

Challenge, Opportunity and Change: The New Frontiers of Energy

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As recent developments around the globe have so vividly demonstrated, our industry is passing through a period of unprecedented challenge, opportunity and change. Technology continues to advance and revolutionize the way we do business, as it enables us to develop and deploy extraordinary new methods for meeting the world's need for reliable and affordable energy.

Earlier this year, in an address to the Japanese Diet, Prime Minister Koizumi reaffirmed Japan's commitment to "promote world-leading environmental industries by promoting the utilization of science and technology." At ExxonMobil, we believe that science and technology remain critical to sustaining our record of achievement and progress in improving the environment and the quality of life where we operate.

In this article, I will share some thoughts about how ExxonMobil envisions the future of our industry and the progress that we can expect from even greater technological advances. I will also touch on some of the ways in which each of us, working in partnership, can play an important role in meeting the challenges still to come.

Because the world is increasingly prosperous and interdependent, new forms of trade, growing foreign investment and modernizing economies are binding nations closer together.

As a leader in global trade, Japan stands forth as a shining example of the benefits and prosperity that flow from international commerce. Yet today, the Japanese model is far from the norm. Fully 85 percent of the world's population lives in developing countries, where gross domestic product (GDP) per capita is only 6 percent of that in the developed world. Some 1.6 billion people have no access to electricity, and more than one billion people lack access to safe drinking water.

We all have a tremendous opportunity and, I believe, a responsibility to improve the quality of life the world over. Inherent in that responsibility is a commitment to build upon the tremendous achievements of our industry, especially through the exchange of ideas and technology that benefit the environment. As the Japanese proverb puts it: "There are no national frontiers to learning."

ExxonMobil does business in nearly 200 countries and territories on six continents. For over 120 years, we have spent our working lives supplying the energy that advances prosperity. Virtually nothing is made today without the energy and products supplied by our industry. Access to affordable and reliable energy supplies remains essential to progress and prosperity, and to the most basic well-being of people.



Each year, ExxonMobil conducts a rigorous examination of the long-term economic and energy landscape. It will come as no surprise to the readers of this magazine that there is a strong, historic link between economic growth and energy demand. It is also clear that the discovery and use of hydrocarbon fuels throughout the last century contributed greatly to improving life for millions the world over.

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Future Energy Demand

The global economy has grown at an average rate of about three percent per year since 1970. We expect growth to continue at that pace, on average, for at least the next 20 years. We also expect worldwide growth in energy demand will likely be lower than GDP growth, at about two percent per year. This takes into account significant but yet-to-be-achieved advances in energy technology and efficiency.

The economies of the developing world should grow more rapidly, at four percent per year on average, through 2020. China, India and Asia's other rapidly expanding economies will lead the world in GDP growth. By 2020, growth from these economies – and significant increases in personal consumption – will lead to higher energy demand rivaling today's energy consumption in the United States and Western Europe combined.

Among our industry's other great challenges and proud achievements through the years have been finding, producing and delivering energy products in an economic and environmentally sound manner.

During the same period, energy demand in Japan, Australia and New Zealand is likely to grow at less than one percent per year. Even with efficiency gains, we expect that the world's demand for energy will reach

close to 290 million barrels per day of oil equivalent by 2020, or about 40 percent more than today. We expect oil and gas – representing 60 percent of energy supplies today – to remain the dominant energy source, at least through the mid-century.

Wind and solar will likely continue to grow very rapidly, but only due to government policies and incentives, not market forces or economics. However, even with double-digit growth rates, wind and solar are unlikely to exceed a one percent share of the world's energy needs by 2020. Affordable oil and gas supplies will remain essential to economic growth, not only in the industrialized world, but also in developing nations where efforts to raise living standards are so vital.

Fifty years ago, gas consumption represented only about ten percent of the world's energy demand. Today, gas represents more than 20 percent of demand. During the next two decades, we expect this trend to continue, with natural gas capturing fully one-third of all incremental energy growth, driven by increasing demand for power generation.

By 2020, worldwide electricity demand will increase by about 70 percent, and about 70 percent of that increase will occur in developing countries. Gas will supply about one-quarter of global energy requirements, second only to oil's share.

Gas Supply and Demand

The resource base is not a constraint to meeting higher demand. The U.S. Geological Survey's estimate of remaining gas resources worldwide is more than 13,000 trillion cubic feet (tcf). Cedigaz puts the ultimate remaining resource estimate at more than 18,000 tcf – equivalent to a 170- to 200-year supply at today's consumption levels.

Although half of the world's known gas reserves are in Russia and Iran, significant geographic diversity of gas resources still makes gas very attractive as an energy supply source. Thus, while there are sufficient resources to meet world demand at least through the mid-century, bringing the gas to market will remain a challenge.

Among our industry's other great challenges and proud achievements through the years have been finding, producing and delivering energy products in an economic and environmentally sound manner – meeting growing demand while replacing oil and gas from natural production declines in existing fields.

For the ninth year in a row, ExxonMobil demonstrated its ability to meet this challenge by adding more energy reserves than we produced. Significantly, these

high-quality additions are in areas where we expect substantial future growth. Indigenous supplies of gas within mature market areas, such as those from the North Sea and in North America, will struggle to keep pace with demand.

As supplies from local production decline, our industry must bring on a substantial number of new, remote and technically challenging developments to fill the gap.

In North America, we expect a rapid fall-off in gas production from existing fields in the U.S. and Canada. Some of this reduction will be offset by a combination of improved recovery in existing fields and new discoveries. However, a gap between supply and demand will grow over time. Increasingly, nonconventional supplies such as coal bed methane, tight gas, long-distance Arctic pipeline supplies and liquefied natural gas (LNG) will fill the balance.

In Europe, we look for a drop in gas production and in currently contracted imports. This development, coupled with demand growth, will leave a growing supply gap beginning about 2005. Additional supplies will come from pipeline and LNG sources in Norway, North Africa, Russia/Caspian and the Middle East.

In Asia's gas-importing countries, including China, India, Japan, South Korea, Taiwan and Thailand, growing demand requirements will need to be filled by new pipeline and LNG imports from a variety of Asian, Middle East and Russian sources.

As the three major regions move more to LNG as the marginal supply, the gas market will become increasingly global. We see greater LNG volumes coming from West Africa, Venezuela and the Middle East, along with greater pipeline volumes from Russia and the Caspian region.

Given the variation in demand growth rates and shifting supply sources, the dependency between importing and exporting countries will grow. This level of growth will depend on significant and timely infrastructure investment to provide access to gas for power and industrial use.

The International Energy Agency estimates that investment in power generation for China and India alone will top \$1 trillion through 2030. Transportation costs will also gain in significance as a component of total energy supply costs, reflecting the need to bring incremental supplies from farther distances to meet market demand.

For Japan and elsewhere in northeast Asia, gas resources are relatively distant. Transnational transportation grids, such as those in Western Europe and North America, remain long-term strategic imperatives.

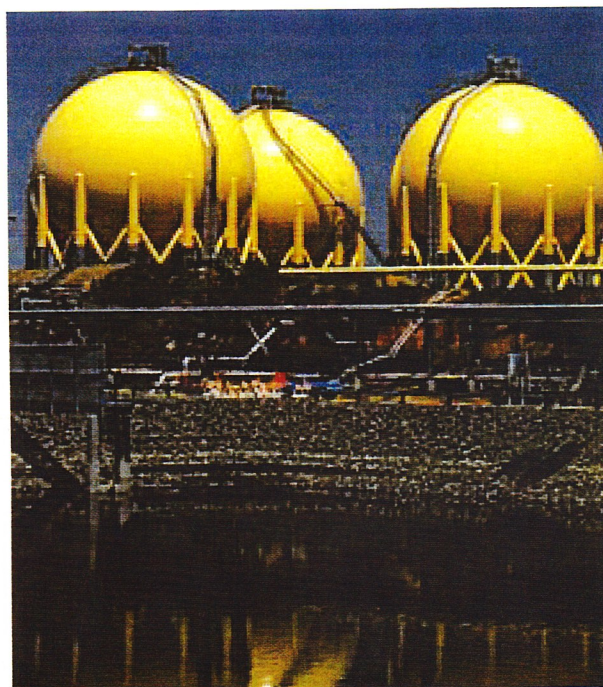
Currently, more than 90 percent of the world's gas is supplied by pipeline. Pipelines will remain the principal

means of transport in North America, Europe and Latin America. However, we expect LNG supplies to grow fourfold or more by 2020, representing about 25 percent of the world gas supply.

New technology now enables us to bring previously unreachable, more-remote gas resources to world markets. As the world's largest market for LNG, Japan has shown that huge amounts of gas can be supplied reliably and safely from remote locations through LNG terminals. Many new terminals in the other major-demand regions will be required to meet the projected LNG growth, and they will benefit from understanding the Japanese experience.

Import independence is not realistic in most cases, nor is it necessary when risks are effectively managed through diversification, especially given the economic incentive for exporting nations to supply the market. In helping to foster an environment where our industry can continue meeting the world's energy needs, governments can play a critical and positive role by embracing policies that promote access to resources and cooperation in all regions. To a large degree, governments set the framework in which the industry performs its essential tasks.

Within that framework, predictable tax structures, transparent accounting procedures, an impartial court system and protection for the sanctity of contracts and intellectual property are all essential features of sound energy policy. A clear and stable legal, fiscal and regulatory



environment is also vital, as are competitive markets in which governments resist the temptation to favor particular fuels, industry participants or technologies. Laws and regulations that hinder the operation of free and competitive markets inevitably undermine supply security. Government-imposed price controls, for example, have always produced undesirable results.

When governments and industry work together, meaningful progress can be achieved, benefiting suppliers and consumers alike.

Besides being inefficient and wasteful, such schemes inflict distortions on economic activity and drive market participants elsewhere. By opening their markets to increased competition, governments can ensure that diverse and reliable supplies of energy are available to meet growing demand.

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Environmental Responsibility

Our industry has an ongoing duty to manage its relationships with governments and communities responsibly. An ongoing challenge facing leaders in our industry and the world's governments is the need to continually improve environmental performance.

The evidence shows that economic growth and environmental improvement can go hand in hand. In the U.S., for example, lead has dropped by 98 percent, particulates by 75 percent and sulfur dioxide by 39 percent since 1970. Other parts of the world have also experienced substantial improvements. In Japan, particulates and sulfur dioxide have dropped by more than 50 percent and 80 percent, respectively, in the same period.

More recently, the public's attention has been focused on the potential contribution of hydrocarbon use to global climate change. ExxonMobil supports efforts to develop common and accepted industry standards for measuring carbon emissions. We voluntarily report our emissions and back mandatory reporting based on effective and reliable procedures as essential preconditions to policies that target emissions reduction.

We are continuing important research on long-term technologies, including advanced vehicles and fuels, improved internal combustion engines, CO₂ separation

and storage and other technologies.

We are also evaluating the use of hydrogen as an energy source. As many readers know, the whole topic of hydrogen has been getting more attention recently. There is understandably a great deal of interest in this subject. On the positive side, hydrogen is abundant, and once delivered to the vehicle, it can be used emissions-free.

However, it does not exist independently of other elements, meaning that significant energy and costs are required to liberate and distribute it for use in fuel-cell vehicles.

It is important to remember that, when considering any fuel, the entire system of production, distribution and consumption must be analyzed to assess overall efficiency and emissions – a well-to-wheels analysis. On this basis, internal combustion engine technology remains the standard against which all alternatives must be measured.

Significant breakthroughs will be required to lower the cost of hydrogen for it to be competitive against the ever-improving performance of the most advanced internal combustion engine and hybrid technologies.

As environmental pressures mount on carbon emissions, the greatest potential for gas will be for use in power generation to displace coal. This will lower CO₂ production by about 60 percent, while the well-to-wheels CO₂ reduction from displacing gasoline with hydrogen produced from gas is only 40 percent.

Some proposals to address climatic issues have included approaches that would have an adverse effect on economic growth and prosperity, and that would explicitly ignore developing countries where the greatest energy growth and related emissions increases will occur.

Developing countries use slightly more than half the world's energy and also produce more than half the carbon emissions. Between 2000 and 2020, we project that these nations will likely contribute about 80 percent of an expected 40 percent increase in carbon emissions worldwide.

The rapidly growing economies of the developing nations will require more electricity, much of which will be generated by carbon-intensive coal, in addition to more fuel for their growing transportation and industrial needs. These realities cannot be ignored if we are to pursue a path that improves the economic prosperity of all world citizens.

Scientific research must continue so that we have a better understanding of global climate change and can reach the best policy decisions. To achieve additional reductions in emissions without impairing prosperity, we will need technology comparable to that deployed in the effort to explore space or to develop personal computing.

Supporting Technology

I have always found it striking – and unfortunate – that ours is seen as an old-economy, low-tech industry. Everyone in the industry knows better. We are one of the most technology-intensive industries in the world.

At ExxonMobil, we invest over \$600 million a year on research and development to discover new technologies and advance their commercial applications. And we do most of it in-house because it is essential to our competitiveness.

We employ about 20,000 engineers and scientists, nearly 2,000 of whom hold a Ph.D. in the engineering and hard-science disciplines we need worldwide. These numbers underscore our belief that the role of science and technology in the public policy arena is absolutely vital if we are to make wise decisions about energy and environmental policies.

In addition, we need to push the technology front, with the help of the best scientists and engineers we can muster. Research and the commercialization of new technologies that expand our capabilities to capture resources are critical, as are advances in production technology.

Late last year, we announced that we would invest \$100 million in Stanford University's groundbreaking Global Climate and Energy Project, also called G-CEP. This 10-year project, with total anticipated investments of \$225 million, is co-sponsored by a prominent group of global companies including Toyota, General Electric and Schlumberger.

The project unites scientific and engineering researchers with private industry from around the world in the search for new, commercially viable energy technologies that can substantially reduce greenhouse gas emissions. This effort will include identifying the most promising technologies, accelerating their commercial applications and overcoming cost, performance and safety issues.

We are committed to ensuring that the output of this initiative is shared with others beyond Stanford University and the business sponsors. Both the research itself and dissemination of the project's findings will explicitly consider developing countries, where much of the growth in emissions will occur.

We have encouraged Stanford to include representatives from leading universities across the globe, including Asia, to help with the breakthrough research required for G-CEP's success. I believe that the partnership and collaboration of global companies and the world's leading university researchers on these matters will ultimately prove to be of great strategic importance.

We want to expand the potential options by breaking through existing technology limitations. The Global

Climate and Energy Project holds great promise for delivering new technologies that can give policymakers more options and help us continue to produce reliable and affordable energy while reducing environmental impacts in a cost-effective way.

Our industry should always encourage and welcome debate about the important policy choices before us, especially those pertaining to the environment. And that debate should be open and replete with scientific and economic candor. In that undertaking, we must demonstrate complete integrity in our actions and unwavering courage to seek the truth and to communicate it to the public, even when doing so flies in the face of popularity or expediency.

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We cannot expect others to tell our story or describe the challenges we face. That is a task for members of our industry, including the leadership reading this article. We must identify our common objectives, utilize people's boundless ingenuity to advance science and technology, and work together to continue to deliver safe, affordable and reliable energy that benefits people everywhere.

In the final analysis, the momentous choices before us should not be decided by passions of the moment or ideological agendas. Nor should we succumb to the notion that sound policies can result when scientific rigor is resisted or when the terms of the debate are continually redefined to fit the purposes of the moment.

It is up to all the members of our industry to engage the debate to delineate and emphasize our common interests and objectives. In our areas of agreement, we can be exceptionally effective, and we can exercise that effectiveness for the benefit of all humanity. In our areas of disagreement, the issues should be carefully defined and technically resolved as much as possible.

It has been wisely said that not every difference of opinion is a difference of principle. As an old Japanese saying puts it: "Where there is no antagonist, you cannot quarrel."

A History of Success

The record demonstrates our industry's remarkable success in finding and providing affordable energy. Moreover,

we have seen that the energy we provide has contributed significantly to human welfare in every part of the world. The affordable energy we produce provides the light, the heat and the productivity gains that take place whenever labor is shifted to machines and people are liberated to do what no machine can.

People the world over count on us and trust us to meet their vital needs in ways seen and unseen. That is a remarkable achievement and continues to be a significant responsibility. It is our charge to build on the great legacy that is the petroleum industry.

We must be worthy heirs to the achievements of its storied past, be wise stewards of its present actions and future plans and pass on to tomorrow's generations an inheritance that benefits all humanity. Since the advent of the Industrial Revolution, the physical, social and economic progress and prosperity of people everywhere have depended on abundant and affordable supplies of energy. This is true today and will be true tomorrow.

I have every confidence that our industry's best years lie ahead – surpassing even the greatest achievements of the century just passed – a future in which innovation, performance and integrity will be absolute prerequisites for success, and success will be measured in terms of a level of human well-being and prosperity that today can be only imagined.

I have no doubt whatsoever that all of us, working together, in every nation and on every continent, are equal to the demands of our legacy and the challenges of our future. We will get there, and we will get there together. And all our fellow citizens – the citizens of all the nations of the world – will be the ultimate beneficiaries of our success. ■

Lee R. Raymond is the chairman and chief executive officer of Exxon Mobil Corporation. Before the merger of Exxon and Mobil on November 30, 1999, Mr. Raymond was chairman and chief executive officer of Exxon Corporation.

A native of Watertown, South Dakota, Mr. Raymond graduated in 1960 from the University of Wisconsin with a bachelor's degree in chemical engineering. In 1963, he received a Ph.D. in the same discipline from the University of Minnesota. He joined Exxon that year as a production research engineer in Tulsa, Oklahoma. Over the next 16 years, he held positions of increasing responsibility with Exxon Company U.S.A., Creole Petroleum Corporation, the former Exxon International Company and Lago Oil & Transport Company, Limited, the Exxon affiliate in Aruba.



He became president of Exxon Nuclear Company, Inc. in 1979 and moved to New York in 1981, when he was named executive vice president of Exxon Enterprises. In 1983, Mr. Raymond was named president and director of Esso Inter-America Inc., with responsibilities for Exxon's operations in the Caribbean and Central and South America. Mr. Raymond was named a senior vice president and was elected to the board of directors of the corporation in 1984. He became president of the corporation in 1987.

Mr. Raymond is a director of J. P. Morgan Chase & Co. and the United Negro College Fund. He is chairman of the board, a director and member of the Executive Committee and Policy Committee of the American Petroleum Institute, and a member of the President's Export Council.