

Economic Perspectives

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CHALLENGES TO

ENERGY

SECURITY

ECONOMIC PERSPECTIVES

Challenges to Energy Security

U.S. DEPARTMENT OF STATE

ELECTRONIC JOURNAL

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World resources are sufficient to satisfy global demand for energy for the foreseeable future, but challenges remain in the form of environmental problems, political concerns, distribution of resources, and myriad other issues. The United States believes that open markets and new technologies working in concert will help us and other countries meet those challenges together.

The United States has developed and pursued an energy policy — the first comprehensive long-term plan in years — aimed at making the U.S. energy future more secure. The United States needs energy to fuel its economic growth and to continue to work as a global economic engine, so we have proposed to explore domestic resources and expand and diversify our energy supplies in ways that support global

development, democracy, and stability.

Making this strategy work requires that we, working with other countries, seek new methods of using traditional fuels such as coal in environmentally sustainable ways and develop new technologies such as hydrogen fuel cells to improve energy efficiency as well as the environment. It also calls for engaging our key trading partners, major energy producers, and international institutions in a dialogue on the role of energy security in our shared global prosperity as well as for promoting international trade and investment throughout the energy supply chain.

Our great nation, in the true spirit of democracy, has been engaged in a free and open debate of our energy objectives, priorities, and policies, both domestically and with our partners around the world. This journal reflects international aspects of U.S. energy strategy derived from that debate.

In it you will find views and insights from key government officials, industry representatives, experts, and leading scholars on how best to use the world's energy resources to meet growing demand and fuel sustainable development. As President Bush has said, an efficient, clean, convenient, and affordable energy future “is achievable, if we make the right choices now.”

A handwritten signature in black ink, which appears to read "C. Powell". The signature is stylized and written in a cursive-like font.

Colin L. Powell
U.S. Secretary of State

ECONOMIC PERSPECTIVES

An Electronic Journal of the U.S. Department of State

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ECONOMIC PERSPECTIVES

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The Bureau of International Information Programs of the U.S. Department of State publishes five electronic journals that examine major issues facing the United States and the international community and that provide information about U.S. society and values. The journals — *Economic Perspectives*, *Global Issues*, *Issues of Democracy*, *U.S. Foreign Policy Agenda*, and *U.S. Society and Values* — provide statements of U.S. policy together with analysis, commentary and background information in their thematic areas.

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□ U.S. NATIONAL ENERGY POLICY AND GLOBAL ENERGY SECURITY

By Spencer Abraham, U.S. Secretary of Energy

Meeting the world's energy challenges will require a determined, sustained global effort over decades, says Abraham. The United States must balance increased energy production with clean and efficient energy use by developing international partnerships, expanding and diversifying its supplies, and promoting competitive markets and sound public policies. At the center of these efforts are new technologies that promise to change the way we produce and consume energy.

Meeting the world's energy challenges will require a sustained global effort over many decades. As the largest single market in an increasingly integrated world energy system, the United States affects and is affected by developments around the world. As a result, U.S. energy policy plays an influential role in maintaining global energy security.

Recognizing the growing strains on energy systems as he took office, President Bush sought to develop a comprehensive and balanced energy policy that could help the private sector and state and local governments "promote dependable, affordable, and environmentally sound production and distribution of energy for the future." The result was the National Energy Policy (NEP) report, which since its publication in May 2001 has guided U.S. energy policy.

ENERGY OUTLOOK

The Energy Information Administration's (EIA) most recent projections paint a clear picture of future energy challenges in the United States. Despite continued advances in technology, total U.S. energy consumption is projected to increase from 98 quadrillion British thermal units (Btus) in 2002 to 136 quadrillion Btus in 2025. Because of slow growth in domestic energy production, net energy imports are projected to grow from about one-quarter to just over one-third of U.S. demand in 2025.

Oil imports account for a large portion of imported energy, and the Organization of Petroleum Exporting Countries (OPEC) is expected to be the principal source

of marginal supply to meet increased oil demand. By 2025, OPEC production is expected to nearly double, and projected growth in demand points to a world price of about \$27 per barrel in real 2002 dollars.

Assuming an increase in gross domestic product of about 3 percent per year over the same period, total U.S. petroleum demand could grow from about 20 million to 28 million barrels per day. As a result, net petroleum imports to the United States could jump from 53 percent to 70 percent, with much of the oil coming from the Persian Gulf. And with refinery capacity growth constrained by regulations and economics, refined products are projected to represent a growing share of these imports, reaching an estimated 20 percent of total net oil imports by 2025.

Although most of the United States' natural gas can be supplied currently by North American production, the trend here is also toward a greater share for gas imported from outside the Western Hemisphere. Even with an accelerated increase in energy efficiency, the United States will still be highly dependent on energy imports to meet future consumption needs.

PRESIDENT BUSH'S NATIONAL ENERGY POLICY

These trends make clear the need for a long-term plan for energy security. The NEP is a revolutionary roadmap that taps into a diverse array of energy sources to enhance U.S. energy security, economic competitiveness, and environmental performance. From the U.S. perspective, energy security is more than a matter of assuring short-term supplies; reliable access to affordable, clean, and efficient energy services also is critical to economic growth and development.

Our approach to our energy security is informed by the following principles. First, we must balance increased production with a renewed focus on the clean and efficient use of energy. Second, we must expand international engagement with consuming and producing nations. Third, we must expand and diversify our

sources of supply. And finally, we must encourage energy decisions guided by competitive markets and public policies that stimulate efficient outcomes.

Achieving the vision of a secure and sustainable energy supply will require transition to advanced energy systems. Therefore, a central aspect of U.S. energy policy is a portfolio of breakthrough technologies that promise to alter fundamentally the way we produce and consume energy. Our efforts also take advantage of public-private partnerships, market-enhancing policy tools, and international cooperation.

CLOSING THE GAP BETWEEN SUPPLY AND DEMAND

A balanced, comprehensive energy policy is imperative to the long-term strength of U.S. economic and national security. Increasing domestic production of traditional energy sources such as oil and gas is obviously an important aspect of the U.S. approach to curbing imports. But the United States also recognizes that it must take greater advantage of a diverse array of other domestic energy sources.

The president's FreedomCAR and Hydrogen Fuel Initiative promise just that. Hydrogen can be produced from a broad range of domestic sources — from renewables to fossil fuels to nuclear — and has the potential to free us from reliance on foreign energy imports. The president's Hydrogen Initiative represents a commitment to the future hydrogen economy, and it has already generated tremendous enthusiasm among the energy and auto industries. Over the next five years, the United States plans to commit \$1.7 billion to overcoming several significant technical and economic barriers to the development and expanded use of hydrogen, fuel-cell, and advanced automotive technologies. The first \$350 million in grants to achieve this objective were announced in late April.

If we are successful, commercialization of fuel-cell vehicles, hydrogen production, and refueling infrastructure could take place by 2015, with hydrogen-powered vehicles appearing in automobile showrooms by 2020. By 2040, hydrogen could replace over 11 million barrels of oil per day — nearly equivalent to current U.S. oil imports.

Like many other nations, the United States has abundant resources of coal, but its use poses environmental

challenges. The administration's FutureGen project is an initiative to design, build, and operate the world's first coal-fired emissions-free power plant. Working with the private sector, this \$1 billion project will employ the latest technologies to generate electricity, produce hydrogen, and sequester carbon emissions from coal. FutureGen simultaneously supports several of the administration's environmental and energy goals, and through this research coal can continue to be part of a diverse energy portfolio well into the future.

INCREASING DIVERSITY OF SUPPLY

To maintain energy security, the United States is also expanding and diversifying the types and sources of energy it imports. Helping to drive this effort are new opportunities for increased investment, trade, exploration, and development that go well beyond the bounds of traditional energy markets. U.S. goals are to diversify energy supplies and promote new resources in the Western Hemisphere, Russia, the Caspian region, and Africa, and to improve the dialogue with key producing and consuming countries to head off energy disruptions before they become crises.

The United States, Canada, and Mexico are working together to further integrate and strengthen the North American energy market by overcoming policy and technical obstacles to increased energy production and delivery. The United States also has been engaging with other countries in the Western Hemisphere. The Western Hemisphere now supplies half of all U.S. petroleum imports, and Trinidad and Tobago is the largest supplier of liquefied natural gas (LNG) to the United States.

Outside the Western Hemisphere, the United States continues to strengthen its energy relationship with Russia, now the world's second largest crude oil producer and exporter. In 2002, the Bush administration initiated a cooperative effort to help improve the regulatory and investment conditions required to increase energy and infrastructure development in Russia.

The United States also has been a strong supporter of oil and gas development in the Caspian region and has urged governments to establish the necessary legal, fiscal, and regulatory environments to safeguard the large investments required to develop these new resources. Reserves estimates suggest the Caspian Basin could produce 3.5 - 4 million barrels per day by 2010, and the

administration has advocated new pipeline capacity to link these resources to world markets.

Energy from Africa plays an increasingly important role in U.S. energy security, accounting for more than 10 percent of U.S. oil imports, and it is a key economic engine for the continent. Good governance and stable regulatory structures are critical prerequisites for private investment in the energy sector. Key energy producing African countries and the United States continue to work together to promote sustainable energy and economic development.

In addition to these efforts, the United States has been strengthening its dialogue with major producing and consuming countries to monitor market developments and respond to supply disruptions. The United States continues to participate in the International Energy Forum, a multilateral forum of oil-producing and -consuming nations, the key focus of which is an effort to improve the timeliness and accuracy of the data that guide oil markets.

The United States is also working closely with major consuming countries to address our common energy challenges. In 2002, energy ministers from the Group of Eight (G-8) countries met in Detroit and reaffirmed the importance of maintaining emergency oil reserves and coordinating their use and agreed to work together to encourage greater energy investment. In 2003, leaders of the Asia Pacific Economic Cooperation (APEC) forum endorsed a plan proposed by the United States to identify best practices for LNG trade and strategic oil reserves, finance clean energy, develop a framework for a hydrogen economy, and cooperate on methane hydrates.

The United States also has stepped up collaborative efforts on natural gas issues. Last December, it hosted the Liquefied Natural Gas Ministerial Summit, which brought together representatives from 24 countries to take a fresh look at the world LNG marketplace. The summit served as a forum to explore all aspects of the global natural gas production and distribution system.

STRENGTHENING INTERNATIONAL TECHNOLOGY COOPERATION

International collaboration is an essential aspect of U.S. technology strategy as well. The U.S. experience has been that well-designed international partnerships can add significantly to the store of human knowledge and propel

the development and commercialization of new technologies. The United States is working with many other countries to develop new technologies and energy sources to improve energy security. These international partnerships help leverage resources, increase the knowledge base, and expand markets for advanced energy technology.

For example, the U.S. led efforts to form the International Partnership for the Hydrogen Economy (IPHE) to coordinate and leverage multinational hydrogen research programs. IPHE will address the technological, financial, and institutional barriers to hydrogen and develop internationally recognized technology standards to speed market penetration of new technologies.

The multilateral Carbon Sequestration Leadership Forum, a presidential initiative launched in June 2003, will set a framework for international cooperation on sequestration technologies. The Forum's 16 partners also are eligible to participate in the FutureGen project.

The United States is also pursuing nuclear energy as a secure and clean energy choice. The Energy Department's Generation IV International Forum program, which has 10 international partners, is working on new fission reactor designs that are safe, economical, secure, and able to produce new products, such as hydrogen. And in 2003, President Bush announced that the United States would rejoin the International Thermonuclear Experimental Reactor, a project to develop nuclear fusion as a future energy source. Although the technical hurdles of fusion energy are immense, the promise of this technology is simply too great to ignore.

EMERGENCY STRATEGIES: RESPONSE TO SUPPLY DISRUPTIONS

All of these activities are directed at ensuring a reliable and affordable supply of energy, but the United States also appreciates the importance of protecting against the possibility of a severe supply disruption. The administration early on reaffirmed the importance of maintaining a strong Strategic Petroleum Reserve (SPR). In November 2001 the president directed that we begin to fill the SPR to its 700 million barrel capacity. Today it contains a record 640 million barrels of oil.

The United States also plays an active role in the

International Energy Agency (IEA), whose 26 member countries are committed to holding emergency oil reserves and taking common effective measures to meet oil supply emergencies. Together, IEA members' oil stocks total nearly 4 billion barrels, 1.4 billion barrels of which are under direct control of member governments, with the remainder in commercial stocks.

CONCLUSION

Today's energy challenges have been long in the making, and the solutions will require a determined, sustained global effort over decades. The United States remains committed to advancing energy security at home and

abroad, and we have developed a long-term strategy to make science and technology central to an integrated energy, environmental, and economic policy.

The Bush administration believes that the approach we have charted will put us on a path to ensuring secure, reliable, affordable, and clean energy to power economic growth across the globe. While the challenges we face are significant, the United States remains committed to leading the way to a bright energy future. □

□ GEOPOLITICS OF OIL AND NATURAL GAS

By Alan Larson, Under Secretary for Economic, Business and Agricultural Affairs, U.S. Department of State

Ensuring the reliability of global energy supplies will call for policies that both encourage the use of newer, cleaner energy technologies and address the political challenges posed by the world's growing demand for oil and natural gas, Larson says. U.S. policy seeks to encourage expansion and diversification of world energy supplies and to promote the transparency and democratic institutions that help energy-producing countries make the most productive use of their resources.

Energy is the vital ingredient in the world economy. While we are working hard on energy efficiency and investing to develop new energy technologies, oil and natural gas will remain critical for many years to come. Economic development around the world means global demand for oil and gas will continue growing in the near term. Most significantly, China's rapid growth and increase in overall energy demand continue to affect energy markets. Some analysts estimate that China could account for as much as one-third of the world's marginal increase in oil demand in the coming years.

As a result, the world must find and develop more reliable supplies of oil and gas at prices that permit sustained economic growth. Unfortunately, it is almost an axiom in the petroleum business that oil and gas are most often found in countries with challenging political regimes or difficult physical geography.

Several realities shape our thinking about energy security and how we should build reliability into our energy supplies:

- Two-thirds of the world's known oil reserves are in the Middle East.
- Imports supply roughly half of the oil and 15 percent of natural gas consumed by the United States, and an even greater share of the needs of some of the United States' most important allies and economic partners.
- Oil-supply shocks in any region of the world will have an impact on the U.S. economy through the instantaneous operation of international oil markets.

RELIABILITY THROUGH DIVERSIFICATION

Energy investments are costly and risky, requiring long-term commitments. Recognizing this reality, U.S. energy policy seeks to encourage expansion and diversification of energy supplies. A number of regions are attracting increasing interest from energy companies in the United States and elsewhere. We see interesting prospects for expanded oil and gas production in the Caspian region, Russia, West Africa, and North and South America, as well as the promise of increased oil and gas production in the Middle East. In each of these regions, our policy aims to support private sector-led development of energy resources by reducing the political uncertainty that otherwise might hinder needed investment.

Russia and the Caspian Basin

Russia already is an energy superpower. To achieve its full potential, Russia needs to strengthen corporate governance and the legal/regulatory framework for business, improve its foreign investment climate, allow competition in the transportation system, open the gas and oil companies Gazprom and Transneft up to reform and competition, improve its technological capabilities, and move domestic energy prices to world levels.

The Caspian Basin has tremendous potential, offering the possibility of production increases from 1.6 million barrels/day (b/d) in 2001 to 5.0 million b/d in 2010. The key issues in Caspian energy development at the moment are to: 1) complete the second pillar of the East-West Energy Corridor by developing the South Caucasus natural gas pipeline; 2) improve the investment climate throughout the region; and 3) bring Kazakhstani oil into the East-West corridor.

Multiple pipelines that economically bring Caspian resources to the world market strengthen the sovereignty and economic viability of the new nation states in the region. U.S. efforts in the Caspian are intended to complement — not detract from — U.S. support for Russia's efforts to develop its energy export potential.

Africa

Africa is playing an increasingly important role as an energy supplier to U.S. and global markets. In 2003, both Nigeria and Angola were among the top 10 suppliers of oil to the United States. Oil production generates substantial revenue in countries such as Nigeria, Angola, Gabon, Equatorial Guinea, Republic of Congo, Chad, and Cameroon. Sao Tome and Mauritania also may become oil suppliers in the coming years. Foreign direct investment is needed to develop African energy resources as most new fields are in deepwater offshore environments that require advanced capital-intensive facilities for development. Growing oil and gas production could be a powerful engine for national economic development in these countries. However, the Niger Delta experience of 2002, in which protesters stormed oil facilities and caused their temporary shutdown, shows that oil can also be a disruptive force if a country's oil revenues are not managed in a fair and transparent manner. Nigeria has learned from its experience in the Niger Delta and is setting an example on transparency and economic reform enabled by oil revenues that the United States hopes other countries in Africa will follow.

North America

The most important and reliable sources of energy for the United States are its neighbors and we are strengthening our energy cooperation with Canada and Mexico. Senior energy experts from Canada, Mexico, and the United States recently released a North American Energy Picture report that, for the first time, jointly measures energy stocks, trading balances, and energy flows. What often goes unrecognized is that North American energy trade is a two-way street. Mexico is becoming an important source of U.S. oil imports. At the same time, the United States is a net natural gas exporter to Mexico, and U.S. refineries supply over 15 percent of Mexico's refined petroleum products.

The reliability of North American energy trade is enhanced by geographic proximity. More important than geography, however, are the rule of law and predictable investment conditions created by the North American Free Trade Agreement, integrated pipeline networks, and long-term reliable supply relationships. We are continually working to enhance this framework of rule of law and predictable investment conditions in North

America even as we seek to build similar frameworks in other regions.

Venezuela

Venezuela and the United States have enjoyed strong historical energy ties. Venezuelan oil policy, until recently, has been built upon a reputation of reliability. Unfortunately, actions and statements by parties from all sides over the last 18 months have called into question the priority Venezuelans place on their reputation as a reliable supplier. The United States will continue to work to help Venezuelans resolve their political differences. But until a constitutional, democratic, peaceful, and electoral solution is achieved, and the level of rhetoric lowered, world energy markets simply cannot view Venezuela with the same certainty that they once did. When the Venezuelan parties show a commitment to reconciliation, they will find a willing and ready partner in the United States.

Saudi Arabia and the Gulf Producers

The Middle East holds some two-thirds of proven world oil reserves. The size of its reserves, combined with its low production cost, guarantees that the Middle East will continue to play a pivotal role in the world energy market. Saudi Arabia plays a key role in global oil markets as the world's largest oil exporter. Moreover, Saudi Arabia supports international energy security by maintaining considerable excess production capacity that can be brought on line quickly in the event of a serious supply disruption anywhere in the world.

Diversifying global oil supplies should not be interpreted as diversifying "away" from Saudi Arabia or other Gulf producers. Gulf producers will continue to have an indispensable role in the world market, and the United States encourages them to increase foreign investment and steadily expand supplies. What we seek is better balance and a more flexible, resilient oil market that responds to price signals.

In this regard, Gulf producers could reap greater benefits by opening their economies to more private investment so that oil and gas capacity could grow and energy supplies could respond more fully to shifts in demand. Investment in natural gas is one sector where this process is beginning. Once only for local or regional use or wasted through harmful flaring, natural gas in the form of liquefied natural gas (LNG) has become an

increasingly globally traded energy source for key markets. Qatar is working with major international energy companies to become a leading LNG exporter.

In the United Arab Emirates, the successful Taweelah power and water privatization project is another example of the dynamic role foreign investment can play in the energy sector. The United States supports these positive private investment initiatives because they expand and diversify its energy sources, provide opportunities for U.S. companies, and foster economic growth in energy-producing nations.

PROMOTING TRANSPARENCY AND A GOOD INVESTMENT CLIMATE

Promoting transparency and good governance is a key part of the U.S. strategy of encouraging diversification. Oil and gas projects are controversial in many developing countries because revenue flows are hidden, or diverted, and average citizens feel they receive no benefit from their country's natural wealth. The United States wants oil-producing countries to invest energy revenue in solid and sustainable economic development for their populations, not only because it is the right thing to do, but also because it builds political support for the further development of energy projects. Democratic processes and the development of responsive governing institutions promote political and economic stability, the use of mineral wealth for poverty reduction and economic development, and the reduction of oil-related conflicts in energy-producing countries around the world.

A comprehensive approach to transparency is particularly important. At the June 2003 Group of Eight (G-8) Summit, President Bush and the other leaders endorsed a comprehensive action plan on Fighting Corruption and Improving Transparency. The core of this approach is forging a partnership to give willing host countries technical and political support to strengthen domestic institutions and enhance transparency and accountability. We want to focus specifically on budget, procurement, and concession-letting transparency, including G-8 support for technical needs identified by experts.

In addition to support for developing country action plans in these areas, the G-8 leaders committed to:

- denying safe haven to corrupt leaders and their assets by, among other things, denying visas to corrupt officials
- pushing for accelerated implementation of the Organization for Economic Cooperation and Development's Anti-Bribery Convention
- encouraging the World Bank and other international financial institutions to insist on greater transparency in the use of funds by borrowing countries

G-8 countries are supporting voluntary compacts among governments, the companies operating in those countries, and civil society to improve transparency in public financial management and accountability. These compacts outline both the political commitment of the G-8 and host governments to achieve specific mutually agreed transparency objectives, with assistance from the G-8 and international financial institutions, and a specific concrete action plan to achieve those goals.

CONCLUSION

In the long run we need new technologies such as hydrogen and carbon sequestration that can fuel our economy while increasing energy security and minimizing the environmental impact of energy use. In the interim, our international energy policy must address the familiar challenges posed by a hydrocarbon-based economy where oil reserves are concentrated in various challenging regions of the world. Transparency and good governance are increasingly important to sustaining international investments in energy development in regions of opportunity for energy production. The United States will continue to engage intensively with energy partners all over the world to diversify supplies, improve investment opportunities, and assure that market forces work as transparently and efficiently as possible. □

□ THE GROWING DEVELOPING COUNTRY APPETITE FOR OIL AND NATURAL GAS

By Amy Jaffe, Wallace Wilson Fellow for Energy Studies, James A. Baker III Institute for Public Policy, Rice University

Projected sharp increases in energy use by the developing world, particularly developing Asia, combined with rising U.S. oil and gas demand could strain global energy systems and environmental conditions, says Jaffe. As a result, she says, the diplomatic, strategic, and trading focus of certain Asian states may shift, leading to a strengthening of economic and political ties among individual Asian states, major Middle Eastern oil-exporting countries, and African oil states. She argues that to deal with the challenges such links could pose, the United States must enhance cooperation with its global partners to develop new energy sources, energy-efficient technologies, and cleaner, alternative fuels — both to reduce international tensions and to promote its own energy security. These efforts also would be critical to ensuring a brighter future for poor countries lacking access to affordable energy, she says.

For the past two decades, growth in the developing world has led to a sharp increase in world energy use. That growth, combined with rising U.S. oil and gas demand, could strain global energy systems and environmental conditions as the 21st century progresses.

The quest for energy will create new economic and strategic challenges as well as alter geopolitical relations. The outcome of these developments will depend on policy choices made by the key players in the developing world and by the United States. Territorial concerns and nationalism remain defining issues in international relations. This means that energy security for all must be managed carefully lest other pathologies spread into deliberations in the energy area.

DEVELOPING WORLD ENERGY USE

Populations will continue to grow much faster in developing countries than in the rest of the world. By 2030, the share of the world's population living in developing regions could reach 81 percent, according to United Nations projections. Coupled with fast economic expansion projected for emerging markets, rapid population growth will lead to dramatic increases in energy demand in the developing world.

According to projections of the International Energy Agency's (IEA) *World Energy Outlook 2002*, by the year 2030 global primary energy demand will be nearly two-thirds above the levels of 2000, reaching 15.3 billion tons of oil equivalent per year by the end of the forecast period, with developing countries accounting for 62 percent of the rise. Similarly, the U.S. Energy Information Administration (EIA) forecasts that by 2025, energy use in the developing world will have almost doubled.

Because the emerging economies are projected to rely increasingly on coal and other fossil fuels, they will contribute much more to worldwide carbon dioxide emissions as their demand for energy quickly grows. Developing countries are forecast to account for two-thirds of the projected increase in carbon dioxide emissions, which according to many scientists contribute to global warming. Four major countries alone — Indonesia, China, India, and Brazil — will emit 2 billion tons of carbon annually by 2010, creating special challenges for international cooperation on climate issues. The United States and other industrialized nations need to engage these countries in multilateral climate initiatives such as research and development of cleaner energy technologies.

Growth in Latin America, where primary energy demand is expected to nearly double by 2015 from 1999 levels, will also contribute significantly to future geopolitics of energy. Rather than serving as a major supply region for the United States, Latin America could also find itself as a major consuming region, needing to be included in international emergency stockpiling systems and alternative energy initiatives.

Explosive growth in Asia is expected to contribute significantly to the rise in use of energy by the developing world and have the greatest impact on world oil use, thus playing the largest role in shifting oil geopolitical trends. In developing Asian countries, where an average annual growth rate of 3 percent is projected for energy use as compared with a 1.7 percent for the entire global economy, energy demand is expected to more than

double in the next two decades. According to IEA projections, demand in the region will account for 69 percent of the total projected increase in developing world consumption and almost 40 percent of the increase for total world energy consumption.

Asia's rapid economic growth, explosive urbanization, dramatic expansion in the transportation sector, and politically important electrification programs will have a dramatic effect on the region's dependence on imported energy. Absent significant growth in renewable energy supplies and/or new energy technologies, consumption of crude oil and natural gas in Asia will rise substantially and with it significant environmental challenges. Given the inadequate resource endowment of the region and the region's already high dependence on imported oil supplies, it is anticipated that Asia will exert an increasing pull on the Middle East and Russia in coming years.

According to *Oil Market Intelligence 2001*, published by the Energy Intelligence Group, an independent research service, Asia's oil use, which exceeds 20 million barrels per day (b/d), is already larger than that in the United States. By 2010, total Asian oil consumption could reach 25-30 million b/d, most of which will have to be imported from outside the region. China alone can be expected to see its oil imports rise from around 1.4 million b/d in 1999 to 3-5 million b/d by 2010. This has awakened fears in Tokyo, Seoul, and New Delhi about competition or even confrontation over energy supplies and lines of transport.

GEOPOLITICAL REPERCUSSIONS

The diplomatic, strategic, and trading focus of certain Asian states can be expected to shift in light of growing energy import requirements, leading to a strengthening of economic and political ties among individual Asian states, major Middle Eastern oil-exporting countries, and African oil states. Such links could pose new challenges to the West both in terms of arbitrating emerging regional conflicts and in rivalry for secure energy supplies, especially in times of supply disruption, war, or other kinds of emergencies. China's proactive oil diplomacy and foreign oil and gas investment campaign, for example, has raised concerns in some quarters that the emerging international power, because of its growing need for oil, could become susceptible to pressures from oil-producing states seeking sophisticated weapons systems or weapons of mass destruction.

Environmental concerns could exacerbate energy security fears, creating other kinds of strains on the international political system. Thus, the benefits of multilateral cooperation between the West and the developing world in forging joint solutions to energy supply and environmental challenges are compelling. It should be considered a high priority for international diplomatic efforts.

The potentially steep costs of confrontation over energy supplies and environmental degradation are pushing some Asian nations to develop more energy-efficient technologies and alternative forms of energy. More likely for the near term, however, will be a move to diversify both the forms of energy used and the sources from which supplies come.

There is huge potential for increased engagement by the United States in enhancing cooperation to develop new energy-efficient technologies and cleaner, alternative fuels both to ensure peace and stability on the world stage and to promote its own national efforts to secure a brighter energy future.

For all the focus on economic growth in Asia, the consistent growth in U.S. oil imports is an overwhelming factor in global oil markets. U.S. net imports rose from 6.79 million b/d in 1991 to 10.2 million b/d in 2000. Global oil trade, that is the amount of oil exported from one country to another, rose from 33.3 million b/d to 42.6 million b/d over that same period. This means that America's oil imports alone represented over one-third of the increase in oil traded worldwide over the past 10 years. As for oil trade with the Organization of Petroleum Exporting Countries (OPEC), the U.S. import market was even more significant — over 50 percent of OPEC's output gains between the years 1991 and 2000 wound up in the United States. Current U.S. oil demand is about 20 million b/d, of which only 40 percent is produced domestically.

MEETING THE NEEDS OF THE POOR

Cooperation in finding new energy sources and cleaner, more efficient technologies, besides being a valuable means to reduce the risks of international tensions and conflict, is critical to ensuring a brighter future for the developing world and reducing poverty and disease in many parts of the globe. Currently, more than a quarter of the world's population has no access to electricity and two-fifths are forced to rely mainly on traditional biomass

— firewood and animal waste — to meet basic cooking and heating needs. About 80 percent of these populations are located in India and sub-Saharan Africa. Four out of five people lacking modern energy services live in rural areas. Indoor air pollution from traditional biomass energy is responsible for the premature death of over two million women and children a year worldwide from respiratory infections, according to the World Health Organization (WHO).

Continued reliance on oil under the growth scenarios outlined above would leave the international community more dependent on oil from OPEC countries, with harmful consequences for the world's poor. While it has often been argued that the U.S. economy can absorb the rising oil prices that might result from OPEC's gaining a higher market share of world demand, a gradual increase in energy costs would likely contribute to a widening economic gap between industrial societies and the developing world. Without a major technological breakthrough, over 1.4 billion people will still be without modern electricity in 2030 under a business-as-usual oil demand scenario — only 200 million fewer than today, according to a 2002 study by the IEA. Moreover, for the past 30 years, developing countries have been borrowing billions of dollars from international institutions such as the International Monetary Fund and World Bank to help them pay for oil they cannot afford. This trend would likely worsen if reliance on OPEC were to increase over time.

Ironically, OPEC countries' policies of promoting increasingly higher oil prices that contribute to massive indebtedness in the developing world have not helped raise the living standards of their own populations. In certain countries, oil revenues have been squandered in official corruption or used to fund military adventurism, international terrorism, or major weapons acquisition programs. Lower energy costs, brought about by new discoveries or breakthroughs in energy efficiency or alternative energy sources, might force such regimes to pursue economic diversification more rigorously, and in the few cases where it might apply, limit capital for programs contrary to U.S. interests.

A CALL TO ACTION

The United States has many means at its disposal to influence the world energy outlook. With the rise in U.S. oil imports such a significant factor in international energy markets, any change in U.S. policy that can

significantly lower the pace of import growth could have a telling impact on OPEC's plans to increase market share as well as limit the environmental consequences of unfettered energy use.

No one doubts that a combination of fiscal instruments and regulations can slow the rate of U.S. increase in demand for oil as a transportation fuel. Needless to say, the United States and Canada, with a much lower consumption base, stand apart from the other Organization for Economic Cooperation and Development (OECD) countries. Japan and European Union (EU) countries have managed, through high consumer taxes, to fundamentally end growth in oil demand. In both cases, total growth for the current decade is expected to fall to the range of 0.1-0.2 percent a year. When it comes to gasoline demand, European consumption is actually falling as consumers opt for more fuel-efficient diesel powered vehicles.

U.S. energy strategies could include modest increases in fuel taxes combined with incentives to use low-sulfur diesel rather than gasoline, thus creating greater efficiencies. Additionally, there could be more regulation of sport utility vehicles, which have been largely exempt from other U.S. efficiency standards. Strategies could include mandates for government fleets to be fueled by natural gas or electric power. A sliding-scale luxury tax on new vehicles based on their mileage performance would be another way to propel more efficient technologies into the marketplace without taxing gasoline per se.

Research and development must also be a major vehicle in promoting effective energy policy. U.S. research and development priorities include the National Nanotechnology Initiative (NNI), the FreedomCar, the Hydrogen Fuel Initiative, and the International Thermonuclear Experimental Reactor project (ITER). President Bush has pledged \$1.7 billion over the next five years for these programs, making it a significant push towards hydrogen as a fuel for the future.

However, critics say a commitment of billions of dollars would be needed to promote the fundamental science needed to solve the energy and environmental problems facing the world community in the coming decades. This research effort can be done in collaboration with other major consuming countries, yielding benefits for all and aimed at revolutionizing advances in solar power, wind, clean coal, hydrogen, fusion, new generation fission

reactors, fuel cells, batteries, and a new electrical energy grid, which can tie all these power sources together. Beyond U.S. initiatives, there should be little doubt that there is considerable room for enhanced energy efficiencies in other major energy-consuming societies in the developing world. As major energy-using countries such as Russia, China, India, and Brazil radically alter the economic signals associated with energy costs to inject market-based pricing principles as a replacement for subsidized energy supplies, oil demand savings can be dramatic, especially in the power generation and household sectors. The continued drive toward energy market liberalization around the world, especially in areas other than the transportation sector, could have significant impact on the rise in primary energy requirements in the developing world.

The U.S. government should also take a much more proactive stance vis-à-vis Russia and China with respect to the international energy sector. It could help the United States and other IEA countries break OPEC's hold on the energy market and help these two critical emerging energy powers define their own goals in manners compatible with U.S. objectives. China needs to be encouraged to enhance its plans for strategic stockpiling, and there are ways the United States can assist it in doing so, whether by sponsoring China's membership in the IEA or assisting the development of new regional energy security arrangements.

Finally, the U.S. and other industrial countries can do a great deal more to enhance the institutional mechanisms that favor markets over political intervention by oil producers. The U.S. needs to show leadership by looking seriously at ways to bring the rules of global oil trade and investment in harmony with the rules governing trade in manufactures and services. This would mean building on open trade and investment within the IEA and discriminating actively against those countries that do not permit foreign investment in their energy resources and that limit their exports to manipulate prices. Liberalization and open access for investment in all international energy resources would mean their timely development rather than today's worrisome delays. Without global norms across the oil sector, the world experiences supply limitations related to capital and political motivations that cripple the global economy and perpetuate poverty in the energy-poor countries of Africa and Asia. The example of Russia over the past five years, with its rapid growth in oil production following economic liberalization, should serve as an example to other still-closed countries of the benefits in enhanced revenues and production. □

Note: The opinions expressed in this article do not necessarily reflect the views or policies of the U.S. Department of State.

□ ENERGY COMPETITION OR COOPERATION: SHIFTING THE PARADIGM

By Joseph A. Stanislaw, President, Cambridge Energy Research Associates

All international energy market participants can achieve their individual goals by working toward the common objective of a new playing field that allows the market to work: a network of operating rules and guidelines that lets countries, industries, and technologies compete, writes Stanislaw. He leaves no doubt that it is not going to be easy and may require a radical change in the way we view the forces of competition and cooperation. Stanislaw argues that the solution is to establish the economic linkages that connect producing countries to consumers, nationalistic economies to free markets, and energy needs to environmental considerations. This will increase cooperation and create a more stable, sustainable international environment, he says.

National and regional energy markets around the world are more open now to trade, competition, and foreign investment than at any time in history. Even countries such as Saudi Arabia and Mexico, whose petroleum industries remain nationalized, recently have opened up to technological and economic cooperation with foreign companies in natural gas developments. Although Mexico's engagement with international operating companies is under a service contract arrangement, Saudi Arabia's involves foreign investment in the natural gas sector for the first time since the country's petroleum industry was nationalized in 1975. The companies involved span the globe from Russia and China to Italy, Spain, the United Kingdom, and France.

At the same time, 10 years after the signing of the North America Free Trade Agreement, questions regarding an integrated North American energy market remain. Market liberalization around the world is slowing and, for many investors, markets have not opened enough to provide for adequate transparency and true competition. Meanwhile, North American energy supply is again becoming a security issue.

So which is the dominant trend — forward movement toward increasing market liberalization or retreat into further market regulation? When considering the issue of international energy competition versus cooperation, the

question to ask is not who is winning the battle, but rather how the market can accommodate the divergent needs of the individual players and encourage the cooperation that has become more prevalent in recent years.

The International Energy Agency (IEA) estimates that the global energy industry will require an unprecedented \$16 trillion in investment over the coming 30 years. Industries require energy to produce goods and services, while individuals need it to maintain quality of life. Producing countries want a fair price for finding, developing, and producing supplies, but consuming nations need affordable energy on which to build their economies. These forces may seem diametrically opposed, but they can be balanced by encouraging economic linkages between nations that support interdependence. How is this achieved? By recognizing the simple reality that producers need security of demand while consumers need security of supply — and that the role of the market is critical in aligning these needs.

A paradigm shift is required — the issue isn't cooperation or competition, but rather cooperation and competition. All of the participants in international energy markets can achieve their individual goals by working toward the common objective of a new playing field that allows the market to work: a network of operating rules and guidelines that lets countries, industries, and technologies compete.

First and foremost, the playing field must be characterized by transparency in information and decision-making, and especially by good corporate governance. It also must allow recognition of the challenges of sustainable development and encourage rules that ensure players' physical and environmental security, all of which will allow relationships and interdependencies to develop fully. In this way, we can create a win/win situation for producers and consumers, governments and individuals, developed and developing economies: a more stable world where cooperation and competition result in more efficient use of resources and services.

HISTORICAL ENERGY COOPERATION

International cooperation and economic engagement have been characteristic of the energy industry since Ludwig and Robert Nobel began exporting Russian oil to Europe in the late 19th century. A more recent example is the Energy Charter Treaty and Protocol, implemented by the European Council (now known as the Council of the European Union) in the early 1990s. The charter is designed to promote industrial cooperation between the countries of Western Europe and those of Eastern Europe and the former Soviet Union by providing legal safeguards in areas such as investment, transit, and trade.

In 2002 and 2003, two U.S.-Russia Commercial Energy Summits were held under the joint sponsorship of Russia's ministries of Energy and Economic Development & Trade, and the U.S. departments of Commerce and Energy. The summits brought together major oil and gas companies from Russia and the United States to identify opportunities for investment in Russia and improvement of its energy infrastructure.

Growing political cooperation in the energy arena has brought about promising, business-backed projects in recent years. The Baku-Ceyhan oil pipeline — undertaken by BP of the United Kingdom, the State Oil Company of the Azerbaijan Republic, Unocal of the United States, and Norway's Statoil — now connects oil production in the Caspian Sea with demand in Europe and beyond through export facilities at Ceyhan, Turkey. And future plans for natural gas production from Russia's vast Sakhalin Island deposits include exports to Japan, possibly China, and perhaps even the West Coast of the United States. For both projects, the forces driving cooperation are governmental involvement and the reality that a supply source without a market has no value.

COMPETITIVE CONSIDERATIONS

The international energy industry is characterized by three pairs of strong competitive forces:

1. Producing vs. consuming nations

In the past, the Organization of Petroleum Exporting Countries (OPEC) often found itself at political odds with consuming nations. The clearest example of this was the famous Arab oil embargo of the 1970s. However, the 1990s and the new century have brought

change to this historical relationship. The Producer-Consumer Dialogue, a forum that facilitates discussions between oil-producing and -consuming nations, as well as IEA and OPEC, has been underway for almost a decade — now renamed the International Energy Forum. The dialogue focuses on exchange of data, increased transparency of demand and supply information, cooperation between governments and industry, and a better understanding between the two sides of the market. In addition to the growing dialogue, economic cooperation between producers and consumers continues to rise, as can be seen in Mexico's and Saudi Arabia's natural gas projects, as well as a host of others.

2. Competition vs. regulation

A long-standing struggle between market liberalization and market regulation continues today. This occurs both between countries, as seen in U.S. opposition to OPEC market "regulation" via production quotas, and within countries, as evinced by the continuing debate over privatization vs. nationalization.

Russia's energy industry, for example, long state-owned under the Soviet system, has experienced a remarkable shift toward a private investment environment in recent years. As a result, the country has seen an unprecedented 10 percent annual growth in oil production.

3. Economic development vs. sustainability

The increasing focus on environmental responsibility and sustainable development around the globe presents an ongoing challenge for industry and government: how to achieve economic growth profitably while meeting the demands of sustainable development. To be successful, development projects must clear environmental hurdles, win community approval, abide by local laws, and satisfy national governments, all while remaining economically justifiable.

The difficulty of meeting the demands of these sometimes competing forces is obvious. The unwillingness of local citizens to allow construction of power plants in California was a major factor in that state's power crisis in the summer of 2000. On a larger scale, economic considerations prevented key countries from ratifying the Kyoto Treaty, in essence forcing the collapse of years of negotiation.

Finding the right equilibrium between economic and sustainable development considerations will not be easy. To meet growing natural gas demand in the supply-short North American market, for example, the biggest challenge is securing the willingness of local citizens to grant permission for construction of needed liquefied natural gas (LNG) receiving and regasification terminals.

WHO IS WINNING THE BATTLE? THE WRONG QUESTION

The questions that traditionally have been posed regarding the forces of competition and cooperation are: Who is winning the battle — producing or consuming countries? Producing or consuming industries? Developed or developing economies? Traditional or emerging energy industries?

If the parties are to achieve a true paradigm shift, this is the wrong way to approach the “conflict.” The question we should be asking is how best to balance the forces of competition and cooperation.

The solution is to build a bridge. This means establishing or strengthening the economic linkages that connect producing countries to consumers, nationalistic economies to free markets, and energy needs to environmental considerations, and in doing so, increasing cooperation and creating a more stable, sustainable international environment.

THE PLAYING FIELD

Construction of this economic bridge must begin with the creation of a playing field on which all parties can compete to increase market efficiencies and cooperate to satisfy mutual needs. The role of the players — government, industry, consumers, and nongovernmental organizations (NGOs) — is to establish the politics of the playing field by providing better information and greater transparency so that the economic participants can play out the game in an efficient manner. All parties must have access to reliable data regarding demand, demand patterns, and the future direction of demand, as well as alternative supplies and supply development plans.

Such a playing field would enable the participants to compete to provide reliable, affordable energy to meet demand in consuming countries while providing producers — countries as well as companies — with an

accessible market for their goods and services. But beyond just meeting demand, the criteria would enable developing countries to realize their “latent” demand — the unrealized energy demand that arises from people's desire to improve their living standards and contribute to sustainable economic development.

The rules governing international cooperation also must be balanced by the new demand for sustainable development. Individuals' needs for a better standard of living must be balanced with the need, and the desire, for a clean, secure environment.

Probably the single most important stepping stone to this end point is the development of new energy technologies. Cooperation among companies and industries allows technology to be developed in a market setting, and a level playing field creates the rules by which it will flow from one place to another. This is key because technology is not simply transferred — it moves only if the owner derives profit from its movement and the buyer derives benefit.

An important example of technology cooperation is the Fuel Cell Annex to the United States-European Union (EU) Non-Nuclear Energy Cooperation Agreement. The annex, which enables the U.S. Department of Energy to conduct research jointly with EU institutions, is “a key step to moving our joint agenda forward to expand the use of hydrogen as an alternative fuel source,” said Energy Secretary Spencer Abraham when he announced the agreement. Similar cooperation is occurring on the business side. The California Fuel Cell Partnership — a collaboration of 20 auto companies, oil producers, fuel-cell technology companies, and government agencies — aims to place fuel-cell electric vehicles on the road in California. If this disparate group succeeds, the technology will undoubtedly spread rapidly to other states and countries and begin to shift energy demand patterns.

COOPERATION — A PROVEN COMMODITY

In order for emerging countries to have the energy needed to meet their “latent” demand, governments and companies must focus on developing all forms of energy. This will be facilitated by cooperation in the areas of resource development, export schemes, and new energy technologies, all of which ultimately benefit both producers and consumers.

Domestically focused policies can play a positive role in stabilizing the international market. Energy-consuming countries seeking affordable, secure energy supplies typically create policies that encourage diversity of supply, increased use of domestic resources, and development of environmentally friendly and sustainable energy forms. The degree to which a country reduces its need to import energy takes pressure off international markets and increases supply reliability for emerging countries.

Cooperation among nations and companies already has proven successful in achieving remarkable strides in energy development. In addition to the examples cited previously, there are numerous other success stories:

- EU-driven liberalization of the European natural gas market has made great progress in international competition and trade.
- A 1,054-kilometer oil pipeline was built in sub-Saharan Africa by ExxonMobil, Malaysia's state firm Petronas, and ChevronTexaco, linking supplies in Chad with world markets via an Atlantic port in Cameroon.
- The 2,350 kilometer Kazakhstan-to-China oil pipeline, already under construction, will link producing fields in northwest Kazakhstan to refineries in western China, representing significant cooperation between CNPC, Kazakhstan's third largest oil producer owned by China National Petroleum, and KazMunaiGas, Kazakhstan's state oil company.
- The proposed West-East natural gas pipeline from Western China to the Shanghai area will connect a major supply center with one of the most promising new demand markets. The project will be carried out by an alliance of Russian, Chinese, and western energy companies.
- The Nahodka project, under discussion between Russia and Japan, would connect crude oil in East Siberia's Lake Baikal region to an export point on Russia's Pacific Coast (a twin natural gas line could follow).

Also on the horizon are a host of LNG import-export schemes that will link remote natural gas supplies in such diverse places as the Far East, Middle East, and South America to gas-hungry markets in North America, Asia, and Europe.

In order for the players on the world energy scene to improve international stability and security through increased cooperation, there must first be transparency of information regarding supply, demand, and prices among the participants. Once established, the marketplace — governed by necessary levels of market oversight and environmental protection — will drive progress forward.

Open global markets allow private capital to flow and facilitate development of resources and technologies — technologies that both producers and consumers can use to change cost structures, fulfill needs, improve standards of living, and promote sustainable development. But reaching this goal will require unprecedented levels of cooperation and an effective, fair playing field where economic players can interact in the international energy arena. Matching international cooperation and competition is the only way to find the estimated \$16 trillion in energy investment the world will need over the next 30 years. □

Note: The opinions expressed in this article do not necessarily reflect the views or policies of the U.S. Department of State.

□ ENERGY DIVERSIFICATION: FINDING THE RIGHT BALANCE

By Pete V. Domenici, Chairman, Senate Energy and Natural Resources Committee

Crafting energy policy for a country as productive and diverse as the United States is complicated and involves a multitude of competing interests, says Domenici. Landmark legislation drafted by the senator and now working its way through Congress seeks to reconcile the often-contradictory needs of the U.S. energy market by diversifying and expanding the country's energy portfolio. Doing so, says Domenici, is the "critical next step" if the United States is to succeed in moving away from existing technologies in favor of cleaner and more affordable and abundant energy supplies.

For the bill to become law, both the Senate and House of Representatives need to pass it and the president must sign it.

When I began work on the energy bill last year, I decided I could write one of two kinds of bills. I could write a bill that limits production of certain kinds of energies, such as coal and oil, and mandates the production of more politically desirable energies, such as wind. Or I could write a broader bill that seeks to diversify America's energy portfolio by encouraging increased production of most energies, from nuclear energy to wind and solar energy.

I chose to write a broader bill that diversifies our energy portfolio and increases the production of more than a dozen different energies, from wind to clean coal.

I wrote this kind of bill for several reasons. First, I believe diversifying our energy portfolio is the critical next step we must take to move us away from existing technologies toward cleaner, affordable technologies. Right now, half of the electricity in this country comes from coal. If Congress passed legislation that discouraged the consumption of coal, the cost of heating a home or lighting a business would skyrocket all around the country. Why? Because we do not have a renewable energy waiting in the wings to replace coal.

Until we diversify our energy supply — produce more wind, solar, geothermal, and natural gas energies — we have no business passing legislation that discourages the production of the very energies that drive this economy.

Second, I chose to craft a sound energy bill that encouraged diversified production because I took a hard look at the political realities. That's the only kind of bill I could get through the Senate. I did not believe and still do not believe that this U.S. Senate will pass an energy bill that discourages the production of some energies while mandating increased production and use of others.

Let's assume Congress decides to discourage the production of coal, an energy source fiercely hated by many environmental groups. If Congress decided to close the nation's oldest coal-fired power plants, located largely in the Ohio River Valley and the Southeast, electricity prices would soar and local economies would slump into a regional recession. In the mid-term, those plants would be promptly replaced with plants fired by natural gas, which is the only other near-term option for large-scale electricity production.

But this nation, as Federal Reserve Board Chairman Alan Greenspan has warned, is facing a natural gas crisis. Demand is high and supplies are tight, making natural gas prices more volatile. By closing the coal plants, we exacerbate the pending natural gas crisis, drive up electricity prices in the southeast, and put thousands of people out of work.

This wouldn't happen because that kind of bill wouldn't stand a prayer of passing. No senator worth his salt stands by and lets Congress put his constituents out of work and drive their electricity prices out of sight.

Energy policy is further complicated by regional differences in energy production and consumption; the hydropower dependent Northwest has very different challenges than does the Southeast with its local, state-controlled monopolies, or the Northeast with its increasing dependence on energy produced outside its region. These differences have made the Federal Energy Regulatory Commission's effort to impose a single, standard market design on the nation's power grid one of the most hotly contested issues in Washington. I worked tirelessly to craft a compromise on this and so many other

issues in order to ensure a fair and reasonable policy that would work nationwide. That meant compromises.

So yes, I took a pragmatic approach to this energy bill. I decided what the ideal bill would be like, then I measured that against what was politically possible. The result is a sound piece of legislation that diversifies our fuel portfolio, so that this nation is pretty prepared to absorb the changes in the price of any particular fuel, implement future environmental restrictions, and meet increased demand.

It's a mid-term step that takes all of us closer to the energy future we all agree on: a future where abundant, reliable, and affordable energy is produced with little impact on the environment and no dependence on the goodwill of hostile nations.

There are some goals this bill doesn't try for because they aren't achievable right now. Some have advocated higher automobile fuel efficiency standards. But efforts to increase automobile fuel efficiency standards have repeatedly failed. I recognized that and took a different approach. My bill provides tax credits of up to \$2,000 to consumers who purchase hybrid vehicles. If I can't mandate that relatively fuel-inefficient, sport-utility vehicles (SUVs) be more environmentally sensitive, I can give consumers incentives to buy vehicles that are.

This bill takes us closer to other goals than we've ever been before. One-third of the tax incentives in this bill would provide a tax credit for the production of electricity from solar, wind, biomass, and geothermal energies. This incentive means that wind farms will spring up around the country like the 204-megawatt New Mexico Wind Energy Center that just came on line. That's the third largest wind farm in the country. Half a dozen more wind farms like it are in the planning stages, pending the enactment of the tax provisions in the energy bill.

The bill will also provide incentives so that future coal-fired power plants will use the most advanced clean-coal technologies and so that a new generation of nuclear power plants that emit no greenhouse gasses will also be available to meet our future requirements.

This bill is a jobs bill. It mandates construction of the Alaska Natural Gas pipeline and in the process creates more than 400,000 jobs. Moreover, it would stabilize the skyrocketing natural gas prices that have driven thousands

of American jobs overseas. Besides creating new jobs, we will help staunch the hemorrhage of jobs we have now to foreign countries.

We create more than 214,000 new jobs with the ethanol provision, which mandates increased use of ethanol in gasoline. That provision alone will expand household incomes in rural America by an estimated \$51.7 billion in the next decade. At a cost of only \$14 billion over 10 years, this bill will be the cheapest jobs bill to come out of Congress this year.

Compromise is necessary. The House of Representatives insisted on a provision to provide faulty product indemnification for producers of methyl tertiary butyl ether (MTBE), a gasoline additive largely mandated by federal law that some claim can result in contamination of water supplies. The Senate rejected that bill last fall.

Earlier this year, I filed a leaner version of the bill with the Senate. That bill costs less and removes the safe harbor for both MTBE and ethanol.

I will seek the middle ground — and what I hope is the higher ground — on this issue as I have on others in this bill. Contrary to what some critics have claimed, there has been considerable compromise in this bill. I have dropped the very controversial provisions that would have opened Alaska's Arctic Natural Wildlife Refuge (ANWR) to oil and gas production. The electricity provisions don't go as far as I would like in some areas because I have crafted compromises among the differing regions of the country.

But on the core, underlying principle, I refuse to compromise. I have insisted on making this a real energy bill that takes tangible steps to expand and diversify our energy portfolio. I refused to write a bill that is just a collection of efficiency and renewable provisions that — while they make for good rhetoric — would not fundamentally add to our nation's supply of affordable and reliable energy.

This is not a perfect energy bill, but this bill does do what I set out to do more than a year ago: it increases and diversifies our production of cleaner energy. By diversifying production, the United States can begin to move toward an energy security that is based on reducing the share of consumption that relies on foreign sourced supplies. In the end, I think that underlying strength will carry the day. □

□ RENEWABLE ENERGY AND NEW TECHNOLOGIES

By David K. Garman, Assistant Secretary, Office of Energy Efficiency and Renewable Energy,
U.S. Department of Energy

Energy research has made huge strides over the past three decades, both in improving the efficient use of traditional fuels and in developing and deploying next-generation technologies that could eventually transform the energy sector, says Garman. Meeting long-term needs for clean energy in the United States and the world will require leapfrogging to new technologies while concurrently continuing investments in energy efficiency, renewable alternatives to fossil fuels, and cleaner non-renewable alternatives, he says.

ENERGY CHALLENGES

Energy is the lifeblood of modern nations and is a mainstay of high standards of living, sophisticated economies, and national security. While greater efficiency of existing energy sources is essential in the short term, the United States, like other nations, must look toward “next generation” technologies, such as hydrogen and nanotechnology, to meet the increasing challenges of providing clean, abundant, reliable, and affordable energy to all people.

The United States’ strategic approach to the energy sector is contained in President Bush’s National Energy Policy (NEP), published in May 2001. The NEP draws attention to the fact that a serious imbalance between U.S. domestic energy supply and domestic energy demand underlies our nation’s energy challenge. It shows that the United States consumes much more energy than it produces and that our dependence on imported energy grows worse each year. The NEP also provides guidance on what we can do about it.

Several features of our current energy economy:

- We enjoy a diversity of primary energy inputs such as fossil energy (oil, coal, and natural gas), nuclear energy, and renewable energy.
- But, we are heavily dependent on oil, coal, and natural gas.
- The transportation sector is almost entirely dependent (97 percent) on oil, a majority of which is imported.
- In all sectors of energy use, a large amount of energy is rejected or wasted, with transportation being the least

efficient of the three main sectors (residential/commercial, industry, and transportation) of our economy.

Promoting efficiency in the use of oil and finding new domestic sources of oil are both important short-term undertakings. But over the long term, a petroleum-free option is eventually required.

The U.S. energy challenge is further complicated by another important factor — the pollutants and carbon dioxide emissions resulting from our use of energy. Although we have made good progress in reducing pollutant emissions from our cars and trucks as well as from factories, homes, and other stationary sources, ultimately new approaches to energy will be required to achieve further emission reductions.

The United States Department of Energy’s (DOE) Office of Energy Efficiency and Renewable Energy (EERE) leads the federal government’s research, development, and deployment (RD&D) efforts in biomass, geothermal, solar, wind, and other renewable and energy-efficiency technologies to provide reliable, affordable, and environmentally sound energy supplies for America’s future. As a result of investing billions of dollars in research, demonstration, tax incentives, and other policy measures over the past three decades, tremendous progress has been made in increasing the efficiency of energy use in our economy and in bringing renewable energy technologies to the marketplace. While our investments — and those of our industry partners — are beginning to pay off, with dramatic and ongoing improvements in the cost and efficiency of these technologies, much more remains to be accomplished to meet our current energy challenges.

THE PROMISE OF HYDROGEN

The development of next-generation energy technology such as hydrogen could greatly reduce the United States’ reliance on energy imports, particularly in the transportation sector. Since hydrogen is not an energy source but rather an energy carrier, it can be produced from all primary energy sources including natural gas, coal, nuclear energy, and renewable energy. Hydrogen can

fuel ultra-clean internal combustion engines, which would reduce auto emissions by more than 99 percent. And when hydrogen is used to power fuel-cell vehicles, it will do so with more than twice the efficiency of today's gasoline engines and with none of the harmful air emissions. In fact, fuel cells' only byproducts are pure water and some waste (excess) heat. Hydrogen fuel cells could also be used in stationary applications, providing electricity for homes, offices, shopping centers, and other buildings.

Since the release of the NEP, President Bush and Energy Secretary Spencer Abraham have unveiled several initiatives related to hydrogen. Most notable are the FreedomCAR partnership announced in January 2002; President Bush's Hydrogen Fuel Initiative, announced during the State of the Union address in January 2003; and "FutureGEN," a zero-emission coal-fired electricity and hydrogen power plant project that includes sequestration — capture and storage — of greenhouse gas emissions, announced in February 2003. In his 2003 State of the Union speech, President Bush announced that "With a new national commitment, our scientists and engineers will overcome obstacles by taking these cars from laboratory to showroom, so that the first car driven by a child born today could be powered by hydrogen and pollution-free." All of these initiatives are contributing to a national approach for moving toward a hydrogen economy through development of the necessary advanced technologies for hydrogen production, delivery, storage, conversion, and applications.

The federal government's role is to accelerate hydrogen and fuel cell development to enable industry to make a commercialization decision by 2015. But the manufacturing and marketing of fuel-cell or other advanced vehicles will be industry's responsibility. Achieving this vision will require a combination of technological breakthroughs, market acceptance, and large investments in a national hydrogen energy infrastructure. Success will not happen overnight, or even in years, but rather over decades, and it will require a steady process that phases in hydrogen as the technologies and markets are becoming ready.

OTHER NEXT-GENERATION TECHNOLOGIES

In addition to resolving critical energy needs for transportation, there is a need to increase energy efficiency in other sectors, such as buildings. With an expanding population and increased amenities that require more

electricity, building-related energy consumption in the United States is growing. New technologies will be needed for a new generation of buildings that will be efficient, comfortable, and simpler to operate and maintain. For example, solid-state lighting that uses semiconductor light-emitting diodes (LEDs) is a revolutionary technological innovation that promises to change the way we light our homes and businesses. In the United States, lighting consumes nearly 30 percent of all electricity produced for buildings. While modern fluorescent bulbs with electronic ballasts are much more efficient than incandescent bulbs, they remain glass nodules filled with gas, not unlike the vacuum tubes of the last generation of electronics. The LED is to fluorescent lamps what transistors were to vacuum tubes, or what the automobile was to horse-powered transportation.

In the long term, U.S. research is focused on "zero-energy buildings" that on average actually could produce more energy than they consume by combining highly efficient design with fuel-cell, solar, geothermal, and other distributed energy and cogeneration technologies. Already, solar cells which convert sunlight directly to electricity, known as photovoltaics (PV), are helping to supplement buildings' energy needs through thin film PV panels located on roofs, as well as providing electrical power to distributed power applications not served by the electric grid. Distributed energy resources (DER) are a variety of small, modular power-generating technologies that can be combined with energy management and storage systems and used to improve the operation of the electricity delivery system, whether or not those technologies are connected to an electricity grid.

DOE is also active in nanotechnology research and development. Nanomaterials — typically on the scale of a billionth of a meter or 1,000 times thinner than a human hair — offer different chemical and physical properties than the same materials in bulk form and have the potential to foster new technologies. According to Secretary Abraham, "This new science of very small things can revolutionize the way we produce, use, and deliver energy." Certain nanomaterials show promise for use in making more efficient solar cells and the next-generation catalysts and membranes that will be used in hydrogen-powered fuel cells. Because of their nanoscale size and excellent conductivity, carbon nanotubes, essentially sheets of graphite rolled into extremely narrow tubes a few nanometers in diameter, are being studied as the possible building blocks of future electronic devices. Woven into a

cable, carbon nanotubes could provide electricity transmission lines with substantially improved performance over today's power lines.

These are just a few examples of how new technologies offer the promise of a radically different energy future.

CONTINUING EFFORTS IN ENERGY EFFICIENCY AND RENEWABLE ENERGY

As important as hydrogen and other "leapfrog" innovations may be in the long run, EERE is continuing to make investments in "workhorse" energy efficiency and renewable energy improvements that will have an impact in the more immediate future. Under the FreedomCAR and Vehicle Technologies Program, we are funding hybrid (gasoline-electric and diesel-electric) technology and lightweight material technologies, in addition to hydrogen fuel-cell technologies. We believe that many of these technologies will deliver fuel savings both prior to and after the introduction of fuel-cell vehicles, since lightweight materials and hybrid technologies are expected to be incorporated into fuel-cell vehicle designs. In addition, we are funding research and development to continue progress in improving energy efficiency in manufacturing and other industries, in appliances, in buildings, and in electricity power transmission and distribution.

EERE is also actively supporting research and development to improve the performance and competitiveness of a variety of renewable energy supply technologies such as wind, solar, geothermal, and biomass. For example, wind energy is one of the most widely used and fastest-growing renewable energies in the world. Since 2000, installed wind turbine electric generation capacity in the United States has more than doubled. With support from DOE-sponsored research, the cost of electricity generation from wind has been reduced by a factor of 20 since 1982, to four cents or less per kilowatt-hour in areas with excellent wind resources. While these resources are being exploited by industry, the department's research and development (R&D) programs have turned to focus on new technology that will make even more widely available lower-speed wind resources viable for development. "Low wind speed" technology will expand available land (and potentially, off-shore) areas for wind development by a factor of 20.

MECHANISMS TO ASSIST TECHNOLOGY RD&D

The Department of Energy uses a variety of investment, policy, and other mechanisms to assist technology RD&D including direct R&D investments, partnerships with the private sector, basic scientific research, investment and production tax credits, loan guarantees, the "market pull" of the government's purchasing power, and consumer education and assistance programs. The administration continues to support comprehensive legislation that would promote energy efficiency and renewable energy, including production tax credits for renewable energy, a renewable fuels standard to support biomass-derived ethanol and biodiesel, and a variety of other energy efficiency provisions. In addition to the federal government, state governments have a number of policies that promote the use of renewable and other technologies, such as net metering, which allows customers to generate their own renewable power and sell any excess back to utilities. Increasingly the U.S. public has the ability to choose to receive electricity through "green power" programs that utilize a variety of renewable energy sources including wind, solar, biomass, and geothermal. There are already 1000 megawatts of green power that have been installed (or planned) nationwide because of customer demand in green power markets.

U.S. WORKING WITH OTHER NATIONS

Because much of the world faces the same kinds of energy challenges as the United States, technology developments by U.S. companies will benefit other nations as well. Furthermore, helping developing nations to use energy more efficiently and develop alternative energy sources may enable them to leapfrog directly to advanced energy technologies. The Department of Energy has numerous bilateral and multilateral agreements to promote energy technologies with other countries, including a recently formed International Partnership for the Hydrogen Economy (IPHE) to promote the research, development, and demonstration of hydrogen technologies and accelerate the conversion of the world economy to one that employs environmentally clean hydrogen technologies. The Terms of Reference document, formally creating the IPHE, was signed by Secretary Abraham and ministers representing 14 other nations and the European Union in November 2003. The IPHE will provide a mechanism to organize, evaluate, and coordinate multinational research, development, and deployment programs that advance the transition to a global hydrogen economy.

DOE is also part of an international climate change initiative known as the Carbon Sequestration Leadership Forum (CSLF) whose purpose is to facilitate the development of improved cost-effective technologies that capture and store carbon emissions. The charter for the CSLF was signed in June 2003 and currently has 16 coal-producing and -consuming members. Carbon sequestration is a priority for the United States because fossil fuels (consumption of which produces carbon dioxide) will continue to be the world's most reliable and lowest-cost energy resources for the immediate future.

Other initiatives include the Generation IV International Forum, where the department is working with a group of international government entities to facilitate bilateral and multilateral cooperation on development of new nuclear energy systems. The United States has also rejoined the

International Thermonuclear Experimental Reactor (ITER), a project to develop nuclear fusion as a future energy source. Although the technical hurdles for nuclear fusion are complex, its promise is considered too great to ignore.

CONCLUSION

The United States and other nations face a number of challenges to providing clean, abundant, reliable, and affordable sources of energy to their citizens. U.S. policy is focusing on leapfrogging to next-generation technologies, such as hydrogen, while concurrently working on increases in efficiency, on alternatives to fossil fuels, and on cleaner non-renewable alternatives, all of which are likely to be an important part of the future energy landscape. □

GLOBAL ENERGY SUPPLIES AND THE U.S. MARKET

By Guy F. Caruso, Administrator, and Linda E. Doman, Energy Analyst, Energy Information Administration, U.S. Department of Energy

The U.S. energy market will continue to rely heavily on fossil fuels for the foreseeable future, and net imports of oil and gas will continue to rise, with most of the increased foreign supplies coming from OPEC, Caruso and Doman say.

Overall, the world's energy resources are sufficient to meet projected global demand for the next two decades, but supplies will remain unevenly distributed among regions and countries. This article provides an overview of oil and gas resources worldwide; takes a look at U.S. energy demand, supply, and production potential; and reviews possible changes in the future U.S. energy mix.

The United States is projected to become increasingly dependent on foreign sources of oil and natural gas to meet growing domestic demand, with most of the increased imports coming from the Organization of Petroleum Exporting Countries (OPEC). In 2002, the United States imported 53 percent of its oil and 16 percent of its natural gas. In 2025, net petroleum imports are projected to reach 70 percent of total petroleum demand and natural gas imports 23 percent of total natural gas demand. In the Energy Information Administration's (EIA) *Annual Energy Outlook 2004*, OPEC accounts for nearly 60 percent of the projected growth in U.S. petroleum imports between 2002 and 2025. Although the United States is expected to produce around three-quarters of the gas it is projected to consume in 2025, net imports do grow over the projection period, mostly in the form of liquefied natural gas (LNG).

Petroleum products accounted for 40 percent of the total energy consumed in the United States in 2002 and natural gas for another 24 percent, with coal, nuclear power generation, and renewable and other energy sources (including methanol, liquid hydrogen, and net electricity imports) making up the remainder. While the United States must import oil and natural gas to meet domestic supply, it is self-sufficient in terms of coal, nuclear power, and renewable energy sources.

GLOBAL OIL RESOURCES

The world's oil resource base is defined by three categories:

proved reserves (that is, those quantities that have been discovered already and that can be recovered under present technologies and prices); reserve growth (increases in reserves resulting mainly from technological factors that enhance a field's recovery rate); and undiscovered reserves (oil that remains to be found through exploration). Data on proved reserves are updated and published annually in the *Oil & Gas Journal*, a weekly publication that covers developments affecting the world petroleum industry. Undiscovered oil resources estimates were derived by the U.S. Geological Survey (USGS) as part of its *World Petroleum Assessment 2000* and regional reserve growth was estimated by EIA. Accordingly, the world's total oil resources are estimated to be 2,935 billion barrels between 1995 and 2025, which includes estimates for natural gas liquids and reflects the removal of cumulative production (oil that has already been produced from the beginning of time).

According to EIA's *International Energy Outlook 2004*, world oil consumption is expected to grow from 28 billion barrels per year in 2001 to 44 billion barrels per year by 2025. Under these growth assumptions, less than half of the world's total oil resources would be exhausted by 2025. The estimate of the world's total oil resources involves only conventional sources of oil.

Nonconventional oil resources are defined as resources that cannot be produced economically with today's technology and include oil sands, ultra-heavy oils, gas-to-liquids technologies, coal-to-liquids technologies, biofuel technologies, and shale oil. In the case of heavy oil and tar sands, for instance, more than 3,300 billion barrels are estimated worldwide, with Canada and Venezuela having the most significant deposits. If world oil prices were to rise to \$35 per barrel (in constant 2002 dollars) by 2025, nonconventional oil could be expected to provide as much as 8 million barrels per day.

There are sufficient resources to meet the world's growing demand for oil through 2025. However, the distribution of these oil resources is not uniform around the world. The member countries of OPEC, a cartel of eleven oil-producing countries (Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United

Arab Emirates, and Venezuela) hold most of the world's proved oil reserves. According to *Oil & Gas Journal*, in January 2004, OPEC accounted for 69 percent of the world's proved oil reserves, 870 billion barrels of 1,265 billion barrels. Six of the seven countries with the largest proved reserves are all OPEC members, and alone account for 61 percent of the world's oil reserves. Moreover, oil reserves among the OPEC nations are dominated by the Gulf states — Saudi Arabia, Iran, Iraq, Kuwait, and the United Arab Emirates — which account for about 80 percent of OPEC's proved oil reserves.

Although OPEC member countries account for much of the world's proved reserves, there are substantial reserves outside the cartel. The regions of Central and South America, Africa, and Eastern Europe and the former Soviet Union (FSU) each hold between 6 and 8 percent of the world's proved oil reserves. There are substantial opportunities in all of these regions to increase reserves over the next two decades. Estimates for undiscovered reserves and increases in reserves have the potential to be twice as large as current proved reserves and, in the case of the FSU, quadruple that level.

North America (United States, Canada, and Mexico) accounts for 17 percent of the world's proved reserves. One of the more dramatic changes to the published proved reserves reported by the *Oil & Gas Journal* was the addition of Alberta's oil sands to Canada's total reserves in 2003. Until this point, oil sands were largely considered to be an unconventional form of oil, one that could not be produced economically relative to conventional forms of petroleum. Large reductions in development and production costs are making oil sands economically viable. The 2003 revision to Canadian proved reserve estimates added 174 billion barrels of reserves (bitumen contained in oil sands) to the Canadian conventional crude oil and condensate reserves as reported by the Canadian Association of Petroleum Producers. Canadian conventional crude oil and condensate are estimated to be 4.5 billion barrels.

NATURAL GAS RESOURCES

Similarly to petroleum reserves, natural gas resources have in general increased every year since the 1970s. As of January 1, 2004, proved natural gas reserves were estimated by the *Oil & Gas Journal* at 6,076 trillion cubic feet. Most of the increases in natural gas reserves in recent years have been in the developing world, and about three-quarters of the world's natural gas reserves are

found in the Middle East and in the former Soviet Union — with Russia, Iran, and Qatar together accounting for about 58 percent of those reserves. The remaining reserves are spread fairly evenly among other regions of the world.

Reserves-to-production (r/p) ratios provide a rough measure of the number of years one could expect a region's supply of natural gas might last, assuming current production levels. R/p ratios are computed by dividing the proved reserves in a given region by current annual production in that region. Despite the high rates of increase in the use of natural gas worldwide, most regional r/p ratios have remained high. Worldwide, the reserves-to-production ratio is estimated at 61 years, but the FSU has an r/p ratio estimated at 76 years, Africa nearly 90 years, and the Middle East more than 100 years.

According to the USGS's most recent assessment of world natural gas resources, there is a significant amount of natural gas that remains to be discovered. The USGS publishes three versions of assessments of natural gas resources over the 1995 to 2025 period. The lowest estimate is an estimate based on a 95 percent chance or better that the undiscovered resources will be found and the highest estimate is that there is a 5 percent chance or better that the resources will be discovered. If we consider the expected value or mean assessment, the estimate for worldwide undiscovered natural gas is 4,258 trillion cubic feet. Of the natural gas resources that are expected to be added over the next twenty-five years, reserve growth accounts for 2,347 trillion cubic feet. As is true for oil, natural gas resources can and do increase over time, owing to technological advancements and economic circumstances.

It is estimated that one-fourth of the undiscovered natural gas is located in undiscovered oil reserves. As a result, more than one-half of the mean undiscovered natural gas is expected to come from the Middle East, former Soviet Union, and North Africa. Although the United States has produced more than 40 percent of its total estimated natural gas resources and holds only 10 percent of its remaining proved reserves, in the rest of the world reserves have been largely unexploited. Outside the United States, the world has so far produced less than 10 percent of its total estimated natural gas endowment and carries more than 30 percent as remaining reserves.

U.S. OIL AND NATURAL GAS SUPPLIERS

Since the early 1960s, the United States has been steadily increasing its reliance on imported supplies of both petroleum and natural gas. Whereas in 1960 the country imported about 17 percent of its oil, by 2002 imports accounted for nearly 53 percent of total oil use. The largest suppliers of U.S. imports have changed somewhat over this period, along with their relative importance. In 1960, Venezuela, Canada, Saudi Arabia, Colombia, and Iraq were the largest suppliers of foreign oil to the United States. In 2002, Canada provided the largest share of U.S. imports, followed by Saudi Arabia, Mexico, Venezuela, and Nigeria. In addition, the number of oil exporters to the United States has increased, with supplies coming from Angola, Argentina, Ecuador, Norway, and the United Kingdom, among others.

In the future, U.S. dependence on OPEC for oil supplies is expected to grow, from about 40 percent in 2002 to around 50 percent in 2025, according to the reference case projection from the EIA's *Annual Energy Outlook 2004*. Gross imports are projected to increase from nearly 12 million barrels per day in 2002 to 21 million barrels per day in 2025 (with the United States expected to consume a total of 28 million barrels per day in 2025). U.S. petroleum production is projected to decline somewhat over the next two decades, falling from 9.16 million barrels per day in 2002 to 8.60 million barrels per day in 2025. Crude oil imports from the North Sea are expected to decline gradually as North Sea production declines. Oil imports from Canada and Mexico decline over the forecast period, with much of the Canadian contribution coming from the development of its enormous oil sands resource base.

In contrast to oil, the United States still produces most of the natural gas the country needs. In 2002, net imports of natural gas accounted for 16 percent of total gas consumption in the United States. Canada remains the country's most important natural gas supplier, as it has been since the 1960s. There is, however, some modest diversification in U.S. natural gas imports, as the number of LNG suppliers have increased over the past several years. Trinidad and Tobago, Qatar, Algeria, Nigeria, Oman, Brunei, and Malaysia all exported LNG to the United States in 2002.

While U.S. natural gas production is expected to grow in the future, demand for natural gas is expected to grow faster than domestic supply. The United States consumed

22.8 trillion cubic feet of natural gas in 2002 and this is expected to increase to 31.2 trillion cubic feet in 2025. By 2025, dependence on gas imports is projected to increase to 23 percent. U.S. gas production is forecast to expand to 24.1 trillion cubic feet, much of which will come from unconventional sources — tight sands, shale, and coalbed methane — as a result of technological improvements and rising natural gas prices. Canada's importance as a gas supplier to the United States is expected to decline in the future. Canadian gas exports will begin to decline after 2010, a result of the depletion of conventional resources in the Western Sedimentary Basin. LNG imports are projected to become increasingly more important to U.S. gas supplies, rising from 0.2 trillion cubic feet in 2002 to 4.8 trillion cubic feet in 2025.

ALTERNATIVE ENERGY SOURCES

There are opportunities for fuel-switching to allow alternative fuels to displace oil and natural gas, in the same way other fuels have been replaced in the past. Fuelwood was the dominant form of energy from the time of the founding of the first American colonies in the 1600s until late in the 19th century. The 20th century saw a number of new energy sources penetrate the U.S. energy market, expand quickly, and replace fuelwood almost entirely. Coal surpassed fuelwood in the United States by about 1895, but was itself surpassed in 1951 by petroleum and then by natural gas a few years later. In addition, hydroelectric power appeared in about 1890 and nuclear generation in 1957, diversifying the electric power sector. Other alternative energy sources, such as solar photovoltaic, advanced solar thermal, and geothermal technologies represent the most recent developments in energy sources. There is also the possibility that new technologies, such as hydrogen fuel cells, might affect the fuel mix in the future.

At present, and notwithstanding new technological advancements, oil and natural gas are not expected to be substantially displaced in the U.S. fuel mix over the next two decades. Oil, in particular, is expected to remain dominant in the transportation sector where there are presently no economically competitive alternative fuels. In contrast, oil has been displaced to a large extent in the U.S. electric power sector. Oil use for electricity generation has fallen since the late 1970s. In 2002, oil-fueled generation provided about 2 percent of total U.S. electricity generation, and it is expected to have a relatively small role in the future.

There has been strong growth in natural gas use for electric power generation, especially over the past 10 years. Natural gas consumption for generation increased by 4.8 percent per year between 1992 and 2002, compared to increases of about 2 percent per year for coal and nuclear power and 0.4 percent per year for hydroelectricity and other renewable energy sources. Economics play a large role in fuel-switching, given that sustained high energy prices can result in weakening demand when there is an opportunity to use alternative fuels. In the case of natural gas, demand in the power sector is likely to slow in the future, particularly after 2020 when natural gas prices are expected to rise and adding new coal-fired electric power capacity would become economically competitive.

In addition to economic forces influencing the U.S. energy mix, government policies can affect diversification of the fuel mix away from oil and natural gas. Many state governments have enacted renewable portfolio standards, for example, to increase the proportion of electric power from renewable energy sources. Upgrades and improved efficiencies at existing plants can also influence the energy supply mix. The average capacity factor of nuclear power plants in the United States has increased from 71 percent in 1992 to 91 percent in 2002,

allowing nuclear power generation to increase by 26 percent, despite a 300-megawatt contraction in installed capacity over this period.

CONCLUSION

The United States will likely continue to rely upon fossil fuels to meet much of its energy needs over the foreseeable future. With demand for oil and natural gas expected to rise steadily over the next two decades and limited new domestic resources available for development, dependence on foreign suppliers will also rise. U.S. reliance on OPEC is poised to increase, but supplies from non-OPEC producers will also grow, ensuring some diversity in supply. The United States will continue to produce much of its natural gas domestically in the future, but LNG from a diverse set of suppliers is expected to become increasingly important to meeting demand. Resources do not pose a key constraint to world demand through 2025. Instead, political, economic, and environmental circumstances are likely to influence the world energy markets of the future. □

LINKING NATURAL GAS SUPPLIES TO CRITICAL MARKETS

By Sara Banaszak, Senior Analyst, PFC Energy

Natural gas could play a key role in the energy security of the United States and other countries in coming decades, says Banaszak. But, she says, development of the natural gas industry has been hampered by the investment costs and market issues involved in converting the gas to liquefied form and transporting it long distances to consuming markets. Banaszak argues that policies promoting stable and transparent regulatory regimes, standardization of energy content and shipping infrastructure for the gas, and understanding of safety and security issues will be critical for the industry's future expansion. She says that it will be particularly important to promote good governance in exporting countries that need to attract huge investments to develop a gas-supply infrastructure.

Natural gas has a key role to play in energy security, at least over the next 20 years, as the United States and other countries work toward developing next-generation and renewable technologies. Because it is clean burning and produces significantly fewer harmful emissions than gasoline, natural gas has become the preferred fuel for many end-users, from homeowners to large electric power plants around the world. In the United States, where the gas is the second largest source of energy and accounts for 24 percent of all energy consumed, demand for natural gas is projected to rise by more than one-third by 2025. To satisfy growing demand, the U.S. economy is expected to rely increasingly on imports, mostly in the form of liquefied natural gas (LNG). However, the price of natural gas is rising and becoming more volatile as domestic production is leveling off and Canadian exports appear increasingly limited. Until exporting and importing countries cooperate on reducing investment barriers and agree on common technical, safety, and security issues, the full potential of natural gas will not be realized.

Historically, natural gas has been traded across international borders less than oil. Only one quarter of the gas used globally in 2002 was imported compared to more than half of the oil consumed. On the other hand, trade of natural gas is growing twice as fast as that of oil. Consumption of gas worldwide is growing faster than oil,

as natural gas becomes a transition fuel in moving away from heavier, more polluting hydrocarbons (coal and oil) and toward new energy sources such as hydrogen cells. In addition, proven reserves of natural gas are more abundant than oil reserves and are being depleted at a much slower rate.

Why, then, is natural gas underutilized? Discovered gas resources are located far from end-using markets, with much of the gas located in technically challenging areas such as deep offshore formations or in areas that are environmentally sensitive. Offshore gas often must go through thousands of miles of pipeline to reach a market or be piped onshore for liquefaction before transportation by ship. Overall, transporting gas to consumers requires greater upfront investment and infrastructure than moving liquid oil or solid coal.

GETTING NATURAL GAS TO MARKET

Commercial technology that transforms natural gas to a liquid has enabled economic transportation of gas in the form of LNG in ocean-going tankers. This has led to creation of an industry with unique characteristics and issues. To make LNG, natural gas is processed to be mostly methane with some ethane and then super-cooled to minus 260 degrees Fahrenheit so that it settles into liquid state, shrinking the volume to 1/600th of the gaseous state. LNG tankers and storage tanks are heavily insulated to maintain the very cold liquid state, but only very slight pressure is involved in LNG handling. As LNG, natural gas is a special, very cold liquid that has very different properties contributing to its safe handling — LNG, for example, will not ignite until regasified back into natural gas and mixed with air at specific concentrations (between 5 and 15 percent volume concentration).

Achieving economically competitive LNG trade involves building large-scale facilities that require \$5-7 billion of capital for exploration, development, liquefaction, shipping, and regasification. To raise such large amounts of capital to get the gas to market, the LNG industry has relied on long-term (20-year) contracts between the gas

supplier and the gas buyer as a way to reduce market risk for lenders. This is an important difference compared to the oil industry, where producers develop resources without contracted buyers and then sell the product into the high-volume and heavily traded global oil market. In the case of LNG, neither consumer nor producer can rely on buying or selling significant volumes without securing a long-term contract, because only about 8 percent of global LNG is traded under short-term and spot market terms.

There has been some evolution away from this reliance on long-term contracts in the LNG industry. LNG producers have sought to build spare capacity in their facilities, and LNG tankers are being built that are not tied to specific long-term trades and could be available to transport spot LNG cargoes. In Asia, where long-term contracts from the 1980s are now expiring and requiring renewal, more flexible and shorter terms are being negotiated. However, the LNG industry will not escape its structure based on long-term contracts quickly because the capital requirements are still a significant barrier. Further evolution toward more flexible and shorter-term trading arrangements is expected but will occur slowly. For countries using LNG as part of their natural gas future, the structure of LNG trade helps define the available options for policies and actions that can reinforce national, regional, or global interests.

SECURING FUTURE NATURAL GAS SUPPLIES

For the United States, LNG is expected to play an important role in future natural gas supplies, as reflected in forecasts made by the U.S. Energy Information Administration (EIA), the National Petroleum Council, and industry consultants. According to projections of the EIA, the share of LNG in U.S. total natural gas supply will increase from less than 1 percent in 2002 to more than 15 percent in 2025. China, India, and Mexico are among new LNG importers while Europe, Japan, Korea, and Taiwan already rely on LNG for a key portion of their natural gas supplies. Other countries in Asia and Latin America have considered LNG imports to meet their natural gas demand — from the Philippines and Thailand to Brazil, Honduras, and Jamaica (the Dominican Republic and Puerto Rico already import LNG).

The LNG market will continue to grow but may not meet its full potential to supply natural gas to the United States and elsewhere unless both exporting and importing

countries cooperate to overcome barriers. Collaboration will be especially critical in three key areas:

- Promotion of stable and transparent investment environments
- Standardization within the LNG industry
- Research, development, and dialogue addressing safety, security, and environmental issues

PROMOTING STABLE AND TRANSPARENT INVESTMENT ENVIRONMENTS

Energy companies are already seeking to develop abundant natural gas resources that are located far from major markets and have announced or proposed more than 20 LNG schemes to double global capacity by 2010. Investment environments characterized by high political risk and other risks, however, can stop or delay development of new LNG supplies. LNG-trading countries can collaborate to improve the investment environment for LNG by promoting stability, good governance, and transparent regulatory regimes, using the same principles that support trade and cross-border investment in general.

As for regulatory regimes, identifying and implementing the best system for natural gas and LNG markets is a complex issue. In the United States, for example, regulatory changes to create competitive markets in natural gas supply and transportation have led to an emphasis on shorter-term contracts between gas buyers and sellers, a trend that is directly counter to the long-term contracts that LNG suppliers require. Creating competition in domestic gas transportation has altered the way the industry invests in transportation infrastructure, which is needed to transport all forms of gas supply, including LNG, around the country. In the near term, it has meant under-investment and delayed investment in needed infrastructure. For example, delays in the construction of pipelines or “just-in-time” construction occurs because local distribution companies are under pressure from the public utility commissions that provide oversight and sometimes from market competition created by deregulation not to sign long-term contracts that provide assurance to pipeline investors. Gas production companies that might invest in capacity expansion don’t want to tie up capital in gas transportation so they prefer to build only to the nearest liquid-market point. Investments have also been hampered by delays in getting required permits.

In the long term, if market forces do not lead to timely and adequate investment in infrastructure, regulators will need to reexamine how to facilitate both competition and profitability in domestic gas transportation.

EXPANDING STANDARDIZATION WITHIN THE LNG INDUSTRY

Because the LNG industry has evolved under long-term contracts, there has been less incentive to develop standardization compared to other traded commodities, including oil.

The standardization of LNG is an important but very difficult issue. The energy content of LNG varies because producing facilities leave different amounts of ethane in the gas, and the energy content needs of LNG consumers also vary. In the United States, the typical limit in a market area for the energy content of gas is about 1100 British thermal units per cubic foot (one British thermal unit is approximately equal to 1055 joules, a metric measure for energy). These “limits” arise because the energy content of gas can affect, for example, flame characteristics, smoke, soot, and emissions. For this reason, LNG supplies from certain facilities cannot be delivered into certain U.S. ports because the energy content is above the level of 1100 British thermal units per standard cubic foot and it is not possible for the importing regasification facility to dilute the energy content of the gas before it reaches consumers. For example, the U.S. terminal located in Boston would have difficulty accepting LNG from sources other than Trinidad or Algeria. The United States and other importing countries can work to increase flexibility within their own systems. They also can collaborate to increase the number of compatible LNG supply sources.

With LNG shipping, both importing and exporting countries would benefit from efforts to maintain standardization, which could be affected by the appearance of several new technologies (such as the introduction of special LNG hoses and offshore tanker unloading). Countries can work to facilitate standard LNG loading and off-loading systems so that LNG tankers can service as many ports as possible. Developing port compatibility within the LNG tanker fleet increases flexibility, contributes to security for LNG trading countries, and helps to facilitate spot market trade.

A third area that could benefit from greater standardization involves LNG sales contracts. Again,

because of the legacy of long-term transactions, the contracts involved have been non-standard, long, and complex. Developing standard contracts and standardized clauses would facilitate trade, benefiting both importers and exporters. Although this issue has been identified by some industry players, it may be lacking a natural advocate because buyers, sellers, and the lawyers in between could each be suspicious if one side stepped forward with a plan to address legal standardization. There may also be no natural forum under which this activity should take place. Because the U.S. government has no commercial interest in the LNG industry, it might be possible for the U.S. to initiate or promote legal standardization for LNG under the umbrella of a trade organization or under a new or existing consortium (for example, the Groupe International des Importateurs de Gaz Naturel Liquéfié).

RESEARCH, DEVELOPMENT, AND REGULATORY DIALOGUE

The LNG industry has an exemplary safety record, but maintaining it requires ongoing research and development. In the post-September 11 world, security risks to LNG facilities are perceived as greater and are garnering more public attention in the United States and elsewhere. Responding to public concerns and designing expanded safety and security measures would benefit from increased understanding of LNG containment infrastructure (tankers and storage tanks). Research and development also should focus on exploring questions such as how to prevent a breach of facilities and what might be the environmental and health implications of a large-scale release of LNG. These are areas for government leadership and collaboration, but countries should coordinate any efforts with existing groups that work in this area, such as shipping and standards societies or gas and technical associations.

In the United States, building energy infrastructure has become complicated by laws that enable local communities to review and influence projects based on their local environmental impact. The existing process for project review does not emphasize community discussion of the potential impact of a project on energy supply, energy prices at the regional level, or the broader regional/national impact. Government can play an important role in this arena and can promote, via international collaboration, more informed discussion of

energy choices and the options available for having safe and secure future energy supplies.

CONCLUSION

With LNG expected to play a larger role in supplying natural gas to the United States and elsewhere, there is much that countries can do to assure future supplies. Stable and transparent investment environments are critical to expanding LNG infrastructure, which requires large-scale capital investments. Standardization within the industry and further research — particularly to bolster safety and security — are key to developing a robust international market. Robust markets provide the greatest form of security to energy importers by contributing to price transparency, providing access to multiple supply sources, and promoting supplier competition and market-driven efficiencies. The U.S.-sponsored LNG Summit held at the end of 2003 featured collaboration among energy ministers and high-level representatives from 24 countries and could be built upon to further cooperation in these areas.

As the United States increases LNG imports along with China, India, and Mexico, supply security is derived from the availability of abundant gas resources and the diversity of countries seeking to join the field of LNG exporters. In the Atlantic Basin, Norway, Angola,

Venezuela, and Equatorial Guinea have plans to join the existing LNG exporters — Nigeria and Trinidad and Tobago.

LNG is used as a way of transporting natural gas to distant markets and across borders, sometimes competing with pipeline transportation. In the future, alternative ways of transporting gas could arise to compete with LNG. Pipeline technologies, for example, could become more advanced and cheaper, extending their reach. Gas-to-liquids (“GTL”) technology is under development but is still too expensive to compete with LNG as an outright form of natural gas transportation. The hydrocarbon liquids produced from the first GTL projects will more likely be used to compete with high-end oil products, at least until this complicated chemical process becomes cheaper. For the immediate future, LNG is set to grow, and for countries involved in LNG trade, it is in their interest to facilitate development of this maturing market. □

Note: The opinions expressed in this article do not necessarily reflect the views or policies of the U.S. Department of State.

ENERGY AND THE DEVELOPING WORLD: THE NEED FOR NEW KINDS OF PARTNERSHIPS

By David J. O'Reilly, Chairman and Chief Executive Officer, ChevronTexaco Corporation

Corporations have compelling reasons to work toward stability and higher standards of living in developing countries in which they operate, says O'Reilly, a recipient of the 2003 State Department award for corporate excellence. He argues that businesses can achieve best results by entering into broad partnerships that can help break down barriers between developing countries and the rest of the world as well as between those countries' governments and their people. O'Reilly describes a partnership in which ChevronTexaco joined forces with multiple partners to spur sustainable investment in Angola.

By necessity, the petroleum industry operates in some of the most challenging parts of the world — challenging in terms of the technology required to find and develop new sources of energy and challenging in terms of social and economic disparity.

Indeed, much of the world's energy resources are located in developing countries where life is a daily struggle against disease, malnutrition, unstable social systems, and conflict. Poverty is at the root of these intractable problems.

When it comes to global poverty, the statistics are alarming. It is estimated that one-half of the world's population exists on the equivalent of \$2 a day, and more than 1 1/2 billion people do not have access to electricity. In Africa alone, upward of 300 million people, half of the continent's population, live on less than \$1 a day. In fact, the average yearly income for African citizens comes to less than the annual agricultural subsidy for a cow in Europe or Japan.

Despite the statistics, I am often asked why business should care about lifting the burden of poverty. In today's highly connected yet fragile world, the reasons are compelling — as compelling, in fact, as for any part of society. Who more than business needs:

- an operating environment of peace and political stability
- a healthy, educated work force

- the highest-quality local suppliers
- a thriving demand for our products

There exists, of course, yet another, even more compelling, reason why business must join the fight against poverty. It is the right thing to do.

Recently, U.S. Secretary of State Colin Powell presented my company with the State Department's highest award for corporate excellence. The honor was based on the sustained efforts over many years of the employees in our Nigerian affiliate to improve the quality of life in the communities in the Niger Delta where they work.

Certainly, the award was a proud occasion for our company. But more important, it underscored the profound philosophical change that has occurred in how many companies are increasingly viewing their role in society, especially in developing nations. No longer is it enough that we fund "bricks and mortar" programs. Instead of giving our neighbors a helping hand, we must, in the words of the late Reverend Leon Sullivan, give people a "hand up."

Of course, no company can do it alone.

In addressing the causes of poverty, I believe progress needs to be made in several areas: trade reform, human capacity building, debt relief, and the improved delivery of development aid. Action on these fronts must be accompanied by government reform in the areas of good governance and transparency. In developing countries where these issues have been addressed, we have seen the benefits of economic growth being more broadly distributed across the population.

I am also convinced there is a need for new, innovative global partnerships and collaborative approaches — approaches that will help create sustainable economic growth while making sure benefits are widely shared. To bring about substantial and lasting change requires that all stakeholders — governments, nongovernmental organizations (NGOs), communities, and business — work together in partnership. Each player has an important role.

- Governments must do the things that only they can do: advocate and practice good governance, provide education and health care, and create a stable and transparent investment climate.

- Multilateral organizations such as the World Bank, the International Monetary Fund, and the World Trade Organization should work with governments and help them establish good policies.

- NGOs must help local populations make sustainable improvements in their economies and be open to working with all stakeholders, including industry.

- Business, for its part, should be focused on making wise investments, creating jobs, and running sound, profitable operations. But it must also work collaboratively with both government and NGOs to improve the quality of life where it operates.

What could these new partnerships look like? To offer one example: Late last year, ChevronTexaco joined with the United States Agency for International Development (USAID) and the United Nations Development Programme to form a \$50 million partnership to spur sustainable investments in Angola.

The largest private alliance ever entered into by USAID, the partnership has opened the way for government to tap new sources of financing and technical expertise that the private sector brings to the table. Major relief groups and nonprofit agencies have joined in the partnership as well. We turned to NGOs with expertise in agriculture, finance, and education — even seed multiplication and goat raising. We worked with international banks and development agencies, the government of Angola and, most importantly, with communities and rural villagers themselves.

One initiative alone, aimed at reviving the nation's small farms, will have helped nearly 900,000 Angolans, approximately 8 percent of the entire population, by the end of this year.

This example shows that success will come, but it will only come through new partnerships and coalitions that combine our separate strengths.

Clearly, business objectives for many companies — including ChevronTexaco — are tied to economic growth around the globe. However, until basic human needs can be met, it will be a difficult world in which to do business, much less to create new markets and growth opportunities.

Effective partnerships can break down barriers that often isolate developing countries from the community of nations and a world of ideas. Partnerships can also break down barriers that are caused when government, businesses, and communities simply do not speak each other's language or, at worst, distrust one other.

One can only wonder how long our shrinking world can tolerate economic disparities so vast that human beings in one place are valued less than livestock in another. By working together, I'm convinced we can begin to span such chasms. □

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KEY INTERNET SITES

Internet resources were active as of May 2004.

The U.S. Department of State does not take responsibility for those websites whose addresses have changed and/or websites now displaying inappropriate material.

UNITED STATES GOVERNMENT

Department of Energy

<http://www.energy.gov/>

Energy Information Administration

<http://www.eia.doe.gov/>

Information Bridge

(Research and Development Projects)

<http://www.osti.gov/bridge/>

Department of the Interior

U.S. Geological Survey

<http://energy.cr.usgs.gov/>

Department of State

Office of International Energy and Commodity Policy

<http://www.state.gov/e/eb/c9982.htm>

Federal Energy Regulatory Commission

<http://www.ferc.gov/>

INTERNATIONAL ORGANIZATIONS

International Association for Energy Economics

<http://www.iaee.org/>

International Energy Agency

<http://www.iea.org/>

International Solar Energy Society

<http://www.ises.org/>

Organization of Petroleum Exporting Countries

<http://www.opec.org/>

World Bank Group – Oil, Gas, Mining & Chemicals

<http://www.worldbank.org/ogmc/>

World Energy Council

<http://www.worldenergy.org/>

World Petroleum Congress

<http://www.world-petroleum.org/>

World Renewable Energy Network

<http://www.wrenuk.co.uk/>

World Wind Energy Association

<http://www.wwindea.org/>

ACADEMIC AND RESEARCH INSTITUTIONS

Cambridge Energy Research Associates

<http://www.cera.com/>

Energy and Resources Institute

<http://www.teriin.org/>

Energy Intelligence Group

<http://www.energyintel.com/>

Petroleum Industry Research Foundation

<http://www.pirinc.org/>

PIRA Energy Group

<http://www.pira.com/>

Rice University

Baker Institute Energy Forum

<http://www.rice.edu/energy/>

University of California Energy Institute
<http://www.ucei.berkeley.edu/>

Washington State University Energy Program
<http://www.energy.wsu.edu/>

University of Houston
Institute for Energy, Law & Enterprise
<http://www.energy.uh.edu/>

SELECTED INDUSTRY-SPONSORED GROUPS

American Coal Ash Association
<http://www.acaa-usa.org/>

Independent Petroleum Association of America
<http://www.ipaa.org/>

American Coal Foundation
<http://www.acf-coal.org/>

International Gas Union
<http://www.igu.org/>

American Council for an Energy-Efficient Economy
<http://aceee.org/>

International Hydropower Association
<http://www.hydropower.org/>

American Gas Association
<http://www.aga.org/>

Nuclear Energy Institute
<http://www.nei.org/>

American Petroleum Institute
<http://www.api.org/>

National Hydropower Association
<http://www.hydro.org/>

American Public Power Association
<http://www.appanet.org/>

Solar Energy Industry Association
<http://www.seia.org/>

American Wind Energy Association
<http://www.awea.org/>

Association of Oil Pipe Lines
<http://www.aopl.org/>

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