"From Uncertainty to Opportunity: Creating a Comprehensive Energy Roadmap and the Human Capital to Make It Happen"

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Speech Transcript

Thank you for that warm introduction. It is an honor to be the second speaker in this prestigious series, and to have this opportunity to share some thoughts with you, here, in the nation's energy capital.

Let me take this opportunity to congratulate my good friend and colleague, Dr. Neal Lane, for conceiving and bringing to fruition this innovative lecture series. Dr. Lane has cited Benjamin Franklin as an inspiration, noting that this early American prototype of a civic scientist addressed the young nation's concerns with wisdom, practicality, and a deep sense of civic responsibility. We share Franklin's belief that, properly applied, scientific breakthroughs can accrue to the betterment of all humanity. Through forums such as this, we have the opportunity to consider large problems of global significance — problems that will affect not only our nation, but the entire world.

We are witnessing — and experiencing — extraordinary turbulence and uncertainty in the global energy system. There is a palpable sense that the situation is out of control — out of our control, certainly. Within the United States, one hears, more and more, a call for "energy independence." Americans have an historical affinity for the concept of independence.

Almost exactly 34 years ago President Richard M. Nixon issued such a call. Three weeks after the shock of the Arab oil embargo, the price of oil had catapulted to an unprecedented $11 per barrel. President Nixon introduced "Project Independence" on national television, and pledged that the country would, within seven years, "meet our energy needs without depending on any foreign energy source." Needless to say, "Project Independence" fell short, as did similar initiatives by Presidents Ford, Carter, and the first President Bush. Despite the best of intentions, over the last thirty years, we went from importing a third of our oil in 1973 to nearly two-thirds today.

I believe "energy independence" is a troubling misnomer. Energy uncertainty extends far beyond the borders of the United States, and concerns the entire planet and its people. There are more than 190 recognized countries in the world, and it has been observed that none of them is energy independent.

Our vision has to be for energy security; and our goals and our thinking need to be within a broader, global context in order to act wisely, comprehensively, and effectively.

The energy challenge is a key part of a multi-faceted and growing challenge confronting the interconnected world in which we live. Furthermore, there is an acute urgency to this challenge.

We are witnessing — and becoming more acutely aware of — a worldwide surge in energy consumption, driven by population growth, higher standards of living, and increasing reliance on energy-dependent technologies. From 1950 to 2000, the world population rose from 2.5 to 6 billion people. Water use tripled — as did grain production. The number of automobiles, globally, grew from 53 million in 1950 to 539 million in 2003. And, with the introduction of commercial jet aircraft in the late 1950s, air travel volume mushroomed. . . from about 28 billion passenger-kilometers at mid-century to more than 2.9 trillion in 2002.

Worldwide energy consumption per capita is now roughly 13 times higher than in pre-industrial times. And this is only the average rate; bear in mind that there are still 2.4 billion people — more than a third of the planet's people — who have no access to modern energy services.

Failure to resolve today's uncertainty and to achieve adequate, sustainable energy supplies will leave billions in underdeveloped countries stranded in energy poverty, with all the attendant implications: inadequate access to food and water, inability to combat infectious diseases, lack of education, and civil unrest. A large section of the Earth's population would be unable to progress.

In short, we are nowhere near the endpoint of the energy consumption chart. Over the next 50 years, if current trends continue, humans will use more energy than in all of previously recorded history.

But failure in the other direction — in terms of over-consumption following current fossil fuel usage patterns — holds its own implications for major environmental impact.

So, where will the energy come from? From which fuels will it be derived? Can our planet — a planet of limited resources and interconnected commerce — sustain the impact? How can we achieve higher standards of living for all, while addressing legitimate concerns about the environment?

We must learn to think about energy in new ways.

A convergence of multiple factors makes it bluntly obvious that a comprehensive global energy system restructuring has begun. The open question is: will the United States lead the inevitable restructuring, or will it occur without us?

The combined forces of energy supply uncertainty, rising energy costs, and the impact of climate change are major drivers. Against this backdrop, let us examine six the elements of this restructuring:

Growing energy demand is driving new markets worldwide, creating opportunity, options for new players, and concern.

New major players have emerged who are changing the terms of reference for traditional energy alignments, especially with regard to oil and gas supply.

Nations are realigning in new ways, shifting old alliances.

With rising energy costs, corporations are swiftly realigning their priorities, changing how they do business, and making investments to secure market opportunity.

Climate change mitigation — linked to energy security — is creating new markets including investments in new sources and new technologies, and new trading schemes.

Oil-generated wealth and other actors are changing who plays in global financial markets.

These factors already are in play, altering how the global energy system works — affecting who plays, how they play, and who reaps the rewards. Let us examine each.

GROWING DEMAND AND NEW ENERGY MARKETS

The unprecedented economic development and industrialization of China and India are creating tremendous pressure on energy markets worldwide, straining global oil trade, driving prices higher, and contributing to higher carbon dioxide emissions. Moreover, the populations of these two nations alone are predicted to grow by about 240 million between 2005 and 2015, adding to the pressure and consuming new production capacity.

A November 7 report by the International Energy Agency indicated that China and India accounted for about 70 percent of the increase in energy demand in the last two years. Energy use in the two nations is projected to double from 2005 to 2030, by which time they will account for nearly half the increase in global demand. Yet, energy use, per person, is considerably lower than in developed nations, and the IEA urged advanced economies to work with China and India to cut overall growth in energy consumption.

The report predicted that China would become the largest energy consumer soon after 2010, overtaking the United States. In India, where more than 400 million people have no access to electricity, energy demand is, nevertheless, expected to more than double by 2030. At the same time, net oil imports for the two nations are expected to climb to 19.1 million barrels a day in 2030, up from 5.4 million barrels in 2006. By 2030, global oil demand is expected to reach 116 million barrels a day.

The unprecedented growth in energy use has impacted markets. The power and influence of global traders and investors over oil markets has been increasing gradually for some time. Before 1980, international oil companies had long-term contacts which set prices and volumes. Relatively small amounts were traded daily on what was called the “spot” market. In 1983, the New York Mercantile Exchange opened a market for crude oil which has grown steadily. Now, most major oil companies tie sales and purchases to the fluctuating prices on the exchange.

With the emergence of new energy markets, traditional corporate and country alignments are shifting, creating new alliances and cooperative agreements, and completely altering not only the geopolitics of energy production, distribution, and markets, but also relationships between and among nations, as well.

NEW MAJOR PLAYERS

The original "seven sisters" — Western companies that controlled Middle East oil after World War II — have begun to lose prominence to a new set of seven. Saudi Aramco, Russia's Gazprom, China's CNPC, NIOC of Iran, Venezuela's PDVSA, Brazil's Petrobras, and Petronas of Malaysia control almost a third of the world's oil and gas production, and more than a third of its total oil and gas reserves.

The old "seven sisters," which became four after the 1990 mergers — Chevron, Exxon-Mobil, BP, and Royal Dutch Shell — produce about 10 percent of the world's oil and gas, and hold around 5 percent of reserves. The International Energy Agency estimates that 90 percent of new production supplies, over the next four decades, will come from developing countries — a big shift from the past 30 years when 40 percent came from industrialized nations. This asymmetry is leading supply countries, and their national oil companies, to change contract terms with traditional international oil and gas companies, and to shift alliances, to have greater ownership of assets, and greater oil revenue shares.

Global energy markets already are impacted as supplier country-based companies regulate the price of oil and natural gas by controlling production. If they control more integrated supply chains, the effect on global energy markets, and economies overall, would be even more dramatic.

Some $700 billion annually are accruing to the world's oil-exporting countries. Venezuela's new oil wealth gives it powerful new influence among traditional U.S. allies in South America. Iran can better sustain economic sanctions over its nuclear program. Saudi Arabia is stabilizing its social system by building four new cities and new research universities, burnishing its image. Angola has joined OPEC, and is cooperating less than it used to with the International Monetary Fund.

The fact that the new "sisters" are state-owned, and that growth in the oil and gas industry rests strongly in their hands, is restructuring national and international alliances, and will impact them for decades. The emergence of the "sisters" from oil-rich countries has been a basis for the creation of Sovereign Wealth Funds (SWF) — nation-owned financial entities, which give their countries tremendous investment power. I will return to these funds shortly.

GLOBAL REALIGNMENTS

All these challenges are global in reach. But each region and country is affected differently — based on factors such as indigenous fuel sources, relationships to other supplier countries, reliability of infrastructure, economic stability, the degree of attention given to environmental concerns, and how government leaders and the public at large view the risks and benefits of different energy sources. Variations in how these factors are weighted in the policy-making process of a given country can lead to contrasting strategies for achieving energy security — even though the effects of these decisions are likely to extend to other countries and regions.

In a recent example, Gasunie, the Dutch National gas company, has taken a stake (9%) in the controversial Nord Stream Pipeline Project. The pipeline, controlled by Gazprom (the Russian gas

monopoly), would carry gas directly from Russia, under the Baltic Sea, to Germany — bypassing Poland, Belarus, Ukraine, and the Baltic States. The Baltic States in particular are objecting to the pipeline on the basis of environmental concerns. For others, such as Poland, it means a revenue loss (from transit fees). For yet others, it can affect supply (Ukraine). The deal, also, gives Gazprom the option to acquire from Gasunie a 9 percent stake in the Balgzand-Bacton pipeline, connecting the Netherlands and the U.K. This would give Gazprom a stake in a British supply pipeline for the first time.

Moves such as this are occurring as more and more countries in the EU worry about energy supply, especially oil and gas. The European Commission estimates that ". . . over the next 20 to 30 years, energy import dependence will rise to 70% overall and up to 90% for oil, in the absence of policy action in the near term to reduce dependence . . . " This is causing the EU to develop strategies for new and renewable sources of energy and energy efficiency, both to assure supply through diversification, and to mitigate climate change. The European Union already is the world leader in renewable energy technology; for example, EU companies hold 60 percent of the market share in wind technology.

Moreover, China is on a worldwide march to lock up energy supplies, as well as access to other resources such as minerals and heavy metals. This, especially, is seen in its presence in Africa where it trades assistance, infrastructure development, sometimes education, and always embassy presence and diplomatic ties, for such access. Over time, China's move, and the increased involvement of Asean countries (e.g. Malaysia) surely will reshape sub-Saharan African countries alignments.

CORPORATE ADAPTATION

Worldwide, corporations are making changes to mitigate the impact of high energy costs on their bottom lines, and to exploit business opportunities inherent in the need for alternative sustainable energy sources. Already, they are making large capital investments in renewable energy technologies, creating new supply chains, and new value. A 2007 report by the United Nations Environment Programme's Global Trends in Sustainable Energy Investment found that investment capital flowing into sustainable energy (especially wind, solar, and biofuels) more than doubled in just two years — from $28 billion in 2004 to $71 billion in 2006. A similar trajectory is continuing throughout 2007. The International Energy Agency (IEA) estimates that as much as $16 trillion will be invested in the energy sector through 2030.

Exxon Mobil, for example, has found opportunities to improve by 15 to 20 percent the energy efficiencies at its refineries and chemical plants, with annual cost savings of $750 million.

Microsoft, Google, and HSBC are building data centers alongside hydropower sources to better manage the electric power they demand.

PepsiCo and Coca-Cola have pledged to buy more than 1.1 billion kilowatt hours of renewable energy over the next three years.

Wal-Mart has been a leader in stocking energy-efficient products, and has reduced the packaging material of some goods to lower energy content. They, also, have begun a pilot program with suppliers of DVDs, toothpaste, soap, milk, soda, beer, and vacuum cleaners to measure and reduce the energy required to produce and deliver them.

As one of the largest industrial users of energy in the world, Dow Chemical has an intense self-interest in reducing its energy consumption and improving overall energy efficiency. Dow has committed to a decade-long reduction in energy intensity to 25 percent below what it consumed in 2005. Additionally, Dow has committed to developing alternative energy sources — and specifically those that have "less carbon-intensive raw material sources" as well as "other solutions not yet imagined." Dow believes that it has a unique perspective on finding and developing alternative energy sources and efficiencies because it is a world leader in chemistry and manipulating natural resources.

CLIMATE CHANGE MITIGATION AND NEW MARKETS

What is significant about the anticipated growth in global demand for energy is that so much of it will occur in countries that are not prepared to reduce their dependencies on fossil fuels. In fact, more of the current rapid increase in Chinese and Indian electrical generating capacity is coming in the global form of coal-fired power plants. The IEA projection indicates a greater increase in coal use in the coming decades — mainly for electricity generation — than that of any other energy source.

China is projected to become the largest emitter of greenhouse gases and other pollutants within a couple of years. The effect of this is global — being felt all the way to California in the U.S. — where, by some estimates, 30 percent of the background sulphate particulate matter in the Western U.S. originates in Asia.

It is important to help rapidly developing countries like China to gain energy efficiencies in manufacturing, and in products, while reducing its carbon footprint through the use of renewable and alternative energy sources. Multinational corporations are working with their Chinese suppliers to help them reduce costs by reducing energy use and carbon load. New management techniques and new technologies have important roles to play here, which create new opportunities for trade, and for commercial (and diplomatic) engagement.

Globalization of capital, climate change mitigation, and mounting investment volume, from multiple sources, are creating opportunities for new markets, as well. Some, such as the European Trading Scheme (ETS) or the UN Clean Development Mechanism (CDM) are government-sponsored, established under the Kyoto Protocol. Others have sprung up voluntarily, such as the Chicago Climate Exchange (CCE) which integrates voluntary, legally binding emissions reductions with emissions trading, and offsets for six greenhouse gases.

The carbon content of fuels, processes, and commercial and consumer goods, has begun to get a lot of attention, with Congress expected to pass legislation that would regulate, and hopefully, reduce carbon content or carbon dioxide production through financial incentives.

In fact, earlier this month, a Senate Subcommittee approved a bill to establish a cap-and-trade system for carbon dioxide in which allowances would cost money — although it is not yet clear what the House of Representatives will do. Others have proposed a carbon tax to reduce carbon load.

All schemes would have industry and the consumer pay the carbon cost. A carbon tax and a cap-and-trade system both depend upon the ability to measure the true carbon content of products and processes in a consistent way. Companies are beginning to jump into lowering the carbon and energy content in their products in a big way — sometimes in anticipation of regulation, sometimes for good business reasons. This is not entirely easy, since not all companies measure all aspects of carbon generation in product development. General Electric, for example, does not include supply chain CO2 emissions because they do not control all elements of their supply chains. What companies are focusing on is the carbon and energy content of products — but consistent definitions are hard to come by.

Concerns about climate change and energy security have contributed to a resurgence of interest in nuclear power.

In principle, nuclear energy satisfies many of the optimum requirements for enhancing energy security. Nuclear power produces virtually no sulfur dioxide, particulates, nitrogen oxides, volatile organic compounds, or greenhouse gases. The complete cycle, from resource extraction to waste disposal, emits only about 2-6 grams of carbon equivalent per kilowatt-hour. This is about the same as wind and solar — if one includes construction and component manufacturing — and is roughly two orders of magnitude below coal, oil, and natural gas. Moreover, unlike small wind and solar facilities, nuclear power can supply the large baseload capacity needed to support large urban centers and to stabilize large electrical grids.

This renewed interest takes different forms in different regions. The heaviest concentration of new nuclear power plant construction currently is in Asia, primarily in China. In Europe, Finland and France are constructing the new European Pressurized Reactor (EPR).

Earlier this year, the U.S. Nuclear Regulatory Commission (NRC) approved the first nuclear power plant site in over 30 years, in central Illinois. [The nuclear power plant would be built by the energy company Exelon.] More recently, the energy company NRG has submitted to the NRC an application for a combined construction and operating license to build a new GE-designed plant, here in Texas.

At a meeting in March (2007), EU leaders agreed that a country’s nuclear power capability will be taken into account when calculating its national commitments to renewable energy, targeted to be 20 percent of Europe’s energy production by 2020.

One of the most controversial aspects of nuclear power — which I have sometimes referred to as the “Achilles’ Heel” of the nuclear industry — relates to the management and disposal of spent fuel. The amount of spent nuclear fuel produced annually [— about 10,000 tons (2,000 tons per year in the U.S.) —] is actually small when contrasted with the [25 billion tons of] carbon waste from fossil fuels, that is released directly into the atmosphere.

Given the intense polarization around the nuclear waste issue, public opinion will likely remain skeptical until waste repository or other fuel cycle closure solutions have been demonstrated.

In the U.S., the federal government has been making progress toward building a nuclear waste repository at Yucca Mountain in Nevada. But, due to state opposition, no license application has been filed with the NRC.

Elsewhere, the greatest progress on deep geological disposal has been made in Finland and Sweden. In particular, Finland's government and parliament have approved a decision, in principle, to build a spent fuel repository near Olkiluoto. Construction is slated to start in 2011, and operation in 2020.

In the meantime, the trend has been to construct and use above-ground interim storage facilities. Many countries are exploring the feasibility of interim storage for 100 years or more.

R&D is progressing, as well, on the use of fast reactors and accelerator-driven systems to incinerate and transmute long-lived waste, in order to reduce the volume and radiotoxicity of waste to be sent to geologic repositories.

The importance of nuclear power has led to the renewal of the operating licenses of 48 out of the country's 104 nuclear power reactors, and virtually all U.S. nuclear plants either have filed for renewal already, or are expected to file eventually.

Extending the life of an existing plant is economically attractive because it requires relatively little capital expenditure, provides a longer amortization period for expenditures that are made, and offsets the short-term need for new generating capacity.

On the technical front, several advanced and innovative concepts are moving toward implementation. The Generation IV International Nuclear Forum — a U.S.-led project in which France, the United Kingdom, and the European Union are also members — is moving forward toward R&D on six innovative reactor concepts, [such as the "Molten Salt Reactor" and the "Supercritical Water Cooled Reactor". Russia has licensed the KLT-40, a 60 megawatt reactor design that can be floated and transported by barge, which takes advantage of Russian experience with nuclear-powered ice-breakers and submarines, and can also be used for district heating. The Republic of Korea intends to construct by 2008 a one-fifth-scale demonstration plant of its 330 megawatt SMART pressurized water reactor, which will also include a demonstration desalination facility. And South Africa recently approved initial funding for developing a demonstration unit of the 168 megawatt gas cooled Pebble Bed Modular Reactor (PBMR), to be commissioned around 2010.]

Nuclear plant operating costs are low when compared to most other energy sources. And unlike coal, oil, or natural gas, the purchase of fuel comprises such a relatively small part of nuclear costs, such that volatility in fuel markets has relatively little effect on overall costs of nuclear electricity generation. Moreover, uranium resources are abundant and widely distributed, with multiple stable supplier countries.

On the other hand, nuclear power plants are capital-intensive, requiring initial investments in the range of $2 billion to $3.5 billion — as well as a sophisticated regulatory infrastructure to ensure independent safety oversight. For some countries, governments may need to reduce the initial risk to stimulate private investment.

With all these costs taken into account, new nuclear power plants can produce electricity at a cost of between 4.9 and 5.7 cents per kilowatt-hour. This makes nuclear power cheaper than electricity from natural gas if gas prices are above $4.70 to $5.70 per MBtu. On the other hand, nuclear is more expensive than conventional coal, unless coal rises above $70 per ton. Nuclear power would be more competitive, however, if a financial penalty on carbon dioxide emissions were to be introduced.

Regulatory strength and multinational collaboration are important, as nations and regions develop and/or evolve their energy infrastructures — especially in the nuclear arena.

OIL-GENERATED WEALTH AND FINANCIAL MARKETS

In the financial services sector, Sovereign wealth funds (described earlier) have emerged as important new players in global financial and energy markets. Worldwide, it is estimated that some $3 trillion have been assembled in SWFs, especially out of the Middle East, and is likely to reach $7.5 trillion by 2012. The availability of these substantial funds, their sovereign support, and appetite for risk offer both challenges and opportunities for governments and corporations, and is changing behaviors between and among these entities.

These funds, together with central banks in emerging markets, hedge funds, and private equity, are beginning to play, in a major way, into financial markets. They are moving to participate in IPOs, provide additional financial backing in business deals, and take major stakes in stocks and other financial instruments.

The six broad considerations I have outlined tell us that our nation’s economic security and our national security are inextricably interlinked with global energy security. This is a challenge without borders, whose elements are interrelated and interdependent, but which affect us directly.

Therefore, we must understand the comprehensive global energy system, its impact on markets, and national alignments, as we shape our own national energy goals and strategies. We also must realize that energy security and climate change are fundamentally linked challenges.

COMPREHENSIVE ENERGY ROAD MAP

I would like to return, now, to the distinction between energy independence and energy security, and to examine energy security in more detail. I define energy security as having an adequate and sustainable supply of energy to meet the needs and aspirations of citizens, commercial enterprises, and public sector functions, and to provide that supply in as environmentally benign a way as possible. The practical definition — that is, the set of strategies for achieving energy security —

varies according to nation and region. To reach it for our own country — we must build a comprehensive energy roadmap. At its core, it should adhere to five basic principles:

First — redundancy of supply and diversity of source — where optimum source is linked to specific sector of use. This entails maximizing domestic production and ensuring reliable sources for necessary fuel imports. This provides protection against supply disruption events, such as natural disasters or geopolitical instability, and a hedge against price volatility.

Second — support for well-functioning energy markets. This includes ensuring a level playing field with regard to the transparency of fuel pricing and energy generation, as well as mechanisms to secure financing for long-term strategic investments. The latter frequently is a sticking point of energy insecurity for developing countries, and sometimes developed ones, as well. This, also, means understanding and/or developing new schemes and instruments for trading in energy markets, which link to climate change mitigation strategies.

Third — investment in sound infrastructure for energy generation, transmission, and distribution, including the necessary regulatory and operational protocols to ensure the safe, secure, and reliable performance of refineries, power plants, the electrical grid, and other facilities.

Fourth — providing for environmental sustainability and energy conservation — which calculates full lifecycle costs, including environmental costs, of goods — from production through use and eventual disposal.

Fifth — the development of policy alternatives which balance legal requirements with incentives. These include consistency of regulation, and transparent price signals.

As Congress debates current legislation, and as Presidential candidates lay out their own programs, each proposal must be examined to determine if it would lead to a comprehensive national energy roadmap.

Like corporations and markets, states in this country, and even cities, are not waiting for a national energy plan, but, already, are enacting legislation and regulations addressing both energy costs and climate change mitigation, and, like corporations, are exploiting economic opportunity.

A 1999 Texas state law requires utilities to produce 5,880 megawatts of electricity from renewable sources by 2015. As a result energy technology investment in the state has topped $1 billion, and it is estimated that carbon dioxide emissions already have been reduced by 3.3 million tons. Texas now leads the nation in wind-produced electricity.

As early as 1983, Iowa passed a renewable energy requirement, and, experienced something of a boom in wind turbine production, such that wind power development, now, is taught in many of the state’s community colleges.

At the end of October, GE Energy announced a major expansion at its downtown Schenectady (NY) plant, adding as many as 500 new jobs for engineers and technicians in the alternative-energy sector, giving a much needed boost to the struggling economy in upstate New York.

In New York City, Mayor Michael Bloomberg has called for a 30 percent reduction in greenhouse gases by 2030. And, Chicago announced a plan to reduce its emissions 80 percent by 2050.

The federal government also has been getting into the game. News reports noted yesterday that in 2004, the Environmental Protection Agency (EPA) and the Commerce Department formed the Green Suppliers Network to help small companies learn less carbon intensive, more profitable management and manufacturing techniques.

INNOVATION

I would add a sixth element to a comprehensive energy formula; and that is continuing, robust innovation — both in terms of technological advances, as well as business process innovations, and policy alternatives.

We must innovate the technologies which uncover and exploit new fossil energy sources [such as oil shale or methane hydrates] and improve their extraction. We must innovate the technologies which conserve energy and protect the environment. And, we must innovate the technologies which lead to alternative energy sources, which are reliable, cost-effective, safe, as environmentally benign as possible, and sustainable. This can range from new nanostructured materials for photovoltaics, to new drilling and exploration, to new imaging and computational techniques, to new nuclear technologies, to the science and technology of carbon capture and sequestration, to hydrogen fuels, biofuels, etc.

In terms of policy, technological innovation must be seen as both a policy tool, and a policy outcome. Public policy can be a driver of technological innovation, if one provides both requirements and incentives — for example, with regard to nuclear power, or alternative and renewable energy sources. In these cases, technological innovation is an outcome of policy.

Innovation can be a public policy tool. If, for example, one chooses to set standards—such as reducing carbon dioxide load in the atmosphere—then technological innovation plays a role in schemes such as carbon capture and sequestration, or in completely closing the carbon cycle, either through hard technology or through biologically-based schemes.

Technological innovation on the scale needed requires multi-sector, multi-national cooperation. In this context, it is interesting to note agreements over the last two years between the U.S. and Russia to cooperate in R&D on: advanced reactors, including fast reactors; new reactor fuels and fabrication processes; advanced methods for recycling and transmuting spent nuclear fuel; and exportable small and medium-sized reactors. And between the U.S. and India not only on nuclear R&D, but in the area of deep ocean drilling and gas hydrate extraction.

But again, we need a comprehensive energy roadmap because a patchwork approach will be ineffective in outcome, cumbersome for business to navigate, and will fail to optimize the inherent opportunity imbedded within the energy challenge.

HUMAN CAPITAL

Innovation requires investment in research and development, but innovation fundamentally requires people. The question is, are we, as a nation, equipped with the human capital for the robust innovation the energy challenge demands of us? As a university president, and as a theoretical physicist, I have deep concerns that our national innovation capacity is in jeopardy. Converging forces have created what I call the "Quiet Crisis," which is eroding the production of scientists, mathematicians, engineers, and technologists we need. The scientists and engineers who came of age in the post-Sputnik era, are beginning to retire. At the same time, we are no longer producing sufficient numbers of new graduates to replace them. This looming talent crisis already is evident in the nuclear and the oil and gas sectors.

The rate of growth of talented international scientists, engineers, and graduate students coming to the United States has slowed, with the number down 27 percent since 2003. Other nations are investing in their own education and research enterprises, offering new opportunities for their own scientists and engineers to study and to work at home. The "flattening" world means that they, also, can find employment elsewhere, not necessarily in the U.S.

There has been a parallel decline of investment in U.S. basic research, especially in the physical sciences and engineering. Federal investment in scientific research has been shrinking, driven by concern over "big government," limits on federal spending, concern for federal deficit growth, and confidence in market-driven private sector research. The American Association for the Advancement of Science estimates that, overall, federal science research spending has declined by half since 1970, as a percentage of Gross Domestic Product (GDP).

Finally, our demographics have shifted. The "new majority" in the United States now comprises young women and the racial and ethnic groups which, traditionally, have been underrepresented in our advanced science and engineering schools. It is to these "nontraditional" young people to whom we, also, must look for our future scientists and engineers, while spurring the interest in science and engineering of all of our young people.

This "Quiet Crisis" is "quiet" because the true impact unfolds gradually over time — it takes decades to educate a biomolecular researcher or a nuclear engineer. It is a "crisis" because our national innovative capacity rests solely upon their talents, and upon our ability to interest and excite all of our youth to the marvels of science and engineering — to the wonders of discovery and innovation.

Due to the efforts of many, from multiple sectors, we have a new law, the America COMPETES Act, which seeks to address and mitigate the challenges, and to create a specific new governmental entity, ARPA-E, to spur new technological development, and to speed market adoption of technological innovation in the energy arena.

What we need now is funding, and cross-governmental coordination, to flesh out a robust energy roadmap, and to enlist all relevant government departments and agencies to make it come to life.

LEADERSHIP

We are a year out from national elections. At this time next year, we will have elected a new president. To achieve a comprehensive national energy plan, requires the full weight and leadership of the nation's chief executive, as well as strong, coordinated leadership in Congress, and associated leadership at the state level. Only stability and consistency of outlook, and linked federal and state regulatory policies and incentives, can give us a comprehensive national energy roadmap which will make a real difference. These same elements are important to provide signals and confidence to the corporate and financial communities that invest in new energy systems and technologies, and to ensure that investments in new energy markets make business sense.

There are many who are looking ahead to this time and to these issues. Currently, I am co-chairing (with Jim Owens, CEO of Caterpillar, and Mike Langford, National President of the Utility Workers Union of America) an Energy Security, Innovation, and Sustainability Initiative launched by the Council on Competitiveness.

Other national groups include the Council on Foreign Relations (CFR), whose "Task Force on Climate Change" is focusing on U.S. strategy for international engagement on climate change between now and 2012, with a view toward shaping action through 2050. The group also is connecting the issue of Climate Change to economic opportunity, jobs, and security.

The Brookings Institution has an Energy Security Initiative, which is reviewing energy security, energy policy, and climate change, and focusing on international negotiations and the Bali, Indonesia, United Nations Framework Convention on Climate Change (UNFCCC) meeting in December.

Actually, the energy security challenge that confronts us, today, requires the very capabilities that the U.S. has in abundance — a higher education system that is widely regarded as the best in the world, a well-developed science infrastructure — including advanced computational resources, a financial system that provides ready access to venture capital, government structures with a record of supporting and investing in cutting-edge scientific work and government policies that encourage investment and entrepreneurship, a history of collaboration between the public and private sectors, a thriving and diverse culture of risk-takers where unconventional approaches to problems are welcomed, and a long history of taking great risks for great rewards.

CONCLUSION

To reiterate, true global energy security will require a more complete understanding of energy markets and geopolitics, the new players, and the new alignments. It also will require innovation of the highest order. Meeting global energy needs, also, will require unleashing the human talent needed to accelerate innovation.

We have addressed challenges like this before.

The launch of the Soviet satellite Sputnik in 1957, followed by the history-making flight of a cosmonaut in 1961, set in motion a space race (actually, a science-based, defense race) that was transformational.

President John F. Kennedy issued a call to action in May 1961—and restated, here at Rice University in September 1962, the nation's resolve to land a man on the moon, and return him safely, before the end of the decade. He urged that the United States rally its intellectual, industrial, and economic resources to this challenge. His challenge was considered by many to be unattainable, and there was considerable concern about how much money it would cost.

President Kennedy said, "We choose to go to the moon. We choose to go to the moon in this decade . . . not because (it is) easy, but because (it is) hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win . . . "

The Congress and the country responded. The wave of activity that followed included an intensive focus on identifying and providing the necessary education and research supports.

The nation's achievements in human space exploration — executed, of course, from the Johnson Space Center in its celebrated Mission Control, here in Houston — showcased American innovation, American democracy, and restored American prestige worldwide.

From all of this came exponential advances in an extraordinary number of fields including health and medicine, communications, and transportation, which have changed where we live, how long we live, and the way we live.

For decades, we have avoided facing tough realities. To work through them now, we will have to make tough decisions, commit to consistent policies, and follow through. In the spirit of President Kennedy, we should feel positive about the challenge, and take it up with resolution, clear-headedness, and, yes, even enthusiasm.

Nations are realigning, corporations are reassessing and shifting their investment decisions, U.S. states and cities are legislating changes, and while national legislation under debate addresses some aspects, we still have no comprehensive national energy plan.

We need a new call to action — a call that will ignite our commitment and our collective imagination — a call that will secure the investment and the innovation needed — a call for a comprehensive energy roadmap. In short, we need a national conversation, led by our national leadership, to help our citizenry understand what is at stake, and to motivate all to action.

The open question remains, will we have the leadership to enter, as a nation, more fully into the global energy restructuring, or will it go on without us?

Indeed, global energy security is the space race of this millennium.

Thank you.