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U.S. Energy Perspective

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ABSTRACT

Introduction

The global focus on climate issues presents a unique opportunity for significant economic expansion that relies less heavily on fossil fuels to drive that growth. Every major economic expansion in history, such as in the post-War United States, has been accompanied and fueled by similar expansions in energy production and consumption. Access to energy is fundamental to fulfilling basic social needs, driving economic growth and fueling human development. But sustainable human development requires a fundamental shift in production and consumption patterns, to a clean energy economy.[1]

In the 1990s, low prices for fossil fuels suggested secure future energy supplies. More recently, surging petroleum prices, increasing concentration of fossil fuel supplies and reliance on supplies from unstable regions have led to rising demand. Additionally, climate change concerns have prompted the U.S. government to pursue policies that move from a fossil-based to a low-carbon economy, which will require even more cooperation among countries in what has become a global marketplace for energy development and deployment.

This presentation examines the current and future U.S. energy supply mix, including prospects and options for transitioning to a clean-energy economy. The U.S. relies on diverse energy sources including nuclear to ensure a stable, reliable supply of electricity, and is the world's largest producer of nuclear energy with 104 operating units accounting for more than 30% of worldwide nuclear generation. The presentation also examines nuclear energy's role in the U.S. today and in the future, including challenges to expanded use as well as programs and policies that address technology, financial and regulatory issues associated with expanded use of nuclear energy.

Energy and Electricity Supply and Demand

The U.S. has vast energy resources and uses a diverse mix to protect Americans from price fluctuations and shortages that drive up costs. Major energy sources are petroleum, natural gas, coal, nuclear and renewables. Major users are residential and commercial buildings, industry, transportation and electric power generation. President Obama has set a goal of generating 80% of U.S. electricity from a diverse set of clean energy sources by 2035 including renewables such as wind, solar, biomass and hydropower; efficient natural gas; nuclear; and clean coal.[2]

The U.S. Energy Information Agency predicts that energy consumption will grow by 0.7% per year over the next 25 years, with most of this growth in the industrial and commercial sectors. Renewable sources will lead the rise in primary energy consumption, as the share of renewable energy increases from 8% in 2009 to 13% in 2035. The increase in renewable energy is facilitated by Federal tax credits and state renewable portfolio standards. Individual energy usage will continue to decline in relation to GDP due to structural changes and vehicle/appliance efficiency improvements. Electricity consumption will grow by 31% over the next 25 years (0.7% per year).[3]

EIA predicts nuclear growth of 9.5 gigawatts, but that the nuclear share of primary energy falls from 8.8% in 2009 to 8.0% in 2035 (electricity share falls from 20% to 17%). The U.S. is moving forward with new nuclear plants, but more slowly due to world economic conditions. Increase in nuclear generation is facilitated by Federal loan guarantees, tax credits, and in regulated states, by the ability to recover capital investment through the rate base. A future U.S. carbon tax would increase nuclear generating capacity significantly, on the order of 29 gigawatts.[4]

Why Nuclear?

Nuclear and hydroelectric are the only large-scale electricity sources that do not produce air emissions and greenhouse gases. One of the lowest-cost/low-emission technologies, nuclear energy is reliable, affordable and essential for grid stability; in particular, it provides large amounts of constant power that can complement the highly variable power levels of renewable energy technologies. While capital costs are high, fuel and operating costs are low. Because uranium is a small proportion of generating costs, relative price stability is assured regardless of uranium price fluctuations.[5] Nuclear energy is also an engine of high-quality jobs.

Today, nuclear energy is used to supply electricity; after 2020, however, U.S. industry could pursue other applications such as process heat, enabling cleaner production of petrochemicals. The U.S. and other countries are

exploring other applications such as very high temperature reactors for process heat; U.S. industry is pursing light water and other innovative small- and medium-size reactors for electricity and process heat applications. Further, if a price is put on carbon, nuclear energy could replace natural gas as a feedstock in the petrochemical industry.

Challenges to Expanded Use of Nuclear Energy Are Largely Economics and Waste Management

In a market economy, energy technology choices are based on capital, operating and transmission costs. Coal, nuclear and renewable energy are capital intensive, while fuel is the largest cost component for natural gas. Nuclear energy delivers low-carbon base load electricity at stable costs over time, but plant construction is capital intensive (an estimate $4B for a single unit). Access to low-cost financing is critical for capital-intensive technologies like nuclear and renewable; when financing costs are higher, coal and gas combined cycle are the most competitive. The Energy Policy Act of 2005 (EPACT 2005) authorized loan guarantees for first movers of new nuclear plants. In addition, nuclear is competitive in state-regulated markets that allow recovery of costs through the rate base.

In the longer term, a failure by the U.S. government to fulfill its legal obligation to take possession of commercial used nuclear fuel would be an obstacle to building new plants. The issues associated with used nuclear fuel management are not technical, but societal and political. With the withdrawal of the license application for the Yucca Mountain geologic repository, long-term storage at reactor sites will be necessary for an extended period. Onsite storage is safe, secure and relatively cost effective for the near term, but a geologic repository will eventually be necessary. The government is seeking new options for improved management of used nuclear fuel; a *Blue Ribbon Commission on American's Nuclear Future*, appointed last year, recently issued draft recommendations. While the Commission's work is still underway, initial recommendations call for the establishment of a modern waste management strategy that includes development of one or more permanent geological facilities, consolidated interim storage facilities, and research, development and demonstration on advanced fuel cycle technologies that have the potential to offer substantial benefits to management of used fuel.[6]

Finally, the accident at Fukushima-Daiichi nuclear plant has raised public awareness about the safety of nuclear power in general. The U.S. Nuclear Regulatory Commission performed an initial 90-day review of regulatory oversight and safety standards for the current fleet, and issued 12 recommendations. NRC confirmed that "continued operation and continued licensing activities do not impose an imminent risk to public health and safety and are not inimical to the common defense and security."[7] Both NRC and industry are committed to learning from Japan's experience and applying relevant lessons to make facilities even safer.

Federal Nuclear Energy Research Programs

The Department of Energy's four main R&D objectives[8] address challenges to long-term use of nuclear energy: developing technologies and solutions to improve the reliability, sustain the safety and extend the life of current reactors; improving the affordability of new reactors; developing sustainable fuel cycles; and understanding and minimizing risks of nuclear proliferation and terrorism.

The Light Water Reactor Sustainability program is a cost-shared initiative with industry investing about $25 million/year of federal funding to investigate and resolve issues such as materials degradation associated with long-term operation. Research to improve the affordability of new Generation III+ and Generation IV reactors, to enable nuclear energy to meet energy security and climate change goals, includes development of advanced systems such as a very high temperature reactor suitable for nonelectric applications, small modular reactors and other concepts. The U.S. collaborates on advanced reactor development through the Generation IV International Forum, an international collective of 13 countries. Japan serves currently as the GIF Policy Group Chair.

Current U.S. policy calls for a once-through fuel cycle (direct disposal of used fuel in a geologic repository), but investments in research to support a broad range of fuel cycle options continue with a goal of demonstrating technologies necessary to allow deployment by mid-century. Advanced technologies are those that improve uranium resource availability and utilization, minimize waste generation and provide capability and capacity to manage all wastes produced. For example, new technologies such as those with minimal treatment or those that involve transition to fast reactors could prove sustainable in the future. In the absence of a commitment to any particular back-end technology the U.S. has the opportunity to consider all options for creating a more sustainable fuel cycle.

Conclusions

The U.S. is committed to continued development of nuclear energy as a secure resource for energy and it continues to invest in nuclear energy research, development and demonstration. The U.S. views cooperation with traditional partners as important to advancing technology, and will continue to explore opportunities for collaboration.

[1] *The Real Wealth of Nations: Pathways to Human Development*, United Nations Human Development Report 2010.

[2] *Blueprint for a Secure Energy Future*, The White House, March 30, 2011.

[3] *Annual Energy Outlook 2011*, Energy Information Agency, DOE/EIA-0382 (2011), April 2011.

[4] Ibid.

[5] *Uranium: Sustaining a Global Nuclear Renaissance?* World Nuclear Organization. (2005)

[6] *Draft Report to the Secretary of Energy*, Blue Ribbon Commission on America's Nuclear Future, July 29, 2011.

[7] *Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Daiichi Accident,* U.S. Nuclear Regulatory Commission, July 21, 2011, p. 46.

[8] *Nuclear Energy Research and Development Roadmap*, U.S. Department of Energy, Office of Nuclear Energy, April 2010.