More Diverse
More Domestic
More Efficient

A VISION FOR America's Energy Future

Business Roundtable℠

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Business Roundtable (www.businessroundtable.org) is an association of chief executive officers of leading U.S. companies with $4.5 trillion in annual revenues and more than 10 million employees. Member companies comprise nearly a third of the total value of the U.S. stock market and represent more than 40 percent of all corporate income taxes paid to the federal government. Collectively, they returned $112 billion in dividends to shareholders and the economy in 2005.

Roundtable companies give more than $7 billion a year in combined charitable contributions, representing nearly 60 percent of total corporate giving. They are technology innovation leaders, with $90 billion in annual research and development (R&D) spending — nearly half of the total private R&D spending in the U.S.

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A Vision for America's Energy Future

June 2007

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Executive Summary

During the 1970s, two global energy crises challenged the federal government and American businesses to diversify their energy portfolios and develop new technologies to increase efficiency and promote conservation. After these crises passed, the United States enjoyed a long period of affordable energy and stable markets. However, new supply constraints and geopolitical uncertainties coupled with surging global demand have again created a challenging energy environment for U.S. consumers and businesses.

Although the U.S. economy has proven resilient in the face of higher energy costs, concerns about energy security remain a top priority for businesses, policymakers and the public. Business Roundtable members, 160 CEOs of leading U.S. companies with more than $4.5 trillion in annual revenues and more than 10 million employees, share these concerns. We recognize that domestic and worldwide energy trends not only affect consumers but also have important implications for economic growth, capital investment and U.S. competitiveness in the global economy.

Today's energy challenges are not insurmountable, but there are no silver bullets. Long-term progress requires balanced and integrated approaches that take advantage of *all* promising energy improvement pathways. Despite its superficial appeal, energy independence (the elimination of energy imports) is an unrealistic goal for the foreseeable future. But there is much we can do to enhance our energy security. Policies that promote new technologies, conservation, efficiency, greater diversity of supply, lower energy intensity, and greater access to domestic and global energy resources will over time reduce the nation's vulnerability to upheavals in global energy markets.

To develop a vision of America's energy future, Business Roundtable conducted a unique "bottom up" process in which CEOs representing several major economic sectors developed technology roadmaps describing pathways the sector could take to improve conservation, efficiency and domestic energy production between now and 2025. These roadmaps were vetted at a brainstorming workshop attended by industry energy experts and senior executives. This process resulted in a strong consensus that the United States, using technological innovation, sound government policies and proactive voluntary efforts, must:

- Significantly enhance energy security in the transportation sector by improving the fuel efficiency of vehicles, diversifying our mix of transportation fuels, increasing access to energy resources, reducing vehicle miles traveled and promoting greater implementation of advanced technologies.
- Bring supply and demand for natural gas into better balance by expanding access to domestic natural gas sources, making timely investments in new infrastructure (e.g., pipelines and liquefied natural gas terminals) and using natural gas more efficiently.
- Maintain a viable and growing nuclear power sector, both to relieve demand pressure on fossil fuels and to reduce the U.S. greenhouse gas footprint.
- Significantly accelerate improvements in energy efficiency in our commercial, residential and industrial sectors.

- Support and fortify free markets and global energy trade and investment.
- Promote fundamental research to develop advanced technological solutions to long-term energy and environmental challenges.

How We Get There

In each of these areas, Business Roundtable developed ambitious goals for the next 20 years, which are detailed in the body of this report.

Roundtable members strongly support an aggressive national initiative to promote increased energy efficiency. We advocate a national goal of reducing energy intensity (energy consumed per unit of economic output) by at least 25 percent more than the anticipated business-as-usual rate of improvement. This would mean a reduction of at least 2.2 percent per year, for an overall reduction in energy intensity of more than 40 percent by 2025. Achieving this goal will require a concerted effort to deploy energy efficiency technologies across the economy, emphasizing opportunities in multiple sectors such as:

- Improving building efficiency
- Increasing the energy efficiency of appliances
- Increasing efficiencies in the transmission and distribution system
- Using more efficient motors, drives and transformers
- Expanding demand-side management in the retail power distribution sector
- Upgrading the existing gas and steam turbine fleet
- Investing in advanced coal generation technologies
- Accelerating wind and solar generation
- Increasing combined heat and power units

Capturing these opportunities will require leadership and commitment by the business community, and Business Roundtable will be strongly encouraging its members to champion energy efficiency.

Business Roundtable recognizes that our energy future is increasingly linked to our environmental goals — most notably progress in reducing greenhouse gas emissions and addressing concerns about global climate change. Our proposals for improving energy efficiency, investing in alternative fuels, expanding the U.S. nuclear fleet and pursuing new technologies, such as gasification with carbon capture and sequestration potential, will not only strengthen our energy security but also contribute to reducing the U.S. carbon footprint.

Business Roundtable would like to express its appreciation to Cambridge Energy Research Associates for its review of the Business Roundtable's policy statement on energy.

The U.S. Energy Challenge

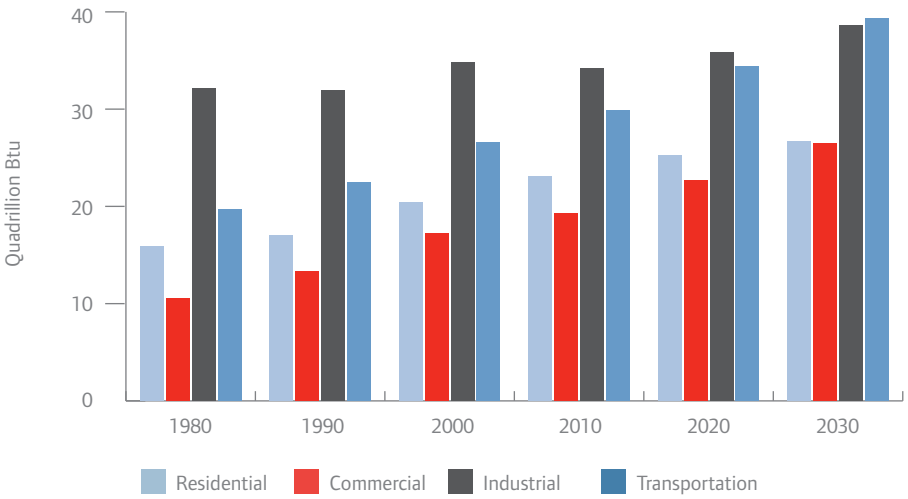
During the 1970s, two global energy crises challenged the federal government and American businesses to diversify their energy portfolios and develop new technologies to increase efficiency and promote conservation. After these crises passed, the United States enjoyed a long period of affordable energy and stable markets. However, new supply constraints and geopolitical uncertainties coupled with surging global demand have again created a challenging energy environment for U.S. consumers and businesses. Marked increases in the prices of oil and natural gas have put economic pressures on energy users, including corporations of all sizes and individual households. Although energy prices have fallen somewhat from their mid-2006 peak, they remain high by historical standards and continue to threaten U.S. economic and national security objectives. Moreover, rising energy demand resulting from strong economic growth in developing nations is likely to persist for the foreseeable future, leading to continuing tight market conditions and constraints on supply.

Although the U.S. economy has proven resilient in the face of higher energy costs, concerns about energy security remain a top priority for businesses, policymakers and the public. Business Roundtable members, 160 CEOs of leading U.S. companies with more than $4.5 trillion in annual revenues and more than 10 million employees, share these concerns. We recognize that domestic and worldwide energy trends not only affect consumers but also have important implications for economic growth, capital investment and U.S. competitiveness in the global economy.

Solutions to our energy challenges need to be based on a realistic understanding of world energy markets, sound economic analysis, and an appreciation of the opportunities and limitations of current and future technologies, as well as the lead-time necessary to incorporate technology changes into our capital stock. Although different sectors of the economy face different energy challenges, all sectors have the same interest in maintaining access to secure and stable energy supplies at globally competitive prices — and no one sector will be able to meet its energy needs without the actions of a wide range of energy producers and users throughout the economy.

Today's energy challenges are not insurmountable, but solving them will require a collective national commitment to a comprehensive long-term strategy that addresses *all* aspects of the energy equation: increasing conservation and efficiency; boosting access to domestic conventional energy reserves; diversifying energy sources and increasing supplies; fortifying free markets and international trade; and investing in advanced technologies to improve energy efficiency, develop alternative fuels, strengthen our fuel distribution infrastructure and manage environmental risks. Although policymakers are understandably eager to allay consumer concerns about high energy prices, "quick fix" proposals that distort markets over the short term without providing a foundation for comprehensive long-term solutions are likely to do more harm than good.

Primary Energy Consumption by Sector, 1980–2030



Source: *Annual Energy Outlook 2007.*

Despite its superficial appeal, energy independence (the elimination of energy imports) is an unrealistic goal for the foreseeable future. But there is much we can do to enhance our energy security. Policies that promote new technologies, conservation, efficiency, greater diversity of supply, lower energy intensity, and greater access to domestic and global energy resources will over time reduce the nation's vulnerability to upheavals in global energy markets. While the United States has made dramatic progress since the 1970s in reducing energy intensity, additional significant gains remain essential.

The energy bill enacted by Congress in 2005, the Energy Policy Act of 2005 (EPAct05), was an important and valuable first step toward achieving these goals, but more must be done to meet our long-term supply and price challenges and ensure the availability of stable and competitive energy supplies. Business Roundtable urges Congress and the White House to pursue thoughtful, comprehensive approaches that leverage the power of markets and technology. Rather than mandate solutions or pick winners and losers, government must encourage all promising innovations that increase supply and promote efficiency, with incentives to accelerate the development and deployment of new technologies and fuels so they reach the market as soon as possible. Competition and consumer demand in the marketplace, not top-down requirements, should shape our energy future.

U.S. environmental and energy policy must create a stable fiscal and regulatory framework for long-term planning and investment. This means recognizing and providing the energy tools to address important environmental challenges (like rising levels of greenhouse gases in the atmosphere) while removing unwarranted regulatory and market barriers (like rigid new source review requirements) to improving energy efficiency and enhancing supply.

What Business Roundtable Is Doing to Address America's Energy Challenge

Leadership in addressing our energy challenges is not just a job for government. The business community has a special obligation to step forward because of its central role in producing, distributing and consuming energy.

Business Roundtable member CEOs have consistently ranked energy as one of the most pressing and difficult challenges affecting their businesses and the overall U.S. economy. In response to this concern, the Roundtable formed the Energy Task Force, chaired by Michael Morris, CEO of American Electric Power, to create a single blueprint to improve the U.S. energy situation and unite competing interests across the business community.

Business Roundtable's membership represents nearly every sector of the economy and therefore possesses unparalleled expertise in the technologies for creating our energy future. To harness that expertise, the Roundtable issued *Changing America's Energy Future: An Energy Action Plan* in June 2006. This plan emphasizes four broad objectives:

- Increasing conservation and energy efficiency
- Increasing access to conventional domestic energy sources
- Diversifying our energy supply mix
- Investing in new energy technologies

To achieve these objectives, the plan calls for voluntary national goals for increasing conservation and efficiency, expanding access to energy resources, and developing a diverse array of energy sources. The plan also calls for a realistic implementation strategy to meet these goals, drawing on the technological capabilities of the energy-producing and energy-using sectors of the economy.

To build on the Energy Action Plan, Business Roundtable developed a unique "bottom up" process to capture the insights and experience of leading industry energy experts. At the invitation of Mr. Morris, 11 CEOs agreed to be leads for major sectors of the economy. Mr. Morris asked each of the sector leads to develop technology roadmaps describing pathways the sector could take to improve conservation, efficiency and domestic energy production between now and 2025. For each pathway, the roadmaps were to identify technical or economic obstacles to be overcome, a realistic time frame for implementation and the energy benefits to be achieved. All the roadmaps were to address environmental concerns, particularly the reduction of America's greenhouse gas (GHG) footprint.

To examine the roadmaps prepared by the sector leads, Mr. Morris convened an energy technology workshop on November 29, 2006. During the workshop, panels of experts from member companies summarized and discussed the highlights of the roadmaps. The participants then formed breakout groups to examine critical issues in greater depth. The workshop was attended by representatives of 21 companies, including several CEOs.

The workshop underscored the wide range of exciting and innovative energy solutions that Business Roundtable members are pursuing and the benefits of collective brainstorming by industry energy experts on the most promising energy improvement pathways. During the workshop, companies from all sectors strongly affirmed the importance of improving energy efficiency, and they committed to work together to encourage the adoption of energy efficiency technologies across the economy.

Business Roundtable's Recommendations: The U.S. Energy Path for the Next 20 Years

Our Overall Objectives

In the next 20 years, the United States, using technological innovation, sound government policies and proactive voluntary efforts, must:

- Significantly enhance energy security in the transportation sector by improving the fuel efficiency of vehicles, diversifying our mix of transportation fuels, increasing access to energy resources, reducing vehicle miles traveled and promoting greater implementation of advanced technologies.
- Bring supply and demand for natural gas into better balance by expanding access to domestic natural gas sources, making timely investments in new infrastructure (e.g., pipelines and liquefied natural gas [LNG] terminals), and using natural gas more efficiently.
- Maintain a viable and growing nuclear power sector, both to relieve demand pressure on fossil fuels and to reduce the U.S. GHG footprint.
- Significantly accelerate improvements in energy efficiency in our commercial, residential and industrial sectors.
- Support and fortify free markets and global energy trade and investment.
- Promote fundamental research to develop advanced technological solutions to long-term energy and environmental challenges.

How We Get There

In each of these areas, we must set ambitious goals for the next 20 years. Business Roundtable proposes the following goals:

- To increase *energy security in the transportation sector,* we should aggressively pursue seven parallel strategies:
  - Reduce petroleum consumption by maximum feasible development and deployment of energy-efficient vehicle technologies, including advanced batteries and fuel cells;
  - Enhance conventional domestic oil production by increasing extraction rates at existing and new fields and expanding access to currently off-limit reserves;
  - Enhance refinery output to meet market demand and required fuel specifications cost effectively;
  - Substantially increase the use of renewable transportation fuels by voluntarily scaling up to 10 percent ethanol in gasoline as quickly as possible, undertaking intensive research and development (R&D) on advanced bio-fuel technologies such as bio-butanol and cellulosic ethanol, and reaching agreement within the industry on a single specification for bio-fuels in light-duty fuels;

- Scale up the production of transportation fuels from unconventional sources, like oil shale and coal-based feedstocks, by relying on gasification and other emerging technologies;
- Moderate fuel demand by adopting policies that reduce vehicle congestion and idling and growth in vehicle miles traveled per capita; and
- Maintain access to the world's energy resources by preserving the integrity of free markets and opportunities for robust foreign investment by our energy industry.

- To achieve a *better supply-demand balance in natural gas markets,* we should increase supplies of natural gas while curbing demand by:
  - Broadening access to land and offshore reserves that are now off-limits to development;
  - Developing alternative sources of supply by increased gasification of coal and bio-mass to produce natural gas for electricity production and synthetic gas for use as a manufacturing feedstock;
  - Building pipelines and LNG facilities to transport new domestic supplies and facilitate imports where needed to meet demand; and
  - Reducing consumption through energy-saving practices and increased energy efficiency, principally in the electricity supply and consumption sectors.

- To maintain a *viable and growing nuclear power sector,* we should:
  - Establish an efficient, predictable licensing system for new nuclear plants;
  - Continue to provide effective financial incentives for new plants; and
  - Implement a workable and effective program for the management and disposal of spent nuclear fuel.

- To improve *energy efficiency in the commercial, residential, industrial and electric power sectors,* we should reduce energy intensity (energy consumed per unit of economic output) by at least 25 percent above the anticipated business-as-usual rate of improvement.
  - This would mean a reduction in intensity of at least 2.2 percent per year (as compared to the 1.8 percent reduction projected by the U.S. Department of Energy's Energy Information Administration [EIA]), for an overall reduction in energy intensity of more than 40 percent by 2025.
  - An accelerated rate of improvement in energy intensity will require a concerted effort to deploy energy efficiency technologies across the economy, emphasizing opportunities in multiple sectors such as:
    - — Improving building efficiency
    - — Increasing the energy efficiency of appliances

— Increasing efficiencies in the transmission and distribution system

— Using more efficient motors, drives and transformers

— Expanding demand-side management in the retail power distribution sector

— Upgrading the existing gas and steam turbine fleet

— Investing in advanced coal generation technologies

— Accelerating wind and solar generation

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Our Implementation Principles

Business Roundtable's goals are intended as guideposts for industry and government, not as mandates. Although a variety of helpful policy tools can contribute to achieving these goals, an essential role must be performed by technological innovation and capital investment in response to market forces. Government programs should accelerate market trends and support promising technologies, but they should not distort the forces of supply and demand. Competition and consumer demand in the marketplace, not top-down requirements, should shape our energy future.

Business Roundtable members strongly support an aggressive national initiative to promote increased energy efficiency, and we recognize that business must play a leadership role in this effort. As described in the text that follows, the Roundtable is launching several ambitious initiatives to promote energy efficiency in different areas of the economy — demonstrating the powerful role that voluntary commitments by the nation's leading companies can play in driving positive changes in how energy is produced and consumed.

Underlying Business Roundtable's goals is the recognition that there are no silver bullets to solve our energy challenges and that long-term progress requires balanced and integrated approaches that take advantage of *all* promising energy improvement pathways. For example:

- In the transportation sector, diversifying the transportation fuel mix and increasing domestic fuel sources require multiple strategies, including maximized deployment of bio-fuels and alternatives in gasoline and diesel fuels, increased access to domestic petroleum resources, deployment of nonconventional fuel production technologies like coal-to-liquids, and continued adoption of advanced vehicle technology to the maximum extent feasible.
- Improving energy efficiency in the electricity sector will reduce natural gas consumption and help moderate prices, but supply-demand imbalances will not ease unless we strongly increase the domestic production of natural gas; maintain a strong national commitment to nuclear power; and use coal gasification to ensure a reliable and globally competitive supply of low-cost fuels and feedstocks for the chemical, fertilizer and other manufacturing industries.

- Pressure on energy markets can be reduced by efficiency and conservation measures in other parts of the economy. As an example, energy efficiency improvements in new and existing residential and commercial buildings, on the order of 50 percent beyond current practice, are both practical (using known technology) and cost effective (based on life-cycle costing). Given that more than 70 percent of electricity production is consumed in residential and commercial buildings, improvements in this area will deliver significant electrical demand reduction, as well as direct fossil fuel combustion reductions.[1]

Business Roundtable recognizes that our energy future is increasingly linked to our environmental goals — most notably progress in reducing GHG emissions and addressing concerns about global climate change. Our proposals for improving energy efficiency, investing in alternative fuels, expanding the U.S. nuclear fleet and pursuing new technologies, such as gasification with carbon capture and sequestration potential, will not only strengthen our energy security but also contribute to reducing the U.S. carbon footprint.

Diversifying Our Fuel Mix and Increasing Fuel Supplies to Meet the Energy Needs of the Transportation Sector

The U.S. Petroleum Situation

After the price shocks of the 1970s and early 1980s, the United States enjoyed lower oil prices for nearly a quarter of a century. Through investments in capacity expansion, the major oil exporting nations and international oil producers ensured adequate supplies of oil at reasonable prices even with an upturn in demand, while political stability in the Middle East and other regions prevented severe disruptions in supply. Oil prices stayed far below the high levels of the early 1980s — low enough to keep the world economy growing at a healthy pace and avoid the need for large-scale investments in alternative fuels and new energy technologies. But in recent years, three new global forces have reshaped global energy markets:

- **Economic growth:** Sustained strong global economic growth has added to global oil demand and put upward pressure on world oil prices as surplus production capacity has diminished. This has resulted in global markets' experiencing imbalances between supply and demand, constraints on supply, and associated price volatility.
- **Security concerns:** U.S. security concerns that arose after the 9/11 terrorist attacks have intensified worries about our vulnerability to disruptions in supply due to terrorist attacks on production facilities and pipeline infrastructure, political instability, and boycotts by countries hostile to U.S. interests.
- **Foreign policy concerns:** An escalation of frictions between the United States and key oil exporters that have adopted policies that many consider anti-American, such as Iran and Venezuela, has heightened foreign policy worries. The leverage of U.S.-based energy firms and the U.S. government has declined because increasing shares of the world's oil and gas reserves are in regions controlled by national oil companies (NOCs). Only 19 percent of global reserves are available for full application of the capital and technology of international oil companies (IOCs). An additional 49 percent are restricted by NOC owners, with limited access by IOCs, and the remaining 32 percent are effectively closed to IOCs.

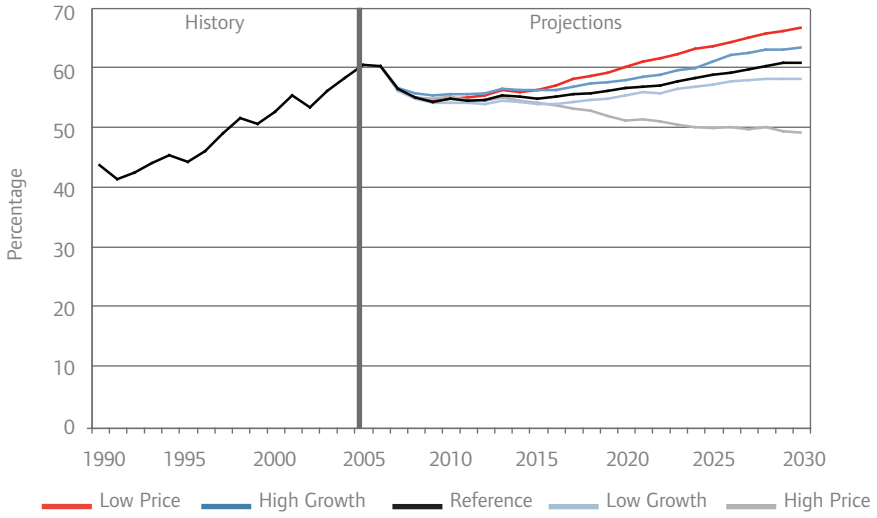
In 2006, the imbalance between supply and demand contributed to a surge in world oil prices to more than $75 per barrel, placing substantial burdens on U.S. consumers and businesses. Although oil prices have moderated somewhat, they remain significantly above prevailing levels in the 1990s.

In 2005, the United States consumed 20.7 million barrels of oil per day (mbd) of petroleum products — roughly a quarter of world petroleum consumption and more than the next five largest consuming countries (China, Japan, Germany, Russia and India) combined.[2] With

domestic production in decline and consumption on the rise, U.S. petroleum imports increased from 20 percent to 60 percent during the past 35 years.[3] U.S. petroleum demand is primarily driven by the transportation sector, which accounts for two-thirds of petroleum consumption.[4] In contrast, the industrial sector consumes approximately 24 percent of all petroleum products, while the residential, commercial and electric power sectors' use *combined* represents less than 10 percent.[5]

Looking forward to 2025, EIA projects that — in the absence of significant policy changes or unanticipated technological advancements — petroleum consumption in the United States is expected to increase by more than 5 mbd, while domestic oil production is expected to remain at current levels.[6]

Net Import Share of U.S. Liquid Fuels Consumption, 1990–2030



Source: *Annual Energy Outlook 2007*.

It is estimated that the transportation sector will account for more than 90 percent of the growth in petroleum consumption, reflecting the growing mobility of our society, with more cars on the road traveling longer distances and creating greater congestion and idling.[7] Worldwide, demand is expected to grow by 33 percent by 2025, increasing from 84 mbd to 110 mbd.[8] Demand in India and China alone is projected to double during this period. Simultaneously, production is expected to decrease in the developed world while substantially growing in Organization of the Petroleum Exporting Countries (OPEC) member countries, Russia, and developing economies in South America and Africa.

Given these trends in petroleum demand, diversifying our fuel mix and increasing access to all domestic and global sources of supply are critical national security goals. Business Roundtable believes that achieving these goals requires the nation to aggressively pursue six parallel strategies:

- Continue the development and deployment of vehicle technologies that improve fuel efficiency to the maximum extent feasible.
- Increase domestic petroleum supplies.
- Scale up the domestic alternative fuels industry.
- Develop nonconventional domestic sources of hydrocarbon-based fuels, such as coal-to-liquids and oil shale.
- Adopt government policies that slow the growth in fuel demand by reducing congestion, idling and the growth in miles traveled per vehicle.
- Pursue national security policies that seek to preserve the integrity of free markets, global energy trade and opportunities for robust foreign investment by the energy industry.

These strategies are described below.

Deploying Fuel-Efficient Vehicle Technologies

For the vehicle manufacturing industry, *a key pathway is to continue the development and deployment of advanced light- and heavy-duty vehicle technology to reduce petroleum usage* at the maximum feasible rate allowed by economic forces, safety concerns and consumer preferences.

Near-term actions are to continue the deployment of advanced internal combustion power-trains, using technologies such as variable valve timing, cylinder deactivation, direct injection and electromechanical automatic transmissions (hybrid-electric), as well as advanced vehicle materials such as light-weight, high-strength composites.

Mid-term goals are to move toward the high-volume application of alternative fuel vehicles, advanced clean diesels and hybrids. As described below, alternative fuel vehicles take advantage of bio-fuels and other nonpetroleum alternatives. Further enhanced fuel standards are critical enablers for scale-up of these vehicles. Hybrid power trains combine electric motors and heat engines to reduce fuel consumption, particularly in stop-and-go urban traffic. Diesel technology, which makes up a substantial portion of light-duty fleets in Europe, is poised for expansion in the United States as manufacturers successfully address consumer acceptance and air quality concerns. Diesel vehicles can typically achieve 30–35 percent improvements in fuel economy over their gasoline counterparts.[9]

In the long term, the goal is to move toward the high-volume application of breakthrough power-train technologies, such as plug-in hybrids, electric vehicles with range extenders, series hybrid hydraulic power trains and fuel cell-powered vehicles. Development of these technologies will require a sizable ongoing commitment of funds and expertise to R&D programs. In some cases, the high level of risk and investment required will dictate joint programs among companies (the two-mode hybrid cooperative development initiative

among BMW, General Motors and DaimlerChrysler is a leading example). In other cases, the fundamental technical challenges presented require partnerships between government and industry (such as the FreedomCAR and Fuels Partnership to develop hydrogen fuel cell vehicles and other technologies).

Two important priorities for joint R&D are batteries and fuel cell technology. Breakthroughs in battery systems are needed for successful commercialization of conventional hybrid and related battery-dependent vehicle technologies, such as plug-in hybrids or fuel cell electric vehicles. Cost reduction and the development of U.S. manufacturing capacity are the main challenges. The United States Advanced Battery Consortium (USABC) has established cost reduction goals for high-energy and high-power batteries, which are critical to the commercial viability of plug-in hybrids that allow consumers to access the electricity grid for battery recharging and further reduce the need for liquid fuel inputs; with successful R&D, this technology could become cost-competitive after 2012.[10]

Fuel cell-powered vehicles also have substantial promise. Because they are fueled by hydrogen (derived from natural gas or electrolysis of water) rather than petroleum, fuel cells potentially have substantially lower CO_2 emissions on a "well-to-wheel" basis than conventional gasoline vehicles. Despite advancements in the technology, however, there are still major barriers to fuel cell commercialization. For example, improvements are needed in the power density, durability and cost of the fuel cell. In addition, on-board hydrogen storage capacity needs to be increased. With these barriers overcome, a steady commitment will be required to establish the infrastructure to supply hydrogen fuel to motorists and to expand hydrogen production capability.

Incentives to increase R&D and early consumer purchase of advanced technology vehicles are important steps toward the ultimate deployment of these technologies. Government purchases of flex fuel and advanced technology vehicles are essential to overcoming market barriers.

Overall, the vehicle manufacturing industry is committed to aggressively deploying conventional and advanced power-train technologies to improve fuel efficiency to the maximum extent feasible as determined by competition and consumer demand in the marketplace.

Increasing Domestic Petroleum Supplies

For the petroleum industry, *a key energy improvement pathway is enhancing conventional domestic oil production*.

A comprehensive energy strategy must fully capitalize on America's petroleum resources at the same time that we moderate demand and diversify our supply of transportation fuels. While

U.S. oil production has been declining since its peak in 1970, increased recovery and yields from existing wells and refineries and expanded access to U.S. reserves can offset this trend.

In every oil field, a proportion of the oil in place cannot be recovered economically using current technologies. Although the recovery rate has constantly improved over time, continuing advances in technology will further boost recoveries from U.S. oil fields. One such advance, which has been in use for many years, is enhanced oil recovery (EOR) through a concentrated underground injection of CO_2 in oil wells. EOR could receive a significant impetus from expanded CO_2 capture in the coal-fired power sector and facilities that gasify coal.

In addition, it is possible to convert more of each barrel recovered into usable fuel. Upgrading today's refineries with deep conversion units using the latest technologies can minimize output of "heavy" fuel oil or petroleum coke, for which there is relatively little demand, and increase yields of gasoline, diesel and jet fuel.[11] The United States currently leads the world in deep conversion capacity, although other regions, especially Asia-Pacific and the Middle East, are making large investments in this technology.

Substantial R&D is required for the technological advances that will achieve the highest recoveries and yields. This R&D would be accelerated by increased support for joint government-industry research partnerships and fiscal incentives for early deployment of new technologies.

Improving the productivity of existing wells and refineries must be coupled with increasing access to currently off-limit oil reserves onshore and offshore. Too many significant oil prospects are now unofficially or officially off-limits.

The United States Geological Survey (USGS) estimates that onshore conventional undiscovered technically recoverable resources of oil total about 45 billion barrels of oil (Bbo).[12] A significant portion of these resources lie under federal lands and remain either officially or practically off-limits to exploration and development. In fact, two of the potential largest concentrations of undiscovered oil deposits, the National Petroleum Reserve–Alaska and the Arctic National Wildlife Refuge, are located on federal lands in Alaska's North Slope region. These two regions alone represent almost half of all undiscovered resources on U.S. lands.[13]

As onshore resources have been increasingly difficult to find and develop economically, a significant portion of U.S. production has shifted offshore to the Outer Continental Shelf (OCS). The U.S. Mineral Management Service estimates that the OCS has a total endowment of approximately 115 Bbo, with nearly two-thirds of the amount remaining undiscovered.[14] As with onshore resources, a significant portion of offshore oil deposits remain inaccessible to exploration and development. Specifically, much more than 20 percent of all undiscovered offshore resources are located in OCS waters under congressional moratoria and/or presidential withdrawal.[15] Industry's exceptional track record at existing OCS sites provides strong assurances that these resources can be developed without adverse environmental impacts.

It is critically important to increase access to currently off-limit oil reserves onshore and offshore through enactment of legislation by Congress and expanded leasing on federal lands. As an initial step, the U.S. government should conduct a modern inventory of key areas in the OCS, as authorized in the EPAct05. An effective, targeted two-dimensional seismic survey of selected areas in the Pacific, Atlantic and Gulf regions would form the basis of an informed and fact-based discussion about OCS potential.

Without measures to increase the productivity of existing wells and refineries and expanding access to currently off-limit reserves, domestic conventional oil production would be expected to decline significantly by 2025. Collectively, however, the strategies described above could contribute 3.6 mbd by 2025, offsetting declines in existing production or potentially allowing for a moderate increase to current production levels.

Increasing Renewable Transportation Fuels

For the bio-fuels, auto and fuel distribution industries, *a key pathway is to substantially increase the production and use of renewable transportation fuels.*

There is considerable interest in increasing the contribution of bio-fuels to the U.S. transportation fuel supply. Domestically produced bio-fuels can diversify the transportation fuel mix, improve U.S. energy security and reduce the carbon footprint of the transportation sector. Business Roundtable supports reasonable steps to scale up the domestic bio-fuels industry.

The principal renewable fuel now in use in light-duty vehicles is ethanol.[16] In 2006, the United States produced 4.9 billion gallons of ethanol — more than 3 percent of fuel consumption in the transportation sector on a volumetric basis.[17] This ethanol is produced primarily by converting the starch in corn grains into sugar and then fermenting it to alcohol. Today ethanol is primarily used as a "fuel extender" and oxygenate — that is, it is blended into gasoline to displace petroleum and increase combustibility. Most gasoline-powered vehicles on the road today can run on ethanol blends as high as 10 percent, known as E10, without complication. The EPAct05 creates a renewable fuels portfolio standard that mandates the use of 7.5 billion gallons of renewable fuel by 2012, a goal that could be achieved as early as next year.

In 2007, the alternative fuel, auto and fuel distribution industry stakeholders should commit to a voluntary, national goal of increasing ethanol use to achieve 10 percent ethanol in gasoline as quickly as possible. Meeting this goal would require tripling the volume of ethanol that was used in transportation fuels in 2006. This increase can be achieved with existing technology, is compatible with the existing fuel distribution system and is consistent with evolutionary progress in ethanol production technology.

There is considerable interest in further increases in the use of ethanol and other bio-fuels. However, high-volume use of fuel blends with higher levels of ethanol and other bio-fuels (greater than E10) will require conversion of feedstocks to ethanol or other bio-fuels using technology that currently is not commercially feasible. The principal of such technology is the conversion of cellulosic bio-mass (e.g., corn stover, switchgrass), which entails the hydrolysis of plant fibers to yield a variety of sugars that are then converted into ethanol. Other bio-fuel sources such as bio-butanol are nearing market entry. To be successful, these sources should produce bio-fuels from domestic feedstocks on a cost-competitive basis with petroleum-based fuels.

Government should strongly support and fully fund R&D programs on cellulosic ethanol and other bio-fuel feedstocks, including the specific R&D programs authorized in EPAct05. Expedited research also should be conducted by government and industry on the emissions and other environmental impacts of different bio-fuel configurations.

Some policymakers have proposed aggressive market-penetration targets for fuel blends with higher levels of ethanol (E85) or other bio-fuels produced from non-corn-based feedstocks. Whether these goals are realistic will depend not only on the results of R&D on new ethanol production technologies but also on the production of vehicles that can accommodate blends with higher levels of bio-fuels and the creation of a fueling infrastructure for delivering these blends to consumers. **Vehicle manufacturers and fuel suppliers share a goal of maximizing alternative fuel penetration while resolving marketplace complexities and consumer acceptance issues as expeditiously as possible.** To that end, Business Roundtable proposes proceeding on the following parallel tracks:

- The alternative fuels producers and fuel distribution industry should identify pathways to make fuel blends greater than E10 competitive and widely available. The gasoline goal (for light-duty vehicles) should be to move as expeditiously as possible to make ethanol and other bio-fuel blends widely available and take maximum advantage of vehicles that must be purposefully designed for greater than E10 blends. The diesel fuel goal (for heavy-duty vehicles) should be to define high-volume-blend standards (e.g., greater than B5) that ensure a diesel bio-fuel that is compatible with all existing and next-generation diesel-powered products.
- The vehicle manufacturing industry should in parallel maintain its commitment to producing a significant portion of the light-duty fleet as flex-fuel vehicles (FFVs) capable of using greater than E10 ethanol blends. (General Motors, Ford and DaimlerChrysler already have committed to making FFVs 50 percent of their fleets by 2012, provided there is ample availability and distribution of E85.)
- To maximize and diversify the mix of alternative fuels in transportation fuels, there should be a collaborative process among the automobile manufacturers, fuel suppliers and alternative fuel producers to develop a single specification for ethanol and other

bio-fuels in gasoline for light-duty vehicles that enables these vehicles to use alternative fuels cost-effectively, maximizes the efficient distribution of fuel and advances a well-thought-out deployment of advanced bio-fuel technologies.

- An acceptable diesel bio-fuel specification (e.g., greater than B5) should be developed as soon as possible, and standards on other bio-fuels should be developed as necessary to support the rollout of flex-fuel technology.
- In the interim, Corporate Average Fuel Economy credits should continue for FFVs to enable a vehicle population that can use a variety of fuel blends as dictated by market conditions.

With these cooperative steps, large-scale bio-fuel use by 2025 is a legitimate goal, but its achievement will depend on technological advances, supportive federal policies, and the successful development and deployment of bio-fuel technologies in a market-driven, technology-enabled future. If these efforts are successful, U.S. bio-fuel production could be 30 billion gallons per year or more annually.

Developing Unconventional Sources of Petroleum — Oil Shale and Coal-to-Liquids

For the petroleum and coal industries, *a key pathway is to scale up production of transportation fuels from oil shale and coal-based feedstocks using gasification and other advanced technologies.*

Oil Shale

Oil shale is a hydrocarbon-bearing rock containing high concentrations of an organic material known as kerogen — a geological precursor to petroleum. It is generally found in shallower geologic zones and, as a result, has not been subjected to the persistent and intense heat required to produce oil accumulations naturally. Commercial production of petroleum from oil shale entails placing oil shale deposits under high temperature, eventually converting the embedded kerogen into usable liquid fuels.

Potential North American supplies of oil from shale are very large (totaling 1.5 to 1.8 trillion barrels of oil in the Green River Basin alone).[18] Although there have been several attempts in the past to commercially produce petroleum from oil shale — including a roughly $2 billion federal effort in the early 1980s — the projects became uneconomic and were discontinued due to low oil prices in the late 1980s. However, the recent rise in crude oil prices has renewed commercial interest in oil shale production. Oil shale's strategic significance was recognized by the EPAct05, which identified oil shale as an important domestic resource, directed the Secretary of the Interior to begin leasing oil shale tracts on public lands, and directed the Department of Energy to coordinate and accelerate the commercial development of oil shale.[19]

With further R&D, oil shale production could be economic in 10–15 years, with costs less than $40 per barrel.[20] Development of a viable oil shale industry would be facilitated if the Bureau of Labor Management were to modify and streamline procedures for leasing and permitting sites for R&D oil shale projects and to prepare an oil shale development plan addressing the technological, economic and environmental challenges posed by large-scale oil shale development.

With continuing high oil prices, oil shale is likely to be an increasingly important supply source. Assuming existing technology, oil shale production could contribute 0.4 mbd.[21] With technical breakthroughs such as cost-effective *in situ* production, oil shale production could contribute as much as 1.0 mbd to the supply of transportation fuels by 2025.[22]

Coal-to-Liquids

Coal-to-liquids (CTL) is the process of converting solid coal into liquid fuels or chemicals. Considering that coal typically contains 5 percent hydrogen and distillable liquid fuels typically contain 14 percent hydrogen, the process of converting solid coal into distillable liquid fuels requires the addition of hydrogen or the removal of carbon to achieve a higher hydrogen content.[23] On average, one ton of coal can produce about two barrels of liquid fuel.[24]

The United States has the largest coal reserves in the world. EIA estimates that the U.S. demonstrated coal reserve base is nearly 500 billion tons — approximately 270 billion of which are recoverable with existing mining methods. The United States accounts for nearly 20 percent of global coal demand, making the country the second largest coal user in the world behind China (36 percent).[25] More than 90 percent of coal consumption takes place in the electric power sector, while the industrial sector accounts for most of the balance.[26]

There are two primary processes for converting coal to liquid fuels:

- **Direct coal liquefaction:** Developed in the early 1900s, direct coal liquefaction is a process by which hydrogen is forced into the coal under high temperature and pressure, often in the presence of a catalyst. The products are high-octane gasoline and low-cetane diesel.
- **Indirect coal liquefaction:** Developed in the 1920s, indirect coal liquefaction — also known as the Fischer-Tropsch (FT) synthesis process — requires the gasification of coal with oxygen and steam to produce a synthetic gas (syngas) containing hydrogen and carbon monoxide. This syngas is then passed over a catalyst to form hydrocarbons. The products of this process are high-cetane diesel and low-octane gasoline.

Generally speaking, indirect coal liquefaction appears to be more flexible, more efficient, and more amenable to carbon capture and sequestration (CCS). Moreover, the products from indirect liquefaction tend to be less dense than products produced with direct liquefaction, and they make excellent transportation fuels.

CTL technology has been well known for decades and has been successfully deployed in South Africa for many years. In the United States, commercial development efforts have been hindered by comparatively low crude oil prices. The recent rise in oil prices has increased interest in using CTL technology to produce transportation fuels such as FT diesel as well as natural gas, fertilizer, ethanol and hydrogen. Fifteen commercial facilities have been proposed or announced in the United States, and some members of Congress have proposed legislation expanding the role of CTL in supplying transportation fuels and industrial feedstocks. If authorized by Congress, investment tax credits and loan guarantees for CTL plants and the excise tax credit for alternative liquid fuels will provide an important impetus to this developing market for domestic coal.

Total well-to-wheels CO_2 emissions from CTL production are estimated to be roughly 1.8 times as high as the emissions level from fuels produced from crude oil.[27] With CO_2 capture, emissions could be reduced to roughly the level of today's crude oil operations.[28] The development of a large-scale CTL industry will likely require the adoption of effective CCS technology — technology that is promising but remains to be proven on a large scale and will require additional government R&D support as well as a definitive regulatory framework. The CO_2 generated during CTL production and other coal-based gasification processes, if captured and stored, has the potential to increase EOR through concentrated CO_2 injection in oil fields. If expanded aggressively, EOR can add 1.7 mbd to the transportation fuel supply.[29]

Business Roundtable believes that, with appropriate incentives and continued high oil prices, a domestic CTL industry could produce 1 mbd of liquid fuels by 2025 and 2 mbd by 2030.[30]

Slowing the Growth in Vehicle Miles Traveled

For state, local and federal governments, *the key pathway is to adopt policies that reduce congestion and idling and prevent further growth in vehicle miles traveled (VMT) per capita*.

Fuel demand in the transportation sector is not just a function of the fuel efficiency of the nation's vehicle fleet but is influenced by the number of cars on the road, how far these cars are driven and how many hours they are operated. In combination, these factors determine total VMT, which in turn directly affects fuel consumption. In our increasingly mobile society, VMT has been steadily increasing, with population growth, longer commutes, and increases in congestion and idling all creating pressure to consume more fuel. If unconstrained, rising fuel consumption driven by strong VMT growth could offset improvements in energy security achieved through improved fuel efficiency and greater reliance on domestic fuel sources.

EIA estimates that VMT by light-duty vehicles (cars and light trucks) will increase by roughly 44 percent between 2007 and 2025.[31] **As President Bush recently recognized, reducing this level of VMT growth should be a top priority of state, local and federal**

governments. In 2003, traffic congestion resulted in 47 hours of delay for the average U.S. commuter and commercial truck driver in urban areas during peak hours and 2.3 billion gallons of wasted fuel — 1.4 percent of all fuel consumed by light-duty and commercial vehicles that year.[32]

For the 85 most congested U.S. cities, the cost of congestion exceeded $63 billion in 2003.[33] Many strategies can be employed to reduce congestion, including expanding high-load-factor public transit; improving high-speed intercity load-service; promoting intermodal passenger and freight transportation; increasing truck size and weight without compromising safety; and increasing incentives for telecommuting, carpools and employee mass transit.

Business Roundtable believes that aggressive policies that reduce congestion and idling and prevent further growth in VMT per capita can conserve 0.15 mbd of transportation fuels.

Maintaining Access to Global Supplies through Open Markets

Although diversifying our fuel mix by developing domestic energy sources is critically important, the reality is that the United States will continue to rely heavily on energy imports for decades to come. We therefore have a compelling interest in maximizing global energy supplies. Maintaining the stability of world oil markets will be increasingly challenging as worldwide energy demands continue to grow and some consuming and producing nations pursue political agendas that threaten the operation of market forces. In addition, with production increasingly occurring in remote and unstable regions, transportation infrastructure will be vital in maintaining the flow of supplies to energy users, and threats to global security from terrorism or military conflict will pose a serious risk of market disruption. The control of the great bulk of the world's energy reserves by governments raises a host of additional concerns — including whether these governments will devote sufficient funding to advanced production and exploration technology to optimize energy yields and whether private investors will receive fair and reasonable opportunities to participate in major energy projects.

For all these reasons, global energy security should be a key element of U.S. national security strategy. In partnership with other consuming nations, the United States should pursue the overriding goals of preserving the integrity of free markets and energy trade and promoting opportunities for robust foreign investment by the private energy sector. We can take several steps toward this goal.

First, the United States should work more closely with energy-producing nations to harden their infrastructures against disruption from terrorist attacks or natural disasters. Second, the United States should encourage the International Energy Agency to help developing countries that are experiencing surging energy demand build adequate strategic reserves and coordinate the operation of these reserves

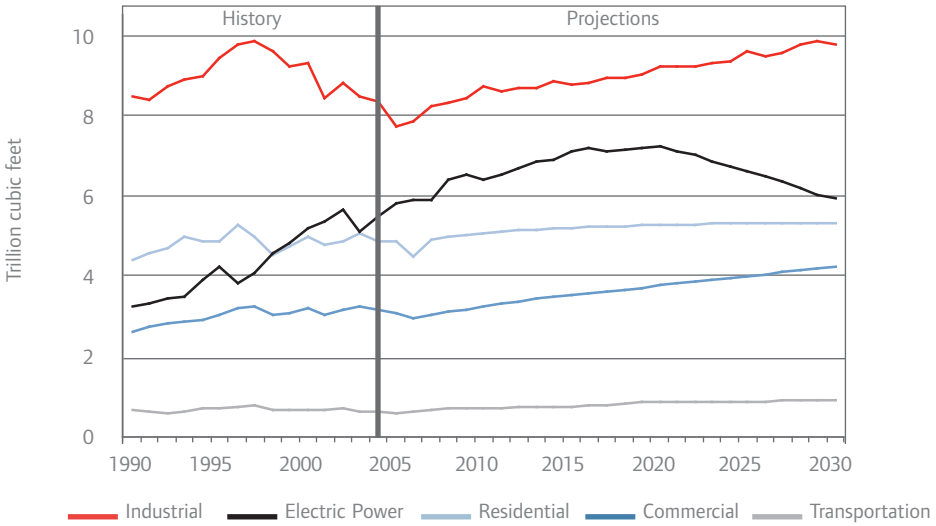
with other large consuming nations in the event of supply interruptions. Third, the United States should offer assistance to producing nations with weak political and economic institutions in developing stable governance structures and legal systems as well a trained and prosperous workforce. Finally, market imperfections, such as subsidies and price regulation or discriminatory investment policies, should be eliminated.

Achieving Better Supply-Demand Alignment in Natural Gas Markets

The U.S. Natural Gas Situation

In 2005, U.S. natural gas consumption totaled 22 trillion cubic feet (Tcf) — roughly 23 percent of the U.S. energy portfolio.[34] The largest consumer of natural gas is the industrial sector (35 percent), and significant quantities also are used in the electric power sector (26 percent), the residential sector (22 percent) and the commercial sector (14 percent).[35]

Natural Gas Consumption by Sector, 1990–2030



Source: *Annual Energy Outlook 2007*.

Between 1985 and 2005, natural gas consumption grew by roughly 27 percent.[36] Natural gas-fired plants have accounted for more than 90 percent of electric power capacity installed in the past five years, and roughly half of all new homes are heated by natural gas.[37] EIA anticipates that this strong growth in demand will continue and projects that natural gas consumption will grow by more than 20 percent over the next 20 years — more than any other primary energy source.[38] One reason for this increase is the expected demand for additional natural gas to support higher production levels of ethanol for use as a transportation fuel. Additional natural gas demand could develop if CO_2 regulation causes further switching from coal to gas by utilities.

Although the United States historically has been self-sufficient in natural gas, a growing gap between consumption and domestic production has increased natural gas imports from

5 percent of consumption in 1987 to 16 percent today.[39] Domestic production of natural gas increased by just 11 percent during the past 20 years and has remained relatively flat over the past 10 years.[40] The vast majority of imports have been delivered via pipeline from Canada, but it appears increasingly unlikely that Canada will be able to continue to bridge the U.S. domestic supply-demand gap. In the future, natural gas, like crude oil today, will increasingly become a global commodity instead of only a regional one. As a result, LNG imports will become increasingly important in global markets, with geopolitical issues around LNG supply and access coming to the fore.

Constraints on domestic supply and increased demand have placed burdens on energy consumers and companies who depend on natural gas for fuel and feedstocks. U.S. natural gas prices have been among the highest in the world. Between early 2002 and late 2005, natural gas wellhead prices nearly quadrupled before retreating to lower levels.[41] These price increases have translated into higher electricity and heating bills for households and businesses and have hurt the competitiveness of U.S. manufacturing companies, discouraging investment in the U.S. manufacturing sector. For example, the U.S. chemical industry — the largest industrial user of natural gas — has experienced substantial plant shutdowns and job losses, as investment in new capacity has moved outside the United States because of lower natural gas prices.

As described below, achieving a better balance of supply and demand and stabilizing prices at competitive levels over the long term will require a multifaceted strategy of:

- Boosting domestic natural gas production
- Developing alternative sources of supply through gasification of coal and bio-mass
- Moderating demand through energy efficiency in the power distribution and home heating sectors
- Building LNG terminals to handle imports

Increasing Domestic Production

OCS legislation enacted by Congress in late 2006 will modestly increase domestic supplies of natural gas in the Gulf of Mexico, but broadened access to land and offshore fields now off-limits to development can add significantly to domestic volumes.

The Rocky Mountain region contains extensive natural gas resources. Although the region has mostly nonconventional deposits that are costly and difficult to develop, conventional deposits offer significant opportunities for growth in supply. The extent and pace of that growth, however, will depend on improved access. Although much of the Rocky Mountain natural gas resources are officially accessible to exploration and development, a significant

proportion remains effectively off-limits due to onerous lease stipulations, conditions of approval that make development impractical or uneconomical, and cumbersome leasing and permitting procedures.

Although Alaska's sizable natural gas resources have been well known for decades, they remain underdeveloped and stranded in the absence of the infrastructure that is necessary to cost-effectively deliver them to North American markets. A natural gas pipeline from Alaska to the lower 48 pipeline grid, as currently proposed, could substantially enhance U.S. natural gas production over the next 20 years and beyond.

Although the OCS represents a sizable and important part of the U.S. natural gas resource base, nearly 20 percent of all OCS natural gas resources remain off-limits to commercial exploration and development due to congressional moratoria and presidential withdrawal in the 1980s and 1990s. Improving access to these resources — especially in select regions with the highest potential to yield relatively large volumes at comparatively low cost — remains an important objective.

Approximately 114 Tcf of additional natural gas supplies would be made available for exploration and development if the OCS moratoria were lifted and the permitting process in the Rocky Mountain region were improved — a development that would save natural gas consumers an estimated $300 billion over a 20-year period.[42] **Lifting the moratoria on the Atlantic Coast, Pacific Coast and the Eastern Gulf of Mexico regions and improving access in the Rockies could potentially contribute between 1.8 and 2.9 Tcf per year of additional natural gas supply by 2025.[43] Legislation by Congress and more flexible and responsive leasing and permitting policies by federal and state agencies will be necessary to develop these resources.**

Expanding Gasification of Coal and Bio-Mass

Gasification of coal and bio-mass can increase natural gas supplies and reduce demand in a variety of ways. Similar to CTL technology, gasification is based on the production of syngas from coal or bio-mass. This syngas can be converted to liquids or used to fuel a combustion turbine and generate electricity. Alternatively, the syngas can be used to produce natural gas for pipeline distribution or as a source of hydrocarbon feedstocks for manufacture of chemicals and fertilizer. Gasification can occur in Integrated Gasification Combined Cycle (IGCC) facilities, which produce electric power, or in co-production facilities, which effectively integrate the CTL and IGCC processes by using a once-through cycle to convert syngas to liquid fuels and employing the unconverted syngas as a source of fuels and feedstocks for electricity generation or manufacturing.

IGCC facilities have been proposed by several utilities, but few are now in operation. Co-production facilities sponsored by coal producers also are in the planning stages. The Bush administration's FutureGen project — supported by the Department of Energy, South Korea, India, and possibly China and Japan, in addition to energy companies from several nations — will demonstrate the potential of gasification to provide fuel for power generation and will generate a variety of useful feedstocks and raw materials for other purposes.

IGCC technology results in moderately lower CO_2 emissions than conventional pulverized coal technology. In addition, the gasification process makes IGCC plants more amenable to cost-effective carbon capture and sequestration (CCS), although CCS technologies that could work well at pulverized coal plants are being explored. With CCS becoming a viable CO_2 control strategy for IGCC or pulverized coal units, the potential will exist to expand coal-based generation to meet future power needs and replace existing plants. This will reduce demand for natural gas in the electricity sector. Similarly, syngas derived from gasification will replace a portion of the natural gas supply that is now distributed by pipeline to utilities, homes and manufacturing sites.

The EPAct05 contains programs to encourage both IGCC and industrial gasification facilities. These programs need to be fully implemented. In addition, Congress needs to substantially increase incentives (investment tax credits, loan guarantees and grants) for deployment of gasification technologies using CCS. This will improve the economics of gasification and build a foundation for long-term public acceptance of increased coal generation capacity. For example, greater sequestration of CO_2 generated during gasification will expand opportunities for EOR and other commercial applications for CO_2 and create a revenue stream that will offset the added costs of CCS technology.

Business Roundtable believes that, with all the necessary incentives, gasification can be used to produce 2.0 Tcf to 4.0 Tcf per year of coal-based syngas by 2025, equivalent to 15 percent of projected natural gas demand.[44] This is an ambitious goal that will require multiple plants, substantial capital investment and strong government support.

Natural Gas Conservation Measures

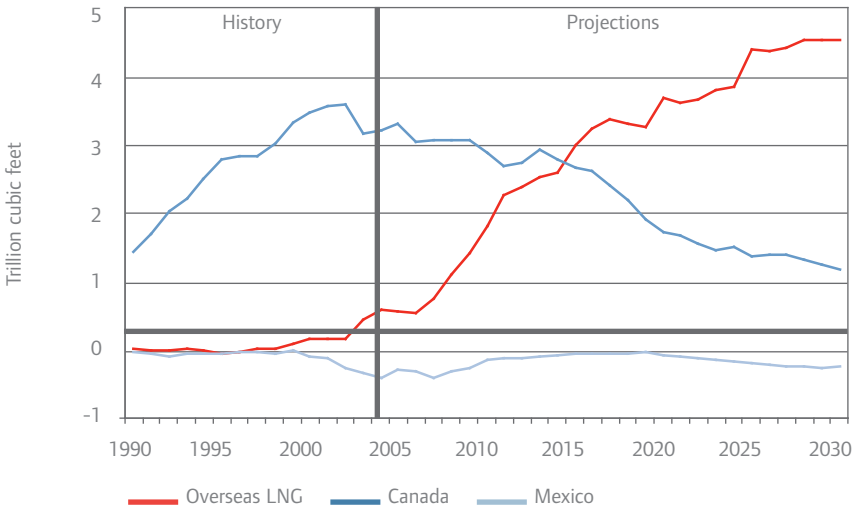
To ease pressure on supply, a concerted national effort to use natural gas wisely and efficiently is essential. Improving energy efficiency in the production, distribution and use of electric power is an important conservation strategy; more efficient power plants and demand reduction programs targeted at consumers will reduce the need for new power generation and lower natural gas consumption. Encouraging other energy sources for electricity generation (coal, nuclear and renewables) also can help moderate demand. Other conservation opportunities are in the use of natural gas to heat residences and businesses,

where improved building insulation, high-efficiency furnaces and water heaters, and other energy-saving practices can likewise reduce consumption. Chemical manufacturing facilities and other industrial users also can continue to implement aggressive efficiency measures that reduce natural gas losses during operations and improve production yields. **With Business Roundtable's proposed improvements in energy intensity, an estimated 2.2–2.7 Tcf of natural gas can be conserved per year by 2025.**

Building LNG Terminals to Facilitate Imports

The measures described above to increase supply and reduce demand will likely be insufficient to erase the gap between U.S. consumption and domestic production. Thus, natural gas imports will remain necessary. Because future imports are likely to derive in part from offshore sources of supply, an expansion in import capacity will be required. This will involve greater reliance on LNG technologies, through which gas is cooled and compressed to a liquid, shipped on tankers, and then warmed and re-gasified to its original form. Increasing LNG imports will require additional terminals to receive and re-gasify imported LNG in the United States. Investing in LNG terminal capacity will provide a release valve for medium-term price pressures. LNG import capacity is a necessary, but not sufficient, condition to ensure adequate deliveries of LNG; international supplies also will need to be procured. LNG supply has emerged as the bottleneck within the LNG supply chain. Lining up international supply sources of LNG for delivery to receiving terminals will increase long-term supply availability and contribute to the diversification of supply.

Net U.S. Imports of Natural Gas by Source, 1990–2030



Source: *Annual Energy Outlook 2007*.

Expanding LNG import infrastructure poses several challenges, including financial risk; limited availability of sites with significant amounts of land, storage infrastructure and downstream pipeline access; regulatory uncertainties and delays; and local concerns about safety and security that encourage public opposition and "not in my backyard" politics. Both government and the energy industry need to make a concerted effort to overcome these challenges, particularly by providing greater regulatory certainty and mitigating long-term financial risks.

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In sum, Business Roundtable supports a voluntary national goal of effectively increasing the supply-demand balance for natural gas by 6–9 Tcf per year by 2025 through a combination of increased domestic production and coal gasification and reduced consumption.[45] Given that EIA projects that U.S. gas consumption will increase to 26.3 Tcf by 2025, this rebalancing of supply and demand could relieve market pressures that are driving prices upward and offer substantial relief to consumers and businesses.

Maintaining a Viable and Growing Nuclear Power Sector

Nuclear power produces about 100 gigawatts (GW) of power and accounts for 20 percent of U.S. electricity generation.[46] Despite the lack of new construction of nuclear facilities during the past 30 years, the United States remains the world's largest producer of nuclear power. There are 103 operating units in the country.[47] The electricity output of these units has increased significantly within the past 10 years as they have become more efficient; nuclear facilities have moved from operating at an average of 66 percent of capacity in 1990 to more than 90 percent in 2002.[48]

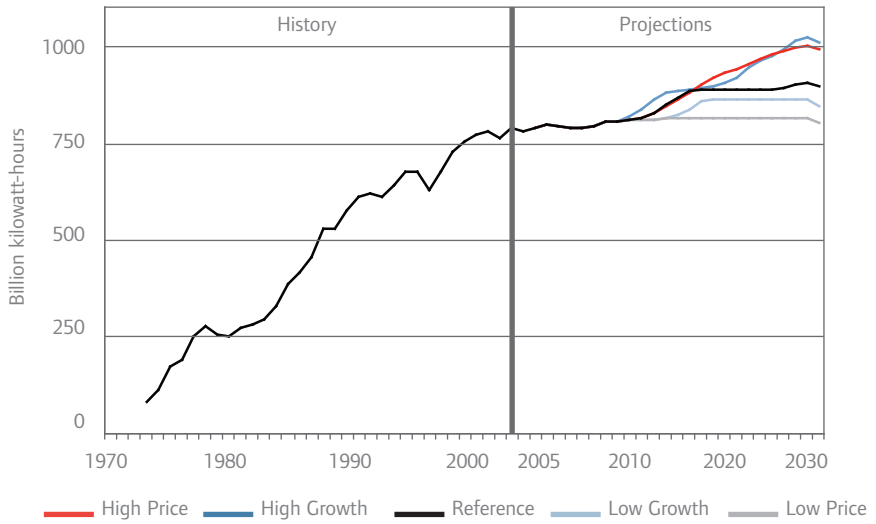
Maintaining and, to the maximum extent feasible, expanding the nuclear share of total electricity generation are critical U.S. energy policy objectives. Nuclear capacity is essential to relieve pressure on fossil fuels (natural gas and coal) used for power generation and to reduce the U.S. GHG footprint.

In the short term, ongoing and planned power uprates are expected to increase the capacity of existing nuclear plants by 3.2 GW.[49] It is estimated that these uprates will displace an equivalent amount of gas-fired combined cycle capacity, representing savings of around 172.2 Bcf of natural gas — enough to meet the needs of about 2.2 million residential gas consumers.[50]

Over the longer term, increased nuclear capacity will require construction of new nuclear plants. The financial incentives in the EPAct05 are creating a stimulus for investment in these plants, and new reactor designs represent substantial improvements on current light water reactors, with lower capital and operation and maintenance costs. Based on public announcements, construction/operating license applications are being prepared for 31 reactors with 40 GW of generation capacity.[51] The Nuclear Energy Institute (NEI) estimates that, by 2014–18, 13 new reactors will be in service, producing 16,850 megawatts (MW) of electric power.[52]

The outlook for new nuclear capacity by 2030 is uncertain, with different scenarios proposed by different sources. The *Annual Energy Outlook 2006* reference case is for 6 GW of new capacity, but two alternative cases for 2030 are presented — the "advanced technology" case (34 GW) and the "vendor estimate" case (76.7 GW).[53] NEI believes that new nuclear capacity by 2030 is likely to fall somewhere between these two estimates.[54] Because electricity demand is anticipated to grow, nuclear capacity will need to increase to maintain or enlarge its current share of U.S. electricity supply. NEI estimates that 50 GW of new capacity would enable nuclear power to maintain its current 20 percent share, whereas 76.7 GW (the "vendor estimate") would increase the nuclear share to 23.8 percent.[55] Under either scenario, NEI projects that demand for fossil fuels for power generation would be reduced.

Electricity Generation from Nuclear Power, 1973–2030



Source: *Annual Energy Outlook 2007*.

Expansion of the nuclear generating sector will require substantial support by the public and government entities. The Nuclear Regulatory Commission will need to establish an efficient, predictable licensing process for new nuclear plants. The Department of Energy will need to effectively implement the financial incentives for these plants in the EPAct05. State and federal energy regulators will need to adopt innovative approaches to the recovery of capital costs by regulated utilities. Most important, a workable program for the management and disposal of spent nuclear fuel will be essential. Thus far, despite years of debate, controversy persists on how to meet this challenge. Business Roundtable believes that, to ensure the future of nuclear power, it is essential to make continued progress toward licensing and construction of a permanent disposal facility at Yucca Mountain Nevada, while developing a centralized federal interim storage capability until a permanent disposal facility is necessary and available.

Investing in Energy Efficiency: Accelerating Improvements in Energy Intensity in the Industrial, Residential and Commercial Sectors

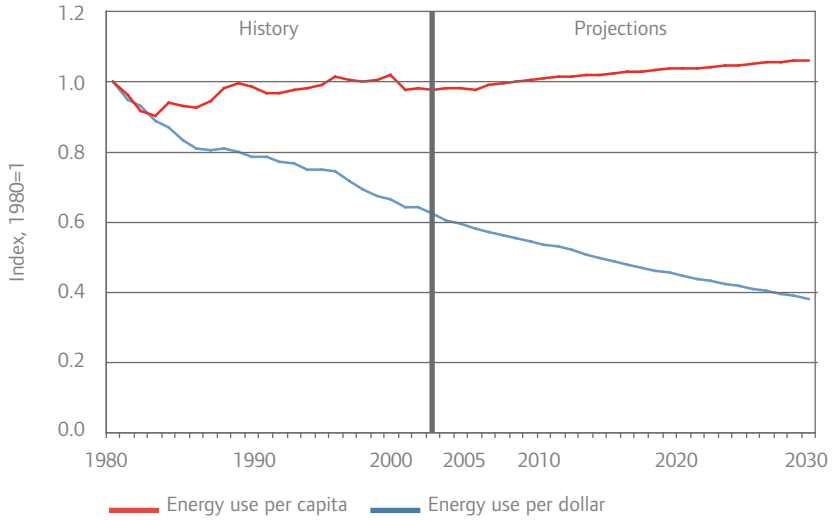
Business Roundtable's Energy Intensity Improvement Goal

Wise and efficient energy use is one of the best strategies for enhancing energy security. Every unit of energy we conserve through greater efficiency means lower energy consumption and therefore less oil, gas or coal to meet demand. Energy efficiency has important environmental benefits. As the United States consumes less energy, we will reduce our GHG intensity and improve America's carbon footprint. Energy efficiency also strengthens our economy by improving the productivity, financial performance and competitiveness of U.S. companies and the purchasing power of consumers. Because U.S. industrial, residential and commercial sectors account for more than 70 percent of total U.S. energy consumption, improvements in efficiency will have far-reaching impacts on the U.S. energy profile.[56]

America's businesses and consumers have already made dramatic progress in improving energy efficiency. U.S. energy intensity — the amount of fuel consumed divided by gross domestic product — was halved over the past 30 years.[57] This decline (approximately 1.3 percent per year during the past 20 years and 2.1 percent per year during the past 10 years) was primarily the result of greater penetration of energy-efficient technologies in the marketplace, increased recognition of the economic payoffs of efficiency investments and structural shifts in the U.S. economy (less manufacturing activity and growth in the service sectors). The contribution to these trends by major industrial sectors has been noteworthy. For example, since 1974, the chemical industry has reduced its fuel and power energy consumption per unit of output by an outstanding 46 percent.[58] Leading companies in the petroleum industry have achieved similar results.[59]

Nonetheless, important opportunities for further intensity improvement remain untapped. **At Business Roundtable's energy workshop, there was broad-based support for a national goal of improving energy intensity in the nontransportation sectors by 25 percent above the "business-as-usual" rate of improvement. Because EIA is projecting that intensity will drop at an annualized rate of 1.8 percent between 2007 and 2025, this goal would result in an annualized intensity improvement of more than 2.2 percent.[60] During the next 18 years, this would mean an overall reduction in energy intensity of more than 40 percent.** Such an ambitious goal would challenge businesses, consumers and government to greatly strengthen investments in energy efficiency technologies and practices. Although a voluntary aspirational target, the 40 percent goal could be embodied in legislation enacted by Congress as a strong statement of U.S. resolve to improve energy efficiency.

Energy Use per Capita and per Dollar of Gross Domestic Product, 1980–2030



Source: *Annual Energy Outlook 2007*.

The Cornerstones for U.S. Energy Efficiency Improvement

The companies participating in Business Roundtable's energy workshop identified several specific efficiency pathways that collectively would drive energy intensity improvements sufficient to meet Business Roundtable's goal. These pathways are listed in the table of page 33.[61]

Several of these pathways are described below.

- **Substantially boost the efficiency of new and existing commercial and residential buildings.**

  The 120 million homes and 7 billion square feet of commercial buildings in the United States account for about 40 percent of total U.S. energy consumption (39.6 quads or 6,811 mboe), with energy use expected to grow 35 percent by 2025.[62] Energy efficiency improvements in new and existing residential and commercial buildings are both practical (using known technology) and cost effective (based on life-cycle costing). Realistic levels of improvement are between 30 percent and 50 percent for new and existing buildings.[63] Achieving these targets will require strengthening codes and standards for new buildings to encourage and reward energy efficiency and adopting codes and standards for energy upgrades at existing buildings. It also will be important to focus homebuyers and mortgage providers on the long-term costs of occupancy in addition to the up-front costs of purchase to address the well-known "split incentive" barrier, which limits the motivation of builders to invest in energy efficiency because they do not pay electricity bills. An aggressive program of energy audits or ratings for all homes and commercial buildings sold would

Potential Energy Savings Beyond Business-as-Usual

(Estimated Savings above Business-as-Usual in 2025, Quadrillion Btu and Million Barrels of Oil-Equivalent per Day)

Residential and Commercial Buildings Sectors	quads	mboe/d	Source
Upgrade Efficiency of Existing Residential Buildings	1.50	0.71	Owens-Corning
Upgrade Efficiency of Existing Commercial Buildings	2.00	0.94	Owens-Corning
Boost Efficiency of New Residential Buildings	0.80	0.38	Owens-Corning
Boost Efficiency of New Commercial Buildings	2.00	0.94	Owens-Corning
Subtotal	**6.3**	**2.97**	
Electric Power Generation			
Replace Inefficient Oil/Gas Turbines	0.85	0.40	Siemens
Upgrade Coal Steam Units	0.36	0.17	Siemens
Improve Efficiency of New Gas Turbine Units	0.30	0.14	Siemens
Accelerate Deployment of IGCC	0.39	0.18	Siemens
Accelerate Deployment of Super/Ultra-Supercritical Coal Steam	0.62	0.29	Siemens
Accelerate Deployment of Wind Generation	1.00	0.47	Siemens
Subtotal	**3.52**	**1.65**	
Electric Power Transmission, Distribution and Demand-Side Management			
Reduce Transmission and Distribution Losses	0.17	0.08	ABB
Encourage Smart Metering and Other Demand-Side Management Strategies	0.19	0.09	ABB
Subtotal	**0.36**	**0.17**	
Industrial			
Improve Industrial Motors and Drives	0.71	0.34	ABB
Expand Industrial Combined Heat and Power	1.50	0.71	Business Roundtable Energy Task Force
Subtotal	**2.21**	**1.05**	
Total	**12.39**	**5.84**	

create additional incentives for energy improvements that would highlight energy efficiency opportunities and increase their prominence in building sales. The ultimate goal should be widespread adoption of whole-building design strategies for new buildings that make them Net Zero Energy Capable and Net Zero Energy.

- **Deploy a broad portfolio of energy efficiency technologies for building operations and appliances (including heating, ventilation, air conditioning, refrigeration, lighting systems, distributed generation and other on-site power units, etc.).**

  Operating a building — powering the heating, ventilation, air conditioning, refrigeration, lighting, office equipment and water heating systems — accounts for much of the energy that a building consumes. Great strides have been made in improving appliance efficiency.

For example, residential central air conditioners and heat pumps are 60 percent more energy efficient than they were 15 years ago and 30 percent more efficient than they were just last year.[64] At the same time, population growth, increasing home sizes and greater reliance on electronic equipment in offices have resulted in an increase in residential and commercial building energy use. Reversing this trend will require both energy-efficient building designs and dramatic advances in technology. These advances will include on-site equipment that produces more electricity and thermal energy than it consumes, such as photovoltaic panels, fuel cells and microturbines; high-efficiency lighting, heating and cooling; and high-performance automation and communications systems. Greater government incentives and private-sector investment will accelerate the development of technologies with a high potential to be affordable and cost effective and achieve marketplace acceptance. In many cases, government funding for basic research will be essential. Programs, such as the U.S. Environmental Protection Agency and Department of Energy's Energy Star, that increase awareness and recognition of energy-efficient products have already been highly successful and need to be continued and expanded.

- **Expand the transmission and distribution system to enable optimal generation resource utilization and to reduce transmission congestion (allowing access to clean fuel sources such as wind power, nuclear and new clean-coal plants).**

  The electric power transmission and distribution (T&D) system interconnects generating stations and main load centers and delivers electric power to end users. By ensuring reliable, secure and economic operation of the power grid, the system is a potential "enabler" to improve energy efficiency, increase reliance on domestic energy resources, and reduce coal and gas consumption. Of all energy consumed to generate electric power, approximately one-third leaves generating plants in the form of electricity, and two-thirds is lost in the generation process. Of the one-third that leaves plants as electricity, about 10 percent is lost in transmission and distribution — representing more than 1.3 quads and costing about $4.8 billion annually.[65] Investment in T&D capacity is lagging behind electricity demand growth, increasing the risks of bottlenecks and congestion and major system disturbances. Reversing this trend and expanding the T&D system would lower costs and conserve energy by allowing optimum dispatch of the lowest-cost power resources and reducing transmission congestion. Tax credits and other incentives would be valuable in stimulating investment in new T&D capacity. A major impediment to T&D investment is lack of clarity about the ownership of T&D assets and regulatory jurisdiction over T&D improvements, creating uncertainty over whether and how investments can be recovered. A national policy regarding ownership, maintenance, optimization and upgrades of T&D assets would be an important step in facilitating T&D capacity expansion.

- **Optimize power-grid design with new or advanced technologies to save energy, reduce the stress on the grid and improve reliability.**

  There are several advanced technologies that would greatly improve the efficiency and reliability of the grid:

  - Flexible Alternating Current Transmission Systems (FACTS), such as Static VAR Compensators and Series Capacitors, enable more power to flow on existing power lines, improve voltage stability and make the grid more resilient during power fluctuations.
  - Direct power delivery to megaload centers with High Voltage Direct Current (HVDC) technology incurs lower losses than AC counterparts, cannot be overloaded, and stabilizes the surrounding AC grid.
  - Distributed generation/microgrids eliminate long-distance transmission, where more energy losses occur.
  - Underground distribution lines reduce 80 percent of distribution power losses.
  - Intelligent grid design (smart grids via automation) enables gridwide monitoring and control that allow early detection and mitigation of outages.
  - Gas insulated substations enhance reliability using a minimum of space, allowing high voltage lines to be located in the heart of urban centers.
  - New network and substation topology designs reduce overall T&D transformer Megavolt Ampere (MVA) installation requirements, using less power while maintaining required service availability.
  - High temperature superconducting lines, cables and transformers can increase power transmission capability and significantly reduce loss.
  - Large-scale deployment of advanced energy storage technologies can reduce the need for new transmission and generation capacity, improve economy of operation, and improve grid reliability.
  - Three-phase design for distribution reduces losses inherent with single-phase feeder branches.
  - Ground wire loss reduction techniques can save 5-6 percent of the total line loss.

  Widespread introduction of these technologies will require incentives and education so that regulators, the public, and T&D system owners and operators are motivated to make larger upfront investments in expanding and modernizing the grid because they can deliver long-term efficiencies and cost savings. Public policy and regulatory frameworks should facilitate advanced and conventional electric transmission technology investments to reduce congestion and to connect new generation, especially wind generation, with load centers.

- **Install highly efficient motors, drives and transformers in the T&D system and industrial manufacturing plants.**

  Electric motors consume 64 percent of the electricity produced in the United States. Small improvements in efficiency can generate significant savings in energy costs.[66] A U.S. motor challenge study indicated that 85 billion kWh/year could be saved using AC drives and high-efficiency motors.[67] Moreover, only a small percentage of large motors are controlled by variable speed drives. Most simply run at full speed all the time. Energy consumption of motors varies with the square of the speed; a centrifugal pump or fan running at 80 percent speed consumes only half of the energy of one running at full speed. Thus, a variable speed drive can reduce energy consumption by as much as 60 percent.

  Transformer loss reduction also is a promising energy efficiency strategy. Transformers experience two types of energy loss — core and winding. New designs and materials can reduce these losses; core construction can be improved by new alloys for core steel, while new insulation materials (polymers) can reduce winding losses. A national standard would be invaluable in driving manufacture and deployment of higher efficiency distribution transformers.

- **Encourage smart metering and other demand-side management (DSM) strategies that use electricity pricing to reduce peak period demand on the grid.**

  While wholesale electricity prices fluctuate hourly in response to changes in supply and demand on the grid, retail customers generally do not see these price changes. Wholesale prices generally increase during periods of peak demand, when generators must activate less-efficient power resources to augment supply. But consumers often have no incentive to reduce usage during these high-load periods because their rates depend on overall electricity consumption and not when power is used. DSM — which uses price signals to influence power consumption — can reduce peak period demand, which in turn will reduce reliance on inefficient power production units and relieve generation and transmission constraints that add to the cost of power distribution. Smart metering is a DSM tool that adjusts electricity rates based on when power is consumed, creating incentives for lower demand during peak periods.

  Smart metering is but one of several strategies that electric utilities can use to reduce electricity demand. States such as California have achieved remarkable success in avoiding load growth at the same time that population and economic activity have increased. According to the National Action Plan for Energy Efficiency, EIA data indicate that, in some states, energy efficiency programs are saving energy at about one-half the typical cost of new power sources and about one-third the cost of natural gas supply.[68] The plan projects that extrapolating the results of existing programs to the entire country would yield annual

energy bill savings of $20 billion, defer the need for 20,000 MW of new power generation and reduce U.S. CO_2 emissions by more than 200 million tons.[69] Underinvestment in energy efficiency is due in part to a number of market and regulatory barriers, including disincentives for utility energy efficiency programs. There is growing support for eliminating these disincentives by adopting rate structures under which utilities can earn returns from energy efficiency initiatives commensurate with those from supply-side investments, with energy efficiency expenditures included in utility rate bases along with total power output.

- **Improve the efficiency of the nation's power plant fleet by a combination of efficiency upgrades at existing units and construction of new advanced technology generating facilities to replace inefficient existing units and meet growth in demand.**

  Despite the benefits of energy efficiency improvements in the transmission and retail distribution sectors, demand for electricity in the United States is expected to grow more than 30 percent by 2025.[70] Thus, the existing U.S. power plant fleet will be unable to meet our electricity needs. To respond to demand growth, we will need to increase supply through efficiency upgrades at existing units and construction of new power plants. Upgrading, rebuilding or repowering existing steam gas units can lower heat rates by one-third. Equipment replacements and repairs at coal steam turbine plants can likewise improve generation efficiency. New plant construction also is an important strategy to enhance efficiency since the most advanced power plant technologies are far more efficient than units now in service. For example, the efficiency of the current coal-powered fleet is less than 35 percent, whereas supercritical and ultra-supercritical pulverized coal and IGCC units can achieve efficiencies of 46 percent or higher.[71] Either as replacements for older units or as new capacity, these plant designs offer an opportunity to increase electricity output without commensurate increases in fuel consumption, conserving U.S. natural gas and coal supplies.

  The investment required to modernize our power plant fleet is massive, on the order of more than $200 billion by 2025.[72] Financial incentives can provide an important stimulus to upgrades and new plant construction. It will be important to target this government support at technologies, such as CCS at IGCC or pulverized coal plants, with the greatest potential to improve our GHG profile. In addition, current regulatory barriers to efficiency upgrades at existing plants, such as rigid new source review requirements, should be eliminated.

- **Accelerate deployment of wind and solar-thermal generation.**

  Increasing the role of renewables in our power generation mix is another important energy efficiency strategy. Renewables (wind, biomass and solar thermal) have the potential to reduce fossil fuel (oil, gas and coal) consumption, resulting in lower GHG

emissions. Current installed wind generation capacity is 9.65 GW, and it could increase by 20 GW by 2025 (representing about 1 percent of total electricity generation).[73] Solar thermal generation is estimated to have the potential to generate an additional 4.5 GW by 2025 (as compared to 140 MW in the base case).[74] However, renewables do have some disadvantages, including transmission constraints for many wind sites and the inability to dispatch wind power, and incentives will continue to be required for these power sources to become commercially viable.

- **Increase use of efficient combined heat and power (CHP) units in U.S. industry.**

  CHP (also known as cogeneration) is the most efficient form of power production in the U.S. market today, and it represents the single most important opportunity to improve the energy efficiency of most large industrial facilities. A typical CHP unit achieves net energy efficiency in excess of 75 percent by creating both useful thermal energy output (steam, hot water, chilled water, process heat, etc.) and electric power from a single combustion process. Because of its greater efficiency, emissions of CO_2 per unit of useful energy are substantially lower at CHP units than at conventional fossil-fired power generation facilities. In comparison to remote generation, CHP units also do not require additional T&D capacity since power is consumed at the site where it is produced. As of the end of 2005, CHP capacity in place was 83.5 GW. Department of Energy projections suggest that additional CHP opportunities at large industrial and commercial sites could be as high as 130 GW.[75] However, it is important to recognize that year-round thermal/steam demand is typically required to make CHP viable. To encourage investment in CHP capacity, a tax credit would be helpful. It also would be desirable to restructure the relationship between CHP owners and incumbent utilities to provide a fair apportionment of system costs that does not penalize CHPs yet appropriately rewards utilities for their investment in the electricity grid.

- **Challenge individual companies to set and meet ambitious energy efficiency goals.**

  Motivated companies with aggressive leadership have set and achieved impressive energy efficiency goals. Many effective tools have been used in these programs, including energy audits, thorough scrutiny of energy purchases to identify potential savings, upgrading of equipment and technology, best manufacturing practices, investment in distributed generation units, improved recovery of waste heat and energy, and open-market energy sourcing. In addition, reductions in waste materials and increased recycling reduce energy requirements. Broader adoption of the principles of aggressive energy management by U.S. companies can accelerate the rate of efficiency improvement throughout the economy.

Business Roundtable's Energy Efficiency Initiatives

Although government programs can play a critical role in promoting energy efficiency improvements, leadership by Business Roundtable companies can make a significant contribution. To promote broader awareness of energy efficiency opportunities and innovative energy management programs by its members, Business Roundtable will encourage its members to consider an array of energy efficiency initiatives, including:

- Investing in efficient appliances, lighting and building materials at manufacturing and office locations owned or operated by Roundtable members.
- Committing to an efficiency target for new buildings and upgrades of existing buildings owned or operated by Roundtable members that requires no less than a 30 percent increase in efficiency over existing stocks.
- Implementing a computerized energy management and control system in facilities along with formalized shutdown procedures when lights and equipment are not required.
- Offering "green" mortgages that provide financial incentives for home purchasers to invest in efficiency upgrades (for financial institutions only).
- Building, sponsoring, piloting or hosting at least one Net Zero Energy building within the next five years.
- Installing highly efficient transformers, smart metering and advanced power systems technologies.
- Installing highly efficient motors, drives and turbochargers in industrial manufacturing applications.
- Setting ambitious energy efficiency goals for operations; sharing energy-saving strategies, technologies and best practices with industry peers; and monitoring and reporting efficiency gains.

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