



An Outlook for Energy and the Role of Natural Gas **Steve Briggs** **ExxonMobil Gas & Power Marketing Company**

Energy, in all its forms, is critical to economic growth, development and social welfare. From the world's most modern cities to the smallest communities in developing countries, reliable access to affordable energy is necessary to drive long-term economic and social progress.

Over the next two decades, demand for energy is expected to rise dramatically across the globe, as populations and economies grow at rapid rates. Ensuring reliable and affordable energy supplies to support human progress – safely and with minimal impact on the environment – is a dual challenge facing not only the gas industry, but also governments and societies around the world.

In this presentation, we will examine energy-demand trends to the year 2040. This includes key drivers of rising demand and how this demand will be met by various available energy sources, including fossil fuels, nuclear power and renewable energies. Growth in efficiency and fuel-saving technologies, such as advanced natural gas and wind power plants and hybrid vehicles, are expected to help curb energy demand as well as emissions. New technologies will continue to play a pivotal role to meet the world's rising global energy needs safely and with minimal impact on the environment.

It is important to understand the links between population growth, economic progress, and the amount and type of energy used around the world. Growing populations continue to advance economically over time and seek better living standards, which in general leads to increased energy use. Studying these links gives us a more accurate assessment of future energy demand.

In 1990, the global population was 5.3 billion people. By 2010, it had risen to roughly 6.8 billion people. This represents an average annual growth rate of about 1 percent. However, birth rates today are slowing in most parts of the world, and so between 2010 and 2040 the average annual growth rate is expected to be less than 1 percent. The global population is projected to reach 8.7 billion by 2040, and developing countries, or Non-Organisation for Economic Cooperation and Development [OECD] countries will make up 85 percent of the global population.

Global economic output, as measured by gross domestic product [GDP], is expected to increase about 2.9 percent per year from 2010 to 2040, led by the rapidly expanding economies of the Non OECD. Though the world's economies ebb and flow through cycles, when viewed over decades, economic growth is surprisingly consistent on a global scale. Despite recent economic challenges, global energy demand is projected to increase about 30 percent from 2010 to 2040. We expect developing countries with expanding populations and economies will account for virtually all of the growth in energy use. By 2040, the global demand for energy is expected to rise to nearly 700 quadrillion British thermal units [BTUs]; energy demand in Non-OECD countries will represent nearly 70 percent of that total.

Still, it is important to note that energy demand is rising at a much lower rate than GDP growth; this illustrates the fact that we expect energy use to be much more efficient in the future. Without improved efficiency, we would expect to see an additional 500 quadrillion BTUs of energy demand by 2040! After 2010, global demand for energy is expected to rise at



a more modest rate than it has in previous decades. This is due in part to efficiency, but it is also because the United States, Europe and other OECD countries have already developed their economies to a point where their demand for energy has reached a plateau.

ExxonMobil expects that overall energy demand will continue to see growth across all sectors through 2040. The biggest source of growth is the need for energy to generate electricity around the world. With growing prosperity, energy for electricity generation is expected to grow more than 45 percent between 2010 and 2040.

Electricity generation is expected to be the largest demand sector, accounting for about 40 percent of total energy demand by 2040 and it is the fastest growing sector. The industrial sector, which accounts for approximately 30 percent of demand, is the second largest demand sector. Transportation is projected to be the second-fastest growing sector, at a little more than 1 percent per year through 2040. The residential and commercial sector is expected to see minimal growth, as reduced demand in OECD economies caused by efficiency gains nearly offsets demand growth in Non-OECD countries.

As we look toward 2040, we will continue to see a shift toward cleaner-burning fuels like natural gas and renewables to meet the world's energy needs. However, fossil fuels (oil, coal and natural gas) are expected to continue to meet nearly 80 percent of global energy needs. Other energy types like wind and solar will grow sharply, albeit from a smaller base. Oil is projected to remain the No.1 global fuel to meet the demand for global energy, but natural gas is expected to overtake coal as the No. 2 fuel by 2025. ExxonMobil expects natural gas demand to rise by more than 60 percent through 2040.

On the other hand, coal usage is expected to fall slightly from 2010 to 2040 and by more than 10 percent from 2025 to 2040, marking the first long-term decline in global coal demand since the start of the Industrial Revolution. Global nuclear energy is expected to also grow significantly, at about 2 percent per year, even in the aftermath of the Fukushima incident in Japan. Wind, solar and biofuels are the fastest-growing energy sources; by 2040, they will account for about 4 percent of global energy demand, compared to 1 percent today. Wind is especially strong; it is the fastest-growing source of energy over the 2010 to 2040 period, growing on average about 8 percent a year.

Natural gas plays a critical role in the global outlook for energy. Overall, we see global natural gas production continuing to increase, reaching about 540 billion cubic feet per day [BCFD] by 2040 from about 300 BCFD in 2010. Over the next few decades, we expect to see the composition of natural gas production shifting from conventional gas sources to production from so-called "unconventional" gas sources. Unconventional gas includes gas found in shale as well as tight gas and coal seam methane. Gas from unconventional sources is expected to account for about 30 percent of global gas supplies by 2040. Meanwhile, conventional natural gas production is expected to plateau after 2030.

Demand for natural gas will grow in every part of the world. Gas is the fastest-growing major fuel source through 2040, reflecting technology advances and strong demand for cleaner-burning fuels. Demand for natural gas is rising in all regions and sectors, increasing by more than 60 percent from 2010 to 2040. Asia has the largest volumetric growth with gas demand more than doubling. The Middle East, Latin America and Africa are expected to see strong growth in natural gas demand. While North America, Europe and the Russian and Caspian regions are expected to see relatively modest growth in natural gas demand over the next 30 years.



Natural gas is a versatile fuel that can be used for many purposes, and so the factors driving these increases in natural gas demand vary by region. In North America, natural gas provides a competitive alternative to coal for power generation, especially as greenhouse gas policies are strengthened. Also, recent advances in unconventional U.S. natural gas production will keep domestic supplies ample for the foreseeable future. China's gas growth is split between the electricity generation sector and the residential and commercial sector, where natural gas distribution lines are being rapidly expanded and gas is competitive versus liquefied petroleum gas. In India, about half of the gas growth is in the industrial sector. And in the Middle East, demand for natural gas is being driven by the need for electricity generation as well as industrial demand.

Gas demand for electricity generation is expected to almost double from 2010 to 2040. In OECD countries and more developed Non-OECD countries (i.e., China), growth is driven by gas replacing coal as the cost of CO₂ emissions increases. In the rest of the Non-OECD some countries have abundant local supplies of natural gas. In others, gas is being imported to increase diversity of supply and to provide a clean fuel source to meet local environmental issues, particularly in urban areas.

Demand in the industrial sector has the second-largest growth, driven by an expanding gas grid to industrial areas, particularly in the Non OECD, and ongoing use of gas for fertiliser production. The demand for gas in the transportation sector will grow more than 4 percent per year through 2040, but this growth is on a small base, and so will constitute only a small portion of total global gas demand by 2040.

From where will the gas supplies come to meet the world's future natural gas needs? Natural gas is an abundant, widespread resource. The International Energy Agency [IEA] estimates that the world has more than 28,000 trillion cubic feet [TCF] of remaining recoverable natural gas resources. With this resource base, the IEA estimates the world will have about 250 years of natural gas at current demand levels. Resource estimates from other sources currently vary between 175 to 250 years of coverage. Globally, unconventional gas makes up about half the estimated remaining resource. In North America, about two-thirds of the remaining resource is unconventional gas. The Russia and Caspian regions have more than 8,000 TCF of remaining recoverable gas resources. According to the IEA, the Middle East and North America hold 4,900 TCF and 4,800 TCF, respectively, while Europe is the region with the smallest remaining recoverable gas resource at 1,300 TCF.

From where will consumers get natural gas to meet rising demand? Globally, unconventional gas and liquefied natural gas [LNG] are expected to play an increasing role, but the answer will vary widely by region. Given its flexibility, LNG is a natural choice to help meet the world's growing energy needs by allowing gas from countries with large resource bases to reach countries with high gas demand.

In North America, we expect demand to grow modestly and then flatten toward 2040. Unconventional gas production is expected to grow substantially and is expected to satisfy around 75 percent of the region's gas demand by 2040. The United States is benefitting from recent technology advances that have made the production of unconventional gas supplies much more economical, enabling companies to tap vast quantities of natural gas found in shale and other rock formations around the country. Declining conventional gas production in the United States is being more than offset by growth in unconventional gas production. Unconventional gas is expected to almost entirely eliminate the need for imports into North



America. It is unclear if other parts of the world will achieve a growth in unconventional gas production of similar magnitude to the United States, but we do anticipate unconventional production becoming a growing source of supply.

In Europe, while we expect similar demand trends to North America, local natural gas production continues to decline, resulting in increasing dependence on imports over the next two decades. This will require more pipeline supply, primarily from Russia and Caspian countries, as well as LNG. Later in this period, we also expect to see an increase in local unconventional production, which will reduce the need for imports.

In the Asia-Pacific region domestic gas production continues to climb from both conventional and unconventional gas sources, but local production is outpaced by growth in demand. As a result, the Asia-Pacific region will see a continuing reliance on gas imports, especially LNG, which meets more than 35 percent of that region's demand in 2040. Much of this increased LNG will come from other Asia-Pacific countries such as Australia and Papua New Guinea.

In Latin America, local natural gas production is expected to increase to meet rising demand, with the potential for unconventional gas to contribute much of the region's supply growth later in the period. The Middle East, Africa and Russia also have unconventional gas resources, but gas demand is expected to be met primarily by increasing conventional production.

Looking out to 2040, ExxonMobil projects that global energy-related CO₂ emissions are expected to continue to rise globally through 2030, growing by about 15 percent, and then remaining relatively flat out to 2040. This is primarily a reflection of declining emissions in OECD countries as efficiency improvements and carbon costs shift the fuel profile, along with a reduction in China's emissions over this period as carbon costs are incorporated and the country moves away from less-efficient heavy manufacturing. From 2010 to 2040, all of the increase in CO₂ emissions occurs in Non-OECD countries.

In OECD countries, we see energy-demand growth that would (absent any offsets) drive CO₂ emissions higher. However, this growth is more than offset by efficiency gains and the use of less carbon-intensive fuels. As a result, OECD emissions are projected to fall by approximately 20 percent from 2010 to 2040. For Non-OECD countries, there is a steep increase in energy demand between 2010 and 2040. About 80 percent of the emissions associated with this increased demand are expected to be offset by efficiency gains and a smaller offset from less carbon-intensive fuels. Overall, Non-OECD emissions are projected to increase by more than 40 percent over the period through 2040, but still significantly less than the almost 60 percent increase in energy demand.

As we look out to 2040, we see ongoing challenges to development. By 2040, the world population will be approaching 9 billion people, and each one of them will be seeking improved standards of living. We will need to develop all reliable, affordable forms of energy and capture significant gains in energy efficiency to meet global energy demand, which will grow by 30 percent between 2010 and 2040. At the same time, we see an ongoing need to protect the environment for future generations. Natural gas will play a pivotal role in achieving this objective.

However, while it is important to acknowledge our energy challenges, ExxonMobil is optimistic about our ability to meet them. World development will continue. Lives will improve and economies will grow. Access to energy to fuel an expanding global economy will be key



to reducing poverty, enhancing literacy, and improving health and life expectancy. Technology will continue to evolve and will play a key role in increasing efficiency, expanding supplies, and mitigating emissions. These three elements must be pursued with vigor and constancy of purpose over many decades if we are to meet our global energy and environmental challenges.

In conclusion, I would like to leave you with two thoughts. First, this energy outlook was developed by a team of experts within ExxonMobil, reflecting as best we can an informed view of what the energy future will actually look like to 2040. Naturally, the future is subject to any number of unexpected developments that we cannot predict with precision. For example, a breakthrough in low-cost, large-scale electricity storage would greatly improve the prospect for wind and solar for power generation. Unusual economic or geopolitical events might also have significant impacts. And, of course, a dramatic pooling of various technologies can help unlock vast resources, much like what we are seeing today with unconventional gas.

And second, when it comes to energy, the future is not predetermined. How much, and what types, of energy we will use through 2040 and beyond will depend on the actions taken not just by companies like ExxonMobil, but by everyone, including policymakers and consumers.