Strategic Theme 1

Energy Security

Promoting America's energy security through reliable, clean, and affordable energy

Keeping America economically strong requires reliable, clean, and affordable energy, and the best way to achieve this is through competitive energy markets, science-driven technology, and supportive government policies. Technological advances enable Americans to use new energy sources that did not exist 50, 100, or even 200 years ago. Well-functioning energy markets, supplemented by effective government collaboration, incentives, and regulation, stimulate the private investment and competition necessary to spur the adoption of new technologies. New technological advances in energy supply, distribution, and utilization will help ensure we meet the energy challenges of the 21st Century.

The Department's principal tool for advancing technology is investing in high-risk, high-payoff energy research, development, and demonstration (RD&D) that the private sector would not or could not develop alone in our market-based economy. Since 2001, the Department has invested nearly $10 billion developing and promoting the use of cleaner, more affordable, and more reliable alternative energy sources and DOE is on the threshold of incredible scientific and technological advances that will change how we power our homes, businesses, and automobiles. In January 2006, the President announced the Advanced Energy Initiative to dramatically accelerate research on domestically available fuels that will diversify the Nation's use of energy sources and help reduce America's dependence on foreign resources.

To address domestic energy security, DOE is focused on stimulating private investment in energy supply and advanced technologies through diversifying energy markets, reducing emissions, and increasing reliability and productivity. The Department will work with other Federal agencies to develop a more comprehensive government-wide approach to solving America's energy needs. For example, DOE is working closely with EPA to accelerate deployment of energy efficiency and alternative energy technologies by coordinating activities that enhance progress toward each agency's respective goals.

Strengthening the systems that transmit and distribute electricity and fuels to consumers is imperative for the economic prosperity of Americans and their quality of life. Facilitating the process to modernize the electric grid, enhancing the security and reliability of the energy infrastructure, and facilitating recovery from disruptions in energy supplies are critical DOE activities. In the transmission and distribution (T&D) of electricity, the Department is partnering with industry to undertake research in developing cost-effective solutions in the areas of advanced sensors and high temperature superconductors that will reduce line losses and have the capability to carry more electric current than conventional T&D lines. The Department is also working with other Federal agencies and State and local governments to develop a resilient grid, identify and mitigate congestion, and protect critical services. With regard to fuels, the Department is working with industry and government agencies to address research and infrastructure issues related to the "fuels of tomorrow," such as biofuels and hydrogen, as well as the fuels that are the current lifeline of America's economy—petroleum, natural gas, coal, and nuclear.

The Department also supports research in developing energy efficiency technologies and practices that will enable Americans to use energy more productively. By reducing the energy intensity of America's economy, energy efficiency advances provide one of the best means for reducing the Nation's dependence on foreign fuel supplies and improving the quality of the environment, both in the near and long term. The Department supports innovative RD&D that will increase the energy productivity of all sectors of the economy—buildings, transportation, industry, and electric power.

The Department's programs extend beyond the research, development, and deployment of energy technologies. The Department operates: (1) the Strategic Petroleum Reserve, which provides emergency oil supplies in the event of a serious supply disruption; (2) the Northeast Home Heating Oil Reserve, which helps ensure adequate heating oil supplies in the event of severe energy disruptions; and (3) four Federal Power Marketing Administrations,which sell electricity from Federal hydropower dams.

Over the next six years, the Department will research advanced technologies to achieve its energy strategic goals.

Energy Security Challenges

The United States is heavily dependent upon oil, especially in the transportation sector. Rapid increases in U.S. and world energy demand, combined with regional resource and production constraints, have led to large increases in oil and natural gas prices, changing the industrial and commercial business environment. The Nation's energy infrastructure is not keeping pace with the growth in energy demand, thereby endangering the reliability of the energy system. Finally, there is a need to reduce the environmental impacts associated with energy use. The following strategic goals address these energy challenges.

Energy Security Strategic Goals

Goal 1.1 – Energy Diversity

Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruption and increasing the flexibility of the market to meet U.S. needs.

Description: Energy diversity is essential for America's energy security and economic prosperity. In 2004, America imported 65 percent of the crude oil it used domestically. By 2030, the Energy Information Administration forecasts that crude oil imports will rise to 75 percent of our total crude oil supply and natural gas imports will rise from 17 percent today to 21 percent of our total natural gas supply. America's energy security and economic well-being are challenged when the United States is dependent upon other countries for the fuels that account for over 60 percent of the Nation's current energy use. This is especially true in the case of the transportation sector, which is the least energy-diverse sector of the American economy with petroleum accounting for more than 95 percent of the fuel consumed. Taking steps to reduce the transportation sector's dependence on oil is a critical component of the Department's strategic goals.

The Department is investing in both alternative fuels and energy efficiency technologies to reduce the energy-intensity and increase the fuel-flexibility of America's economy while maintaining environmental stewardship. In the near-to-mid term, advances in biofuels, fuel blends, plug-in hybrids, and more efficient vehicle technologies could increase the energy diversity and efficiency of America's transportation sector. In the long term, innovation in hydrogen production, storage, and use may enable consumers to drive vehicles powered by hydrogen produced from multiple domestically available energy sources and help pave the way for a full-scale hydrogen energy economy.

The Department is also pursuing energy diversity by supporting the development of a suite of electricity generation options that can promote reasonable and stable prices and a variety of efficiency technologies that will improve energy productivity in all sectors of the American economy. Taken together, these technologies diversify our energy portfolio and increase our energy security (these advances are addressed in Strategic Goals #1.2 and #1.4).

Strategies to reach this goal

- Reduce dependence on energy imports, particularly oil in the transportation sector, by developing and effectively deploying technologies to increase fuel efficiency and enable the substitution of alternatives such as biofuels, electricity, and hydrogen.
- Collaborate globally with governments and scientists to expedite the development and deployment of unconventional energy resources, such as biofuels, that can substitute for oil and natural gas.
- Collaborate globally with governments and scientists to expedite the development and deployment of nuclear power which can substitute for natural gas.
- Ensure adequate crude and regional home heating oil supplies during emergency shortages by maintaining the operational readiness of the Strategic Petroleum Reserve and Northeast Home Heating Oil Reserve.
- Ensure an expanding supply of domestic energy for the American public by promoting the construction of an Alaska Natural Gas Pipeline and the environmentally responsible development of the Outer Continental Shelf and the Arctic National Wildlife Refuge.

Goal 1.2 – Environmental Impacts of Energy

Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.

Description: The consumption of fossil fuels for electricity generation and transportation accounts for three-fourths of the carbon dioxide emissions in the United States and is a major contributor of air, water, and land pollution. The Department is funding research in a robust portfolio of technology options that will help reduce the environmental footprint resulting from the supply, distribution, and use of energy.

In electricity generation, the Department is partnering with industry, academia, State, and local governments, and other countries in advancing a variety of carbon-free electricity options. These partnerships range from wind farms and solar power systems to central station near-zero atmospheric emissions fossil fuel power plants that capture and store carbon. Also included in the partnerships are nuclear facilities that rely upon advanced fuel cycle technologies that will help to address nuclear waste disposal issues. The Department is also helping to mitigate the environmental impacts of electricity generation by reducing the need for new power plants through advances in energy efficiency technologies and peak load reduction technologies and strategies (these advances are addressed in Strategic Goals #1.3 and #1.4).

In transportation, the Department is investing in options that are less carbon intensive than petroleum, such as biofuels, plug-in hybrids, and hydrogen-powered fuel cells. Another option is advancing technologies that enable vehicles to travel further on a gallon of fuel, thereby simultaneously reducing petroleum use and carbon emissions.

Strategies to reach this goal

- Support the creation of new nuclear generation capacity to produce carbon-free electricity in the near term (2015); complete a permanent repository for nuclear waste at Yucca Mountain by 2017; and develop next-generation advanced reactor and fuel cycle technologies for deployment in the long term (2025) for both electricity and hydrogen production.
- Advance clean coal technology through public-private partnerships for continued electricity generation from the country's extensive coal resources, ultimately resulting in near-zero atmospheric emissions power plants.
- Support research and development efforts to reduce the costs of renewable energy technologies and accelerate the large-scale use of carbon-free electricity sources.
- Develop technologies to reduce vehicle emissions by improving efficiency and greatly expanding the use of clean fuels, while maintaining vehicle safety, performance, and cost characteristics.
- Work collaboratively with other Federal agencies, private industry, and other countries to accelerate the adoption of technologies capable of substantially reducing global emissions of greenhouse gases and other emissions.

Goal 1.3 – Energy Infrastructure

Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.

Description: One of the greatest energy challenges facing America is the need to use 21st Century technology to improve our aging energy infrastructure. This infrastructure is comprised of many components, including the physical network of pipes for oil and natural gas, electricity transmission lines, and other means for transporting energy to consumers; facilities that turn raw natural resources into useful energy products; and rail networks, truck lines, and marine transportation.

The energy industry has undergone major changes in the last two decades and more are expected. These changes affect how our energy infrastructure operates. For example, while the electricity industry was once vertically integrated, it is increasingly separated into three isolated segments: generation, transmission, and distribution. Electricity providers have built more power plants; however, without a comparable increase in transmission and distribution facilities, it is not possible to handle the increased output.

Over the next six years, the Department's energy infrastructure activities will be primarily focused on modernizing the electricity grid. The Department will accomplish this objective by working with other

government agencies and industry to reduce the frequency of blackouts, reduce energy losses, and improve asset and energy resource utilization. The results will provide consumers with competitive costs for electricity and a more secure infrastructure.

Strategies to reach this goal

• Develop advanced wires and coils to increase the capacity, efficiency, and reliability of the electricity system.

• Advance real-time visualization and control tools to improve the reliability and efficiency of the Nation's electricity delivery system by increasing the utilization of transmission and distribution assets.

• Integrate advanced technologies, including distributed generation, storage, and load management on distribution utility feeders to improve the efficiency and reliability of constrained sections of the electricity grid.

• Provide technical assistance to State and regional officials on policies and emergency response options.

Goal 1.4 – Energy Productivity

Cost-effectively improve the energy efficiency of the U.S. economy.

Description: Energy efficiency is the ability to produce more energy services (e.g., lighting, heating, and transportation) from a fixed amount of energy. Energy productivity is the ability to create more economic value (gross domestic product, worker productivity, and air quality) from a fixed amount of energy. Many energy efficiency technologies exist today that produce more lighting, heating, or transportation services, but the higher capital costs associated with these technologies often outweigh the lower energy costs over the life of the technology. As a result, energy efficient technologies do not always increase energy productivity. The major objective of the Department's energy efficiency RD&D is to lower the cost and promote deployment of energy efficient technologies in all sectors of the economy (building, industrial, and transportation), thereby enabling these technologies to increase the Nation's energy productivity.

Strategies to reach this goal

• Support enhancements to existing energy markets that will help stimulate private investment in more efficient and economically productive end-use technologies.

• Develop integrated building technologies and formulate appliance standards to significantly increase the energy efficiency of residential and commercial buildings.

• Partner with energy-intensive industries to develop technologies that enable more efficient use of energy in their industrial processes.

• Develop technologies that enable cars and trucks to be fuel efficient, while remaining cost and performance competitive.

• Promote increased energy efficiency and sustainable practices in Federal facilities.

Crosscutting Science Integration

Through recent deliberate and highly disciplined assessments, several critical areas of technology barriers have been identified, that if overcome through basic research, could create paradigm-shifting developments for the U.S. energy sector. They are, in a sense, a select set of grand challenges for the science and technology communities. Specifically, breakthroughs are required in electric energy storage, superconductivity, biofuels (including cellulosic ethanol), hydrogen storage and fuel cells, solar photovoltaic technology, advanced nuclear materials, and capture of CO_2 from existing fossil-fueled plants. Additionally, there are significant opportunities for crosscutting science "push," that is to say, areas where fields of science hold seemingly broad potential to accelerate innovation in many areas of energy supply and demand. Significant science opportunities include the design and synthesis of materials exploiting nanoscale understanding; advanced computation and predictive modeling of complex materials, technologies, and systems; catalysis and control of chemical transformations; and systems and synthetic biology for energy applications. While these are not exhaustive lists, they represent an initial and ambitious set that offer high potential payoff, thus motivating the science and technology communities to work together in the years ahead.

External Factors

The following external factors could affect the Department's ability to achieve the Energy Security theme:

Federal Government/Consumer Roles

Most energy intensive products (e.g., power plants, automobiles, etc.) have high capital costs and low turnover rates. Power plants can cost billions of dollars to build and generally operate for 30-40 years. The electricity grid infrastructure has required billions of dollars and a century to develop and will require decades to transform. The lifetime of the average automobile is 10-20 years, so a conventional automobile sold today will still be consuming petroleum in 2020 at about 25 miles per gallon. The energy economy, therefore, changes slowly and new technologies receive a cautious reception from consumers because they represent large financial investments that must operate effectively over decades. For electricity, State regulators, who have jurisdiction on retail electric rates for consumers, as well as siting and construction of new electric infrastructure, can be cautious with new technologies as they seek to ensure adequate supply at a reasonable cost. The Federal government works with industry partners, State and local governments, and non-governmental stakeholders to advance programs that encourage consumers to purchase products that contain new energy technologies.

Fuel Prices

Fuel prices will affect the rate at which many new energy-related technologies penetrate target markets. When fuel prices are high, typically large-scale market penetration occurs sooner than when fuel prices are low. One factor that most of the energy technologies being researched by the Department have in common is that they are more costly than conventional technologies in today's marketplace. The Department is therefore working to reduce the costs of these technologies through the application of new scientific and engineering discoveries. However, fuel prices may affect the rate of transfer from the laboratory to the marketplace independent of the scientific and technological merit of the advances made by the Department.

Other Federal and State Policies

Air pollution control policies enacted in the United States since the 1970s have affected the adoption rate of energy technologies by internalizing the cost of regulated pollutants. As a result, technologies that utilize cleaner fuels, such as natural gas, have had significant market penetration in many parts of the energy economy. These regulations and other Federal and State policies such as energy tax incentives (e.g., hybrid vehicles) and targeted rebate programs for energy efficient products could also affect market penetration of select technologies and accelerate progress toward the Energy Security goal.

Energy Disruptions

Natural disasters (e.g., hurricanes, earthquakes, floods, droughts, heat waves, etc.) and other catastrophic events could have a major impact on the Nation's energy security and supply.