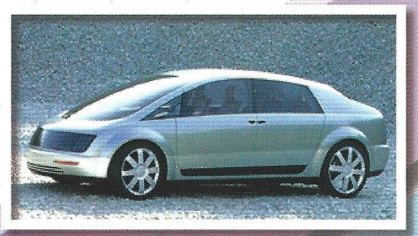
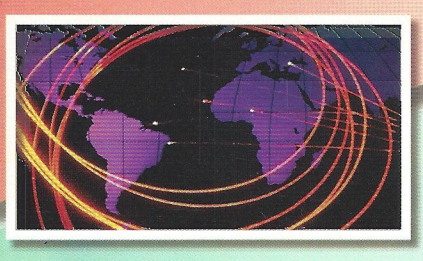
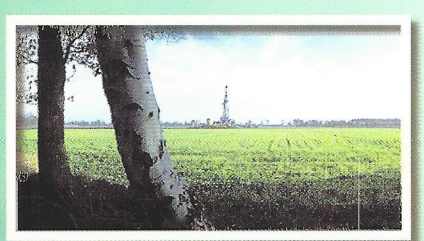
The Outlook for Energy

The Op-Ed Series







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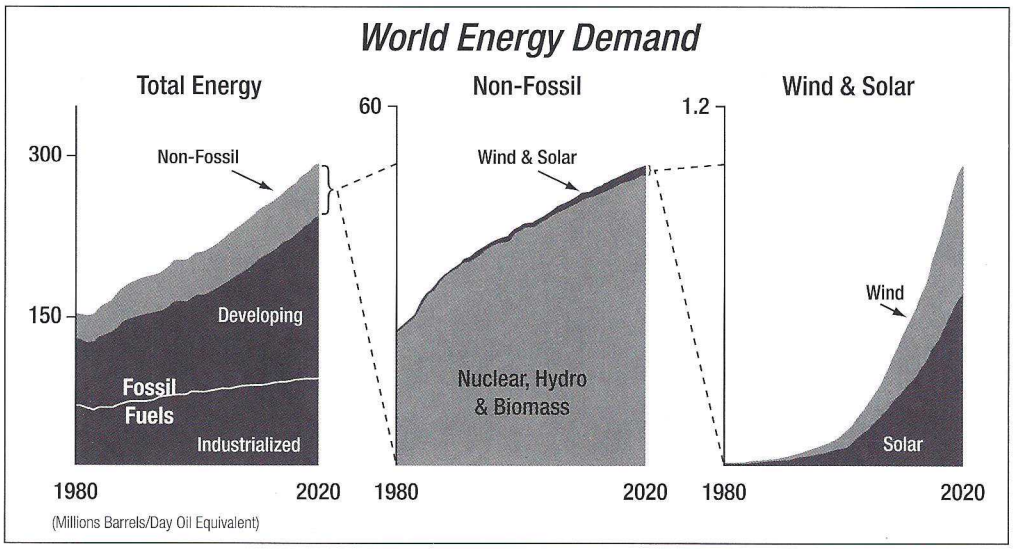
Energy: building an outlook



What does the future hold for energy? It's an important question, because the world needs energy to prosper. Furthermore, the need for energy heavily influences international relations, public debate, government policies and technology choices.

Many economic experts believe that the world's economy will grow at about 3 percent a year through 2020, more slowly in developed countries and faster in developing ones. Because there is a proven link between economic growth and energy demand, we expect that worldwide energy use will grow about 2 percent a year, reflecting long-term trends for improving energy efficiency.

Conventional fuels such as oil, gas and coal have aided both growth and human comfort, and have been affordable. Consequently, their use has expanded rapidly over the last century and they now account for about 80 percent of the energy used today.

And the future?

Numerous experts assess the costs of different energy types and the potential impact of technological changes.

The consensus is that oil, gas and coal will remain cheaper than alternatives for the foreseeable future. Public opposition and lack of suitable sites limit nuclear power and hydropower. Others and we project much faster growth from solar and wind, reflecting both government policies favorable to them and niche market opportunities.

The result of our assessment to 2020 is seen in the three-panel chart. Overall, energy shares will not change much. Because solar and wind power start from such a low base, and are expensive, even with enormous growth they may provide only one-half of one percent of the world's energy in 2020.

It is possible to argue around the edges of this outlook about higher or lower energy efficiency, the impact of unanticipated technologies, and fuel mix. But the enormous size and the capital-intensive nature of the world energy economy mean that changes will not happen quickly.

Yet changes will come, based, we believe, on cost-effective technology advances in the service of consumer needs.

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Building the energy future

Recently we shared our view of the worldwide energy outlook through 2020. Energy use is expected to grow, even with significant efficiency gains, and oil and gas will remain the predominant fuels, reflecting their cost and convenience advantages in meeting consumer needs. Now we will highlight some key implications of this outlook.

First, the world will need to develop substantial new supplies to meet growing demands. By 2015, because of depletion in existing fields, the petroleum industry will need to add the oil equivalent of some 100 million barrels per day to production — close to 80 percent of today's levels. To do this successfully will require access to resources, huge investments, timely project development and government cooperation.

Energy dependency between producing and importing nations will continue to grow. Diversifying supply sources will remain important in promoting energy security.

Second, new technology will be needed to benefit supplies, efficiency and the environment. Exploration and production technologies — such as 3-D seismic imaging, advanced drilling, and arctic and deepwater development — continue to extend the amount of recoverable oil and gas. New technology that directly detects the presence of hydrocarbons is also under development to enhance supplies.

More-efficient and environmentally improved ways of using conventional energy will continue to be deployed. These measures include personal vehicle technology and cleaner fuels. Internal combustion engines continue to improve, as do hybrid vehicles that combine a conventional engine with an electric motor.

Longer term, a possible fuel is hydrogen. Although hydrogen is abundant, it takes a lot of energy to isolate it, and considerable costs to distribute and use it safely. Significant breakthroughs are necessary for hydrogen-based systems to be competitive.

Providing reliable, affordable and clean energy

Advanced technologies must also be developed and deployed to achieve reductions in greenhouse gas emissions without impairing global prosperity. New approaches also need to be applicable in developing nations, which are likely to produce about 60 percent of worldwide carbon emissions by 2020.

Third, government remains a potent force to promote development. Nations are relying increasingly on market forces — not prescriptive regulations. They are recognizing that clear and stable legal and fiscal frameworks are essential to encourage investments. This recognition promises to improve the environment for energy development and thereby to improve the welfare of people everywhere.

Today, roughly 85 percent of the world's population lives in developing countries, where GDP per capita is only about 6 percent of that in the developed world. Providing reliable, affordable and clean energy will bring enormous benefits.

Yet doing so will require the concerted efforts of government and business. Each of us has a role to play. We stand ready to do our part.

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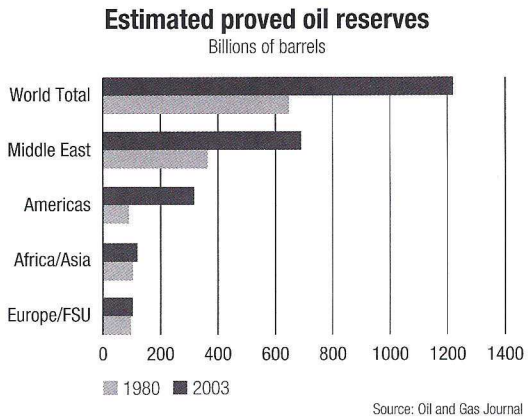
A look back at a look ahead

For decades, forecasts of expected energy demand and supply have been used as an aid to economic and business planning.

As we look back to 1980 prognostications, we see that virtually all energy forecasters significantly underestimated the amount of oil and gas that would be found. Our 1980 expectations were that additions to reserves would soon be well below likely production rates, leading to a decline in proven world oil reserves.



In fact, estimated proven reserves of oil are now nearly twice 1980 levels (see chart). This enormous net increase of nearly 600 billion barrels has occurred even as production over the two decades has exceeded 500 billion barrels.

What accounts for this growth of about 1,100 billion barrels in new oil reserves?

The majority of the global increase stems from factors such as the petroleum industry's increased access to prospective areas, particularly outside the U.S., and significant technological advances. In addition, it is clear that energy forecasters in 1980 did not give nearly enough credit to how greater access to resources and technology would transform the business of finding and supplying oil and gas.

In 1980, we underestimated the resources that exist in deep water, at great depths in the earth, in remote Arctic regions, and in difficult-to-produce "tight" reservoirs. And even when we knew about resources such as heavy oil imbedded in sand formations, we did not know how to produce that oil at costs competitive with costs of other energy sources.

The growth in supplies over the past two decades has been underpinned by technologies that have improved our ability to identify hydrocarbons using advanced seismic technology, to drill wells in deep water, to find resources in remote areas of the world, and to produce from reservoirs at great depth. The promise of greater supplies through new technology is not at an end.

Potential advances such as remote sensing of oil and gas promise to make exploration even more productive and effective. And we expect other improvements in reservoir modeling and production of both conventional and non-conventional resources such as extra-heavy oil or tar sands, of which there are vast quantities.

All of which should add to the ability to find and economically produce and deliver more oil and natural gas, providing many more decades of affordable energy.

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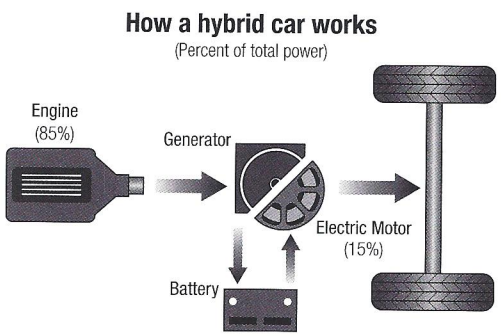
Bridging to the automotive future

Auto shows are famous for dazzling displays of "concept cars" that excite the imagination with future possibilities. Although these cars boast inspired styling, many of us are drawn to check under the hood. And here, the fact is that automotive advances have as much to do with future energy sources and the environment as with design.

Though the ultimate technology choice for personal transportation remains uncertain, the starting point is a basic marvel that powers cars and trucks today — the internal combustion engine. Since Nikolaus Otto's invention of this engine in 1876, technology has continued to produce higher-performing engines with lower emissions. Opportunities for further improvements continue.



One avenue involves research to better understand the complex interactions between a fuel and an engine. Gasoline and diesel fuel are blends of molecules, and each molecule behaves slightly differently during combustion. This research will help optimize future fuel/engine systems for higher efficiency and lower emissions.

A second path involves new combustion engines that have attributes of both gasoline spark ignition and diesel compression ignition. Called homogeneous charge compression ignition (HCCI), these engines combine the efficiency of a high-compression diesel engine with some emissions benefits inherent in a gasoline engine. The payoff of this research can be substantial. For example, better understanding of fuel chemistry and combustion could lead to 30 percent better fuel efficiency, and a corresponding reduction in smog-causing emissions and carbon dioxide.

Other options can also improve automobile performance significantly.

High on the list is hybrid-engine technology. Hybrids use a gasoline engine for steady speeds and an electric motor for extra power during the more-energy-demanding phases of start-up and acceleration. A battery, which is recharged while driving and braking, powers the electric motor. In cities, where this technology has major advantages, hybrids can deliver a fuel-economy improvement of more than 50 percent. Some models using this technology are on the road today.

For the longer term, significant research is under way related to automotive fuel cell systems powered by hydrogen. Hydrogen is abundant but not found alone in nature, and producing it requires significant energy. Technical and economic challenges related to the cost, safe distribution and widespread use of hydrogen remain significant.

As automotive technology advances, improvements in current fuel/engine systems are being introduced worldwide. Nearer-term gains are likely as gasoline and diesel engine advances are combined with hybrid vehicle technology to provide even greater effectiveness in reducing emissions and improving fuel economy.

With growing car ownership worldwide, especially in developing countries, research to deliver further automotive technology improvements together with reliable, affordable and environmentally advanced energy supplies will only increase in importance.

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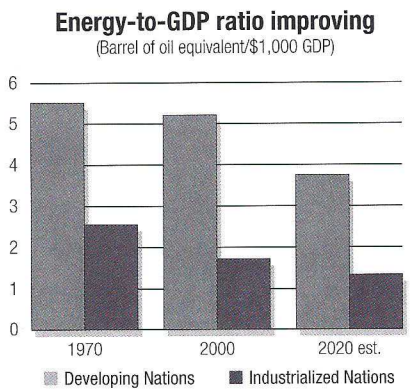
Building a more energy-efficient world

Close to one hundred years ago, President Theodore Roosevelt remarked that "the conservation of our national resources is only preliminary to the larger question of our national efficiency." A century later, the linkage between energy use and economic progress is clear. Reliable and affordable energy supplies have been vital in enabling a remarkably rapid improvement in the quality of life here and around the world.

With growing prosperity and energy use, it is natural that questions regarding the efficient use of energy continue to engage consumers, suppliers, investors and policymakers.



From a historical perspective, energy efficiency has improved dramatically, yielding economic and environmental benefits. As shown in the accompanying chart, industrialized countries now use about one-third less energy to produce $1,000 of economic output than in 1970. On a worldwide basis, total efficiency gains represent energy savings of more than 55 million barrels of oil equivalent (BOE) per day. Without these savings, energy use today would be more than 25 percent greater.

Significant advances in technology have led to better energy efficiency in homes, offices, transport and industrial facilities. ExxonMobil's Global Energy Management System and other efforts have helped improve energy efficiency in our own refineries and chemical plants by more than one-third over 25 years. For example, our cogeneration facilities have improved our efficiency and helped cut expected carbon dioxide emissions by almost 7 millions tons annually, equivalent to about 750,000 fewer cars on the road.

Worldwide, we expect efficiency improvements to continue, averaging about one percent per year and resulting in additional savings of about 60 million BOE per day by 2020.

In power generation, gains will come from growing use of efficient natural gas turbines, combined heat and power facilities, and technologies that continue to improve emerging options.

New transportation technologies, including advanced internal combustion engines and hybrid cars, will also boost energy efficiency.

As the chart shows, we also anticipate continued efficiency improvement in developing nations, which now consume roughly three times more energy per unit of GDP than the industrialized world. Performance will improve as better technologies reach these developing economies, aided by free trade and investment.

Expanding free-market competition and commercial incentives will promote energy efficiency. Market-based prices will provide critical signals for energy suppliers and for the millions of consumers who each day make important personal decisions and tradeoffs regarding the value of energy use and conservation in their own lives.

The path ahead remains to be navigated. But we look forward to the journey, confident that the legacy of this generation will be a better, more energy-efficient world tomorrow.

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Energy beyond 2020

Historically, long-term estimates of how much oil and natural gas exist have been far too low, primarily because forecasts have not sufficiently anticipated the contribution of technology and access to previously barred areas.

Nevertheless, when additions to reserves of petroleum-based energy are no longer adequate to replace production, reserves will begin to decline. We do not know when this will be, as advances in technology will continue to allow us to find petroleum in unanticipated places and develop resources that are currently too expensive.

Of course, economic growth and prosperity are highly dependent on affordable energy. As a result, further efforts to discover and extend the life of oil and gas resources are critical for continuing to improve global standards of living.

Today, oil and natural gas account for about 60 percent of world energy use and are likely to remain the dominant sources of energy through at least mid-century.

Prolonging the availability of needed petroleum resources requires serious public dialogue, increased consumer awareness and a political willingness to take advantage of the energy options that we know exist.

Conservation and wise use of petroleum energy are central to prolongation. Accordingly, we devote hundreds of millions of dollars each year to make our operations and products more energy-efficient. And we strongly support other efforts with the same goal, including work on advanced automobiles for better fuel economy, and cogeneration for better operating efficiency.

But meeting future demand also depends on access to economic resources. For example, known or suspected petroleum resources exist offshore or in areas where exploration and development can be accomplished with little impact. These resources will be needed: access to them should not be delayed forever.

Developing all economical and competitive resources

And petroleum is not the only energy resource that we will need to find economic ways to use. For example, coal resources are enormous — sufficient for centuries. The challenges associated with coal — particularly land-surface impact and air quality — continue to be the focus of technological advances. Other energy forms, such as wind power, are also likely to become more economical and widespread because of technical advances but are also likely to remain small in the context of total energy demand.

Equally vital is a commitment to research and development of very challenging energy options. The full spectrum of alternatives is being investigated by efforts such as the Global Climate and Energy Research Project at Stanford University, which ExxonMobil supports.

Above all, the energy business around the world is immense and touches everyone. To continue to provide opportunities to all people, we will need to simultaneously improve the efficiency of energy use and develop all economic and competitive energy sources.

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These Op-Eds appeared in several U.S. publications *(The New York Times, Washington Post, National Journal, USA Today* and the *Houston Chronicle)* as well as *The Asian Wall Street Journal* and the *Financial Times*.

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