

- The world's energy needs will continue to soar as developing countries seek prosperity for their citizens.
- The economic security of developed countries continues to depend on reliable sources of oil.
- Action to reduce CO₂ emissions must be taken while the causes of climate change are studied.

Our future in the balance

The task of balancing conflicting global economic and environmental pressures is going to be a huge challenge. And it is a balance we can only get right by deepening our understanding of the economic and environmental consequences of our energy choices, writes Rex W Tillerson, chairman and CEO of ExxonMobil Corporation.



By 2030 the world's energy needs will be almost 50% greater than they were in 2006, driven mostly by growth in developing countries, as they attempt to escape poverty and secure a degree of prosperity.

An immense industry is required to meet the world's energy needs, the scale of which is often difficult to grasp. Every day, consumers around the globe use the energy equivalent of 230 million barrels of oil. Oil alone is consumed at a rate of 40,000 gallons a second. To give you another perspective on the oil industry's size, ExxonMobil has the largest market capitalisation of any corporation in the world, yet it produces no more than 2% of the world's total energy. Meeting the world's rapidly growing and varied energy needs in future is an immense challenge.

And there are many additional challenges we face, energy security being one. The gap between US energy consumption and domestic energy production – a gap of 15mb/d of oil equivalent a day, or 30% of daily demand – is filled primarily by imports of fossil fuels, which may come from unstable parts of the world.

Another challenge comes on the form of the environmental impact of energy use. Industry has made tremendous strides in developing cleaner fuels and lowering its emissions in recent years to meet rising environmental expectations, but no energy source of sufficient scale to meet global needs comes without consequences. How do we manage the inevitable environmental impacts of increased energy use?

With an understanding of the importance, scale and complexity of the challenge before us we can better answer questions about our energy future.

Meeting our needs

Many question whether sufficient oil remains to meet our needs. Some worry that we will soon reach 'peak oil' or the point at which worldwide oil production begins to decline. Oil, like all fossil fuels, is finite, but it is far from finished. The US Geological Survey estimates that approximately two trillion barrels of conventional oil resources remain – or about twice the amount yet produced. An



The production and refining of oil will continue to be a fact of life for the foreseeable future.

additional one trillion barrels of unconventional oil resources, such as heavy oil and oil sands, are also believed to be recoverable. And don't forget industry's extraordinary track record of using technology to expand the resource base.

Fossil fuels are not the only energy resource, of course. Alternative sources play an important and growing role in meeting the world's energy needs. Some, such as wind and solar, are likely to see double-digit growth over the next 25 years, due in part to government mandates and subsidies. However, these alternatives build upon a relatively small base and are expanding within a world energy system that is itself expanding.

For this reason, these alternatives will not fundamentally change the world energy mix, despite their impressive growth, while challenges of scale, cost and technical limitations must be overcome if they are to contribute in a material way. Several energy companies – including ExxonMobil – are supporting research and development into ways for alternatives to overcome these hurdles. But until energy breakthroughs are achieved and implemented worldwide, fossil fuels will remain the predominant energy source for the foreseeable future. No other energy source holds the same advantages of availability, affordability and adaptability.

So the real question is not whether we will soon reach peak oil, but whether we can reach peak performance in terms of the responsible production and use of oil and other fossil fuels.

The answer to that question is as much a matter of policy as geology. If policymakers enable the investment, technology and managerial expertise found in the oil industry to be brought to bear on the available resources, we can produce, refine and deliver the energy we need in an economic and environmentally responsible way.

Energy independence

A second question dominating many minds in the US is the issue of energy security: can Americans achieve so-called energy independence? As I mentioned earlier, the current energy demand-domestic supply gap in the US is approximately 15mb/d a day. More efficient use of energy can reduce demand, and increased use of alternatives can increase domestic energy supply, but no conceivable combination of the two can realistically close the gap. To leave the gap between supply and demand unfilled would have dire consequences for the US economy, and possibly the country's security.

But if energy independence is not a viable path to greater energy security, energy diversification is. The best hedge against a market is a diversified portfolio. The same holds true for the US's energy supply portfolio. More energy from more sources mitigates the impact from a downturn in any one supplying country or region.

The US's experience during the hurricane season of 2005 proves the point. With as much as 25% of US refining capacity shut down in the aftermath of hurricanes Katrina and Rita, an influx of fuel imports from Europe helped meet the shortfall and there were no supply interruptions in the US. Diversification, enabled by free markets, strengthens US energy security. And free trade and investment are enabling the diversification of US energy supplies. Currently, Americans import crude oil from over 30 countries on six continents, and are importing more and more every day.

About 55% of US oil supplies originate in North America. No other region – including the Middle East – meets more than 15% of US oil needs. It may surprise some to learn that the US imports more oil from Mexico than it does from Saudi Arabia.

Betting on biofuels

What about biofuels, such as ethanol? Could domestic production of these sources enable Americans to achieve energy independence?

This question has captured the popular imagination, and Brazil's success in reducing oil imports has provided some inspiration.

Biofuels, like many alternative energy sources, can play an important role in increasing the energy supply. But they currently face significant obstacles. In the US, corn is the principal source of ethanol. Currently, 13% of the US corn crop is needed to meet 2% of total US petrol demand, by equivalent volume. By 2012, mandated ethanol production would drive ethanol's share of total US petrol demand up to 3%. But to achieve this, about 21% of the US corn crop will be needed – an increase of about 50%. Clearly the US cannot produce enough ethanol from corn to meet its needs.

Brazil is an interesting case. Ethanol production there has been on the rise, in part because its principle feedstock, sugar cane, produces a higher yield of ethanol at a lower cost per gallon than corn. Brazil now produces the same amount of ethanol as the US does, for a petrol market one-twentieth of the size.

But what is often not mentioned is that, while Brazil has boosted ethanol production by three to four times over the past 25 years, it has substantially boosted its domestic oil production more than tenfold over this same period. Brazil became energy independent by increasing oil production. In fact, about 85% of Brazil's current liquid fuels demand is met by domestic oil production and about 15% by domestic ethanol production.

This brings me to a question I am often asked: Can the US boost its oil production? The US is a mature oil province, meaning that a sizable portion of the oil found there has already been tapped. However, a sizeable portion has not. In fact, the US was endowed with the second largest oil and gas resource base in the world, and even after more than a century of development and production is still ranks fifth in terms of remaining oil and gas. This domestic resource currently meets approximately 50% of US domestic demand, but it could supply more if more of it were opened to exploration, development and production.

Federal and state governments in the US have ruled an estimated 31 billion barrels of recoverable oil and 105 trillion cubic feet of natural gas off-limits. Most of this is not to be found in the Arctic National Wildlife Refuge, but in the Rockies and off the coast of the continental US.

Industry has developed the technologies and acquired the experience to produce these resources safely and with a minimal environmental footprint, and this is being done around the world

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today. What is lacking is permission to access these resources. The granting of access to them could lead to reduced imports.

As well as obtaining access to existing untapped resources, the US needs to continue to develop the technologies required to produce, refine and deliver hydrocarbon resources in an effective, economic and environmentally responsible way.

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High-tech industry

In discussions about technology in the oil and gas industry, two things often surprise me. First, some claim that the era of 'easy oil' is over. It is true that today oil is not easy, but during my 32 years in the industry it never has been. Changing conditions, growing demand and evolving environmental expectations test the latest technology and require the industry to innovate continuously. Oil only seems easy after it has been discovered, developed and delivered.

The second surprise is the perception that the oil industry is not particularly high tech. ExxonMobil topped the Fortune 500 list of US companies last year. It invested over \$1 billion last year in technology applications and R&D, and it currently employs over 14,000 scientists and engineers. Nevertheless, the magazine does not categorise any oil and gas company as a technology company, as it does many pharmaceutical, computer and aircraft manufacturers. Perhaps it is because the industry's most well-known product, petrol, appears simple when compared with a mobile phone or a flat-screen television. Even the term 'fossil fuels' sounds primitive.

However, the fact is the oil business is an extraordinarily technology-intensive enterprise, from the wellhead to the petrol pump. Innovations have enabled the industry to overcome incredible obstacles to produce something that seems so simple and has been relatively unchanged for decades.

In eastern Russia, for example, cutting-edge directional drilling technology is being used to intersect a reservoir target with pinpoint accuracy to reach oil and gas reserves one mile deep and six miles away laterally. Offshore in West Africa, floating drilling vessels are being deployed to drill in waters almost 4,000ft deep and produce to massive floating and storage vessels. Meanwhile, at refineries, nanocatalysis is being used to manage hydrocarbon molecules and remove impurities from oil products. Technologies such as these have helped the oil industry dramatically reduce

the emissions that arise from burning its fuels. A new car today, running on new low-sulphur diesel fuel and equipped with the most advanced emissions technology, produces 97% less emissions than a new vehicle did in 1970.

The industry can and will continue to achieve such technological feats and make oil look easy – even if it is not – as long as the right conditions and sensible policies are sustained.

Climate change

For all the technological progress that has been achieved in the energy field, we have yet to discover or develop an energy source that meets the world's enormous needs without affecting the environment. There are no silver bullets for the energy-environment challenge, and this is a reality we dare not ignore and must not mismanage. This is especially true when it comes to the issue of climate change.

While our scientific understanding of climate change continues to improve, it remains nonetheless an extraordinarily complex area of scientific study. Having said that, the risks to society from climate change could prove to be significant, so despite the areas of uncertainties that exist, it is prudent to develop and implement strategies that address the potential risks.

In my view, this means we should continue to fund ongoing scientific research without conditions or preconceived outcomes to increase our understanding of all of the forces that are part of the Earth's elegant, but highly complex, climate system. This should include ongoing study, not only of the effects of human socio-economic activity, but also, and perhaps more importantly, of the natural factors that are and always have been part of the Earth's climatic system.

While the scientific community continues this study, we should gradually pursue public policies and learn along the way, while fully recognising the economic consequences of our actions. All countries should be brought into the effort. This is a global, century-scale problem. Some 85% of the growth in CO₂ emissions are associated with economic activity in the developing world, while only 15% of this growth comes from developed countries. We should start to reduce the likelihood of the worst outcomes while being mindful of the consequences of managing carbon emissions and other developing world priorities, such as economic development, poverty eradication and public health. We should now take steps to reduce emissions in effective and meaningful ways.

Emissions reduction

Improving the fuel economy of the light duty vehicle fleet is one way of reducing emissions. Reducing emissions from coal-fired power plants must also be a priority, as power generation

produces more than four times the carbon dioxide emissions of light duty transport worldwide.

The important point is that a variety of ways exist to mitigate carbon dioxide emissions, but weighing the options effectively requires understanding the scale and cost of the economic and quality of life tradeoffs involved.

Research and development into new technologies could change the game. ExxonMobil through its longstanding relationships with manufacturers of cars and commercial industrial engines is researching improvements to conventional internal combustion engines that could lead to 30% better fuel economy and lower environmental emissions.

Wishful thinking will only lead us farther away from a long-term solution.

The Global Climate and Energy Project (GCEP), based at Stanford University, epitomises this game-changing technology approach. By accelerating research into promising new energy technologies with economic and environmental potential on a worldwide scale, scientists at GCEP are progressing towards breakthroughs that could lead to meaningful, worldwide emissions reductions.

GCEP scientists are researching how hydrogen and solar energy can be made economic, how engine and fuel systems can be made significantly more efficient, how carbon dioxide capture and storage can be made more effective, and how biofuels can be more widely produced.

Questions of peak oil, energy independence, biofuel potential, access to resources, technological innovation and climate change are defining the energy dialogue. A fact-based understanding of the global energy challenge and the energy industry is vital to any determination of an appropriate long-term energy policy. Wishful thinking will only lead us farther away from a long-term solution. ●



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