see a further growth of 4 mb/d by 2030, reaching 53 mb/d. Developing countries account for most of the rise in the reference case, with consumption doubling from 29 mb/d to 58 mb/d. Asian developing countries account for an increase of 20 mb/d, which represents more than two-thirds of the growth in all developing countries.

World oil supply, 2005–2030



Inter-regional oil trade should increase by 13 mb/d to almost 63 mb/d of oil exports in 2020. Both crude and products exports will increase appreciably, with products exports growing faster than crude oil exports. Correspondingly, the reference case outlook calls for a total tanker fleet requirement in 2020 of 460 million dwt. This compares to 360 million dwt as of the end of 2006.

ENERGY CHARTER SECRETARIAT

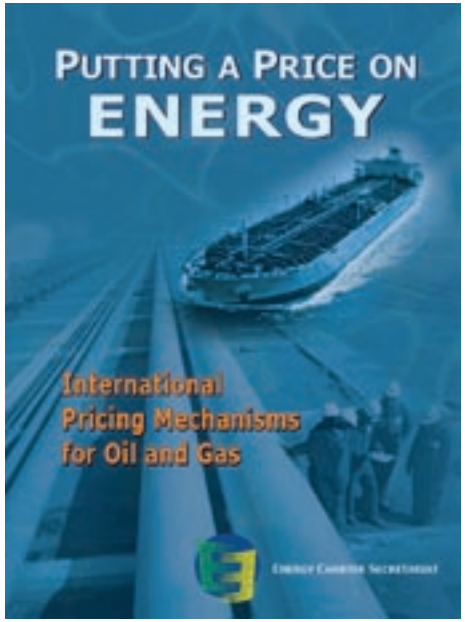
Putting a Price on Energy

International Pricing Mechanisms for Oil and Gas

The Energy Charter Treaty

The Energy Charter Treaty provides a multilateral framework for energy cooperation that is unique under international law. It is designed to promote energy security through the operation of more open and competitive energy markets, while respecting the principles of sustainable development and sovereignty over energy resources.

A core principle of the Energy Charter is 'market-oriented price formation' for the energy sector, within the framework of sovereign rights over energy resources. But this begs the question: how can these two elements be combined and how are they reflected in the formation of oil and gas prices in international trade?



Overall Conclusions

Website: http://www.encharter.org

This report looks at the pricing mechanisms for oil and gas by also using approaches of some more specialised parts of economic theory, mainly transaction cost theory dealing with different pricing and contract mechanism of open markets, long-term contracts and vertical integration, the theory of finite resources as reflected in Hotelling and Ricardian rent and the principal-agent theory. They suggest the following analysis:

The transaction cost theory suggests that the combination of marketplaces, long-term contracts and vertical integration depends on technology, market structure and regulation, and that it will change to reflect their development. Geology and geography provide the overall context, but the impact of endowments changes with the development of technology, as well as of markets and regulations. An important element in order to understand differences in pricing mechanisms is that there are two actors on the supply side: the resource owner, usually represented by a national government, which takes decisions determining the depletion of its resources, and the producing company, which takes the decision to invest.

Oil has already been traded internationally for more than a century, and trade in oil has developed all the features of a global commodity market. However, natural gas has not (yet) followed suit, and whether and how a global gas market might emerge is a hotly debated topic in international energy.

What we see instead, in the case of natural gas, are strong variations in the pricing mechanisms for international gas trade into different regional and national markets. This study examines possible reasons for these differences, starting with the physical properties of natural gas and the distribution of gas reserves, and continuing with a detailed consideration of the mechanisms that have emerged to determine gas prices in North America, in the UK and in Continental Europe. It also examines the role of liquefied natural gas in providing a link between different markets.

The aim of this study is to encourage an informed debate about international oil and gas pricing, which itself is a key to understanding many current developments on international energy markets. The study, available on the Energy Charter's website, does not recommend a particular model for national energy markets or for international commercial arrangements. However, and particularly where gas is traded through pipelines, it underlines that the international gas trade depends on long-term decisions that are taken along the entire energy chain. This in turn strengthens the significance of the Energy Charter as an instrument for international energy cooperation, since the Charter establishes binding disciplines protecting these long-term investment and trade decisions.