

U.S./INDIA ENERGY COOPERATION

HEARING BEFORE THE COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE ONE HUNDRED NINTH CONGRESS

SECOND SESSION

TO

EXAMINE UNITED STATES AND INDIA ENERGY COOPERATION IN THE
CONTEXT OF GLOBAL ENERGY DEMAND, THE EMERGING ENERGY
NEEDS OF INDIA, AND THE ROLE NUCLEAR POWER CAN PLAY IN
MEETING THOSE NEEDS

JULY 18, 2006



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CONTENTS

STATEMENTS

	Page
Bingaman, Hon. Jeff, U.S. Senator from New Mexico	2
Bunning, Hon. Jim, U.S. Senator from Kentucky	3
Domenici, Hon. Pete V., U.S. Senator from New Mexico	1
Gadbaw, R. Michael, Vice President and Senior Counsel, General Electric Company	38
Poneman, Daniel B., Principal, The Scowcroft Group	34
Pumphrey, David, Deputy Assistant Secretary for International Energy Co- operation, Department of Energy	3
Simons, Paul, Deputy Assistant Secretary for Economic and Business Affairs, Department of State	11
Thomas, Hon. Craig, U.S. Senator from Wyoming	2
Victor, Dr. David G., Director, Program of Energy and Sustainable Develop- ment, Stanford University	27

APPENDIX

Responses to additional questions	49
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U.S./INDIA ENERGY COOPERATION

TUESDAY, JUNE 18, 2006

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:10 a.m., in room SD-366, Dirksen Senate Office Building, Hon. Pete V. Domenici, chairman, presiding.

OPENING STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. Hello, everybody. The purpose of today's hearing is to examine recent developments in U.S./India Energy Cooperation. After committing to a framework exactly one year ago, President Bush and India's Prime Minister announced an agreement in March this year on civil nuclear cooperation between our countries. This is an historical agreement that I believe will lead to a strategic relationship between our great democracies. I'm pleased with the recent action taken by my good friend, Senator Lugar, of the Foreign Relations Committee to pass the U.S./India Civil Nuclear Agreement, withstanding bipartisan, strong bipartisan support. I encourage the Senate and Senator Frist to bring this measure to the Senate floor prior to departure of the August recess.

In hearings that led up to the approval of the Foreign Relations Committee nonproliferation issues, issues related to sharing nuclear technology played a promising role. A related measure focused on U.S./India energy security. Cooperation did not receive the same level of media attention but it raises a very serious issue that we all became keenly aware of after the hurricanes hit our gulf coast last year and that is that human and economic toll that can result from a tight, inter-dependent world energy market reliant on energy sources that are subject to disruption. Energy security is not only a concern for the United States but for the developing countries like India, that has a population to surpass China in the next 50 years, an economy rapidly expanding with a growth rate of over 7 percent in 2005, resulting in increased energy consumption which is expected to double in the next 25 years. Our witnesses today will speak to the role of technological cooperation and industry partnerships to aid in developing options to meet future global energy demands while assuring diversified, proliferation-resistant energy sources.

My good friend Senator Bingaman and I have engaged in serious discussions on another topic of global importance, that is of climate change and I have said that I do not know where we will end up

but I do believe that a large number of our citizens are concerned about climate change. I think that Congress needs to explore ways to reduce our contribution to those gases. Our cooperation with India also encourages the development and the developing world to do their part by adopting sustainable energy sources that reduce greenhouse gases and their emissions. It is no secret to anyone in Washington that I am a serious proponent of expanding nuclear power generation along with many members of the Senate who sit here today. The global community is rapidly examining nuclear power as a means of providing sustainable energy. India has announced plans to significantly expand its civil nuclear program with nine reactors currently under construction. I am hopeful that cooperation with India will lead to significant opportunities for U.S. industry in nuclear powers resurgence as India and other countries develop plans for expanded nuclear power in the next decade. I strongly support an evolving strategic U.S. relationship with India. India is home to one billion people, the largest democracy and a worthy partner that we can work with in our pursuit of global security. I look forward to the testimony today and hope that the Senators who are here are also looking forward to what we are going to hear today.

We are going to have two panels testifying before us. On one panel we have Mr. David Pumphrey, Deputy Assistant Secretary for International Energy Cooperation at the Department of Energy and Mr. Paul Simmons, Deputy Assistant Secretary for Economic and Business Affairs at the Department of State. I will stop with that and ask if Senator Bingaman will have any comments and then either of you two Senators. Thank you for coming today. It is a very interesting panel.

**STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR
FROM NEW MEXICO**

Senator BINGAMAN. Thank you very much, Mr. Chairman, for having the hearing. It is an extremely important hearing and set of issues. I'm interested in hearing from the witnesses, of course, about the energy cooperation aspects of this but also about the implications of what is proposed for our nonproliferation efforts in the world. I hope to have some questions when we get to that part of the hearing. Thank you.

The CHAIRMAN. Thank you.
Senator Thomas.

**STATEMENT OF HON. CRAIG THOMAS, U.S. SENATOR
FROM WYOMING**

Senator THOMAS. Thank you, Mr. Chairman. I think it is an interesting issue as well. Nuclear power has great promise, of course, and I think we are looking at the growth and change in the world, change in the economies, India being one of those that is going to make a change in the world and so this is an opportunity. I think we need to work with them to talk about it in terms of air quality and the environment. However, that responsibility with nuclear power doesn't end just with the environment. We have to be concerned about nuclear proliferation and so on. So I think it is important we work in this area and help to develop the economy, our re-

lationships as well as the safety, over time. So thank you. I look forward to your comments.

**STATEMENT OF HON. JIM BUNNING, U.S. SENATOR
FROM KENTUCKY**

Senator BUNNING. Thank you, Mr. Chairman. This hearing represents an important step in recognizing that energy prices are governed by a global marketplace. The price my constituents pay for gasoline at the pump in Kentucky and the price Americans pay for natural gas to heat their home is directly related to energy demands in countries like India. The growing demand for energy in India will stretch limited international resources and push energy prices even higher. To meet worldwide energy challenges, it is important that America and India cooperate.

America is the worldwide leader in mining, processing, burning and gasifying coal. It is the most abundant domestic energy resource that we have. Similarly, India relies on coal to fuel more than half of its energy needs. With its electricity growth forecast to increase by 8-10 percent annually, India has the potential to be an important new marketplace for our America coal and electricity companies. In partnership with India, we can apply the newest clean coal technologies and mining techniques. India will benefit from our experiences and American companies will take advantage of a new market. Cooperation is not only about helping India or developing a new market for American goods, it is a way for us to take control of our own energy prices. Every time an American company shares a new technique or asset or a new project, we can increase the efficiency of India's energy production and usage. Added efficiencies will curb demand and decrease pressures on international energy prices. As we help India develop a vibrant, efficient and environmentally friendly energy marketplace, we must ensure that American companies who share their technologies are protected. They need a level playing field with India's companies in terms of regulations, market participation and intellectual property rights. The partnership of America and India is an opportunity for both nations to realize significant benefits. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator. I note the arrival of Senator Craig. We were just finishing a few observations by each Senator before we proceeded. Do you have any?

Senator CRAIG. No, Mr. Chairman.

The CHAIRMAN. Very good. All right. Witnesses, let us proceed. Mr. Pumphrey, if you would start.

STATEMENT OF DAVID PUMPHREY, DEPUTY ASSISTANT SECRETARY FOR INTERNATIONAL ENERGY COOPERATION, OFFICE OF POLICY AND INTERNATIONAL AFFAIRS, DEPARTMENT OF ENERGY

Mr. PUMPHREY. Thank you, Mr. Chairman, members of the Committee. I am pleased to appear before you this morning to discuss India's expanding role in global energy markets and the important energy cooperation taking place between our two countries. India has been mentioned already, a Nation of over a billion people with an economy growing at nearly 8 percent per year has a large and

rapidly increasing appetite for energy. Providing clean, reliable and affordable energy to sustain this high level of economic growth is a critical challenge for the Indian government. Between 1980 and 2004, energy demand increased by over 270 percent and based on our latest EIA assessments, we expect demand to double again by the year 2030. Concerns about assuring adequate energy supplies prompted President Bush and Prime Minister Singh to focus on energy security cooperation as a key aspect of a transformed Indo-U.S. strategic relationship. This focus on energy security was reflected in the launch of the new U.S./India energy dialogue on May 31 of last year, chaired by Secretary Bodman and Deputy Chairman of India's Planning Commission, Dr. Montek Singh Ahluwalia. The goal of the dialogue is to identify concrete actions the two countries can take to help India address its energy challenge through increased trade and investment and cleaner domestic energy production, energy efficiency, clean energy technologies and diversified imports of energy.

This dialogue has established five Working Groups, each co-chaired by the Department of Energy and an appropriate government of India counterpart and we also have a number of other U.S. Government agencies involved in the activities. So I will briefly highlight some of the key activities and accomplishments so far and of course, there is more detail in the formal testimony.

Coal, as was mentioned, currently provides about half of India's energy and is expected to remain the dominant fuel in the future. The dialogue is focused on a number of activities to improve the mining, transport and utilization of coal. Perhaps the most significant development has been India's decision to become a partner in the Government Steering Committee of the FutureGen alliance. India is contributing \$10 million to this demonstration powerplant, which will capture and sequester carbon dioxide.

India has recently discovered significant reserves, new reserves of natural gas but lacks an adequate infrastructure to move this gas to major national markets. In addition, India has a large potential for coal-bed methane. We have brought together the private sector and government officials to review the potential for natural gas development and to assist the government of India in shaping the regulatory environment necessary to attract the investment in these natural gas resources.

Looking towards the longer term, we are also working with India on the first efforts to drill for gas hydrates offshore. We hope this research will accelerate efforts and develop this resource of considerable untapped potential. Energy efficiency and renewable energy resources, we believe, will also make an important contribution in shaping future demand for energy in India. We have undertaken a number of activities to support energy efficiency practices and stimulate investment in renewable energy. This work builds on significant programs undertaken by the U.S. Agency for International Development. Clearly, nuclear energy will be an important part of India's energy future as well. While we have had only limited exchanges under the dialogue, meaningful collaboration in this area will be contingent on the modification of our own legal framework.

In looking longer term again, at our urging, the ITER partners have invited India to participate as a full member in this project

to advance fusion energy research. Private sector investment in all parts of the energy supply chain is critical to achieving any of India's energy goals. We and the government of India have made it a priority to include the participation of U.S. and Indian business community in aspects of all of the Working Groups. We have launched several events designed to bring U.S. industry in contact with Indian counterparts, including a CEO Roundtable in Houston put together by the U.S./India Business Council with the Minister of Petroleum and Gas to discuss investment in India's oil and gas sector. Finally, we have also been working with India to help develop its emergency response capability and its own strategic stockpiles. Over the past few years, we have hosted study tours to visit the U.S. SPR sites, invited Indian officials to international conferences in the United States and invited Indian representatives to visit with the International Energy Agency to better understand how the IEA members plan for and respond to severe supply disruptions.

Mr. Chairman and members of the committee, let me conclude by emphasizing that the economic growth that India is experiencing today will lift many people out of poverty. It is in our mutual interest to help India meet its energy needs and become a more efficient user of energy in order to sustain this growth. We are convinced that bilateral, multi-lateral energy cooperation maximizes everyone's energy security. Thank you again, Mr. Chairman, for the opportunity to address the committee and I'll be happy to take any questions that you or the members have.

[The prepared statement of Mr. Pumphrey follows:]

PREPARED STATEMENT OF DAVID PUMPHREY, DEPUTY ASSISTANT SECRETARY FOR INTERNATIONAL ENERGY COOPERATION, OFFICE OF POLICY AND INTERNATIONAL AFFAIRS, DEPARTMENT OF ENERGY

Mr. Chairman and Members of the Committee, I am pleased to appear before you this morning—the one-year anniversary of the Joint Statement concluded by President Bush and Prime Minister Singh—to discuss India's expanding role in the global energy market and the important energy cooperation taking place between the U.S. and India.

President Bush placed energy security high on his agenda from the beginning of his first term and that commitment has only increased. The President's policy recognizes the global nature of the energy markets, and that a nation's energy security does not end at its national boundaries. Our overarching energy security objective is to promote adequate and reliable supplies of affordable energy, as well as the clean and efficient use of energy resources. As the world's largest producer and consumer of energy resources, the U.S. must play a leading role in addressing the world's energy challenges and ensuring a secure energy future. The world's demand for energy is growing rapidly and the demand growth will be increasingly concentrated in the developing world.

We are working internationally to create expanded energy partnerships with major consuming and producing countries. These partnerships are designed to improve energy security globally through domestic energy resource development, increasing the use of clean fuels, improved legal and regulatory regimes, increasing private investment, diversifying resources to include alternative and renewable energy sources, and helping the developing countries and growing economies to be more efficient producers and consumers of energy.

INDIA'S ENERGY OUTLOOK

India—a nation of over a billion people with an economy growing at approximately 8 percent per year—has a massive and rapidly growing appetite for energy. Rapid population growth, expanding industrial production, economic development, urbanization, and increased motor vehicle ownership are all driving this energy demand. Between 1980 and 2004, energy demand increased by over 270 percent. In

1980, total primary energy demand was only 4.16 quadrillion BTUs but by 2004 demand had risen to over 15 quadrillion BTUs of commercial energy, thus making it the fifth largest consumer of energy in the world behind only the United States, China, Russia, and Japan. This growth will continue at a rapid pace with total energy demand projected to be 25.7 quadrillion BTUs by 2020 and 32.5 quadrillion BTUs by 2030.

India is the world's third largest coal producer behind China and the U.S. Coal consumption was 478 million short tons (mst) in 2004, growing to 775 million mst by 2020. India's coal has twice the ash content of U.S. coal, resulting in serious environmental and health consequences for its population. Currently, about 53 percent of India's total energy (and 70 percent of India's electric power generation) is derived from coal.

Of the remaining sources:

- nearly 33 percent is derived from oil;
- 8 percent from natural gas;
- 5 percent from hydro-electric power;
- less than one percent from renewable (solar and wind) sources; and,
- the remaining 1 percent comes from nuclear energy.

India's current civilian nuclear program has an installed capacity of 3,850 megawatts electric (MWe), but, according to the Government of India, it is expected to reach 20,000 MWe by 2020.

India's demand for oil and natural gas is substantial, and will only increase as its economy grows and industrializes. Indian consumption of natural gas has risen faster than any other fossil fuel in recent years, from 63 trillion cubic feet per year (Tcf) in 1995 to 1.09 Tcf in 2004. Its use is projected to reach 1.5 Tcf by 2010 and 2.2 Tcf by 2020. Oil accounts for 33 percent of India's total energy consumption. India's average oil production level was 828,000 barrels per day in 2005. Future oil consumption is expected to grow from 2.6 million barrels per day (mmbd) in 2005 to 3.7 mmbd in 2020 and 4.5 mmbd in 2030. In 2005, India imported (net) approximately 1.7 mmbd of oil. Based on conservative estimates, these imports will continue to grow as consumption needs will rapidly outpace growth in production capacity. Looking ahead, in 2020 India's production capacity will be 1.4 mmbd, leaving an estimated import demand of 2.3 mmbd. Likewise, by 2030 import demand will continue grow to 2.9 mmbd as production will only increase slightly between 2020 and 2030 (1.4 to 1.6 mmbd.)

U.S. POLICY RESPONSES

The U.S. began engaging India on energy more than a decade ago. We realized the enormous growth potential in its economy and recognized the implications for our energy security and for the global environment. My colleague from the Department of State can elaborate on the Civil Nuclear Cooperation Initiative; I would like to discuss more fully the broad range of energy-related activities we have undertaken with India. Today, the Department of Energy leads a wide variety of joint activities with India designed to increase its energy security while building a lasting partnership and friendship between our two nations. These partnerships include participation from several agencies, the Department of State, the Department of Commerce, the Agency for International Development, the Trade and Development Agency, and the Environmental Protection Agency.

Our efforts in 1994 focused on improving the efficiency of India's coal-fired power plants, promoting the use of clean fuels such as natural gas, wind and solar energy, helping establish public-private partnerships in industrial energy efficiency, and improving the investment climate for U.S. energy firms.

President Bush and Prime Minister Vajpayee bolstered our energy cooperation in November 2001, issuing a Joint Statement establishing energy as one of five pillars of the Indo-U.S. Economic Dialogue, with the other pillars being trade, investment, commerce and the environment. This enabled the implementation of the President's National Energy Policy Plan's recommendation that the Department of Energy work with India's Ministry of Petroleum and Natural Gas to enhance domestic oil and gas supply.

U.S.-INDIA ENERGY COOPERATION

Growing concerns about energy security prompted the U.S. and India to launch a new energy dialogue in 2005 that reflects the transformed strategic relationship between the world's two largest democracies. The United States and India recognize their mutual interests are best served by working together in a collaborative fashion to ensure stability in global energy markets. Adequate and reliable supplies of clean

energy at reasonable cost are essential to fuel India's rapidly growing economy. Both the U.S. and India are increasingly reliant upon global oil and natural gas markets to satisfy their energy needs. Both nations depend heavily upon domestic supplies of coal for electric power generation and seek to increase their utilization of natural gas, renewable energy and nuclear power, as well as pursue energy efficient practices to ensure a balanced and sustainable energy economy that helps preserve a clean environment.

In addition to our bilateral work, the United States and India joined with Australia, China, Japan, and South Korea to launch the Asia-Pacific Partnership on Clean Development and Climate in January. This results-oriented, pro-growth initiative will help Partner countries to focus on steps that will create new investment opportunities, build local capacity, and remove barriers to the introduction of clean, more efficient technologies. This partnership, pursued in close collaboration with the private sector, will help each member meet the challenges of improving energy security, reducing pollution, and addressing the long-term challenge of climate change. We look forward to India's active participation in this critical initiative.

U.S.-INDIA ENERGY DIALOGUE

President Bush has called for a transformed Indo-U.S. relationship premised upon a new strategic partnership under which energy security and energy cooperation are key factors. This relationship was reflected in the launch of the new U.S.-India Energy Dialogue on May 31, 2005 chaired by Secretary Bodman and Deputy Chairman of India's Planning Commission Montek Singh Ahluwalia. It established five Working Groups along with a Steering Committee to provide oversight and direction. The goal of the Dialogue is to identify concrete actions that the two countries can take to help India address its energy challenges. The underlying strategy is to address these challenges through increased trade and investment in cleaner domestic energy production, energy efficiency and diversified imports of energy. Building upon the broad range of existing cooperation, this effort will help mobilize secure, clean, reliable, and affordable sources of energy.

The five Working Groups are: Oil and Gas, Coal, Power and Energy Efficiency, New Technologies and Renewable Energy, and Civil Nuclear. These Working Groups have launched activities designed to increase the development of domestic resources, promote the deployment of clean energy technologies and fuels, support reforms in the power sector, enhance India's awareness of steps it needs to take to attract foreign investment in the energy sector, and bolster India's energy security. The Department of Energy co-chairs each of these Working Groups with the appropriate Government of India counterparts and we convene experts from a variety of U.S. Government agencies to participate in the projects.

DEVELOPING INDIA'S DOMESTIC ENERGY RESOURCES

The Department of Energy, in partnership with several other U.S. Government agencies, has been working with the Government of India on several projects that will increase the use of India's domestic resources.

More Efficient Utilization of Coal Resources

The Department of Energy is undertaking a number of steps to support the most efficient development of coal resources. In April 2006, India became a partner in the FutureGen international partnership which will work to create a zero-emissions coal-fired power plant that will produce hydrogen and sequester carbon dioxide underground, enabling greater use of coal in an environmentally sustainable way. Successfully demonstrating and adopting this technology will allow India to reduce the intensity of future greenhouse gas emissions from the burning of their abundant coal resources. India became the first country to join the United States on the FutureGen Government Steering Committee and plans to participate in the FutureGen Industry Alliance. The Government of India will contribute a total of \$10 million to the project to join the government steering committee, \$2.2 million of which has already been contributed.

The Coal Working Group has recently identified several high priority projects that will be pursued by our two countries over the next 2 years, including pursuing investment opportunities and information exchanges in the areas of coal mining and processing, coal mine safety, coal mine methane, and in situ coal gasification. The U.S. Trade and Development Agency has provided a \$360,000 for a feasibility study grant for the Neyveli coal mine expansion project. Technical exchanges and visits are underway between the U.S. and India to examine the potential for pilot projects in India in the areas of underground coal gasification and coal beneficiation/coal washeries.

Finally, a Memorandum of Understanding, or MOU, between the U.S. Minerals Management Service and India's Oil Industry Safety Directorate is expected to be signed in July 2006 in Washington, D.C. The MOU will deal primarily with operational safety, inspection issues and accident investigations of offshore oil and gas operations related to both drilling and production.

In the area of coal-based power generation, a proposed strategic partnership has been established between India's National Thermal Power Corporation and the U.S. Department of Energy's National Energy Technology Laboratory to collaborate on advanced research and development of clean and efficient power generation. A workshop is planned in India for September 2006 to discuss the results of a study on the feasibility of Integrated Gas Combined Cycle power plants in India.

Promoting Natural Gas Development

The promotion and development of clean coal technologies and carbon sequestration efforts associated with power generation remain a focus of current U.S. initiatives with India.

The Department of Energy has been working with India to help them develop their domestic natural gas resources that can offer near-term alternatives. India has discovered a significant reserve of natural gas off its east coast but lacks an adequate infrastructure to move this gas to major national markets. We recently held a joint conference on natural gas that included representatives from government and the private sector to review the potential for natural gas development and to assist the Government of India in shaping the regulatory environment necessary to attract the investment needed to move this gas to market.

Another important area for future domestic natural gas production is from coal bed methane (CBM). India is believed to have significant resources of CBM that could make important contributions to meeting future energy needs. This is an opportunity for the U.S. private sector, which has extensive experience in the area of CBM development, to engage in this key energy source. The Ministry of Coal and Ministry of Petroleum and Natural Gas with the U.S. Trade and Development Agency (USTDA) and the U.S. Environmental Protection Agency are working together to establish a CBM Clearinghouse Information Center, an initiative under the Methane to Markets Partnership. This Center would promote the development of CBM projects and CBM resources by collecting data, conducting training, facilitating technology transfer, and providing consulting services. USTDA plans to support a kick-off event such as a workshop or conference showcasing U.S. technologies, and the Environmental Protection Agency plans to provide financial assistance, technical training, and other support to the organization. In addition USTDA is providing a \$506,000 grant to Reliance Industries Limited to partially fund the cost of technical assistance to develop CBM resources at Reliance's Sohagpur field.

The U.S. Department of Energy is also working with India on ongoing research and development of the first hydrate drilling offshore India; this research is expected to accelerate efforts to develop methane production from hydrates in both countries, potentially providing a significant increase in the quantity of domestic natural gas available to the Indian market. The ocean research ship *Joides Resolution* is currently drilling and coring hydrate-bearing sediments offshore India. DOE has provided specialized equipment and research scientists to detect and evaluate gas hydrates in cores. DOE and the Directorate General for Hydrocarbons are in discussions to develop an MOU to exchange information and analyses, conduct joint studies and projects, and exchange scientific and technical personnel in order to increase understanding of the geologic occurrence and the potential for methane production from natural gas hydrates in both India and the United States.

ACCELERATING ENERGY SECTOR REGULATORY REFORM

In order to meet India's growing demand for energy, significant new investment is needed and the necessary legal and regulatory framework must be in place to attract the needed capital. Recently, the two governments conducted a workshop on natural gas regulation held at the Ministry of Petroleum and Natural Gas. India has recently enacted a Petroleum and Natural Gas Regulatory Board Act which seeks to promote competition, open access and greater transparency in gas pipeline transportation. The meeting addressed a number of regulatory issues and processes that India will have to address to develop a regulatory scheme that will be attractive to potential investors. The meeting was attended by various U.S. Government officials (from the U.S. Department of Energy, U.S. Department of Commerce, U.S. Trade and Development Agency, and U.S. Embassy in India); and a senior official of New York State's regulatory body for natural gas who is an expert on both U.S. federal and state regulation. The Indian representatives at this meeting included the Ministry of Petroleum and Natural Gas, and its Petroleum Planning Analysis

Cell, as well as the Gas Authority of India (GAIL). The effort to establish an appropriate regulatory regime is also being supported by a USTDA grant to the Government of India for a limited feasibility study of a national pipeline grid and to explore the possibility of providing further technical assistance in the area of gas sector regulation.

DATA COLLECTION AND INFORMATION EXCHANGE

A key element of a fully functioning energy market is the availability of timely and accurate information. To help support India's efforts to develop much better data and information, the U.S. Energy Information Administration and India's Ministry of Petroleum and Natural Gas have initiated activities to help develop Indian data systems. The initial work has focused on techniques for collecting hydrocarbon data in India and the United States and methods to improve data collection in India.

IMPROVING ENERGY EFFICIENCY

One of the most important areas of cooperation between the U.S. Government and the Government of India is improving energy efficiency. Energy efficiency investments could make a major contribution to shaping the future demand for energy in India. Much of the recent cooperation between DOE and India has focused on facilitating the development and deployment of energy efficient technologies and practices, including those directed at the industrial, residential, and transportation sector. Building on much of the work of the U.S. Agency for International Development mission in India, the Power and Energy Efficiency working group has engaged in several projects designed to decrease energy demand and improve power generation infrastructure in India.

A U.S.-India Energy Efficiency Technology Cooperation Conference, jointly organized by DOE and India's Ministry of Power, was held on May 2nd and 3rd, 2006 in New Delhi with technical support from USAID and sponsorship by several Indian and U.S. industry groups. The focus of the conference was on industrial and building energy efficiency. Among the key recommendations that came from the event was the establishment of five regional centers of excellence in energy efficiency in India as well as a collaborative program of assistance in developing macro-economic energy efficiency indicators. Following the conference, USAID in technical partnership with the State Government of Karnataka and the Ministry of Power, announced the establishment of a center of excellence for efficient lighting technologies and products, to be called the "Lights Museum and Energy Centre" in Bangalore. Cooperation is also continuing on energy efficient buildings and on the development of building codes, and a U.S. team conducted training in India in May 2006.

Major strides have been made towards rural electrification as well. USAID recently launched a public-private partnership with the General Electric Company to increase access to clean and affordable energy services in rural communities in India. The partnership will span a two-year period and provide up to four communities in India with access to clean energy. The Distribution Reform Upgrades and Management program under USAID has also completed detailed project reports on four model projects on efficient power distribution in the states of Karnataka, Maharashtra, Gujarat and Delhi.

INCREASE USE OF ALTERNATIVE AND RENEWABLE ENERGY RESOURCES

U.S.-India energy cooperation has also focused on the fostering of reliable sources of fuels, including development, deployment, and commercialization of technologies for sustainable, renewable fuels. This work includes creating public-private sector partnerships, as well as the promotion of investment, trade, and technology cooperation in the development of renewable resources such as solar, wind, hydro, and biomass. The Minister of Non-Conventional Energy Sources recently met with experts at DOE's National Renewable Energy Lab to discuss potential areas of collaboration in hydrogen and biofuels research.

CIVIL NUCLEAR ENERGY COOPERATION

Nuclear energy will also be an important part of India's energy future. To that end, the Department of Energy held a joint technical workshop earlier this year in Mumbai to advance dialogue and cooperation on technical issues associated with civilian nuclear energy use. Initial preparations are underway for a second workshop to take place this fall in the United States. However, any meaningful collaboration in this area is contingent on modification of our legal framework as proposed under the U.S.-India Civil Nuclear Cooperation Initiative.

Looking longer term, the U.S. and its ITER partners, the European Union, Russia, Japan, Republic of Korea and China, have invited India to participate as a full partner in the international research project which aims to demonstrate the feasibility of fusion power. U.S. support was instrumental in ensuring this final agreement. The partnership represents the first tangible and concrete step towards greater cooperation between the U.S. and India in the area of civil nuclear energy.

IMPROVED BUSINESS CLIMATE AND MOBILIZE PRIVATE INVESTMENT

Private sector investment in all parts of the energy supply chain is critical to fostering energy security. We have made it a priority to include the participation of U.S. business in aspects of all of the working groups under the U.S.-India Energy Dialogue, which we have encouraged on the Indian side as well, and we have consistently made an effort to encourage the Government of India to take the necessary steps to improve the investment climate and attract U.S. companies.

This past March, the Department of Energy, with the Department of Commerce and USTDA, organized a CEO-roundtable event for the Ministry of Petroleum and Natural Gas in Houston. This event was held in conjunction with the roadshow for the sixth round of New Exploration Licensing Program and third Coal Bed Methane bid round. The meeting was designed to be a forum for U.S. companies to discuss their potential investment and voice any concerns they may have about the oil and gas sector in India.

In addition, the Department of Energy and the U.S.-India Business Council jointly organized a meeting in January of this year with the purpose of soliciting industry views on key commercial issues and building private sector participation in the Energy Dialogue and to promote increased U.S. trade and investment in India's energy sector.

The Coal Working group is also establishing a Coal Business Council consisting of representatives from business, industry, academia and other non-governmental organizations to serve as a resource to the Working Group.

DEVELOPING CRISIS RESPONSE MECHANISMS

The Department of Energy has been working closely with India for some time to help develop its emergency response capability and its strategic stocks. India is developing a 5 million ton (approximately 36.5 million barrels) strategic crude oil reserve, with several locations near Mangalore on the east coast being considered. The Department of Energy has hosted study tours for Indian officials to visit U.S. Strategic Petroleum Reserve sites and speak with U.S. experts in these areas. Indian officials have also participated in international oil stockpile conferences we have held in the U.S. We have also invited Indian representatives to visit with the International Energy Agency (IEA) to better understand how the IEA members plan for and respond to a severe supply disruption.

As such, the Department of Energy has been actively improving relations with senior Indian officials in energy policy-making. In order to ensure a coordinated response in an emergency or crisis situation, we must continue to develop close relations at the highest levels of government. In recent months we have had several high level meetings and exchanges between senior Department of Energy and Indian government officials.

CONCLUSION

Mr. Chairman and members of the Committee let me conclude by emphasizing that the economic growth that India is experiencing today will lift many people out of poverty and it is in our mutual interest to see that growth continue. Therefore, it is in our mutual interest to help India meet its energy needs and become a more efficient user of energy, both that which is available domestically and that which it imports.

The U.S. is leading by example and making needed investments in technologies that will fundamentally transform how we produce and consume energy in the future. We have embarked on an ambitious agenda through the President's Advanced Energy Initiative. We can share these bold ideas and our experiences with India. We are convinced that bilateral and multilateral energy cooperation maximizes everyone's energy security. Thank you, Mr. Chairman, for the opportunity to address the Committee on this important subject and I am happy to take any questions you or the Members may have.

The CHAIRMAN. Thank you very much. We will have some questions.

Mr. Simons.

STATEMENT OF PAUL SIMONS, DEPUTY ASSISTANT SECRETARY FOR ECONOMIC AND BUSINESS AFFAIRS, DEPARTMENT OF STATE

Mr. SIMONS. Thank you, Mr. Chairman. From the perspective of the State Department, we very much appreciate the interest of this committee in the U.S./India energy relationship. Let me ask that my full statement be entered for the record and I'd just like to focus on three brief points in my opening statement.

The CHAIRMAN. It will be made a part of the record and we thank you for doing that. Please proceed.

Mr. SIMONS. Thank you. Let me focus on three very brief points this morning in my opening statement. First, Mr. Chairman, as you pointed out, we have an evolving strategic relationship with India and as the Secretary stated in her speech on July 10, 2006, we do consider strengthening and expanding and deepening this U.S./India relationship to be one of the President's signature foreign policy achievements. India is the world's largest democracy. It is a natural partner for the United States. Its society is open and free and transparent and stable and multi-ethnic and multi-religious. India's democracy is characterized by individual freedom by Rule of Law and by civilian control of the military, all aspects that we very much support and want to reinforce. India will soon become the world's most populous Nation as well as one of the five largest economies of the world and of course, as a rising global power, India can be a pillar of stability in a rapidly changing Asia and a strategic partner for the United States as we meet many of the broad challenges of the 21st century. We have invested the necessary capital to build a global partnership with India. This partnership is founded on strategic success and strategic interests, common democratic ideals and this partnership will advance the cause of peace and freedom and the opportunity in the new century. So we definitely agree, Mr. Chairman, with your support for this evolving strategic partnership with India.

The second point is that from our perspective and again, as Secretary Rice noted last week, a key to unlocking the full promise of this partnership is the very Civil Nuclear Cooperation Initiative that President Bush and Prime Minister Singh put forth last July. By addressing India's unique situation creatively and responsibly, we believe that our civil and nuclear initiative will elevate our partnership to this new strategic position that we all seek. The Secretary noted that this is the first benefit of the Civil Nuclear Agreement. She also noted four other improvements.

First, the initiative, as several of the Senators have pointed out, will enhance energy security. Second, it will benefit the environment. Third, it will create opportunities for American jobs and finally, it will add to stability and security of the world and in fact, be a net gain for the cause of nonproliferation worldwide.

The third point I'd like to stress is the role of nuclear energy in acting as a critical element in building a portfolio of technologies that will bring the world onto a more sustainable energy path. This concept of a portfolio of technologies was laid out in a recent report issued by the IEA, the International Energy Agency. For the first

time, they conducted a survey out to the year 2050, to try to take a look at what a sustainable, global energy future would look like. And their conclusions are very similar to the conclusions that have been arrived at by the Bush administration and which basically frame our overall approach to global energy security, which is that we need work simultaneously in a number of key areas, technology-related areas, to assure this sustainable future and nuclear energy is clearly one of those. It is an important component. Other areas are clean coal, including the incorporation of carbon capture and steward's technology. A third area is increased use of biofuels for road transport and a fourth area is a strong focus on energy efficiency. I point this out because, as Mr. Pumphrey pointed out, we have an energy partnership now with India and I think it is important to note that we are focusing on all four of these areas in our energy partnership and they are very much consistent with the analysis of the IEA and the administration's analysis, in terms of what is necessary to lead towards a sustainable energy future.

Thank you, Mr. Chairman and I look forward to your questions.
[The prepared statement of Mr. Simons follows:]

PREPARED STATEMENT OF PAUL SIMONS, DEPUTY ASSISTANT SECRETARY FOR
ECONOMIC AND BUSINESS AFFAIRS, DEPARTMENT OF STATE

Mr. Chairman, distinguished Committee members, I am pleased to be here today, with Department of Energy Deputy Assistant Secretary David Pumphrey to discuss Indian energy issues. As the world's largest democracy and an important emerging energy consumer, India surely warrants the extra attention.

U.S.-INDIA PARTNERSHIP

During the visit of President Bush to New Delhi last March, he proclaimed that "India in the 21st century is a natural partner of the United States." It is this natural partnership that has led to our ongoing U.S. India Economic dialogue since 2000 and led to the launching of the U.S.-India Energy dialogue prior to the Prime Minister's visit in July 2005.

The U.S.-India economic relationship has become stronger. We are working with India on a full agenda of economic issues through our Embassy in New Delhi, the many cabinet-level visits to the sub-continent, and the four policy forums of the Economic Dialogue—the Trade Policy Forum, the Financial and Economic Forum, the Environment Dialogue, and the Commercial Dialogue—as well as two cross-cutting forums focused on biotechnology and information technology. We also established a CEO Forum last year composed of 10 chief executives from each country. Their input will help the United States and India make progress on key issues that will enhance economic growth and job creation and promote bilateral trade and investment by harnessing the energy and expertise of private sector leaders.

India is increasingly becoming a major U.S. trading partner. From just \$16 billion in two-way trade in 1998, U.S.-India trade has grown to \$26 billion in 2005. U.S. exports (of goods), now at approximately \$8 billion, grew almost 30 percent last year and we expect continued strong growth. In the past year, we have taken steps that are opening many new opportunities for both India and the U.S. We negotiated a comprehensive open skies agreement that has brought momentum to the aviation sector. Since then Boeing has sold almost \$15 billion in new aircraft to India and two U.S. airlines have opened non-stop routes to India. Airport privatization is underway and the air transport market has grown by close to 40 percent in the past year.

ECONOMIC CHALLENGES

There are a number of mutually beneficial strategic reforms that could contribute significantly to India's progress and encourage American business to invest in India's future. Private enterprise and free markets are key to long-term progress. Effective public-private cooperation will address economic growth and development challenges far more effectively than micro-management by governments. Business activity and people-to-people engagement will be critical to the transformation of U.S.-India relations. Nevertheless, governments play an important role in setting

the ground rules for much business activity. Prime Minister Singh has put economic reform at the top of India's agenda. We recognize that these reforms must be politically viable to survive. There are a number of mutually beneficial strategic reforms that could contribute significantly to India's progress and encourage American business to invest in India's future.

The most prominent challenge is world-class infrastructure, which India must provide as a platform for higher sustained growth to enable India to achieve its vision of becoming a world power. Infrastructure is now a national priority, but bringing together federal/state authorities and public/private players is just beginning, and remains a tall order. Infrastructure challenges are complicated by the fact that India's federal/state fiscal deficits severely restrict necessary finances for development. India must invigorate private sources to finance long-term project development. This means that the regulatory environment and attitudes towards private investment in infrastructure at the federal and state level must change. Opening up sectors of the economy where private investment is now restricted, such as retailing, real estate, food processing, small-scale industry, and telecommunications will improve rural connectivity and help generate the growth and revenue streams necessary to provide positive returns to infrastructure investment.

Investors need greater confidence to undertake infrastructure investments, especially in the power sector, where our U.S.-India Energy Dialogue promotes increased trade and investment, including in civilian nuclear power. Transparent market structures and commercial practices help to open markets. They enable foreign investors to better understand and negotiate on a level playing field. These are essential for realizing the energy security objectives of India as well as other countries in the South Asian region. Market structures will be critical for nations as they seek to increase access to global energy markets and strive to meet the needs of their growing economies.

U.S.-INDIA CIVIL NUCLEAR COOPERATION INITIATIVE

One of the most important aspects of our strategic partnership with India is, of course, the U.S.-India Civil Nuclear Cooperation Initiative. As Secretary Rice said during her Senate hearing, this initiative is an historic strategic achievement that will advance energy security, further environmental protection, foster economic and technological development in both of our countries, bolster international security, and strengthen the global nonproliferation regime.

The significance of this initiative should not be underestimated. India has pledged, for the first time, to submit its entire civil nuclear program to international inspection and to take on significant new nonproliferation commitments in exchange for full civil nuclear cooperation with the international community. With this initiative, the world expects India to be a full partner in nonproliferation, and India expects the world to help it meet its growing energy needs. We will continue to work with India on a range of nonproliferation issues as it implements its Joint Statement commitments and our strategic partnership further unfolds.

Implementing this Initiative is a top priority for both the United States and India. We continue to engage our Indian counterparts on a daily basis as we both move forward. In doing so, we look to Congress as a full partner in this endeavor. We are thankful for the support of the Senate Foreign Relations Committee and the House International Relations Committee in favorably reporting legislation on this initiative by overwhelming bipartisan margins. Your support for this is crucial and we look forward to continuing to work closely with you to ensure that we grasp this important opportunity by passing the enabling legislation by the full bodies of both houses.

ENERGY CHALLENGES

Another top priority for India is found in ensuring energy security to maintain its strong economic growth. India's growing appetite for energy has been fueled by urbanization, economic development, population growth, expanding industrial production, and increased motor vehicle ownership. Between 1980 and 2001, demand increased by 208 percent. By contrast, China, often thought of as the next big energy consumer, saw a 130 percent increase over the same period according to the U.S. EIA (Energy Information Administration). India ranked fifth in the world in total energy consumption in 2004, only behind the United States, China, Russia, and Japan. India's energy needs are expected to double by 2025.

India has experienced very strong growth in energy demand, growth that threatens to outstrip supply and lead to energy shortages around the country. This is a serious challenge for the country, but we need to keep in mind that this is the result of strong economic growth, which is good news. We should also understand that

India is not the only country facing this challenge. For oil importing countries, the rise in the cost of oil and refined products has added to trade deficits and in some cases, created balance of payments problems. Many developing countries, whether in Asia, Africa or Latin America, are also facing challenges meeting growing electricity demands, resulting in brownouts and blackouts.

ENERGY OPTIONS AVAILABLE

While these are enormous challenges, I believe that India has more options than many other countries in meeting them. In order to meet these challenges, it needs to pursue a policy of energy security through diversification of supply and resources.

India relies on the following principal sources of energy:

Coal is the dominant energy source in India. Currently, over 50 percent of India's total energy, and 70 percent of India's electric power generation, is derived from coal. India is the world's third largest coal producer (after China and the United States), so domestic supplies satisfy most of the country's coal demand. One major drawback is that Indian coal is extremely energy inefficient. It produces about twice as much ash and particulate matter as American coal. Coal consumption is projected in the International Energy Outlook 2005 to increase to 544 million short tons (Mmst) in 2010, up from 431 million short tons (Mmst) in 2003.

Oil demand in India grew by over 6% annually during the past decade, more than three times the world average, while at the same time oil production rose barely at all. This has led to a widening of the demand-supply gap and in an increased dependency on imports. The EIA says that future oil consumption in India is expected to grow rapidly from 2.2 million barrels per day in 2003 to 2.8 million barrels per day in 2010. At current rates of economic growth this figure is likely to rise to over 5 million barrels per day by the year 2030 according to the IEA (International Energy Agency). Unless India obtains or develops alternative sources of energy, in 15 years it will have to import close to 90 percent of its petroleum needs. India is trying to limit its dependence on oil imports by expanding domestic oil exploration and production and by diversifying to other energy sources where possible. Much will depend on India's ability to locate and use existing domestic oil reserves.

Natural gas is an increasingly important fuel as India strives to meet growing energy needs by diversifying its fuel supply, with the recent focus on development of gas-fired electric power plants in coastal areas. India's domestic natural gas is unlikely to keep up with demand, and the country will have to import much of its natural gas, either via pipeline or as liquefied natural gas (LNG). Potential for gas use in India's growing economy is large and has so far mainly been constrained by insufficient supplies. India became a gas importer in February 2004 with the arrival of the first LNG tanker at the Dahej terminal. India needs to almost triple its existing pipeline capacity over the next five years to accommodate LNG imports and growing domestic consumption. Construction of a "National Gas Grid" is one of the major national priorities and plans for the construction of over 7,000 km of pipelines for a cost of about \$4.5 billion by 2008 have been announced. India also currently lacks a coherent natural gas policy and regulatory framework. The price of natural gas also remains regulated, reducing incentives for energy companies in the Indian market.

Electricity: India's installed power generating capacity on 31 January 2005 was 115,545 MW reflecting a 44 percent increase in capacity in the decade between 1993 and 2002. India currently relies on coal for nearly 70% of its electricity generation and forecasts indicate that coal will remain the backbone of the country's power sector for many decades. To meet its mounting power demands, the Indian government plans to double its capacity to produce electricity within the next eight years. The government of India has set an ambitious target of adding 100,000 MW of new capacity by 2012.

Nuclear energy currently only comprises approximately two percent of India's total power generation. In comparison, the United States, receives over 20 percent of its power from nuclear energy, Japan derives 30 percent, and France roughly 78 percent. India's operating civil nuclear power plants currently have approximately 3,310 megawatts of installed capacity. If given the opportunity under the U.S.-India civilian nuclear initiative, India plans to invest quickly in additional civil nuclear reactors so that, by 2030, its capacity to produce electricity from clean nuclear technology would reach 40,000 megawatts—a twelve-fold increase, according to India's Atomic Energy Commission. Under this plan and further long-term objectives, the Indian government has indicated that approximately 20 percent of India's total power production would eventually be met by nuclear technology, thus significantly decreasing the growth in its reliance on fossil fuels.

India's power generation resources are unevenly distributed and far away from major load centers. Two-thirds of India's population lacks access to electricity, and those who are connected to the power grid have to live with frequent power disruptions. State Electricity Boards (SEBs) are responsible for the production and distribution of electricity in all but 3 of India's 28 states. Old equipment, subsidized electricity rates, and bloated payrolls mean that reform of the Indian power sector is necessary to maximize economic growth.

Renewable Energy: India has a modest renewable-energy program, and the plans for its expansion are ambitious. According to the government's Policy Statement on Renewable Energy, India hopes to obtain as much as 10 percent of its new power capacity from renewable sources—wind, biomass, hydroelectric, and solar—by 2012. If the country even hopes to approximate this goal, however, it will require both external funding and technological expertise. US companies, which have considerable expertise in the development of alternative and renewable energy sources, could play a vital role in energizing the Indian market.

EXTERNAL ENERGY POLICY

India has increased its energy diplomacy with states in the South Asia region as well as states in Central Asia, Russia, the Middle East, Latin America and Africa. The Indian state-owned Oil and Natural Gas Company (ONGC) has invested \$3.5 billion in overseas exploration since 2000. It has invested in gas fields in Vietnam, as well as energy projects in Algeria, Kazakhstan, Indonesia, Venezuela, Libya and Syria. Indian private sector firms have pursued projects in the Middle East and in Africa.

Gas Pipelines involving Iran, Turkmenistan, Burma and Bangladesh have also been considered in recent years. Each of these proposals has serious geopolitical problems and the outlook for pipeline supplies will depend on resolving key regional geopolitical rivalries and constraints. The Iran-Pakistan-India pipeline has been in discussion since the early 1990's. A meeting earlier this year reached no consensus on gas price and project framework. The U.S. government continues to make clear our concerns about the pipeline, based on long-standing U.S. policy and law. We encourage India to look to non-Iranian sources for their gas supplies. The proposed Burma-Bangladesh-India has also seen little progress due to opposition in Bangladesh. Instead, a longer and more costly route directly from Burma through India's northeast is being considered. In 2006, India agreed to join the Turkmenistan-Afghanistan-Pakistan (TAP) pipeline project.

U.S.-INDIA ENERGY COOPERATION ON INDIAN ENERGY CHALLENGES

Diversifying India's energy sector will help to alleviate the competition among India, the United States, and other rapidly expanding economies for scarce carbon-based energy resources, thereby lessening pressure on global energy prices. At the same time, increased energy efficiency can have significant environmental gains. An India that can meet its energy needs efficiently and rationally ultimately strengthens global and U.S. energy security.

Our cooperation with India in its energy sector goes back to the 1960's through a variety of initiatives. More recently, we have continued this cooperation through the U.S.-India Energy Dialogue. The U.S. and India are cooperating on energy initiatives through five working groups: The Civil Nuclear Working Group, the Coal Working Group, the Power and Energy Efficiency Working Group, the Oil and Gas Working Group, and the New Technology and Renewable Energy Working Group. These DOE-led groups have been actively meeting since the formation of the U.S.-India Energy Dialogue in May 2005, and plan a full range of activities in the near term.

National Gas Grid: These groups are allowing us to work with India on key areas of concern in the energy sector. A key example is our support of a national gas grid. Through the support of the USTDA (U.S. Trade and Development Agency), the Indian Ministry of Petroleum and Natural Gas, is exploring the feasibility of a national gas grid for reaching all major energy consuming areas in India. Expanded access to, and utilization of, natural gas is expected to facilitate economic growth and maintain sufficient energy supplies to avoid potential shortages as India's energy demand grows. This represents an example of the U.S.-Indian private and public sector cooperative efforts underway as a part of the U.S.-India Energy Dialogue.

Power Sector: There are many other challenges that both our countries face in the energy sector. As the IEA noted in a report several years ago, reform of India's electricity supply sector is important in order to maintain its level of economic growth. The demand-supply gap will grow unless more market mechanisms are introduced while taking into account goals of electricity access, environmental protection and

economic growth. State Electricity Boards are heavily dependent on government subsidies, which have reached the point where their impact on state and national fiscal operations could threaten India's overarching development objectives. Power utilities lose almost \$7 billion per year, and this figure is growing at 15 to 20 percent each year.

The U.S. government has worked closely with the Indian government to promote best practices in the power sector, expand electrification to rural areas, and to enhance billing and tariff collection systems through USAID's new Distribution Reform, Upgrades, and Management (or "DRUM") activity. In April of this year, USAID launched a public private partnership with General Electric Company in association with Winrock International India to bring energy to rural areas in India that currently lack access to electricity by establishing several pilot projects. Such partnerships with the private sector help to introduce new technologies and management expertise and provide access to financing.

Electricity Imports: In addition to reforming the power sector, another option is exporting electricity from Central Asia to South Asia. The World Bank has done some work in this area, and the U.S. hosted a conference in Istanbul in June to bring together officials from the region to look at this. Transporting power across borders offers a number of advantages that simply cannot be achieved otherwise: In addition to providing supplies to South Asia, it can provide new markets for countries like Tajikistan and Kyrgyzstan. The U.S. believes that regional cooperation and integration are key elements of long-term energy security in this region. We support regional integration because we are confident that it will benefit the economy and security of all South Asian countries. It will create stronger partners and bring member countries closer together. Through USAID's South Asia Regional Initiative for Energy (SARI/Energy), we have focused on regional approaches to meet South Asia's energy security needs through increased trade, investment and access to clean energy. Energy linkages between South Asia and Central Asia can strengthen the energy security of both regions.

Clean Coal: India's dependence on its domestically-produced coal raises many other environmental concerns. Power plants are also the main source of Indian emissions of carbon dioxide, the most important greenhouse gas. These high emissions, along with emissions from other sources, have made all four of India's largest cities—New Delhi, Mumbai, Chennai and Kolkata—among the most polluted in the world leading to serious health consequences for inhabitants. The Coal Working Group has been meeting since July 2005 with several key goals: increased collaboration on clean fossil energy technologies; creating an attractive investment climate for domestic and foreign investment in the energy sector; and developing an efficient and environmentally sound energy infrastructure.

India's agreement to take part in the FutureGen Project is important since the project will create the technology to produce a near-zero emissions coal-fired power plant that will produce hydrogen and sequester carbon dioxide underground, enabling greater use of coal in an environmentally sustainable way when the technology is eventually used in other coal-fired power plants. We strongly support the IEA's Clean Coal Center and their work with India. In May 2006, the IEA and the World Coal Institute co-hosted a workshop, "Coal for Sustainable Energy: Clean Development and Climate Change" in New Delhi, India. To the extent that India expands its use of cleaner energy technology, the result will be reduced air pollution locally, regionally, and globally. We have also encouraged by the IEA's efforts to work with India on developing a strategic petroleum reserve.

During Indian Prime Minister Singh's visit last year, President Bush stated that "the United States and India have built a relationship of great potential as we face this century's challenges." Among those challenges is that of ensuring energy security. The U.S. and India are working together to address this crucial challenge.

Thank you for the opportunity to testify today.

The CHAIRMAN. Thank you very much.

Senator Bingaman, would you like to proceed first?

Senator BINGAMAN. Thank you very much, Mr. Chairman and let me focus on the set of issues that I think are probably the most controversial in connection with this Indian/American proposal, and do so by reference to an article that was in the *Washington Post* in March of this year, where it said—it was quoting our former colleague, Senator Sam Nunn, as saying, "If I were still in Congress, I would be skeptical and looking at conditions that could be attached," in connection with this agreement. It says he was

briefed by the State Department, said that he is concerned that it could lead to the spread of weapons-grade nuclear material, unleash a regional arms race with China and Pakistan, and make it more difficult for the United States to win support for sanctions against nuclear renegades, such as Iran and North Korea. Then it says that Nunn is a board member of General Electric. It also states in this article, the Bush administration originally sought a plan that would have allowed India to continue producing material for 6-10 weapons each year but the new plan would allow India enough fissile material for as many as 50 weapons a year. Then it goes on to quote Senator Nunn as saying, "The current agreement certainly does not curb in any way the proliferation of weapons-grade nuclear materials." I'd ask Mr. Simons, as the spokesman for the State Department, what your response is to Senator Nunn's concerns.

Mr. SIMONS. Thank you, Senator, for that question. I think the important point here and it has been pointed out by Secretary Rice as well as a number of other administration officials in their various testimonies, is that our initiative essentially brings India into the tent. It makes India a partner for the first time in more than 30 years, in global nonproliferation. So this is the point the administration has been stressing in support of this initiative: basically, it gives us an opportunity to work with the Indians to bring them in as a player, as a contributor to future solutions as opposed to as an outlier and India really has been an outlier for the past 30 years. I think that the chairman made a good point in his. I believe he wrote a response back to the *Wall Street Journal* addressing some of these points and we would endorse some of the same arguments that the chairman made in his article back, which is that we do focus now on transparency for the first time. We have a window into India's nuclear problem for the first time, into its program. And we do think that by creating this type of partnership, we are more likely to see successful results more broadly in terms of our global nonproliferation policy.

Senator BINGAMAN. Let me ask about one other aspect of Senator Nunn's criticism. He says that among the conditions he would attach to the legislation is the requirement that it could not take effect until the President certifies that India pledges not to produce nuclear material such as plutonium and highly enriched uranium for weapons. The current agreement, certainly does not curb in any way the proliferation of weapons-grade nuclear material," Nunn says. And then he goes on to say, "India was a lot better negotiator than we were," Nunn asserted, while the administration has said it has no intention of aiding India's nuclear weapons program, "the reality could be the opposite," he said. "The administration has a high burden to explain this." How do you explain the conclusion that Senator Nunn has, that this agreement will, in fact, aid India's nuclear weapons program and allow them to produce substantially more weapons than they otherwise would be able to?

Mr. SIMONS. Senator, I think part of this question I'll need to consult with my nonproliferation colleagues and give you a more detailed answer for the record but as a general point, I think it is important to stress that by separating its civilian and its military nuclear components and by providing access, full access by the

IEA, to its civilian components, we really do bring India into the tent. We engage them as a partner and we've already started to see some benefits from that in terms of India working with us and working with the IAEA more closely with respect to the Iranian nuclear question. I think it would be useful to question whether that type of cooperation would have been possible in the absence of the U.S./India Nuclear Agreement.

Senator BINGAMAN. My time has expired, Mr. Chairman. Thank you.

The CHAIRMAN. Thank you for the questions, Senator Bingaman. I might add that I did write an in-depth letter in response. It is not here. I can give it to you for your perusal but it even goes one step further, having a recall that I wrote that letter. Since then, the United States has put on the table a fissile material cut-off treaty to curb the production of fissile material and it is interesting that a member of that team, working on that is India, which I'm not sure we would have had working for that goal, had India not been party to this agreement with us, what we have. I'd like to ask, to move ahead on some other issues. On April 4, the Climate Conference sponsored by the Energy and Natural Resources Committee, panelists noted that action by major developing countries like China and India is critical to address climate change. What role will energy cooperation agreements play in providing options to expand greenhouse gas emission-free energy, Mr. Pumphrey?

Mr. PUMPHREY. Thank you, Mr. Chairman. The activities that we have undertaken in the energy dialogue are very much focused on moving towards cleaner technologies, energy efficiency and renewable energy. We believe that all of these efforts will support having India move to a less greenhouse gas intensive framework and a less greenhouse intensive future. Currently, they are very dependent on coal and coal that is burned in older powerplants, so we are working with them on newer coal-burning technologies as well as looking at the introduction of natural gas in areas that it can then take the place of coal, as well as moving ahead on renewables. I should mention that India is also an active member of the Asian/Pacific Partnership, which is a new, multi-lateral group that is looking at innovative ways to move new technologies into the marketplace to help address our concerns about greenhouse gas emissions.

The CHAIRMAN. I have a number of questions but I'm going to hold here now, because there are a number of Senators. So let me proceed and see what we can do with working our way through them getting questions out.

Senators Bunning, Thomas, Craig and Salazar.

Senator BUNNING. Thank you, Mr. Chairman. Either can answer this. It is for both of you. What is, with the strong alliance and strong reliance on foreign oil, what measures has India pursued to diversity its energy policy, what initiatives are being taken in India within its own five energy bureaus, to ensure a comprehensive energy policy is implemented? Either or.

Mr. PUMPHREY. Senator, I'll be glad to start and then—

The CHAIRMAN. But please, we have a devil of a time hearing you.

Mr. PUMPHREY. I'm sorry. Okay. Let me get up closer then. India has been making efforts in many areas to reduce this dependence on oil. One of the most significant has been the introduction of compressed natural gas into its vehicle fleet in New Delhi. They have one of the highest penetration rates for gas—and this is directly backing out gasoline and diesel fuel. They are also looking at ways, as I mentioned in my opening statement, to bring even greater volumes of natural gas in the marketplace and make those available. We have begun discussions with them on the possibility of increased use of biofuels for the transport sector, so there are a number of areas in which they are beginning to operate. The other area that I mentioned that we think is very important is that recognizing their reliance on imported oil, they are taking steps to increase their stockpiles, to start stockpiling oil in case of emergencies, to guard against the disruptions that may take place. So they are looking at it from both ends in terms of diversifying away from the role of oil as well as guarding against their vulnerability to—

Senator BUNNING. Is it a comprehensive plan? In other words, are they looking to taking coal and making liquid fuels out of it and other synthetic-type energy products?

Mr. PUMPHREY. There have been discussions on looking at ways to incorporate coal liquefaction technologies. But I think you raise a very important point that within India, traditionally there have been the five different groups that have had responsibilities in the energy sector. Our understanding is that the Planning Commission is working very hard to try to bring together those elements to come up with a comprehensive crosscutting energy policy.

Senator BUNNING. In other words, they do not have one presently?

Mr. PUMPHREY. They have come up with an initial plan but again, it is a problem that I think we've wrestled with ourselves in terms of coming up with a comprehensive plan.

Senator BUNNING. In your testimonies, both of you said that the government of India is shaping the regulatory environment necessary to attract international investments. What specifically is being done by the Indian Congress and Prime Minister at this time?

Mr. PUMPHREY. In one particular area, they are looking at coming up with a framework for investment in a natural gas pipeline infrastructure. They have recently passed a new pipeline act that allows for the creation of a regulatory body to develop the Rules for Investment so that they can bring in foreign investment in that sector. So that is one of the very real time areas that we are having conversations with them about and lending our experience.

Senator BUNNING. Let me ask the last question I will on this round. Could you describe the benefits of India's participation in the FutureGen alliance?

The CHAIRMAN. Well, that's a good one.

Mr. PUMPHREY. We see the FutureGen alliance as a very important step forward in demonstrating technologies for utilizing coal. We believe that their presence not only in helping to fund the activities through their participation in the Steering Committee but also bringing some of their expertise to the table, will bring an im-

portant dimension of a major coal-burning country to the table in the design and understanding of the operation of this and hopefully the transfer of these approaches to carbon sequestration back to their own economy.

Senator BUNNING. In other words, you think that their scientists are online and up to speed in this technology?

Mr. PUMPHREY. I would actually prefer to consult with my experts in fossil energy on that in more detail but—

Senator BUNNING. Would you give us a written response then?

Mr. PUMPHREY. I would certainly be glad to.

[The information follows:]

India's scientific and technology communities are very interested in the FutureGen technology and science associated with sequestration. They also recognize the potential of this technology for their country in terms of using their coal resources to meet their growing energy needs while mitigating the impacts on climate change. However, in general, their scientists and engineers do not have extensive experience with the primary technology upon which FutureGen is based, namely, advanced coal gasification to produce power and hydrogen. By its involvement in FutureGen, India can gain the engineering and technical experience on FutureGen technology that they can extrapolate and apply to their own needs. Participation by India and other countries is important to gaining an understanding and acceptance of the FutureGen "near-zero atmospheric emission" coal concept, and in so doing, make this technology broadly available to address environmental and climate change issues associated with the use of coal, a strategic and globally diverse energy resource.

Senator BUNNING. Thank you very much. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator. Senator, I think your questions are right on, exactly what we need to know about. It doesn't do us any good to just keep hearing about these great potential relationships. It is what is actually going to happen to exchange with the United States so that we can both improve. We from them, them from us. That's the whole purpose. We ought to hear more about that from the next panel, I hope. Thank you for your questions. Let's see, the next one we have is Senator Thomas. It is your turn, please.

Senator THOMAS. Thank you, Sir. I think it is very important that we are working with India in terms of the economic growth and the relationship there. Why is nuclear power—or is it—the highest priority in terms of energy for India? Either of you.

Mr. SIMONS. We think nuclear power is going to be one very important component of India's energy future. All the other major Asian-emerging countries have large nuclear programs, which are growing. They have all decided—China, Korea, Japan—that nuclear must be an important component of their energy futures but those other countries are much farther ahead than India in terms of making nuclear a big part of their energy equation. Japan has about 30 percent of its electricity in nuclear, Korea about 35 percent. Now of course, these countries are more advanced, also, economically. But India's isolation also—and its inability to cooperate on civilian nuclear issues, has also held back and retarded the growth of nuclear in India. So when the Indian government puts forward a forecast and says that in 20 years, they'd like to get up to about 20 percent of their total electricity production in nuclear, I think that demonstrates that nuclear is going to be a very important component—

Senator THOMAS. Let me interrupt.

Mr. SIMONS. It's not the only answer.

Senator THOMAS. You said they haven't made much progress in terms of nuclear negotiations. They haven't signed a nuclear treaty, a nonproliferation treaty.

Mr. SIMONS. Essentially they have been cut off from civilian nuclear cooperation from a lot of countries because they've been outside of the mainstream. So, I bring them into the mainstream—

Senator THOMAS. But they still are not interested in doing that now? I mean, isn't that what the nuclear nonproliferation is about, so that you can go ahead with energy development without being concerned about the defense aspect of it?

Mr. SIMONS. That's right, but India, of course, chose a different path 30 years ago and so they isolated themselves from what would perhaps have been a more rapid development of their civilian nuclear side. Now, with this agreement with the United States, assuming that it goes through, we will have the opportunity, to some extent, to jumpstart that nuclear cooperation and to make sure that nuclear plays a similar, important part in India's energy future, as it does in say, the energy future of the United States, France, Japan, and the other Asian countries that have decided that they need to have a large nuclear program.

Senator THOMAS. Yes, I understand that. I guess sometimes I wonder why we would have a different arrangement on nonproliferation with them than we do with anyone else. There is nothing wrong with suggesting that if you can go into the nuclear, that you ought to understand that it is for energy and not for other purposes. What is India's level of consumption of energy, in terms of other countries and so on, Mr. Pumphrey?

Mr. PUMPHREY. The most recent review that we have done through the Energy Information Administration, they rank about fifth in the world in terms of energy consumption. Last year, I believe they were sixth, so they are moving sort of upwards relative to other major countries. They have passed Germany in this past year, in terms of their energy consumption.

Senator THOMAS. You mentioned that they are working on FutureGen and other coals and that they have a fairly high supply of coal, is that right?

Mr. PUMPHREY. That's correct. They have very large supplies of coal.

Senator THOMAS. But they are working at ways of conversion of coal as well?

Mr. PUMPHREY. Into other fuels in terms of—yes.

Senator THOMAS. Gas?

Mr. PUMPHREY. Yes, or liquids, right.

Senator THOMAS. Diesel or whatever?

Mr. PUMPHREY. There is great interest in doing that. Perhaps there has been interest expressed in technologies such as in-situ gasification of coal as well.

Senator THOMAS. Okay. Are we working with them then, on cooperating with other energy development as well as nuclear? Or are we just focusing on nuclear?

Mr. PUMPHREY. We have approached the dialogue in a very broad basis. We feel that as Mr. Simons had mentioned, that you need

a portfolio approach to how you solve your long term energy problems. Diversity is a key for energy security solutions. So while the public debate has been on nuclear, we've pushed very hard in areas of coal development, gas development.

Senator THOMAS. Why is there public debate on nuclear?

Mr. PUMPHREY. The issues concerning the new arrangements under the agreement.

Senator THOMAS. Yes, I understand. That is part of the problem. Thank you.

The CHAIRMAN. Thank you, Senator.

Senator Craig.

Senator CRAIG. Thank you very much, Mr. Chairman. I think bringing India into the fold is extremely important. The Senator from Montana questioned appropriately why they are now just coming, because they did choose a different path early on and then I believe during the Clinton years, as a result of the explosion of some nuclear devices, we put them out on a shelf and really kept them there for a time. This initiative in bringing them onboard is extremely important in the long-term. I think all of us are concerned about the growth of nuclear communities and what it means and how waste or the by-products are controlled and managed. Mr. Simons, do you see a risk that the U.S./India civil nuclear cooperation deal could lead to a nuclear arms race in South Asia?

Mr. SIMONS. We support this deal because we do believe it will actually help to counter global proliferation. We believe it will have a positive, a net positive impact in terms of our global nonproliferation strategy. So the answer is no.

Senator CRAIG. Could the absence of it result in that?

Mr. SIMONS. Well, once again, we do see this as a very, very important opportunity to establish a different type of strategic relationship with India, one that will help bring India into the fold.

Senator CRAIG. Mr. Chairman, I'm certainly no Indian expert but I did have the privilege of going there a spring ago on a different issue. It was just prior to our Secretary of State being there. Efforts were well underway toward bringing us to where we are today and I think for any of us who failed to recognize what India is and what India could be and our relationships with them miss a great opportunity, not only for ourselves but for the rest of the world as it relates to their potential. Obviously, they are technological abilities, our involvement with them in high-tech, what they hope to accomplish for their own nation, many of us have been concerned about moving ahead in climate change without bringing India and China along and why we rejected Kyoto because of that, in part not in total and why they rejected it, obviously, was that they needed to grow and they needed to feed their people and succeed and I think this relationship is extremely important from what I understand of it.

My last question, Mr. Pumphrey. A strategic partnership has been proposed between DOE's National Energy Technological Laboratory and India's National Funnell Power Corporation as well as discussions about potential collaboration between DOE's National Renewable Energy Laboratory and India's Minister of Non-conventional Energy Sources and with the India Oil Corporation. I believe collaborative efforts between these laboratories are extremely im-

portant. How broad do you see this for our total laboratory complex and I'll let my bias show and for our lead nuclear lab in Idaho?

[Laughter.]

Mr. PUMPHREY. Thank you, Senator. There has been long-standing cooperation between those two laboratories leading up to the time of this new and enhanced dialogue. The NETL has been working with NTPC on coal combustion issues. We are now looking at and discussing the possibility of developing what you described as a new strategic relationship. Those discussions are ongoing so I don't really have the knowledge to be able to tell you exactly how those will be defined and where they will be but certainly, I'd be glad to get back to you. With the National Renewable Energy Laboratory, again they've been working closely with NMES in some areas and they are just initiating new discussions of areas of collaboration. In terms of looking at the rest of the laboratory complex, we are still evaluating the types of science cooperation that we can have in place. There is a new science and technology agreement in place, which the lack of that agreement used to be a hurdle to these collaborative efforts and so, our Office of Science is beginning the effort to look at areas for future collaboration.

Senator CRAIG. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much, Senator. I hope your relationship between your lab and them grows and flourishes and multiplies, Senator.

Senator CRAIG. Mr. Chairman, the great hurdle we have and I think we've accomplished in part through EPAct but we've got to work with DOE, and their ability to outreach and bring in and incorporate within their formal agreements and their financial arrangements, outside interests. Because the work we do today at our laboratories, while it is national, it is international in scope but we've held it awfully close to chest for so long, thinking the Federal Government could finance it all. Now we have a great opportunity to both private and publicly finance some of these new technologies but we've got to figure out how we design those relationships and we are well behind in that design instead of ahead of it. That's my concern.

The CHAIRMAN. Well, whatever questions I had of the two of you, I'm going to submit them in writing. We'll yield now to the two on this side who came late but they want to ask questions. But I just want to say that what I'm least impressed with about today is the lack of a significant discussion about the interplay between American companies and American institutions and American research and India with reference to diversification of their energy sources and I just would talk particularly about nuclear. We're clearly, when you look at what they've got, it is a very, very ancient and old-fashioned approach to nuclear power, saying that with no sense of pejorative-ness attached, if you just look at it. It is obviously—it's not going to stay there. It's obvious it is not going to stay there and it would seem to me that you all and America and maybe us, have to get a little bit more anxious about making sure we enter this play, this foray, to get some development of technology and the development of business relationships.

India is going to go and prosper and as you look at the make-up, I'm hopeful that their projections are way off because their pro-

jections for nuclear in the future are way too small because they are predicated upon an India that starts with a nuclear that is behind schedule. If you start with that as your baseline and keep off of it, 25 years from now, you're still—unless somebody there has built with a lot of hope and said, "let's change what we're doing," and I think that's our role as Americans and maybe even this committee. Maybe we should do what Senator Lugar did and maybe we should explore the idea of doing something specifically as a Nation on the exchange of technology and business in the fields of energy with them unless that is happening and I think I will ask—if Senator Bingaman wants to join me, I'll ask him to ask Secretary Bodman what he thinks about what I'm just saying and is there something that he thinks we ought to be doing that maybe we're not doing. With that, I'm going to now yield to Senator Salazar and Senator Dorgan, in that order.

Senator Salazar.

Senator SALAZAR. Thank you very much, Mr. Chairman and thank you Senator Bingaman, for holding this hearing. Two quick questions. The first is on coal gasification. When I look at what is happening in the United States, China and India and the amount of coal that we have in those three countries and what we're doing to burn coal for our energy needs, can you, Mr. Pumphrey, comment on what it is that India is doing relative to exploring technologies on coal gasification? We've described in this committee that coal for us is like oil is to Saudi Arabia. What is it that India is doing on that front?

The CHAIRMAN. Very good.

Mr. PUMPHREY. Senator, I think at this point I should really get back to you on that question. I need to go back and consult with the specialists we have rather than giving you information that I'm not sure of myself. But I'd be certainly glad to provide that for you. [The information follows:]

COAL GASIFICATION

There are several integrated gasification combined cycle (IGCC) activities planned or being discussed with India including:

(1) The U.S. Agency for International Development (USAID) has contracted with Nexant (San Francisco, CA), under its Greenhouse Gas Pollution Prevention (GEP) Project to conduct a \$2-million feasibility study on IGCC power generation technology. India is interested in this clean coal technology to increase generation efficiency, protect the environment, and reduce CO₂ emissions. The Department of Energy's National Energy Technology Laboratory is providing technical assistance to USAID in managing the project.

This study is being carried out in three phases. In Phase A, IGCC technologies were surveyed and compared with conventional and advanced pulverized coal (i.e., subcritical and supercritical PC), circulating fluidized bed combustion (CFBC), and pressurized fluidized bed combustion (PFBC) technologies to confirm the economics, efficiency advantages, environmental benefits, and other salient features of IGCC technology under Indian conditions, particularly in using high-ash Indian coals. In Phase B, the three most promising gasifiers were selected for pilot plant coal testing. Based on the tests results, a further screening analysis of the three gasifiers was conducted. A system optimization was also conducted to select the best process configuration to provide the basis for a detailed design and cost estimate of a 100-MWe IGCC demonstration plant in Phase C. Project financing sources and a roadmap to commercialize the IGCC technology in India will also be explored in Phase C. Nexant plans to complete the Phase C study in September 2006. An IGCC workshop is being planned in New Delhi on September 19, 2006, with the National Thermal Power Corporation (NTPC), the Ministry of Power, and other interested organi-

zations to disseminate the study results and to discuss implementation of the planned 100-MW demonstration plant.

(2) India has joined the FutureGen international partnership to create a near-zero atmospheric emissions coal-fired power plant that will produce hydrogen and sequester carbon dioxide below ground.

(3) Under the Asia Pacific Partnership (APP), we are discussing the possibility of workshops and site visits on IGCC with India (and China) under both the Power Generation & Transmission and the Cleaner Fossil Energy Task Forces. The first proposed event is during meetings on zero emissions coal technologies, (such as IGCC and carbon capture & storage), during Japan's Clean Coal Days in early September. This would be the first official activity under the Cleaner Fossil Energy Task Force. India will be invited to participate.

(4) Underground Coal Gasification (UCG) has several important economic and environmental benefits relevant to India's energy goals. This area of energy exploitation would require solutions to numerous technical issues. At least two technical issues first have to be resolved: research is needed to ensure that proper site selection provides both the desired conditions for suitable UCG processes and that usable groundwater resources are not adversely impacted. Several activities to discuss exploitation of UCG are planned under the U.S.-India Energy Dialogue Coal Working Group and the APP Coal Mining Task Force, including plans for a UCG Workshop in India during November that will examine these technical issues. The U.S. and India will co-sponsor this workshop with the other APP countries invited to participate.

Senator SALAZAR. I think it would be important because I think as we looked at both India and China, we are making steps here in the broad portfolio of energy development that this committee has been pushing and certainly coal gasification is part of that. It would be very interesting to see what it is that India is doing, so I would ask you to do that. May I ask you the same question with respect to biofuels? You are part of the International Energy Cooperation. Many of us on this committee have been pushing very hard for a whole new chapter of renewables, based on biofuels across America. Can you comment, Mr. Pumphrey or Mr. Simons, on what you know is happening in biofuels in India?

Mr. PUMPHREY. On the question of biofuels, we are just beginning to engage in that discussion with the Indians about their research. We know that the Indian Oil Corporation has research activities that are underway and we have scheduled this week a meeting of our oil and gas Working Group, one of the five Working Groups, which has a more in-depth discussion of biofuels as one of the topics and to look at collaboration on biofuels for the future. So again, on the specifics, I would have to respond to you later, perhaps after we've gotten a better understanding. But we see it as a very important area to work collaboratively with India on how to move biofuels into the marketplace.

[The following was received for the record:]

BIOFUELS

The Government of India (GOI) is expected to announce a comprehensive policy for use of 20 percent bio-diesel for the entire country by early next year. The Planning Commission has already submitted its report to the Ministry of Rural Development, which will now work on presenting the proposal before the cabinet. According to a GOI official, "the use of bio-diesel will result in a savings of \$4.6 billion annually on imports of crude oil. The GOI is planning to produce 13 million tons of alternative fuel every year. This will require 11 million hectares of land and create 11 million jobs." During a July 2006 visit to DOE's National Renewable Energy Laboratory (NREL), a delegation from India discussed several potential areas of cooperation in bioenergy. The Indian Oil Corporation (IOC) is seeking collaboration on the following proposed topics:

- Biorefinery studies to ethanol and biodiesel
- Life cycle assessments of biofuels

- Biochemical processing of petroleum for nitrogen, sulfur and metal removal as well as biocracking, and bio de-waxing.

In addition, various DOE and NREL officials visited the IOC Research Center outside New Delhi in the first half of 2006 at which biodiesel was discussed. The Ministry of Petroleum and Natural Gas (MOPNG) has a policy to purchase Biodiesel, which is based on an Indian adaptation of the ASTM D6751 standard for 100% biodiesel to be used as a blending agent up to 20% in high speed diesel (HSD). There is an additional standard for B-5 HSD. Other research activities have been on the properties of ethanol blends in Indian light duty vehicles.

The IOC's R&D Center has planned programs to examine the value chain of biodiesel from plantation, production, and utilization to environmental assessment. It has been using a laboratory scale plant of 100 kg/day capacity for transesterification, with design of larger capacity plants in the offing. These large scale plants are useful for centralized production of biodiesel. Production of biodiesel in smaller plants (e.g., 5 to 20 kg/day) may also be started at decentralized level in villages.

A bio-diesel blend from IOC is being used in buses in Mumbai as well as in Rewari, and in Haryana, on a trial basis. Twenty buses are being run on 5% biodiesel—diesel blends and their smoke, fuel efficiency and drivability is being compared with another set of twenty reference buses. Encouraged by these results, the Haryana Roadways has requested IOC to extend trials on all the 180 buses of Gurgaon depot. The IOC has also entered into a MOU with Indian Railways to study the complete value chain of biodiesel. In line with that, the IOC has planted about fifty thousand saplings of *Jatropha* on 62 hectares of railway land at Surendranagar in Gujarat. This project is the only one of its kind in India, where every aspect of *Jatropha* Biodiesel would be studied.

Senator SALAZAR. Mr. Simons, do you have anything to add to either one of those two questions?

Mr. SIMONS. I have nothing to add, Senator.

Senator SALAZAR. I would just say this, Mr. Chairman. I think that given the global competitiveness that we're dealing with, with both China and with India, the billion people in India, the billion-three in China, that having a good understanding of what is happening in those two countries relative to energy development would something that would be very useful for all us. So I would hope that is information that can be developed, both by DOE and the International Working Group that you're on, Mr. Pumphrey as well you, Mr. Simons. Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Dorgan.

Senator DORGAN. Mr. Chairman, I came late and have to leave early because of other obligations so I will not take the committee's time. I do want to say—

The CHAIRMAN. You're welcome.

Senator DORGAN. No, I do just want to say that while I think our relationship with India is very, very important, I have great misgivings about anything that I believe will undermine the issues of nonproliferation, stopping the spread of nuclear weapons is, I believe, one of the most important things that is ahead of us and I think a good many people have raised significant questions about this agreement relative to our ability to stop the spread of nuclear weapons. So I thank you for holding this hearing, Mr. Chairman. I regret I can't be here for all of it.

The CHAIRMAN. Thank you. With that, gentlemen, you have heard that we are interested in things you don't know enough about, to put it mildly and that's no aspersion, that's just the truth. So if you can dig some of it up and respond so Senator Salazar will get it, even if you didn't appear, if the person didn't

appear, you can get it from your Department and submit it so we'll know. I think that will be helpful. With that, we thank you for giving us your morning and you will get home in time for lunch. Thank you very much.

The next panel consists of three different people. They might shed a light on some of the subjects, Senator Salazar, that you raised and others. One of them is Dr. David Victor, director of the program of energy and sustainable development, Stanford University and the other is Mr. Michael Gadbaw, vice president of international law and policy, General Electric Company, Washington, D.C. and the other is Mr. Daniel Poneman, Principal with the Scowcroft Group, Washington, D.C. So we're going to start as I started. It doesn't make any difference which way we go but we're going to start with Dr. David Victor. Would you please make sure that you talk right into the mic so we can hear you, sir? And talk loud, if you don't mind.

STATEMENT OF DR. DAVID G. VICTOR, DIRECTOR, PROGRAM OF ENERGY AND SUSTAINABLE DEVELOPMENT, STANFORD UNIVERSITY

Dr. VICTOR. Thank you very much, Mr. Chairman and thank you for the opportunity to testify in front of your committee. With your permission, I'd like to put my full written testimony.

The CHAIRMAN. It's in.

Dr. VICTOR. I will just concentrate on three points. I think the first and most important point for us to have in mind when we look at this arrangement is the context for this deal, which is that in the energy business, there aren't any easy choices. All of the options for supplying energy have trade-offs, pluses and minuses. Furthermore, we're talking about an arrangement by through which we are trying to affect choices that are made in other countries. Over those choices, we have very, very limited leverage. So it is in this context where we have pluses and minuses for all major energy sources, where we have limited leverage over the choices of other countries, that I think we should look at this nuclear arrangement. In that light, I think this is an extraordinary opportunity. I'd like to say a little bit about India's interests in this and then a little bit about the United States' interests.

Concerning India's interests, the single most important thing here is the demand for electricity and India is rising exponentially. I don't think anybody knows how rapidly it will rise in the coming two decades but India's enormous success with its economic reforms, along with its considerable success in reforming its electric power market means the demand for electricity is rising at least as rapidly as the Indian economy is rising and there is some evidence that demand for power is rising even faster than the economy. Right now, as several of the panelists will remark, coal is king in the Indian electric power system and actually I think the position of coal in the power system in India is getting much stronger. That's because almost all of the other options for power supply are much less attractive economically than coal. In particular, natural gas—there is enormous promise for natural gas but natural gas prices have been rising sharply in India. Several people have commented on the new natural gas finds but they are in the

distant future and the situation today is that the real price of natural gas in India, as in the United States, has risen to something like three times the level it was previously.

The other thing that has happened in the Indian power sector is there have been large reforms in the coal sector and those reforms have encouraged private business and they in particular have encouraged private business to invest disproportionately in coal. This sets up India's interests on power sector reform and on this deal, which is that India would like to remain dependent on coal and that's an extremely important part of India's power system but they are very concerned about excessive reliance on coal. They are investing in advanced coal, as we've heard from the previous panel and they are also looking very carefully at the non-coal options. This deal, in particular, makes the nuclear part of the non-coal options much more attractive. I think it is fair to say that it would be impossible for India to expand significantly its nuclear power sector without some kind of cooperative arrangement such as the one we are talking about today.

The third point I would like to make, very briefly, is the implications of all this for the United States. In my written testimony, I've done some simple calculations on the implications for global warming. Put very simply, this deal makes it possible to save something on the order of 100 million tons of carbon dioxide per year by the year 2020, possibly much more, possibly less but that's the scale of the problem. To put that number into perspective, that is almost as large as the entire European Union's efforts to implement the Kyoto Protocol. The reason the number is so large is because the Indian power sector is growing exponentially and because it is dominated by coal. So we're talking about replacing the most carbon intensive fuel with the least carbon intensive.

The CHAIRMAN. You say this deal. Which deal?

Dr. VICTOR. This is the partnership between the United States and India and in particular, the aspects of the partnership that relate to nuclear fuel and a nuclear technology.

The last point I would like to make about this is that I think we should look at this arrangement not only in terms of the potential carbon savings for this particular arrangement but also because if this is successful, this creates a new model for engaging with developing countries because our efforts under the Kyoto Protocol to engage the developing countries in controlling their emissions of greenhouse gases have been largely a failure, because those countries understandably will not accept caps on their emissions. This arrangement shows a different way of doing things, which is to identify areas that are already in these countries' interests, in this case, cleaner power, rebalancing away from coal and also in our interests. The savings here are on the order of 100 million tons per year. The savings from similar kinds of deals in the clean coal part of India weren't gas in China or nuclear in China, could offer similar savings and be dramatically more effective than what we have seen to date. Thank you, Mr. Chairman.

[The prepared statement of Dr. Victor follows:]

PREPARED STATEMENT OF DAVID G. VICTOR, DIRECTOR, PROGRAM ON ENERGY AND
SUSTAINABLE DEVELOPMENT, STANFORD UNIVERSITY

INTRODUCTION

The debate over the India nuclear deal has been too one-dimensional. Nearly all commentary has focused on whether this proposal would undermine efforts to contain the proliferation of nuclear weapons. Dissent along these lines has been based on a series of largely overblown claims. And the singular focus on proliferation has allowed the debate to lose sight of other ways that this deal is in the interests of the United States and India alike.

Chief among those other reasons is environmental. The fuller use of commercial nuclear power, if done to exacting standards of safety and protection against proliferation, can play an important role as part of a larger strategy to slow the growth in emissions of the gases that cause global warming. That's because nuclear power emits essentially no carbon dioxide (CO₂), the most prevalent of these so-called "greenhouse gases." While this benefit is hardly the chief reason for initiating this deal, with time it will become one of the main benefits from the arrangement. The nuclear deal probably will lead India to emit substantially less CO₂ than it would if the country were not able to build such a large commercial nuclear fleet. The annual reductions by the year 2020 alone will be on the scale of all of the European Union's efforts to meet its Kyoto Protocol commitments. In addition, if this arrangement is successful it will offer a model framework for a more effective way to engage developing countries in the global effort to manage the problem of climate change. No arrangement to manage climate change can be adequately successful without these countries' participation; to date the existing schemes for encouraging these countries to make an effort have failed; a better approach is urgently needed.

ECONOMIC GROWTH, ELECTRIC POWER AND THE OPTIONS FOR SUPPLY

Evaluating the environmental benefits of this deal requires, first, understanding the basic factors that affect investment in the Indian electric power market. From the 1970s through much of the 1990s India's economy was famous for its low rate of growth; with low growth came low demand for electricity. A series of economic reforms, initially introduced in the wake of a financial crisis in 1991 but strengthened over the many years since, has changed that situation dramatically. India's economy enjoyed an average annual growth rate of around 7% from 1994-2004. Most analysts expect growth to be sustained at 8% over the next few years if not longer. India's population is young; and an important fraction is well-educated and increasingly engaged with the world economy. To be sure, the Indian economy has many deep flaws. India has made no progress in solving the development problem in the rural areas where most Indians live, and India's democracy is notorious for its political gridlock. All that said, there is palpable evidence that India's economic reforms have finally taken hold.

Higher growth has led directly to higher demand for electricity. While the exact future needs for power remain uncertain, there is considerable evidence that electric demand will grow at roughly the same rate as the economy. Some factors will tend to dampen the growth in demand for power. For example, economic growth is expected to cause a shift in the Indian economy away from energy-intensive manufacturing and also engender investments that make the economy more efficient in its use of energy. But other factors will cause demand for electricity to accelerate. Among them is an improvement in power quality that is likely to accompany the extensive efforts to reform India's electric power system that have been under way for 15 years. While reformers have found it difficult to make progress, these reforms are beginning to take effect in some parts of the country. Those effects are evident not only in the improved performance of some of the country's power utilities, but also in the rising role for privately owned (and generally more reliable) power plants. In industry, for example, reliable power is essential; many companies are taking matters into their own hands and building their own plants. And where electricity is more reliable, Indians will consume more of it.

There are many projections for total demand for electricity. In Figure 1,* I show the International Energy Agency's projections, which envision a doubling of power demand from the present to 2020. Barring an economic catastrophe, I would be surprised if demand for electric power were dramatically lower than these projections. And it is possible that demand could be higher if India discovered, as China has

* Figures 1-3 have been retained in committee files.

in recent years, that demand for electricity rises even faster than economic output. For now, let's use these projections to illustrate the stakes.

At present, the total size of India's electric power system is 124 GW. Of that, coal comprises 55%, hydroelectric 26%, natural gas 10%, renewables 5%, and nuclear makes up only 3% of total installed capacity. Looking to the future, India has five main options for providing the bulk of its electric needs:

Hydroelectric. Official Indian plans call for much greater use of hydro, but in practice, India has found this option increasingly difficult to deploy due to local opposition to dams. This pattern is evident in all large democracies and there is no evidence that it will become significantly easier to site domestic hydro facilities in the future. While there are possibilities of hydro imports from Bhutan and Nepal, such international projects are invariably fraught with political uncertainty. Overall, hydro will probably play a declining role in the future Indian system; projections that claim otherwise are probably wishful thinking and unlikely to be realized.

Renewables. India makes extensive use of biomass digesters in rural areas and wind and solar energy in a few states. Given India's aggressive and expanding renewable energy program, particularly in wind power, the projection shown in Figure 1 (about 6 GW of installed renewable electricity generation capacity by 2020) is certainly too low. However, even assuming India were to continue its aggressive push on renewable energy, renewables are not likely to represent more than 10% of installed capacity by 2020. More importantly, renewable power generators, notably wind turbines, are intermittent. They are available less frequently than conventional power plants, contributing to the unlikelihood that renewables will supply more than 5% of India's total electricity by 2020 even given optimistic assumptions.

Natural gas. Until recently, most analyses of the Indian power sector envisioned that gas would play a much larger role in the future. Gas is attractive because it is the cleanest of the fossil fuels and because the capital cost of gas plants is much lower than for all the other main rivals such as nuclear, coal, and hydro. Thus, gas plants have been especially attractive to private investors who are wary of sinking large amounts of capital into projects where regulatory rules are in flux. Indeed, nearly all foreign-owned private power plants in India are fired with gas. (In other developing countries, most privately-owned power plants are gas fired). However, the price of gas has risen sharply in the last four years. For two decades gas prices were regulated at approximately \$3/mmbtu and supplies were controlled by the state transmission and marketing monopoly. Over the last decade a private gas market has emerged, with prices much higher than those in the historic government-managed market. India has built three terminals to import LNG as a supplement to its own domestic gas supplies, and has plans to build several others. The workings of that gas market are the best indicator of the real price of gas in India. The most recent large transaction, in which India purchased a spot cargo of LNG from Algeria's Sonatrach, put delivered prices at above \$10/mmbtu. Our group at Stanford is heavily involved in analyzing this gas market, and we expect delivered gas prices will remain high—perhaps not as high as \$10, but probably in the range of \$7-\$8/mmbtu.¹

Nuclear. Until now, nuclear power has been controlled by the central government, mainly for non-energy purposes (namely weapons), and has not been exposed to commercial accountability. In addition, India's domestic uranium reserves are quite meager—the Atomic Energy Commission estimates that domestic resources could support only 10 GW of installed nuclear capacity.² Thus, not surprisingly, nuclear energy has played only a small role in the power sector. Whether and how that could change is at stake in this deal.

The India nuclear deal would provide for "full" civil nuclear cooperation between the U.S. and India. By enabling India to import modern nuclear energy technology, as well as uranium, a properly regulated deal would in effect alleviate the historical restrictions placed on civilian Indian nuclear power.

Coal. In the past and in the foreseeable future coal is expected to provide most of India's electricity. In fact, coal has not met its full market potential in the last decade because coal supplies are unreliable (partly because the railroad network is badly in need of investment) and of notoriously low quality. Both those impediments to coal sector growth are being alleviated. India has begun to encourage private investment into coal mines and pithead power plants that will send the coal "by wire" to the national electric grid rather than via railcars. In addition, the country has adopted favorable rules to encourage investment in the inter-state power grid, ena-

¹Jackson, Mike (2006). "India: challenges to growth," in *Fundamentals of the World Gas Industry, 2006*. Petroleum Economist.

²Presentation by Kakodkar, Anil: Chairman, Atomic Energy Commission (2005). "Energy in India for the Coming Decades."

bling the grid to move much larger quantities of electricity.³ At the same time, changes in import tariffs are making it easier to import high quality coal from other countries; those imports, in turn, are inducing India's domestic coal industry to perform better. These reforms are set to have a huge impact on growth in coal-fired capacity. India is soliciting bids for five new 4 GW coal-fired power projects (known as the "ultra mega power projects")—two of which will produce electricity at coal pitheads in the interior of the country and three coastal plants that will import foreign coal supplies.

In this context, the question for the India's energy future centers on the rivals to coal. Where alternative fuels can be successful, the share left to coal will decline. All the rivals have problems. For hydro and renewables those problems are severe, and the United States, in any case, has no ability to influence them. For gas the severity of the problems created by high gas prices are not yet known. On the one hand, high prices have discouraged (but not stopped) investment in plants that use gas. Indeed, some investors who would have built gas-fired power plants are now looking closely at coal. On the other hand, barely a month passes without the announcement of new gas discoveries in India (in particular the large resources discovered off the country's east coast). These new gas supplies may eventually help to lower the price of gas, which in turn will allow for a much larger gas-fired generation capacity.

For nuclear, the future is really wide open. So long as India's nuclear industry remains isolated, it is hard to see that India will build more than the occasional reactor as the cost basis for nuclear equipment will be too high and fuel needed for such reactors will not be available. Some critics have claimed that allowing exports of fuel for use in Indian commercial reactors will free up domestic fuel supplies for use in the nuclear weapons program. The more likely outcome is that India simply will not expand its commercial reactor fleet so that the military program can obtain the fuel it needs.

It is hard to predict with certainty how the costs of the different options will unfold. In Table 1, I focus on the main contenders: nuclear, coal, and natural gas. I show estimates for nuclear power drawn from a study by a group at MIT evaluating nuclear power in developed countries ("high" and "medium cost" estimates) and also from a study that focuses on nuclear power options in the Indian context ("low cost") but used a notably low capital cost estimate. The coal numbers provide an approximation for costs of a new pulverized coal plant—technology widely available in India—for a plant that meets U.S. environmental standards, as well as a conventional plant in India. The estimates for gas are based on the Indian experience and levelized costs are shown at different prices—from the low price for public gas (which is essentially unavailable for new power plants) to various feasible private gas prices.

Table 1.—CARBON IMPLICATIONS OF INDIA NUCLEAR DEAL

Generation options	US cents/kWh
Nuclear—Light Water Reactor	
High Cost ¹	6.7
Medium Cost ¹	4.2
Low Cost ²	3.8
Pulverized Coal	
U.S. Context ^{1*}	4.2
Indian Context ^{3*}	3.9
Natural Gas	
Public Supplier (\$2.86/mmbtu) ³	4.6
Private Supplier (\$5/mmbtu) ³	6.9
Private Supplier (\$8/mmbtu) ³	10.1

¹Massachusetts Institute of Technology (2003). *The Future of Nuclear Power: An Interdisciplinary MIT Study*.

²Bharadwaj, Anshu, Rahul Tongia, and V.S. Arunachalam (2006). "Whither Nuclear Power?" *Economic and Political Weekly* 41(12): 1203-1212.

³Adapted from Shukla, P.R., et al. (2004). *Electricity Reforms in India: Firm Choices and Emerging Generation Markets*

* Both coal calculations based on assumed delivered cost of US\$1.20/mmbtu.

³In fact, India's power regulations indirectly encourage projects that transmit power long distances across state lines because such inter-state investments are governed by federal regulators and can be managed more reliably than projects that are exposed to the whims of state regulators.

Three things are clear from Table 1. First, at the high gas prices typical of today's market, gas-fired electricity is extremely expensive. Second, while there are many uncertainties—especially for nuclear power—the cost of coal and nuclear are comparable. Third, the costs noted in Table 1 may exaggerate the cost advantage of coal because coal-fired electricity has larger environmental consequences. (The “U.S. Context” number is for a plant capable of meeting current U.S. environmental standards; the “Indian Context” number includes some particulate control but only monitoring of other pollutants). If these are taken into account, nuclear power would be even more competitive with coal.

CO₂ AND GLOBAL CLIMATE CHANGE

While there remains some divergence in opinion in the United States about the causes of global changes in climate and the severity of the global climate problem, the risk of unacceptable changes in climate will undoubtedly rise with increasing atmospheric concentrations of CO₂ and other greenhouse gases. It is impossible to predict the outcomes from climate change with complete certainty. (Indeed, the most worrisome possible changes are the least certain, such as possible catastrophic rise in sea level, a change in ocean currents, or the destruction of vast ecosystems like the Amazonian rainforest). Looking at the totality of the evidence, however, it is hard to escape the conclusion that a prudent and risk-averse policy strategy toward the threat of global climate change must include a substantial effort to control emissions. And because those emissions emanate globally, such a strategy must be pursued globally.

The CO₂ savings implications of replacing coal with a range of installed nuclear capacities are provided in Figure 2 above. Because there is considerable uncertainty as to the exact amount of new nuclear capacity likely to arise from the deal, Figure 2 shows a line rather than any particular point. India's track record of installing power plants, combined with the difficulties that are likely to arise in a shift to a truly commercial nuclear power program, suggest to me that new nuclear capacity could be in the range of 10-20GW by 2020. The State Department has proposed that 20GW of new nuclear capacity could be built by 2020—this represents a middle-of-the-road estimate provided by Secretary of State Condoleezza Rice in her April 5th remarks to the Senate Foreign Relations Committee. Under this scenario, by displacing 20GW of capacity that would otherwise be coal-fired, the new nuclear capacity would save 145 million tonnes of CO₂ per year.⁴ Indian Prime Minister Manmohan Singh has recently suggested that the India nuclear deal could have even larger implications, arguing that it might lead India to install up to 40GW of new nuclear capacity by 2015.

In Figure 3, I put the CO₂ savings from a 20 GW buildout of nuclear power into perspective by comparing it with other relevant emission estimates. The annual savings from the Indian deal could be nearly as large as the entire commitment of the 25 EU nations to reducing emissions under the Kyoto Protocol. This single arrangement in India would exceed the total carbon savings from the 100 largest developing country projects under the Kyoto Protocol's Clean Development Mechanism (CDM). At present, the CDM is the only mechanism for engaging developing countries in the effort to control greenhouse gas emissions.

BEYOND INDIA: ENGAGING DEVELOPING COUNTRIES

Until now, developing countries have adamantly refused to limit their emissions of greenhouse gases. These countries are wary that the possible high costs of climate change mitigation will jeopardize their development goals. The result of that opposition is the CDM—a system that compensates developing countries for the full extra cost of any policies to control emissions. The CDM was a good idea in principle, but in practice it is not working well. The scheme has become mired in red tape as countries and investors try to establish their baseline levels of emissions and the reduction in emissions from each project. (The difference between the baseline and the reduced level is the key to the CDM concept—that difference becomes a credit that can be used to offset emission obligations elsewhere in the world, such as in Europe's emission trading system). The problems have encouraged gaming and they have caused CDM investors to focus on activities that are easy to quantify and which are marginal in nature. Indeed, energy projects account for just 17% of the

⁴Jackson, Mike, et al. (2006). “Greenhouse Gas Implications in Large Infrastructure Investments in Developing Countries: Examples from China and India” (working paper, Program on Energy and Sustainable Development, Stanford University).

CDM pipeline. Almost none of the energy projects are of the type that will lead to fundamental changes in countries' energy systems.⁵

If the India nuclear deal is successful, it will frame a new approach to engaging developing countries in a climate strategy. This approach would focus on finding game-changing policies that align with reluctant countries' interests.⁶ Rather than involving hundreds of small and marginal projects, this style of engagement would focus on just a handful of large pivotal actions involving just a few critical countries. This concept is incidentally at the core of the Asia-Pacific Partnership on Clean Development and Climate, whose six members, including India and the U.S., account for half the world's greenhouse gas emissions. That Partnership has promise, but it remains young. Success with this nuclear deal could offer a credible example of practical actions that the Partnership could encourage.

PROLIFERATION, INDIAN POLITICS AND THE FUEL CYCLE

My brief in this testimony is to focus on the possible environmental benefits of the India nuclear deal. I close, though, with a brief word on proliferation.⁷

My sense is that the claims about proliferation risks stemming from this deal have been overblown for three reasons. One is that many observers are reluctant to treat India differently from other states that have acquired nuclear weapons. Yet that argument is not sustainable. India—in contrast with Pakistan, among others—has not been the locus for proliferation of weapons technologies to other states and possibly terrorists. Nor has India taken the kind of aggressive stance with its nuclear weapons program that has been evident in Iran or North Korea.

A second reason for these hyperbolic claims about proliferation is critics have imagined the world as they would like it—a world before India's nuclear test and when the NPT was intact and functioning—rather than the world as it really is. Both these reasons have been covered extensively and I will say no more on them.

The third reason is that critics have imagined that the U.S. somehow got hoodwinked by India—for example, the list of facilities that are exempt from external scrutiny is longer than most U.S. analysts would like. This is a valid concern, but I think it misses the point because it imagines the India nuclear deal as a construct entirely of U.S. interests when, in fact, it is the product of a nascent cooperation between two democracies that must pay attention to how the deal plays locally. It is striking how much hostility the deal has engendered in the Indian press, as Indian nationalists portray this as an erosion of India's sovereign prerogative to sustain a nuclear weapons program. In such settings I think it is imperative that we give extensive deference to those who were able to negotiate a deal that (probably) has navigated these contours of Indian domestic politics while also delivering what is most essential for the U.S. to gain from the arrangement.

The world is in the early stages of recrafting the fuel cycle. Among the proposals is the Administration's Global Nuclear Energy Partnership (GNEP). The IAEA has a proposal. A tailored proposal is emerging as the logical solution to the troubles with Iran's nuclear program—with off-site fuel production and storage. Similarly, success with the India nuclear deal can establish a practical framework for a new fuel cycle for India. Many in the anti-proliferation community have been uneasy about this shift in fuel cycles, but such a shift strikes me as inevitable. And a practical demonstration with a responsible country could go a long way to making these visions a practical reality with adequate protections against proliferation.

The CHAIRMAN. Thank you very much.
Mr. Poneman.

⁵ Wara, Michael (Forthcoming, 2006). *Measuring the Clean Development Mechanism's Performance and Potential*.

⁶ See T.C. Heller and P.R. Shukla (2003). "Development and Climate: Engaging Developing Countries" in: J.E. Aldy et al., *Beyond Kyoto: Advancing the International Effort Against Climate Change*. Pew Center on Global Climate Change.

⁷ I am mindful that many others have written much more extensively on these subjects. Notably, Levi, Michael A., and Charles D. Ferguson (2006). "U.S.-India Nuclear Cooperation: A Strategy for Moving Forward." Council on Foreign Relations, CSR No. 16. and Squassoni, Sharon (2006). "U.S. Nuclear Cooperation With India: Issues for Congress," *CRS Report for Congress*. Congressional Research Service.

**STATEMENT OF DANIEL B. PONEMAN, PRINCIPAL, THE
SCOWCROFT GROUP**

Mr. PONEMAN. Thank you, Mr. Chairman. It is an honor to appear before the committee and I also would just submit my written testimony for the record and summarize here.

The CHAIRMAN. It's done.

Mr. PONEMAN. I would also note that I am speaking in my personal capacity and not as a member of any institution or organization. I would also like to just focus on three basic points. No. 1, I do believe that U.S. interests are best served by a wide-ranging, deep and broad cooperation with India in energy. I cannot improve upon the comments of our administration colleagues on the panel before or Dr. Victor. I think it is clear that across the full range of diverse energy sources, be it biomass synthetic fuels, clean coal or whatever—we need to and Mr. Chairman, you noted it in your remarks—we need to deepen and strengthen that cooperation and indeed, this forms only a part of a much broader degree of strategic engagement the United States, I think, must have with India, given that we are the world's two most populous democracies, we have coherent interests across a broad array of international security interests and we are clearly much the better for being able to work very cooperatively with India.

My second point. Nuclear power can play an indispensable role in meeting the growing need for the large amounts of electricity that the world needs without aggravating greenhouse gas emissions. Once again, Dr. Victor, I think, provided some very stunning statistics in this degree but I would note that I have been working in these issues for 30 years, over 30 years, starting as an intern in the Senate, after the first Indian nuclear test in 1974, and it is remarkable to witness, as we have in the last few years, how public perceptions of nuclear have evolved in a remarkable direction. We're not there yet but we are now seeing large increases in deployed nuclear power being considered in India, in China, in Russia, indeed in this country. It is critical, it seems to me, that as part of any coherent strategy, to minimize greenhouse gas emissions, that we pursue with all vigor, all sources of energy, certainly including nuclear.

This brings me to my third point. We must, it seems to me, pursue that nuclear option in a way that minimizes the threats of nuclear weapons proliferation. Just consider. If you look at the MIT study of a few years back, merely to maintain the current share of deployed nuclear power as a source of electricity, at about 17 percent of global supplies, could imply, at the growth rates that we've already heard of energy consumptions, the deployment of something like 1,000 nuclear powerplants by mid-century. If you associate with that expansion of nuclear power, a similar expansion of nuclear fuel facilities, of enrichment capabilities and reprocessing capabilities, and if you consider the nuclear weapons threats to those facilities entail, in terms of providing possible access to weapons-grade uranium and weapons-grade plutonium, we face a critical national security threat. That is why I have supported President Bush's proposals in February 2004, to minimize the spread of enrichment and reprocessing facilities, that is why I believe that the Global Nuclear Energy Partnership the President promoted

earlier this year and its reliable fuel assurance, are critical contributors to that nonproliferation effort.

In that respect, I would like to note that I think that it may well be that India, once it is engaged in nuclear cooperation with the United States, based on the agreement for cooperation and the safeguard agreements, which we are all now anticipating will go through, India may be in a position to make a single contribution to the reduction of nuclear proliferation risks. I would note that in the July 18 Joint Statement between President Bush and Prime Minister Singh, Prime Minister Singh committed to refrain and I quote, "from transfer of enrichment and reprocessing technologies to states that do not have them and to supporting international efforts to limit their spread." Now, there have been a number of proposals from President Bush, from President Putin, from the International Atomic Energy Agency, Mr. El Baradei, the Director General there, on how one might do that. But I would like to suggest, for the consideration of the committee, one possibility that may be worthy of consideration. It is expected as it has been noted here today, that India will purchase a number of nuclear reactors from foreign suppliers. I would certainly hope that these would include U.S. reactors, all of which require enriched uranium fuel as do many of the foreign suppliers of reactors as well. India could, for example, offer to lease nuclear fuel from the suppliers of the nuclear reactors and other existing nuclear fuel suppliers. Suppliers would then retain title to that material and that material would never fall by legal title, into the hands of the user of the fuel. The spent fuel extracted from the reactor could either be stored in India or exported for storage in another country. Either way, the material would remain safeguarded and India would claim no right to extract or access the plutonium contained in the spent fuel. The IAEA could guarantee a back-up fuel supply to reassure the Indian government against the risk of an arbitrary cut-off of leased fuel. I emphasize this is a voluntary concept.

By voluntarily refraining from enriched uranium or reprocessing plutonium for its civilian program, India would show international leadership, it would kick-start international efforts to provide fuel assurances in exchange for country pledges to refrain from enrichment and reprocessing and by offering an economical, reliable nuclear fuel solution to countries like Iran and Brazil, nuclear fuel leasing would reduce any justification for engaging in fuel cycle activities that would support nuclear weapons development. Nuclear fuel leasing would imbed the emerging U.S./Indian cooperation and civil nuclear energy into the warp and woof of global nonproliferation efforts. Moreover, it would not erode the NPT bargain, since India would show greater restraint than the treaty requires by voluntarily refraining from enrichment and reprocessing, neither of which are expressly prohibited by the treaty. Obviously, this is no panacea but I do believe it is an idea worthy of consideration and I would note that all of our best aspirations for a large-scale rapid deployment of new nuclear power will be jeopardized, critically perhaps, if we don't find some way, as the power expands, to limit the access to the critical enrichment and reprocessing technologies that bring with them the nuclear weapons threat that we have been

fighting so hard and so long to avoid. Thank you, Mr. Chairman and members of the Committee.

[The prepared statement of Mr. Poneman follows:]

PREPARED STATEMENT OF DANIEL B. PONEMAN, PRINCIPAL, THE SCOWCROFT GROUP

Mr. Chairman, it is an honor to appear before the Committee on Energy and Natural Resources to discuss the prospects for energy cooperation between the United States and India, with particular focus on the role nuclear power can play in meeting those needs.

I will focus my remarks on three aspects of this issue: the U.S.-Indian energy relationship, the role of nuclear power in our energy future, and the need to ensure that our nuclear future minimizes the threat of the spread of nuclear weapons. Now that the Senate has acted on the U.S.-Indian civil nuclear cooperation initiative, and the Executive Branch has taken up the issue for negotiations with the Government of India and consultations in the Nuclear Suppliers Group, I do not propose to address that subject. Instead, I will base my comments on the assumption of a U.S.-Indian agreement for cooperation in the peaceful uses of nuclear energy, and of all requisite safeguards and approvals having been obtained from the International Atomic Energy Agency and the Nuclear Suppliers Group.

I would like to offer three perspectives for the Committee's consideration. *First, U.S. interests would be best served by a wide-ranging, robust relationship promoting energy cooperation in all aspects.* There is broad and deep consensus in our country in favor of strengthening relations between India and the United States. As the world's most populous democracies, we have much in common: our dedication to promote democracy and freedom, our commitment to promote human rights and fight terror, our efforts to increase trade and investment between our two nations, our cooperation to improve public health and to provide energy for our people while protecting our environment. We can do much together to promote the security of each of our nations and that of the international community.

In the energy arena, the initiatives announced by President Bush and Prime Minister Singh this past March represent an important step in building the U.S.-Indian energy relationship. These include India's participation in the FutureGen international partnership to create a zero-emissions coal-fired power plant, its membership in the International Thermonuclear Experimental Reactor (ITER), and its work with the United States and other Asian nations in the Asia-Pacific Partnership on Clean Development and Climate. It would be in our national interest to see these efforts prosper, and to strengthen cooperation across the full range of fossil and renewable energy technologies not only at the government-to-government level but also at the business-to-business level. Expanding bilateral commercial relations between our two countries will help strengthen the political ties that bind us, thereby facilitating effective cooperation in tackling difficult political and security issues.

Second, nuclear power can play an indispensable role in meeting the growing need for large amounts of electricity without aggravating greenhouse gas emissions. I have been working on nuclear energy issues for over thirty years. The years since then have witnessed many trials and tribulations for nuclear power. In addition to the concern that nuclear energy programs might be misused to help develop nuclear weapons, the Three Mile Island and Chernobyl accidents reduced public confidence in the safety of nuclear power. Further, the chronic unresolved question of how ultimately to dispose of nuclear wastes in this and many other nations has also dogged efforts to rebuild public confidence in nuclear power.

But attitudes toward nuclear power are changing. In part, the increased public support for nuclear power has reflected the intensive efforts of the nuclear industry to address the issues of public concern, including through the development of new and improved nuclear reactor designs of greater safety and efficiency. In addition, the citizens of the world are increasingly and properly concerned about the growing impact of global warming, rooted in the inexorable increase of global energy demand and the alarming growth of greenhouse gas emissions should the world rely excessively on fossil fuels to meet that demand.

But it is not enough to chronicle changes in public attitude. Given the rate of projected increases in energy consumption over the coming decades, according to the 2003 MIT *Study on the Future of Nuclear Power*, the world will need to exercise all of its options—increased efficiency in electricity generation and use, expanded use of renewable energy sources, capture and sequestration of carbon dioxide emissions from fossil-fueled plants, and increased use of nuclear power—in order to make a significant impact on global warming. The MIT Study further concluded that, for nuclear power simply to maintain its current share of about 17 percent of

total installed electricity generating capacity, it will need to grow from about 366 reactors today to 1000 or more reactors of 1000MWe capacity. India—with its size, its population, its growth rates, and its existing commitment to nuclear power—is likely to comprise a key component in the global nuclear energy scene for the rest of this century.

Third, the promise of nuclear power can only be fully realized if we take aggressive measures to combat the spread of nuclear weapons. It may be, as I have just suggested, that the world is on the verge of a major expansion in the fleet of nuclear reactors providing electricity in India and, indeed, around the world. But this future will only be realized if nuclear power is successful in addressing all relevant concerns: cost, safety, waste management, and proliferation risks. For the balance of my remarks, I will focus on managing the proliferation risks.

Even as we envisage the possibility of a major expansion of nuclear power around the world, we are also confronting serious challenges in combating the spread of nuclear weapons, most notably in Iran and North Korea. While nuclear reactors themselves are not the central problem in promoting weapons proliferation, a massive expansion of nuclear power *could* be accompanied by a commensurate expansion of fuel cycle facilities capable of enriching uranium to use as nuclear power fuel and of processing spent fuel to separate out the plutonium from uranium and fission products. Those fuel cycle technologies can also be used to produce nuclear weapon-grade uranium and plutonium, and therefore *do* pose a significant proliferation risk. If the product of any fuel cycle plants are, in fact, diverted from peaceful to explosive purposes, it could not only lead to nuclear weapons possession by terrorists or other adversaries, but also abruptly destroy the public confidence critical to the survival of nuclear as a viable energy source.

It is therefore critical, as we seek to promote the expansion of nuclear power, that we pay equal attention to preventing the proliferation of nuclear weapon capabilities. That is why President Bush was correct, in my view, in proposing in February 2004 that we take steps to minimize the spread of enrichment and reprocessing facilities, and why his proposal earlier this year under the Global Nuclear Energy Partnership to provide for a reliable fuel assurance also should be pursued with vigor.

And in this respect, it may well be that India, once it is engaged in civil nuclear cooperation with the United States, may be in a position to make a signal contribution to the reduction of nuclear proliferation risks. In the July 18, 2005, Joint Statement by President Bush and Prime Minister Singh, the Prime Minister committed to refrain “from transfer of enrichment and reprocessing technologies to states that do not have them and [to] supporting international efforts to limit their spread.” There have been a number of suggestions and proposals regarding how the international community might effectively limit the spread of enrichment and reprocessing technologies. Proposals in this arena have come from people in and out of government, from leaders including President Bush and President Putin, as well as from the Director General of the International Atomic Energy Agency, Mohamed ElBaradei.

How could India support these efforts, as pledged in the July 18 joint statement? It is expected that India will decide to purchase a number of nuclear reactors from foreign suppliers. I would certainly hope that these would include U.S. reactors, all of which require enriched uranium fuel. India could offer to *lease* nuclear fuel from abroad. Suppliers would lease enriched uranium fuel to Indian reactors, but title to the material would never pass. The spent fuel extracted from the reactor could either be stored in India or exported for storage in another country. Either way the material would remain safeguarded, and India would claim no right to extract or access the plutonium contained in the spent fuel. The IAEA could guarantee a back-up fuel supply to reassure the Indian Government against the risk of an arbitrary cut-off of leased fuel.

By *voluntarily* refraining from enriching uranium or reprocessing plutonium for its civilian program, India would show international leadership. It would kick-start international efforts to provide fuel assurances in exchange for country pledges to refrain from enrichment and reprocessing. By offering an economical, reliable nuclear fuel solution to countries like Iran and Brazil, nuclear fuel leasing would reduce any justification for engaging in fuel-cycle activities that would support nuclear weapons development.

Nuclear fuel leasing would embed the emerging U.S.-Indian cooperation in civil nuclear energy into the warp and woof of global nonproliferation efforts. Moreover, it would not erode the NPT bargain, since India would show greater restraint than the treaty requires by voluntarily refraining from enrichment and reprocessing, neither of which are expressly prohibited by the treaty.

Nuclear fuel leasing is no panacea. It would not purport to prevent all clandestine efforts to divert civilian nuclear programs to explosive purposes, or to block dedicated bomb builders who are pursuing purely military programs. It would, however, help reduce the risk that the global growth of atomic energy will lead to nuclear catastrophe. And for that India would justly earn the world's lasting gratitude.

I would be happy to respond to any questions the Committee may have.

The Chairman. Thank you very much.
Mr. Gadbow.

STATEMENT OF R. MICHAEL GADBAW, VICE PRESIDENT AND SENIOR COUNSEL, GENERAL ELECTRIC COMPANY

Mr. GADBAW. Mr. Chairman and members of the committee, thank you for the opportunity to provide a perspective on the role of commercial nuclear energy in the U.S./India strategic cooperation. I'd like to ask that my full testimony be put in the record and I will summarize.

The CHAIRMAN. It will be made part of the record.

Mr. GADBAW. The growing partnership between the United States and India has profound implications for a wide range of issues that play into America's enduring national interests. Among them, Asian stability, global nonproliferation, Indian economic development and the renaissance of the nuclear industry.

GE supports the implementation of this historic agreement, because we believe the strategic partnership that it will advance will serve the interests of both our countries in promoting global peace, security, nonproliferation and economic development.

GE has had a unique vantage point from which to observe the evolution of this relationship and I have personally had occasion to travel extensively in India, most recently in March after the agreement was signed, when I had a chance to talk to the Department of Atomic Energy and other private sector and government officials about this agreement. We believe in the vision that President Bush and Prime Minister Manmohan Singh articulated in their Joint Statement in March regarding the role the United States and India must play together in addressing the challenges facing the world in this century. We have seen how the economic reforms launched by Manmohan Singh as Finance Minister in 1991 have committed India to a course of development through open markets, global trade, and investment.

Together with many U.S. and Indian companies, GE has participated directly in the benefits of this evolving economic and political relationship. As economic reforms have stimulated unprecedented Indian economic growth, we have seen an increasing demand for U.S. products and technology, in aviation, power generation, rail, healthcare, and advanced materials benefiting the workers and suppliers. The opening of the civilian nuclear relationship will deepen the support for American jobs. For every order we receive for a 1½ gigawatt powerplant, we anticipate U.S. exports in the neighborhood of \$1 billion, which would equate to supporting around 10,000 U.S. jobs.

As you evaluate the policies needed to ensure the success of this agreement, I encourage you to look at how these policies work together. No longer can we divide policy into distinct compartments, separating security from economics, public policy from private commerce. Government officials and the private sector must work to-

gether to fully integrate the commercial and national security dimensions of government policies.

Leading U.S. companies like General Electric, will play a crucial role in translating the strategic vision of U.S./Indian energy cooperation into a reality. Take for example, America's interests in revitalizing the nonproliferation regime to include a responsible nuclear India. As they do business in India, U.S. companies will bring global standards of compliance and processes to safeguard the international legal regime controlling nuclear technologies. Moreover, nuclear cooperation will require intense and ongoing interaction among governments, local energy providers, and U.S. nuclear suppliers, which will help to increase the transparency of Indian's nuclear program while tightening the relationships between the U.S. and Indian energy sectors.

India's economy is growing dramatically with the potential to lift hundreds of millions out of poverty. To sustain its current growth trajectory, India will have to increase its energy consumption by around 4 percent annually.

Although coal, oil and natural gas dominate India's current energy mix, India's future will increasingly rely on nuclear energy. This is partly due to resource constraints. Nuclear power has long-term advantages for India's development. India has large reserves of coal but its high ash content poses significant environmental problems. Nuclear energy is a cleaner resource. Further, unlike imported gas, oil and LNG, nuclear power would improve India's energy security and lessen its geopolitical anxiety over foreign energy sources. The Indian government has set an ambitious target for its nuclear expansion. It hopes to achieve a nuclear capacity of around 10,000 megawatts by 2011, 2012 and it has recently announced a doubling of its need by 2020, to 40,000 megawatts.

Given India's desire to expand its nuclear capacity so quickly and significantly, U.S. nuclear suppliers have an excellent opportunity to participate in India's energy development and expanding the energy supply will also require broader improvements in India's infrastructure, creating even more opportunities for American companies.

U.S. companies can help the United States become an integral partner in India's economic development. As the last U.S. owned nuclear technology company, GE is committed to do its part. ABWR—Advanced Boiling Water Reactor—is the most modern and advanced design ever built with installations in Japan and Taiwan. ABWR has already received NRC certification. Looking to the future, GE's ESBWR, the economic-simplified boiling water reactor is cheaper and safer than existing reactor technologies.

France and Russia started early in cultivating political channels into India's nuclear market but American companies have the capability to take a leading position as India seeks new reactors. GE not only has great technology but also a history of a successful partnership in India.

U.S. nuclear suppliers can thrive in the Indian market but government policies must enable them to act rapidly and effectively. This means that U.S. policy-makers must be sensitive to the link between security and economics. It is not enough to focus only on formal nonproliferation agreements between India and the United

States, i.e., IAEA or NSG, the nuclear suppliers group. The U.S. Government must think broadly about a range of policies that counts for the needs of commerce.

One pressing example is nuclear compensation and liability. The International Atomic Energy Agency's convention on supplementary compensation for nuclear damage establishes an updated global system for compensation in the event of a nuclear incident outside the United States. We are pleased that Senate consent to ratify was approved in May by the Senate Foreign Relations Committee and is ready for action by the full Senate. We hope that your committee will work promptly on any necessary implementing legislation. This initiative is vital if U.S. companies are to engage in foreign nuclear markets.

The U.S./Indian strategic alliance driven by nuclear energy cooperation opens an array of opportunities for U.S. companies. General Electric is ready to support this endeavor. We are confident that with appropriate government policy and advocacy support, U.S. companies can take a leading role in developing India's energy capabilities. In the end, American commerce underpins the national security goals that animate the U.S./India deal and give substance to the deal's domestic aspiration, the renaissance of America's civilian nuclear industry. Thank you.

[The prepared statement of Mr. Gadbow follows:]

PREPARED STATEMENT OF R. MICHAEL GADBAW, VICE PRESIDENT AND SENIOR
COUNSEL, GENERAL ELECTRIC COMPANY

Mr. Chairman and Members of the Committee, thank you for the opportunity today to provide a perspective on the role of commercial nuclear energy in U.S.-India strategic cooperation. The burgeoning partnership between the United States and India has profound implications for a wide range of issues—Asian stability, global non-proliferation, Indian economic development, and the renaissance of the nuclear industry—that play into America's enduring national interests.

GE supports the implementation of this historic agreement, because we believe the strategic-partnership that it will advance will serve the interests of both our countries in promoting global peace, security, non-proliferation, and economic development.

GE has had a unique vantage point from which to observe the evolution of this relationship. We believe in the vision that President Bush and Prime Minister Manmohan Singh articulated in their joint statement of March 1, 2006, regarding the role the United States and India must play together in addressing the challenges facing the world in this century. We have seen how the economic reforms launched by Manmohan Singh as Finance Minister in 1991 have committed India to a course of development through open markets, global trade, and investment. Ratified and affirmed through a series of democratic elections and successive governments, these policies have created political, economic, and commercial linkages and understandings between our two countries on ways to increase our mutual security and address the threats we face from intolerance, terrorism, and the spread of weapons of mass destruction.

Together with many U.S. and Indian companies, GE has participated directly in the benefits of this evolving economic and political relationship. As economic reforms have stimulated unprecedented Indian economic growth, we have seen the increasing demand for U.S. products and technology in aviation, power generation, rail, healthcare, and advanced materials benefiting our workers and suppliers. The opening of the civilian nuclear relationship will deepen this support for American jobs. For every order we receive for a 1.5 GW power plant, we anticipate U.S. exports in the neighborhood of \$1 billion, which would equate to supporting about 10,000 U.S. jobs.

THE COMMERCIAL ROLE IN STRATEGIC ENERGY COOPERATION

As you evaluate the policies needed to ensure the success of this agreement, I encourage you to look at how these policies work together. No longer can we divide

nuclear policy into distinct compartments, separating security from economics, public policy from private commerce. Consequently, government officials and the private sector must work together to fully integrate the commercial and national security dimensions of government policies.

Secretary of State Condoleezza Rice recognized in her July 10, 2006, speech that

there is a new spirit of partnership between India and the United States and that spirit of partnership arises, first and foremost, from our people, from deep ties and shared aspirations that bind our democratic societies. . . . The relations between our people point a way forward for cooperation between our governments.

The U.S.-India relationship will be cemented through social and especially economic exchange. Government policy should be designed to encourage and expand those channels of private activity—nowhere more than the nuclear energy sector, where international security, national economic development, and commercial innovation come together.

Leading U.S. companies like General Electric will play a crucial role in translating the strategic vision of U.S.-Indian energy cooperation into a reality. Take America's interest in revitalizing the non-proliferation regime to include a responsible nuclear India. As they do business in India, U.S. companies will bring global standards of compliance and processes to safeguard the international legal regime controlling nuclear, technologies. Moreover, nuclear cooperation will require intense and ongoing interaction among governments, local energy providers, and U.S. nuclear suppliers, which will help to increase the transparency of India's nuclear program while tightening the relationships between the U.S. and Indian energy sectors.

INDIA'S ENERGY NEEDS

India's economy is growing dramatically, with the potential to lift hundreds of millions out of poverty. But India needs a huge expansion of power generation to fuel its demand for energy. India currently produces over 139 GWe of electricity, some 2 percent of which is nuclear (2.7 GWe).¹ To sustain its current growth trajectory, India will have to increase its energy consumption by around 4 percent annually.²

Although coal, oil, and natural gas dominate India's current energy mix (constituting roughly 52, 34, and 7 percent of India's energy consumption, respectively),³ India's future will increasingly rely on nuclear energy. This is partly due to resource constraints. A study by the Nuclear Power Corporation of India Limited, which is owned by the Indian government, analyzes the power generation potential of India's resource base. Whereas India's 38 billion tons of coal could produce 7,614 GWe-years of electricity, and its 12 billion tons of oil and natural gas could produce 5,833 GWe-years, it has enough thorium (225,000 tons) to produce more than 155,502 GWe-years.⁴ Moreover, importing uranium to augment its indigenous supply of 61,000 tons costs less per unit of electricity generated than importing coal, oil, or gas.⁵ Nuclear energy also becomes important due to India's strategy for economic growth. Nuclear power has long-term advantages for India's development: India has large reserves of coal, but its high ash-content poses significant environmental problems; nuclear energy is a cleaner resource. Further, unlike imported gas, oil, and LNG, nuclear power, would improve India's energy security and lessen its geopolitical anxiety over foreign energy sources.

The Indian government has set ambitious targets for India's nuclear expansion. It hopes to achieve a nuclear capacity of about 10,000 MWe by 2011-12 and 40,000 MWe by 2020.⁶ By 2052, according to India's Department of Atomic Energy, India hopes to have a nuclear capacity of 275 GWe, with nuclear technologies providing 20 percent of India's overall fuel mix (up from 2 percent today). Coal, by contrast,

¹ Report on Growth of Nuclear Energy in India, Department of Atomic Energy, 2004.

² Sumit Ganguly, Testimony before the Committee on Foreign Relations, U.S. Senate, "Energy Trends in China and India: Implications for the United States," July 26, 2005.

³ "India," Country Analysis Briefs, U.S. Energy Information Administration, <http://www.eia.doe.gov/emeu/cabs/India/Full.html> (as of December 2005).

⁴ "India's Vision: Nuclear Energy," Nuclear Power Corporation of India, Ltd. (NPCIL), presentation by S. Vedmoorthy to the India Energy Symposium, March 2, 2006.

⁵ "A Strategy for Growth of Electrical Energy in India, Department of Atomic Energy, <http://www.dae.gov.in/publ/doc10/index.htm> (as of July 17, 2006). Other sources estimate India's uranium supply to be as high as 78,000 tons. See Ashley J. Tellis, *Atoms for War? U.S.-Indian Civilian Nuclear Cooperation and India's Nuclear Arsenal*, Carnegie Endowment for International Peace, June 2006, <http://www.carnegieendowment.org/files/atomsforwarrevised1.pdf>.

⁶ NPCIL, 2006. Originally, the 2020 target was 20,000 MWe; the Indian government recently doubled it.

will go from constituting more than half of India's installed electrical capacity to about 46 percent by 2052, oil and gas from 24 percent to 15 percent.⁷

Given India's desire to expand its nuclear capacity so quickly and significantly, U.S. nuclear suppliers have an excellent opportunity to participate in India's energy development. And expanding the energy supply will also require broader improvements in India's infrastructure, creating even more opportunities for American companies.

OPPORTUNITIES FOR U.S. NUCLEAR SUPPLIERS

U.S. companies can help the United States to become an integral partner in India's economic development. As the last U.S.-owned nuclear technology company, GE is committed to do its part. GE's ABWR (Advanced Boiling Water Reactor) is the most modern and advanced design ever built, with installations in Japan and Taiwan. ABWR has already received NRC certification. Looking to the future, GE's ESBWR (Economic Simplified Boiling Water Reactor) is cheaper and safer than existing reactor technologies.

France and Russia started early in cultivating political channels into India's nuclear market. But American companies have the capability to take a leading position as India seeks new reactors. GE not only has great technology, but also a history of successful partnerships in India. The Indians know this from their experience with the Tarapur BWR site, built by GE, which is the lowest-cost source of energy in India according to officials of the Indian Department of Atomic Energy.

Furthermore, India recognizes the political importance of America's decision to draw closer to it. America has enabled India to enter the nuclear fold. The Indian government understands the inconsistency, then, of excluding competitive American companies from participating in India's new commercial opportunities.

U.S. GOVERNMENT POLICIES—UNDERSTANDING THE SECURITY-COMMERCE LINK

U.S. nuclear suppliers can thrive in the Indian market, but government policies must enable them to act rapidly and effectively. And the U.S. government must make clear its expectation that U.S. companies will succeed in India as they have succeeded elsewhere. Government engagement and advocacy are essential.

Again, this means that U.S. policymakers must be sensitive to the link between security and economics. Commerce between America and India creates the linkages, the transparency, and the safeguards that advance our national security—but commerce requires a conducive policy environment. Although crucial, it is not enough to focus only on formal non-proliferation agreements between India and the United States, IAEA, or NSG. The U.S. government must think broadly about a range of policies that accounts for the needs of commerce.

One pressing example is nuclear liability: The International Atomic Energy Agency's Convention on Supplementary Compensation for Nuclear Damage (CSC) establishes an updated, global system for compensation in the event of a nuclear incident outside the United States. We are pleased that Senate consent to ratify was approved in May by the Senate Foreign Relations Committee and is ready for action by the full Senate. We hope that the Senate Energy and Natural Resources Committee will work promptly on any necessary implementing legislation. This initiative is vital if U.S. companies are to engage foreign nuclear markets. Without a system ensuring compensation and nuclear liability protection, U.S. companies will find the risks of doing business prohibitive. Moreover, key states—like Japan, South Korea, Canada, Ukraine, China, and not least India—are waiting for America to take the lead in joining the CSC, which the United States promoted and was the first country to sign in 1997. They could be persuaded to join if America does so first. The CSC would then reflect a global standard for nuclear liability that could be used to structure legal arrangements with others as well. If America fails to take the lead, however, the CSC will lose momentum and the opportunity could be lost to establish a global standard for compensation and dealing with legal liabilities in this important area.

CONCLUSION

The U.S.-Indian rapprochement, driven by nuclear-energy cooperation, opens an array of opportunities for U.S. companies. General Electric is ready to support this endeavor. We are confident that, with appropriate government policy and advocacy support, U.S. companies can take a leading role in developing India's energy capabilities. In the end, American commerce underpins the national security goals that

⁷Department of Atomic Energy, 2004.

animate the U.S.-India deal, and gives substance to the deal's domestic aspiration: the renaissance of America's civilian nuclear industry.

Thank you for your time and attention.

The CHAIRMAN. Thank you very much.
Senator Bingaman.

Senator BINGAMAN. Thank you all for being here. Let me ask, first of all, Mr. Poneman, ask you about your suggestion. I think it is a constructive suggestion that perhaps India could be persuaded to lease the nuclear fuel that they need in new reactors from abroad. But is there anything in the works or anything that has occurred that would lead us to believe they might be willing to do that? I'm just not aware of it. I mean, I like the idea but it just strikes me that now that they have negotiated the agreement that they negotiated with us, there is no incentive for them to do anything like that. It is the kind of thing that might have been part of a negotiation but it was not.

Mr. PONEMAN. Thank you very much for the question, Senator. I think this is on. I'd make, I guess, a couple of comments. I think I would certainly, as a tactical negotiating matter, I cannot get to the point that you just made in the sense that if one were to make this as part of a deal, one's leverage would have been greater earlier. There is no question about that. That having been said, the watch word that we have always heard from the Indian government is something that is asked of them cannot go beyond the July 18 Joint Statement from last year between the Prime Minister and the President. And when I first mentioned this concept to an Indian colleague, my attention was invited to that line in the Joint Statement, which I quoted in my prepared statement, which said that India agrees not to export these enrichment or reprocessing facilities and to support international efforts to prevent their spread. So I think if you couch it in terms of the July 18th Joint Statement—A—and B, make sure that it is framed as an opportunity and an option, which having gotten through the gates of the safeguards agreement and the 123 Agreement and the rest, that they could voluntarily do, I think there is a chance. I think that it is better to light one candle than curse the darkness. I'm not under any illusions that it is something that would be rapidly and warmly embraced today by the Indians. But I think under those other circumstances it might be possible.

Senator BINGAMAN. Are you under the impression that this is something that our own administration would advance to the Indians as an initiative they might consider?

Mr. PONEMAN. Well, having served on the National Security Council for 6 years, I am cautious about speaking for a government I'm no longer a member of. I have discussed this idea with members in the administration. I have found, I think, generally positive reactions to the idea, whether they would choose to put it forward in a negotiation with the Indians, I would not presume on their behalf.

Senator BINGAMAN. Mr. Gadbaw, let me ask you. In your statement, you make the general statement here, toward the beginning of your testimony, General Electric supports the implementation of this historic agreement because we believe the strategic partnership that it will advance will serve the interests of both our coun-

tries in promoting, and then you have a variety of things it is going to promote, one of which is nonproliferation. How do you see that? How do you reach the conclusion that this agreement will promote nonproliferation?

Mr. GADBAW. Senator, that really comes from a judgment looking at this relationship over quite a number of years. I, in my role in General Electric, got involved with India, really in the early nineties and I have seen that country—at that time, coming to the United States and came to GE and representatives asking why is India not even on the radar here in the United States. A lot of things have happened over the last 15 years that have brought our two countries much closer together. As we as a company look out over the next 10 years, we see India as a country that will be the kind of ally that the United States wants. So it is really about our alignment of interests in the broadest sense of the term. I think this agreement is one step in that longer process. I don't think it freezes in time our mutual interests. So I think in a broad sense, it brings those interests together around nonproliferation and brings India into cooperation with us, particularly in this civilian nuclear area. In that particular area, in the scope of this agreement, I think American companies being part of that market, bringing their approach to compliance with the export control laws, both in the United States and with India, working with our suppliers to create an understanding of how to implement and enforce those rules, will actually set a standard that will enhance the ability to control the proliferation of this technology and advance our mutual interests. So I see both in a macro sense and in a micro sense, this alignment of interests working towards what I think are both countries' interests in controlling the proliferation of nuclear weapons. India has had a great track record in that regard, despite the fact that it is in a neighborhood that is a very difficult one.

Senator BINGAMAN. My time is up, Mr. Chairman. Thank you.

The CHAIRMAN. Well, Senator Bingaman, you got right to the point. One of the most important things we discuss here today is obviously this issue. Question. How do you test the waters? How do you see it will move? It would seem to me and I would just put this to one of you, perhaps Mr. Poneman first. It would seem to be that if I were them, I wouldn't be very interested unless it was a broader-scoped agreement that involved a number of countries, not just India. I mean, India would say, what are you doing talking about us as if we are in some way most apt to be violative of this process. We are cleaner than most. We would be more apt to be okay without any of this agreement. We probably are not going to be proliferators, which I think is a fair statement. They could make that not offend me, based on their performance. So answer with me whether this should be a broader-based agreement and how does that happen and is it happening?

Mr. PONEMAN. Senator, I could not agree more. I am looking at this as a global issue.

The CHAIRMAN. Okay.

Mr. PONEMAN. I am thinking of this in terms, for example, of President Bush's initiative in February 2004, to minimize those states around the world that are engaged in the commercial enrichment of uranium and reprocessing of plutonium from spent fuel.

My suggestion is that—and of course, we now have the G8 having considered this and President Putin having his initiative. I think what is very, very important is to drain the notion of singling out a Nation as part of this equation. If it is to work, it must be voluntary, it must be consensual. Very few countries will simply knuckle under and say, I'm going to do this because you want me to do this. But when you think of aircraft, when you think of automobiles, when you think of a number of commodities, there is a very rich vein and history about leading. I think there is a very attractive proposition, an attractive may I say commercial proposition to be put to a number of nations that says, hey look, rather than mining the uranium, milling, converting, enriching, fabricating the fuel, going through all those headaches and being saddled with a bunch of spent fuel you don't know what to do with, why don't you lease it from this company? We'll give you a good price. We'll give you a 10-year guarantee. Discounts could be applied. You could have assurances of supply and backstopping arrangements from the IAEA. My suggestion is to really echo a couple of points, one from you, Mr. Chairman, that if we are to make this a meaningful relationship, it can't be just the rhetoric, it's got to be practical and I think this is practical and then to echo my colleague, Mr. Gadbow, when he talks about getting commercial interests to align with our national security interests. If we can get this whole discussion in that context and at the same time, talk about it, yes, more broadly, I think India could play a leadership role in having something like this become an effective mechanism.

The CHAIRMAN. Who is taking the lead in this idea of leasing?

Mr. PONEMAN. Well, there have been a number of governments that have discussed it. I think you will recall that when Prime Minister Howard was visiting President Bush just a few weeks ago, there was some discussion in the run-up to that visit in Australia about nuclear fuel leasing. I have, with a number of my colleagues, many of whom are well known to this committee, published an article that proposed an idea like this. It is an idea that, I think, is certainly waiting to receive more public support but I'm just trying to see if it might engender some support.

The CHAIRMAN. Hasn't Russia thought about it, too?

Mr. PONEMAN. Absolutely and we had a very, I think, constructive visit a few weeks ago from Mr. Karnataka, the head of Atom Prom as it has now been renamed and I think that their—now that we have discussions that have begun between the United States and Russia about the possibility of peaceful nuclear cooperation. I think this is a very ripe subject for discussion in that channel, Sir.

The CHAIRMAN. Mr. Gadbow, as a member of GE, you've spoken here about great potential for commerce in exchange for ideas that would cause growth in India and in other countries that are partners with India and you're assuming in that regard that we would be their friends and would make, would have some potential for working with them. Could you talk a little bit on the record with this committee about how you see that atmosphere at this point?

Mr. GADBAW. I think the atmosphere is quite positive for working commercially with India and it has really developed, evolved over again, the last 15 years, as our interests have converged. I see in India growth across a whole range, particularly in the infra-

structure area. We've seen their airlines go out and lease and purchase U.S. planes. We've seen more of our generation equipment sold there, whether it is work being done in the coal gasification area and the natural gas area, in the rural electrification area. We are seeing work with the railways, the Indian railways, to improve their efficiency, whether it is with new equipment or in signaling devices and in the healthcare business. We have a very active healthcare business in India. This is true across the entire Indian subcontinent. That is, in every part of India, this dynamism that has been unleashed by these economic reforms is demonstrating itself.

So we have a chance now to step up as India is asking us for help in its most critical area of need that is in bridging this energy gap that they have. I think unfortunately, neglected over the years. Nuclear will be a piece of that and this agreement will ensure that everything we do in the civilian nuclear sector will be subject to the strike controls of the IAEA but it will also, I think, create an understanding between the two countries about how we need to work together in these commercial areas and it says to India that we, the United States, want to work with them to serve their needs and in return, we want to talk to them about how we can work together to address some of these pressing global issues.

The CHAIRMAN. Might I just close by asking any or all of you to just comment with some closing remarks with reference to how you see us as a committee—you know what our jurisdiction is to pass laws that would put the United States in the position of stating a policy toward another country or create a policy that would be an enhancement, enhancing of a certain kind of activity. Do you see anything we ought to be doing in light of the new openness and of the fact of us proceeding so far so fast with India? Should we be doing something that we are not doing? Let's start on your end with you, Mr. Gadbaw.

Mr. GADBAW. Well, as I mentioned in my testimony, I hope that the committee will look carefully at the Convention on Supplementary Compensation.

The CHAIRMAN. Yes.

Mr. GADBAW. Which is not just relevant to India but actually is relevant to every country where we are trying to sell nuclear equipment, including places like Canada, where U.S. companies have had to forego sales because of the absence of a international regime. That will require possibly implementing legislation and we would hope that the committee would look at that. Thank you.

The CHAIRMAN. Okay, we will take a look at that. One or two things from you, Sir?

Mr. PONEMAN. Mr. Chairman, first I would echo my colleague's support of prompt Senate action on the supplementary funding convention because I believe not just in this instance but for the whole industry. The second point I would make is that I think with the full range of energies that you have heard discussed today and really, the opening of a new chapter in the U.S./Indian relationship, that perhaps there may be some channels that you could pursue as a committee and as individual members in terms of reaching out to our Indian colleagues so that they fully and deeply appreciate the opportunities that this relationship presents. I would cer-

tainly hope that the United States' industry is able to quickly take advantage of this critical new opening and I think that with your stature and leadership, you can make a signal contribution there. Thank you.

The CHAIRMAN. Thank you.

Dr. Victor.

Dr. VICTOR. My impression is that the country is in urgent need of a strategy to deal with the global warming problem and I know this committee has spent much time on that issue and all that I would urge is that it lay down a marker that this particular arrangement with India can be part of an overseas element of the nation's global warming strategy. I would also urge that we have some discussions, not only about this in the context of India, which has happened somewhat accidentally because of the larger discussions about the U.S./India relationship on nuclear power, but also very similar kinds of arrangements could exist for China, where emissions of carbon dioxide are growing even more rapidly.

The CHAIRMAN. Senator Bingaman, did you have anything to wrap up? Thank you very much, gentlemen. It has been a pleasure having you and you've really contributed here today. We appreciate it.

[Whereupon, at 11:40 a.m., the hearing was adjourned.]

APPENDIX
RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF DAVID PUMPHREY TO QUESTIONS FROM SENATOR DOMENICI

ENERGY EFFICIENCY

Question 1a. The DOE has initiated an “energy dialogue” with India through working groups that address energy efficiency, civil nuclear power, coal, and renewables among other topics. In your testimony, you highlight the importance of improved energy efficiency.

How will improved energy efficiency shape the future demand for energy in India?

Answer. How India pursues the energy efficiency options it has in each of its consuming sectors will determine the pace of growth in future energy demand. It has been estimated by the Renewable Energy & Energy Efficiency Partnership (an international NGO, funded by a number of governments including: Australia, Austria, Canada, Ireland, Italy, Spain, the Netherlands, the United Kingdom, the United States and the European Commission) that the Indian economy could reduce its energy consumption by as much as 23% from current levels. The industrial sector accounts for about 48% of India’s commercial energy consumption, but energy savings of up to 30% have been estimated through retrofitting in this sector. In the power sector, which is plagued by high transmission and distribution losses, nearly 25,000 MW equivalent of capacity creation could be achieved through improved efficiency. In the commercial sector, the use of heat pumps, load management systems & control, refrigeration systems/freezers, high-efficiency boilers, building control, insulation, window coating & films, power factor correction systems and combined heat & power plants could help achieve energy savings. A number of steps could also be taken to reduce energy demand in the transportation sector.

INDUSTRY INFRASTRUCTURE

Question 1b. How will India achieve the necessary investments to fund industry infrastructure?

Answer. India will need to improve its investment climate if it is to attract the private foreign capital it needs to build the infrastructure its energy sector requires. This will require action by the national and state governments to address various investor concerns such as sanctity of contracts, tariff reform, transparency and a level playing field. Recently we have seen progress on key investor issues and believe over time India will begin to attract much of the infrastructure investment it requires.

RESPONSES OF DAVID PUMPHREY TO QUESTIONS FROM SENATOR BINGAMAN

STAFFING

Question 1. Does the Department of Energy directly fund any staff positions at the U.S. Embassy in India to monitor energy and science issues?

Answer. No, the Department of Energy does not currently fund any staff positions at the U.S. Embassy in India.

RENEWABLE ENERGY MOU

Question 2. What is the status of the agreement between the National Renewable Energy Laboratory or the DOE and India’s Ministry of non-conventional resource in for renewable energy, particularly solar?

Answer. The National Renewable Energy Laboratory (NREL) had two Memoranda of Agreement with India’s Solar Energy Center, which later became part of the Ministry of Nonconventional Energy Sources (MNES). The latest one expired in March, 2005, and there is not currently an MOU in place. The Minister of Non-Conven-

tional Energy Sources (MNES) recently met with experts at the National Renewable Energy Lab to discuss potential areas of collaboration. These areas include solar thermal power generation, low wind speed technology research & development, renewable energy resource assessment and the use of resource data in relevant analysis tools. DOE's EERE and Office of Policy and International Affairs are working with MNES officials currently under the U.S.-India energy dialogue.

SCIENTIFIC EXCHANGE

Question 3. Has the Department considered exchanges of scientific personnel between our national laboratories and the equivalent Indian scientific laboratories funded through the Council of Scientific and Industrial Research or the Ministry of Atomic Energy?

Answer. To our knowledge there has been no scientific exchange between DOE laboratories and the Counsel of Scientific and Industrial Research (CSIR) or the Ministry of Atomic Energy. However, the new Science Counselor at the U.S. Embassy in New Delhi has recently made a proposal to Dr. Mashelkar, the Director of the CSIR, to open a dialogue between the DOE national labs and the CSIR labs. One of the outcomes could be an exchange of scientific personnel.

SCIENTIFIC COLLABORATION

Question 4. My understanding is that the Department of State has finalized the master S&T agreement between the U.S. and India, particularly with respect to intellectual property, has the DOE taken action(s) to implement scientific collaboration now that this umbrella agreement is in place?

Answer. The Office of Science of the U.S. Department of Energy (DOE) is interested in starting a dialogue with appropriate counterparts in India as a follow-on to several initiatives that have begun relative to increasing scientific collaboration between our two countries. The U.S. side has interest in high energy physics, nuclear physics and fusion energy sciences while India's interests include collaboration in biotechnology, nanotechnology, climate research, and other areas. Collaboration already exists in high energy physics and nuclear physics on a lab-to-lab basis.

NANOSCIENCE/NANOTECHNOLOGY

Question 5. In my visit to the Indian Institute of Technology, their Cal. Tech., I was briefed by their international projects office who were actively collaborating with countries such as France to develop joint advances in the areas of nanoscience and biomass to methane conversion. They indicated no such collaboration existed with the U.S. much less the DOE. Now that the master S&T agreement is in place would the DOE please reach out to this world class institution?

Answer. Nanosciences/nanotechnology will be a strategic focus area in the new S&T agreement. As part of the Indo-U.S. S&T Forum (established in 2000), there have been several meetings and workshops on nanosciences/nanotechnology. A nanotechnology conclave was hosted in collaboration with Confederation of Indian Industry (CII) in February of 2006. There has also been an ongoing collaboration between the Jawaharlal Nehru Center in Bangalore and UC Santa Barbara. The DOE will continue to collaborate on these technologies under the auspices of the S&T agreement.

FORECASTING

Question 6. What are we doing to help India better forecast its future energy demands? (The ministries in India are organized by fuel and basically no one is charged with doing an aggregate forecast.)

Answer. India understands the significance of the forecasting information as it goes directly into government planning. The closest counterpart to DOE's Energy Information Administration (EIA) is India's Petroleum, Planning, and Analysis Cell (PPAC). An Energy Information Exchange MOU was signed in February 2006 between the EIA and PPAC at the Ministry of Petroleum and Natural Gas. The agreement seeks to improve Indian energy analysis and forecasting. The parties jointly determined at their first meeting in June 2006 that the first step is to improve the quality of Indian energy data. Unlike the companies operating in the U.S., companies operating in India are not required through legislation to report energy data to the government, causing some difficulty. This challenge to national data collection will grow as private sector participation in Indian grows. Therefore, the next step for the Energy Information Exchange MOU will involve a technical workshop about improving the quality of Indian energy data. The timing and location for this workshop will be determined over the coming months. After data quality issues have

been addressed, EIA and PPAC intend to focus more specifically on forecasting issues. Continuing an exchange of ideas in the areas of data forecasting and statistical accuracy is an essential part of the ongoing U.S.-India Energy Dialogue.

IEA

Question 7. How are we helping India to participate in the IEA?

Answer. DOE has been actively encouraging India to participate in IEA activities. India's formal participation in IEA activities dates back to April 1998 when an agreement was signed to establish cooperation. India designated its Ministry of Power to be the nodal agency for this cooperation which has since included a series of energy policy data workshops: the January 2004 IEA-India Workshop on Indian Emergency Oil Stocks; Indian participation in the October 2004 IEA Emergency Response Exercise for IEA non-member countries; the October 2004 workshop on Energy Efficiency Standards and Labeling; a range of informal contacts and ad hoc Indian participation at IEA events; and participation in the IEA Committee on Non-Member countries. We want to continue to develop a closer relationship between the IEA and India by expanding the engagement to all areas of the Agency's work.

RESPONSES OF DAVID VICTOR TO QUESTIONS FROM SENATOR DOMENICI

Question 1. In your testimony, you analyze the potential climate implications and conclude that impact on greenhouse gases will "become one of the main benefits from the arrangement." You state that "annual savings from the Indian deal could be nearly as large as the entire commitment of the 25 EU nations to reducing emissions under the Kyoto Protocol." You also discuss the potential for a framework emerging from the Asia-Pacific Partnership that would apply to U.S. engagement with developing countries on climate strategy. What steps should the U.S. take to encourage such engagement with India and developing countries?

Answer. The United States must show tangible progress from this alternative framework—such as from the Asia Pacific Partnership (APP) that is presently taking shape. However, the framework will work only if it truly demonstrates a path that is complementary to what has emerged within the Kyoto Protocol. The major developing countries are seeing substantial resources flow into Kyoto projects under a scheme known as the Clean Development Mechanism (CDM). Nearly 1,000 projects are in the CDM pipeline right now. Many of those projects are of dubious quality, but the CDM is nonetheless a real entity that is producing real investment. So far, the APP is not. The developing countries will be wary of any scheme to reduce carbon emissions that delivers many meetings but no action. The APP is a good idea, as I outlined in my testimony, but the fact that there has been trouble even getting the money needed for meetings has been interpreted as a warning signal that the very governments whose participation is essential are not committed to the process.

Moreover, the framework I propose—whether through the APP or some alternative institution—would work by engaging the industrial ministries, power companies, gas companies, and other institutions that are actually responsible for building and operating the energy infrastructure. Unlike Kyoto and many other diplomatic institutions, this framework would not focus solely on the diplomatic and environmental regulatory apparatus, but also on the factors that drive performance in the energy industry. The businesses and institutions that actually build energy infrastructure rarely focus on international diplomatic activities. They will be wary of wasting their time if the effort does not yield practical outcomes.

I am deeply concerned that the United States is on the edge of destroying its credibility within the APP due to the lack of tangible progress. The funding fiasco earlier this summer resonated around the world. At the very least, the United States should demonstrate its commitment to the process of the APP by reliably meeting its basic funding obligations without signaling disarray to the outside world.

As for particular projects, I strongly suggest that the United States focus on a few large efforts that demonstrate clear progress rather than a multitude of peripheral activities of limited impact. The U.S.-India nuclear framework could be one such large project.¹ Advanced coal combustion technology represents another opportunity for the United States to engage China or India through cooperative development and testing of technology—to date, the technology has advanced further in China and the prospects are better there than in India. In my testimony, I also highlight

¹David G. Victor, "Nuclear Power for India is Good for us All," *International Herald Tribune* (oped, March 17th 2006).

the potential for the United States to lend its support to gas pipeline projects to deliver supplies to China and India, which could offset increased installation of coal-fired generating capacity in these rapidly growing countries.²

RESPONSES OF DAVID VICTOR TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your paper explains that the carbon reduction benefit from nuclear power is based on 20,000 MW or about 20 additional 1000 MW reactors being built by 2020 with enough carbon savings as the entire commitment of 25 EU nations under the Kyoto protocol—what do you estimate the total cost of such a project and do you think 20 reactors could be built in India in the next 14 years?

Answer. The costs are unknown with precision but they are probably in the range of \$26-40 billion current dollars. The low figures, which are implausible but not impossible, reflect the lowest credible numbers that have emerged from analysts of the Indian power sector (\$1300/kW capacity; see citations in my testimony). The high number reflects the most likely cost (approximately \$2000/kw) for the current new generation of light water reactors, although those numbers are likely to decline with experience.

It is feasible, but difficult, to build 20 reactors in 14 years. The effort would begin with perhaps a few orders for foreign reactors as well as a few Indian projects; in parallel, diligent efforts would be needed by the Indians to streamline licensing procedures (akin to the new build/operate licensing scheme devised in the United States), and new units realistically might come online by about 2015 with a couple new reactors per year thereafter. In that framework, it will be hard to reach 20 but an aggressive program could deliver that number. Much higher numbers have been suggested, but I doubt those are feasible. India's interest in very large coal-fired power projects also makes it less likely that they will build fewer reactors unless nuclear proves to be highly competitive.

Question 2. As compared to their coal reserves, does India have sufficient stocks of uranium to operate 20 reactors or would they have to import it?

Answer. They will need to import fuel, and the United States should welcome that fact because import dependence will allow the U.S., working with other countries and with the IAEA, to frame a new multilateral fuel cycle. The ideas surrounding such a fuel cycle—in which supplies of fuel and fuel services would be controlled by a limited consortium of countries—have been discussed for some time but practical steps to implementation have been few. Potential fuel importers are wary; a successful scheme must allay their fears, and there is no better place to start than with a country that must import and which is prone to work toward a new fuel cycle in a diligent manner.

Some analysts have claimed that imports of fissile material for India's commercial nuclear reactor program will allow India to divert domestic supplies into weapons production. I do not agree and think that argument is based on a false comparison. If India can't create a viable commercial reactor program (which includes imports of fuel) then it won't build many new commercial reactors (if any). The ore and fissile material it has will be devoted to weapons and there won't be a competition between military and commercial nuclear power. Outsiders won't have much influence on the trajectory of the military program. What is at stake here is just the commercial enterprise, and the fuel, more or less, is not fungible between the two.

Question 3. What would be the incentive for India to build Integrated Gasification Combined Cycle plants based on their coal reserves as compared to importing uranium fuel?

Answer. Right now there are few incentives for commercial power companies in India—including the state-controlled NTPC (which is the largest operator of coal plants in the country)—to pursue IGCC. There are some discussions about IGCC in India and some small cooperative programs (notably with the U.S.). But IGCC can't compete with supercritical technologies for coal. Supercritical technologies are proven and they boost fuel efficiency by a large margin; IGCC is still seen as risky and distant, especially when utilized in the context of India's low grade coals. (There are some IGCC technologies that work with low grade coals, and there have been some tests using Indian coal; but small scale tests are quite different from operational commercial plants in the Indian context.)

Implicit in the question is the thought that India will favor coal because it is available domestically and, by the same logic, it will be wary of nuclear reactors because they will require fuel imports. I don't think that is the right way to analyze

²See generally, Jackson et al., "Greenhouse Gas Implications in Large Scale Infrastructure Investments: Examples from China and India," PESD Working paper, Stanford University (http://iisdb.stanford.edu/pubs/21061/China_and_India_Infrastructure_Deals.pdf).

the Indian policy choices today. If the U.S. and other countries are successful in creating a viable multilateral fuel cycle, then fears about fuel insecurity will abate. Moreover, India is already adopting policies to become dependent upon imported coal—especially in western India where coal-fired power plants are located far from India's coal fields (which are predominantly in the northeast of the country) and it is relatively easy to import coal by ship from reliable and low-cost suppliers such as South Africa and Australia. In short, both the coal and nuclear futures imply dependence on imported fuel and the Indian government has equally good prospects in making both fuel supplies equally secure. For coal, that security will come from the world market where coal is increasingly a fungible commodity. For nuclear, that security would come from a viable multilateral fuel cycle.

RESPONSE OF R. MICHAEL GADBAW TO QUESTION FROM SENATOR DOMENICI

Question 1. In the area of nuclear technologies, what opportunities exist for U.S. industry versus countries such as Russia and France that appear poised to exploit Nuclear Suppliers Group provisions allowing cooperation with India?

Answer. India originally planned to build eight new reactors. Reportedly, the Indian cabinet has already approved six for construction: four by the Russians and two by the French. Moreover, the French may well be positioned to obtain the remaining two contracts as well.

Nevertheless, India recently announced another string of reactor projects beyond the original eight, and we understand that U.S. and Canadian suppliers would be invited to compete for them. The Indian government understands the importance of American companies being able to compete fairly for opportunities in India. As S.K. Jain, chairman and managing director of the state-run Nuclear Power Corporation of India, Ltd. (NPCIL), noted in June 2006, India is interested in having a significant American supplier presence, and is considering American technologies like the Advanced Boiling Water Reactor (ABWR).¹

As soon as permitted under U.S. law and regulations, General Electric is committed to playing a major role in India's construction of new civilian nuclear power plants. GE's state of the art boiling water reactor (BWR) designs offer significant cost and safety advantages, and India has a wealth of positive experience with GE's earlier generation BWR reactor at Tarapur. This experience and the quality of GE's technology open the opportunity for the United States to supply a significant portion of the 40,000 MW of nuclear power India would like to build by 2020.

Nevertheless, the French and Russian governments and their associated nuclear companies are clearly working hard to capture large shares of the Indian nuclear market. The most important requirement for U.S. commercial participation in that market will be to ensure that all governmentally related barriers are addressed in a coordinated and timely manner. The United States might consider a formal approach to the governments of France, Japan, and Russia to ensure that no government jumps the gun by allowing its companies to exchange prohibited technology with India. At the same time, the United States government should work with the U.S. industry to identify all actions that must be taken to allow U.S. exports of civilian nuclear technology to India, and should develop a plan for coordinating the efforts of the U.S. and Indian governments to allow U.S. suppliers to obtain necessary licenses at the earliest possible time.

Most immediately, the United States should ratify the Convention on Supplementary Compensation for Nuclear Damage (of which it is a signatory and prime mover) and pass any necessary implementing legislation. U.S. leadership will put us in the strongest position to ensure that India and other countries that currently lack nuclear liability and compensation regimes will join the Convention. As signatories, they would be required to adopt appropriate liability and compensation legislation, and participate with the United States in this multilateral regime. The treaty creates an insurance system to protect nuclear suppliers from unlimited liability, while also ensuring compensation for those injured in the very unlikely event of a nuclear incident. The liability issue is critical for U.S. suppliers, which do not enjoy the protection provided by state ownership. This is in sharp contrast to French and Russian suppliers, which—underwritten by their governments—are proceeding to do business in China and India despite the absence of nuclear liability regimes there. Without effective protection against liability, however, U.S. nuclear companies will not be able to engage those foreign markets.

¹T.S. Subramanian, "Working to a Plan," *Frontline*, 23:11, June 3-16, 2006.

RESPONSES OF R. MICHAEL GADBAW TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. GE has a very long history in India, not just nuclear, but everything from consumer goods to advanced R&D conducted at your Jack Welch center in Bangalore. Given your experience at the Tarapur reactors with the know-how for reactor design transferred to the Indians, how will GE protect a similar technology transfer for their advanced boiling water reactors especially under the Indian Atomic Energy Act's disclosure and inspection provisions?

Answer. It is unclear how much India is focusing on technology transfer. After 1974, India was cut off from foreign technology support, and was forced to move forward on its own, developing its pressurized heavy water reactor (PHWR) technology indigenously. It is proud of that technology, and considers it internationally competitive—more advanced, in India's view, than the current Canadian technology. Rather, India's interest in foreign participation appears to relate more to capacity requirements: India would like to develop a 40,000 MW capacity by 2020, but NPCIL, the national nuclear company, can only complete 12,000 MW of that goal; foreign involvement would help realize the remainder, and the Indians are unlikely to apply regulatory requirements that frustrate that objective.

Nevertheless, maintaining safeguards on technology transfer remains an important consideration, and the U.S.-India deal allows for ample protections in this regard. Under this historic deal, India's civilian nuclear program will be more transparent than ever before, and put under IAEA safeguards, which will provide greater protection against illegal transfer and use of foreign technologies. India has a record of respecting such safeguards, as was the case with the Tarapur 1 and 2 plants supplied in the 1960s.

The 123, IAEA, and NSG agreements required under the U.S.-India deal are designed to ensure that the participation of U.S. companies in the Indian nuclear market will not lead to unauthorized use of American technologies. In the private sphere, moreover, the contracts we establish with the Indian government and other relevant entities will prohibit misuse and provide for compliance with the USG-GOI agreement. India has demonstrated that it will honor such commitments.

GE is fully committed to compliance with U.S. trade control rules, including those administered by the Departments of Energy and Commerce and the Nuclear Regulatory Commission. Working with its businesses, employees, partners, and customers in India, GE will ensure that technology transfers to India accord with all applicable laws and regulations. In addition, we take measures to protect our valuable trade secrets and company proprietary information regardless of export control requirements. We require suppliers, partners, and contractors that have access to company proprietary information to protect such information.

Question 2. One of the unknowns is the licensing of a large 1,000 MW reactor by the Indian Atomic Energy Regulatory Board—Indian reactors typically are smaller in power, 200-500 MW, than the large reactors developed by GE which are 1,000 MW or more. Do you expect any licensing issues with your reactors?

Answer. We do not expect any licensing problems with respect to the capacity of our reactors. GE will offer to supply reactors such as the ABWR, which has already been licensed in the United States, Japan, and Taiwan, and the ESBWR, which is in the process of being licensed in the United States. GE is confident that these advanced designs will meet Indian regulatory requirements or can be modified if necessary to do so. Reportedly, India's Atomic Energy Regulatory Board has already begun to work with the U.S. Nuclear Regulatory Commission in order to facilitate potential licensing of these designs in India.

We note also that Russia is already in the process of constructing two pressurized water reactors of 1,000 MW each at Koodankulam, Tamil Nadu. NPCIL has made explicit its willingness to authorize at least ten reactors of 1,000 MW each. Influential Indian companies expect to build nuclear plants with even greater capacity. Vedanta Resources plans to build a 2,400 MW reactor, Reliance Energy a 2,000 MW reactor; Tata Energy may enter the arena as well. All are seeking international partners. Altogether, this signals that the Indian government accepts and supports a major advance in the capability of India's nuclear plants, and welcomes foreign participation in that process.

[Responses to the following questions were not received at the time the hearing went to press:]

QUESTIONS FOR DANIEL PONEMAN FROM SENATOR BINGAMAN

Question 1. Many have said that aiding India's civilian nuclear program, even under IAEA safeguards, will only free up fuel to make plutonium for their unsafe guarded weapons program—do you find that statement to be true?

Question 2. Unlike the U.S., India integrated their civilian R&D program with their military nuclear program, how hard will it be to separate civilian facilities not only physically local to a military one but the people as well?

Question 3. Do you think the Indians will be receptive to U.S. embassy led end-use inspections of nuclear equipment exported to their facilities to ensure they are not re-exported elsewhere?

Question 4. Your proposal of fuel leasing goes back to the Eisenhower Atoms for Peace program—but the central flaw of the program is it denies India any indigenous capability for self sufficiency in nuclear fuel production—they are reliant on other nations. India has a long tradition of non-alignment—do you think they will be receptive to such a tying arrangement?

QUESTION FOR PAUL SIMONS FROM SENATOR DOMENICI

Question 1. Without nuclear power, how will India meet its energy-mix needs?

QUESTIONS FOR PAUL SIMONS FROM SENATOR BINGAMAN

Question 1. The 1978 Nuclear Nonproliferation Act amended the Atomic Energy Act to provide enhanced safeguard measures and sanctions for non-nuclear weapons states that violate criteria with respect to proliferation or militarizing nuclear energy. In each case the President has the ability to exempt a non-nuclear weapon state that violates the conditions set forth in the Act, by submitting to Congress a waiver and having the Congress enact a resolution accepting the waiver as it pertains to a cooperation agreement or enacting a resolution of disapproval as it pertains to an exempted export. This process actually works—the Congress failed to reject to exports of fuel to the Indian Tarapur reactors in 1979 and 1980. Why do we need to enact new legislation to exempt India from law which has worked in the past?

Question 2. The Global Nuclear Energy Partnership involves reprocessing spent nuclear fuel and fast breeder reactors, it is my understanding that India's Fast Breeder Reactor and some reprocessing facilities will stay on the military facilities list—do you recommend extending the program to India?

Question 3. Do you have a nuclear cooperation agreement in place with India? If not why are we enacting legislation when we have not seen such an agreement?

Question 4. The principal avenue by which we collaborated with India in R&D was through loan repayment funds deposited in India accounts under the "P.L. 480" program. My understanding is those funds are now long gone. Would it be advantageous to set up a fund similar to the Israel—U.S. Bi-national Industrial Research and Development Fund where revenue from supported projects is used to repay the R&D grant?