

Energy and Climate

ExxonMobil¹ appreciates this opportunity to provide comments on the topics of global energy and climate change.

The Importance of Energy

Energy is everywhere and it transforms everything. It is critical to the health, welfare and progress of society. Accessible and affordable energy has made possible many of the breathtaking technological advancements enjoyed by humanity over the past 100 years. These advancements include the growth of agricultural yield, personal mobility, aviation, electrification, chemicals, medical care and manufacturing, to name just a few. The impact of these advancements is real and profound and can be measured in terms of longer life spans, reduced infant mortality, and the effective management and even elimination of diseases that plagued prior generations. Energy is so important to modern-day life, that some consider its ready and affordable access a fundamental right.²

Not everyone in the world has ready access to affordable energy³ and not all access is in the same proportion of energy sources. Energy use tends to rise with improved living standards and varies on a regional basis.

¹ As used in this document, “ExxonMobil” means Exxon Mobil Corporation and/or one or more of its affiliated companies. Statements of future events or conditions in this report are forward-looking statements. Actual future results, including economic conditions and growth rates; energy demand and supply sources; efficiency gains; and capital expenditures, could differ materially due to factors including technological developments; changes in law or regulation; the development of new supply sources; demographic changes; and other factors discussed herein and under the heading “Factors Affecting Future Results” in the Investors section of our website at: www.exxonmobil.com. The information provided includes ExxonMobil’s internal estimates and forecasts based upon internal data and analyses, as well as publicly available information from external sources including the International Energy Agency. Citations in this document are used for purposes of illustration and reference only and any citation to outside sources does not necessarily mean that ExxonMobil endorses all views or opinions expressed in or by those sources.

² See e.g., “Energy for a sustainable future”, The UN Secretary General’s Advisory Group on Energy and Climate Change (AGECC), Summary Report and Recommendations, 28 April 2010, New York and The World Summit on Sustainable Development, September 2002.

³ According to the International Energy Agency, 2.6 billion people still rely on biomass for cooking and over 15% of the world’s population lacks access to electricity (<http://www.iea.org/topics/energypoverly/>).

Climate change poses a risk

While there remains uncertainty in projecting future changes in climate and associated impacts, ExxonMobil believes that changes to the earth's climate, including those that may result from anthropogenic causes, pose a risk; and, in order to address this risk society should consider economically efficient policies that include both mitigation and adaptation, and that balance reduction in climate risk with other global developmental needs, including the need to sustain and provide for growing populations. Climate change is an important consideration for ExxonMobil and its Board, and the Board is updated at least yearly on developments in climate science and policy. We are taking prudent steps on many fronts to address the risks posed by a changing climate, and we also continue to engage the public and policy makers in many ways regarding the issue.⁴

The Outlook for Energy: A View to 2040

Each year ExxonMobil develops and publishes its views on energy sources, requirements and trends.⁵ This Outlook provides the foundation for our business and investment planning and is compiled from the breadth of the company's worldwide experience in and understanding of the energy industry and is based on rigorous analyses of demands, technology, economics and policies. Our most recent Outlook spans the period through 2040. The Outlook is reviewed and discussed extensively with the company's Management Committee and Board prior to its release. The following are some key conclusions from this year's Outlook.

1. Population continues to increase, but at different rates throughout the world

We believe that earth's current population of 7 billion will increase by almost 2 billion through the Outlook period.⁶ Most of the growth will be in the developing

⁴ See discussion, *infra*, on our Engagement at p. 13.

⁵ The *Outlook for Energy: A View to 2040* (Outlook), <http://corporate.exxonmobil.com/en/energy/energy-outlook>.

⁶ See Outlook at p. 10.

world, in many of the same countries that are seeking to improve the living standards of their citizens. Others forecast similar population growth.⁷

2. The world economy grows at a faster pace than population

The world is not only growing larger in terms of population, but it is also growing wealthier. We see the global economy growing over the Outlook period by about 130%, but growth rates will vary around the world. OECD countries are forecast to average a 2% annual growth over the period, whereas non-OECD countries are expected to average a 4.4% annual growth through 2040 as their populations move up the development ladder. Overall, world GDP per capita in 2040 will be 80% larger than it was in 2010, as global GDP will increase on average more than three times the growth rate of population. The resulting economic expansion relative to population means improved living standards for billions of people, especially those in greatest need. It also translates into substantially more demand for energy.

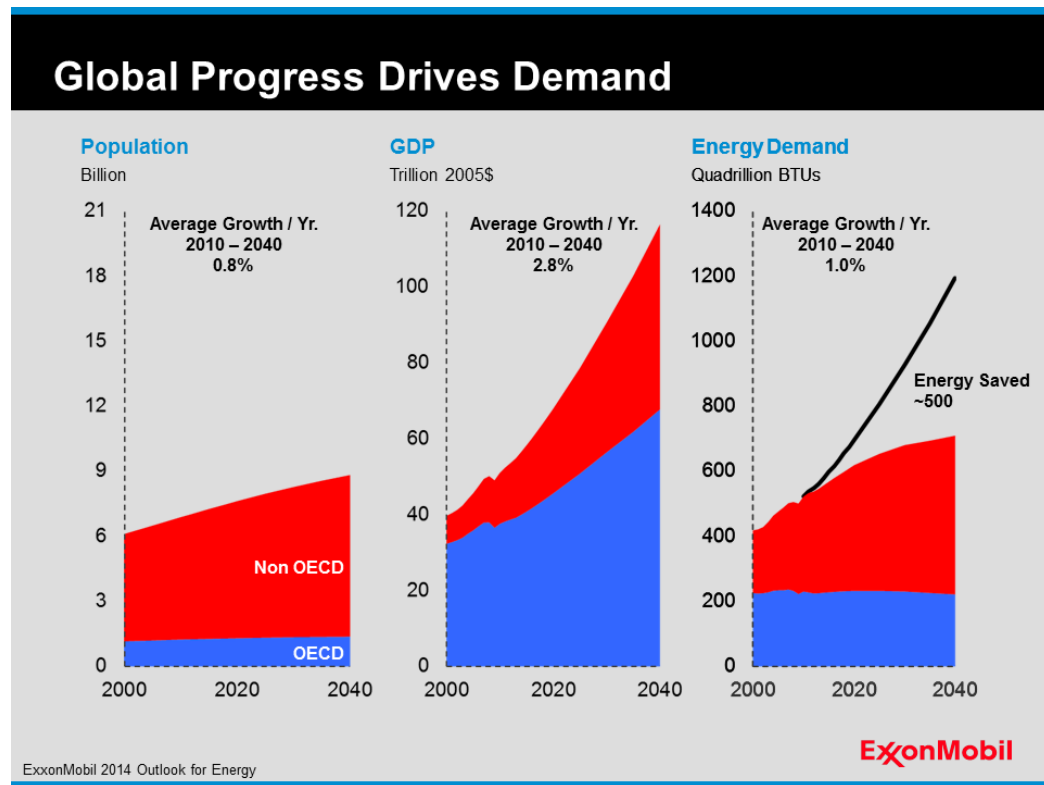
3. Energy demand grows less than GDP thanks to efficiency

As the world grows in population and wealth, it will also become more energy efficient. Due in large part to the factors described above, we forecast that the world will require 35% more energy in 2040 than it currently uses, which is generally consistent with other prominent forecasts.⁸ While this is slightly more than the population growth rate over the Outlook period, it is significantly less

⁷ See e.g., World Population to 2300, Department of Economic and Social Affairs, United Nations, New York, N.Y., and World Bank's database of Health, Nutrition and Population at <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTHEALTHNUTRITIONANDPOPULATION/EXTDATASTATISTICSHNP/EXTHNPSTATS/0,,contentMDK:21737699~menuPK:3385623~pagePK:64168445~piPK:64168309~theSitePK:3237118,00.html>.

⁸ For example, the IEA in its recently released World Energy Outlook, 2013, New Policy Scenario, predicts total energy growth of about a third through 2035, which is slightly higher than our Outlook forecast of 31% growth in total energy use by 2035. For more information on the IEA's World Energy Outlook, See www.worldenergyoutlook.org.

than the rate of anticipated economic expansion.⁹ A key reason why we expect energy demand to grow more slowly than GDP is efficiency. Efficiency gains arise in part due to technological advances and investment. We estimate that the savings to society associated with efficiency gains through the Outlook period are considerable, nearly equaling the *total* amount of energy consumed in 2010¹⁰ and we believe continued focus on enhancing efficiency is one of society’s best means of providing the energy society needs while addressing climate change risks.



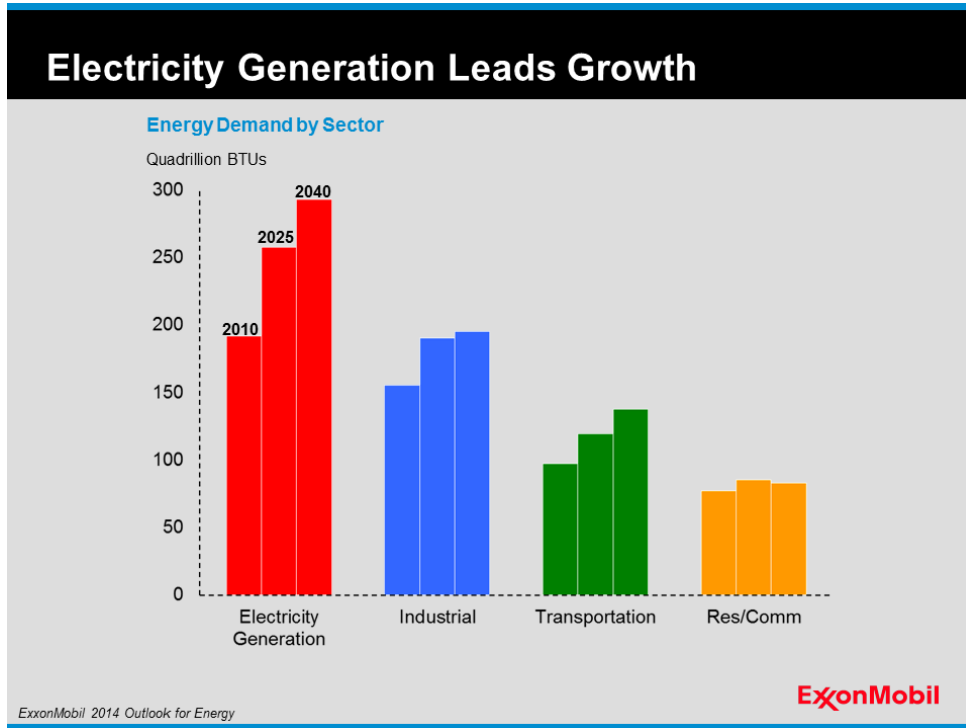
4. Power generation will be the fastest growing demand sector

Worldwide electricity use is projected to increase by 90 percent from 2010 to 2040, with developing countries accounting for most of the increase. As noted above, about

⁹ For comparison purposes, the anticipated growth in energy demand 2010- 2040 will be only 80% of what it was between 1980-2010, even though economic expansion over the Outlook period is twice that of the 1980-2010 period. See Outlook at p. 13.

¹⁰ It could be as much as 500 quadrillion BTUs by 2040. For comparison purposes, without these efficiency gains, global energy demand could rise by as much as 100% over the Outlook period.

1.3 billion people still lack access to electricity today, with half of them in Africa. Urbanization and improved living standards will lead to substantial increases in global electricity usage.



5. Proxy cost for emissions policy

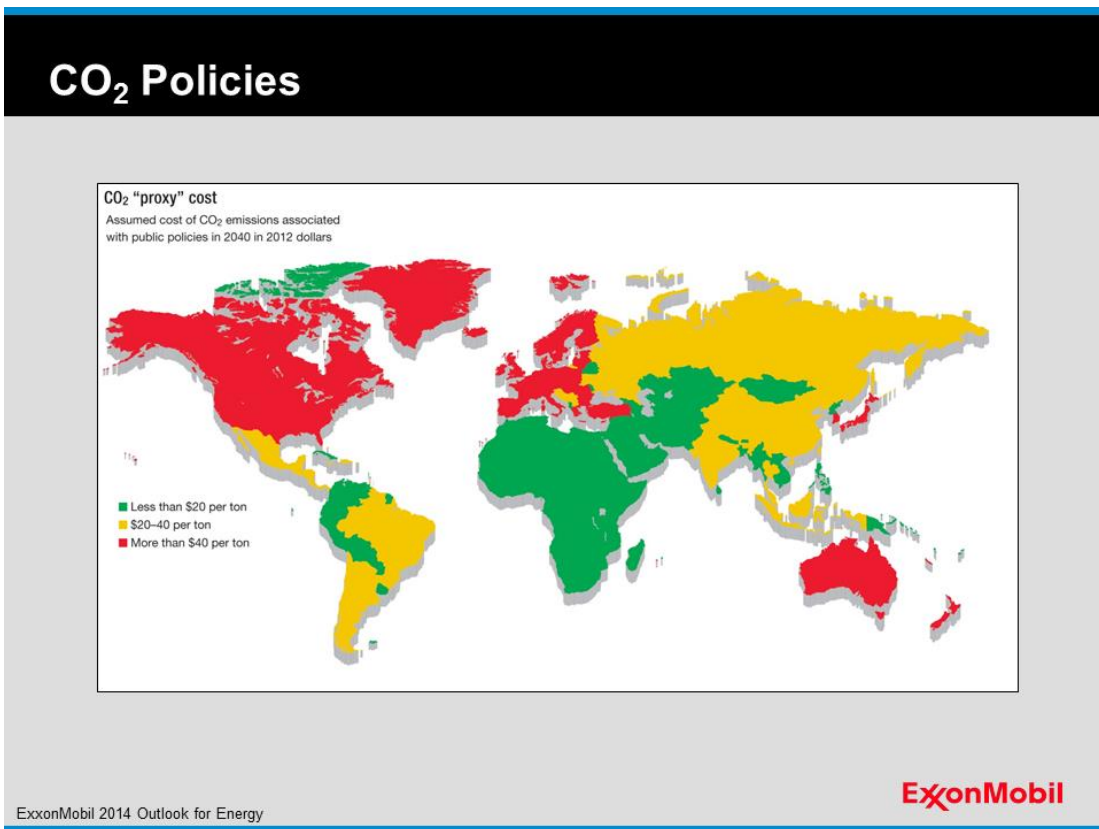
A key factor in assessing the world's energy outlook is the impact of public policies. One area of significant interest in recent years relates to policies enacted to reduce greenhouse gas (GHG) emissions.

Today there are policies in effect that are designed to limit GHG growth, and we anticipate additional policies developing over time. We expect OECD nations to continue to lead the way in adopting these policies, with developing nations gradually following, led by countries like China and Mexico.

Future policies related to limiting GHG emissions remain uncertain and likely will vary over time and from country to country. However, for our Outlook we use a cost of carbon as a proxy to model a wide variety of potential policies that might be

adopted by governments to help stem GHG emissions. For example, in the OECD nations, we apply a proxy cost that is about \$80 per ton in 2040. In the developing world, we apply a range of proxy costs with the more wealthy countries, like China and Mexico, reaching about \$30/ton in 2040.¹¹

The exact nature and the pace of future GHG policy initiatives will likely be affected by their impact on the economy, economic competitiveness, energy security and the ability of society, including those less fortunate, to pay related costs.



This GHG proxy cost is integral to ExxonMobil's planning, and we believe the policies it reflects will increase the pace of efficiency gains and the adoption by society of lower-carbon technologies through the Outlook period, as well as

¹¹ For a more detailed discussion of the implied cost of carbon and how we see this impacting energy mix and GHG emissions, see <http://www.exxonmobilperspectives.com/2013/12/05/exxonmobil-on-carbon-policy-and-business-planning/>.

accelerate the growth of lower carbon sources of energy like natural gas and renewables, while suppressing the global use of coal.

The proxy cost that ExxonMobil uses is not the same as a “social cost of carbon” (SCC). ExxonMobil’s proxy cost seeks to reflect a reasonable approximation of costs associated with policies that society may impose over time on GHG emissions, policies that we believe would drive society towards increased efficiency and changes to the energy system and its fuel mix. The SCC is intended to reflect the current cost of GHG emissions, including future climate change impacts and costs, which we believe are subject to considerably more scientific uncertainty and modelling subjectivity.

6. Emissions stabilize and start decreasing

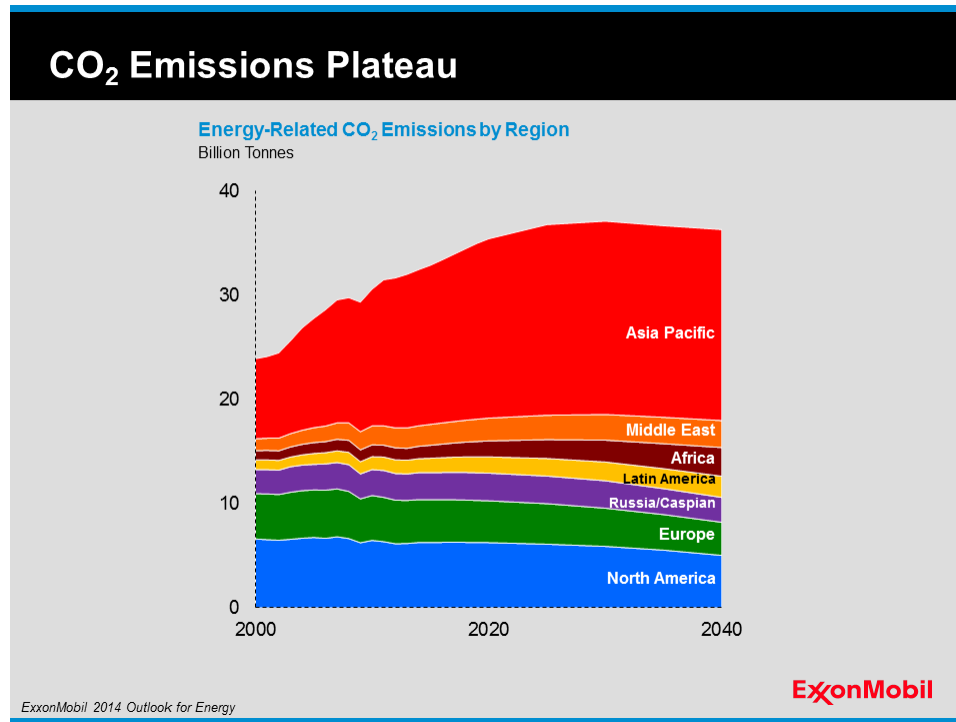
As the world population grows, becomes wealthier and more efficient, and as more stringent GHG reduction policies are adopted, we believe GHG emissions will plateau and start decreasing during the Outlook period. Energy-based GHG emissions have already peaked and are declining in the OECD countries. While GHG emissions grow initially in a number of the non-OECD countries as these countries develop economically, emissions are expected to start plateauing during the next decade and will begin declining during the subsequent decade. Importantly, we believe China’s GHG emissions will plateau and begin to decline by 2030, driven by ongoing efforts to improve energy efficiency and reduce the carbon intensity of their economy, and address pollution. Again, our views in this regard are similar to what others forecast.¹²

As part of our energy outlook process, we do not project overall atmospheric GHG concentration, nor do we model global average temperature impacts.¹³ However, we do project an energy-related CO₂ emissions profile through 2040, and this can be

¹² For example, the IEA predicts that energy-related emissions will grow by 20%, on trend but slightly higher than our Outlook. See www.worldenergyoutlook.org.

¹³ These would require data inputs that are well beyond our company’s ability to reasonably measure or verify.

compared to the energy-related CO₂ emissions profiles from various Intergovernmental Panel on Climate Change (IPCC) scenarios. When we do this, our Outlook emissions profile through 2040 would closely approximate the IPCC's intermediate RCP 4.5 emissions profile pathway in shape, but is slightly under it in magnitude.¹⁴

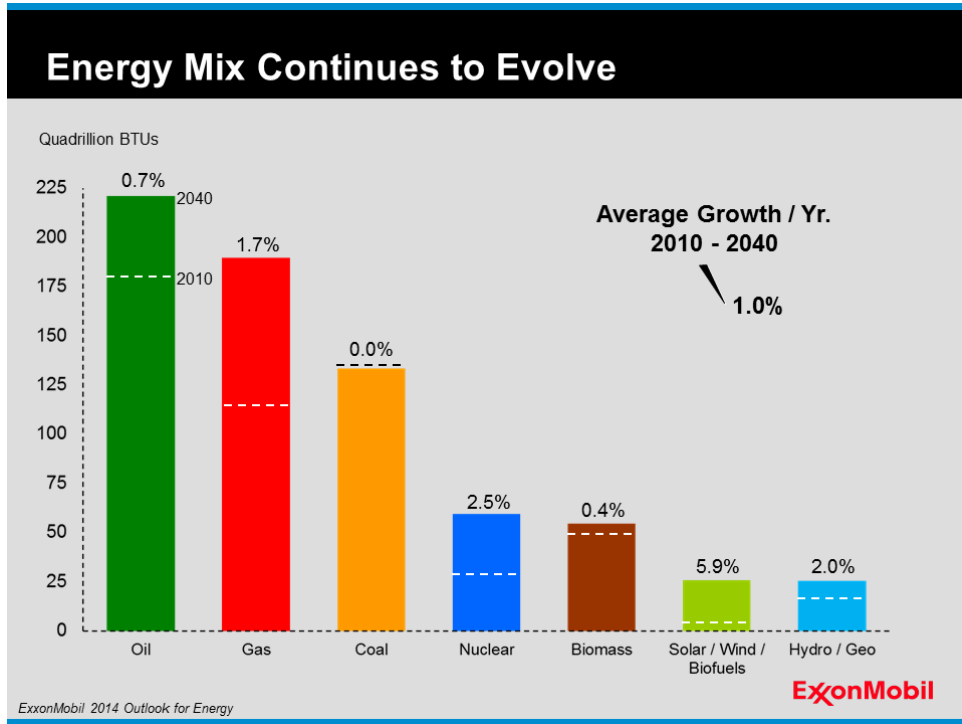


7. Energy use grows and becomes less carbon intensive. Renewables grow fastest, but still account for less than 5% of total energy

Globally we expect energy use to grow by 1% per year from 2010 to 2040, with total energy used about 35% higher in 2040 than 2010. Lower carbon sources of energy, such as natural gas, nuclear and renewables, are expected to grow at the fastest rates. Coal use peaks and then begins to decline for the first time in history. Solar and wind power grow at a very high rate of almost 8%/year throughout the Outlook period, but

¹⁴ The IPCC RCP 4.5 scenario extends 60 years beyond our Outlook period to the year 2100, and incorporates a full carbon cycle analysis. The relevant time horizons differ and we do not forecast potential climate impacts as part of our Outlook, and therefore cannot attest to their accuracy.

due to the vast scale of the global energy system, still account for less than 5% of the total energy mix by 2040.¹⁵

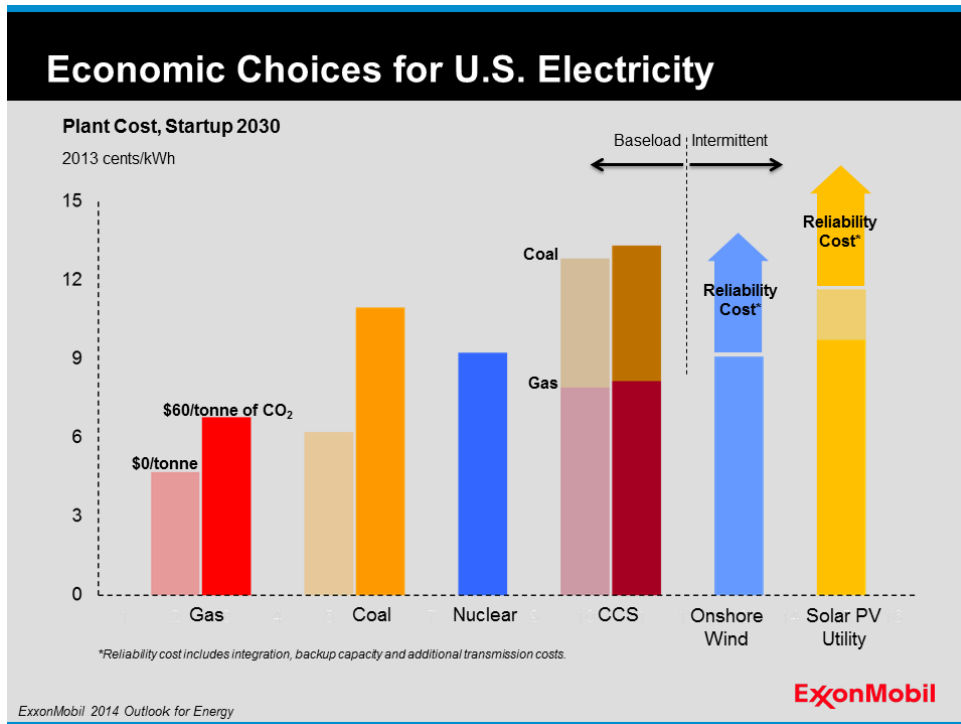


Despite recent improvements in cost, we believe renewable energy sources like wind, solar and biofuels will generally remain more expensive to consumers than more traditional, carbon-based sources of energy. This, especially in relation to the scale of the global energy market, will serve to limit the penetration of renewables in the market during much of the Outlook period, despite the anticipated high rate of growth.

Additionally, wind and solar renewables are intermittent – the wind does not always blow and the sun does not always shine – so they require backup from some other source, typically traditional simple cycle gas-fired generation. Relative economics play an important role in electricity supply choices. A comparison of economic

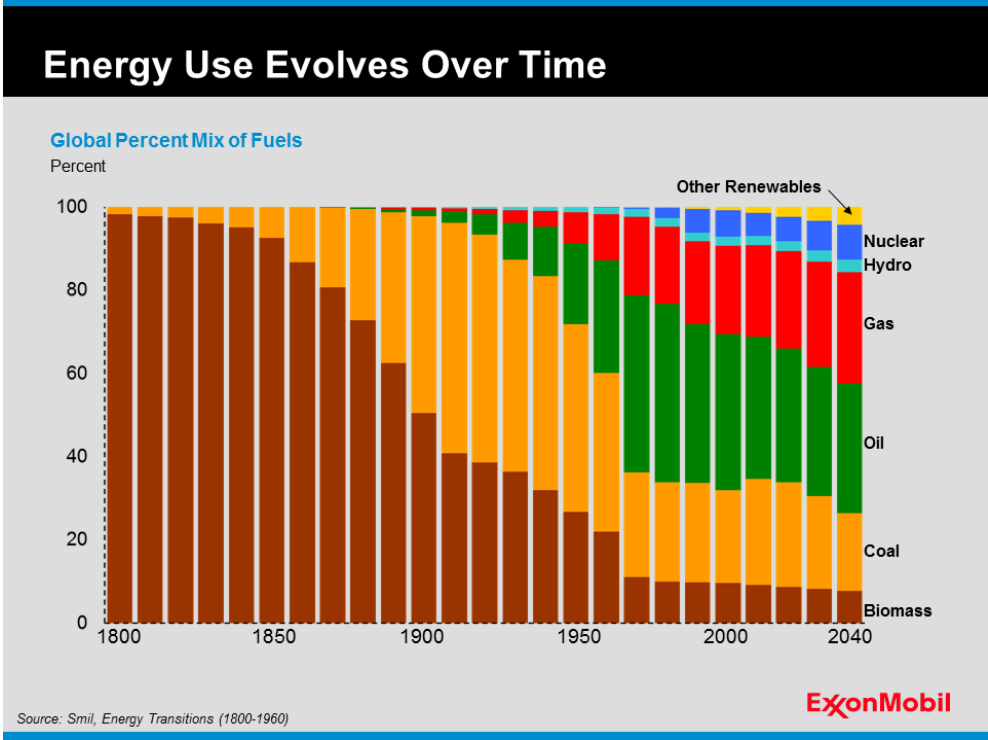
¹⁵ The inability of renewables to scale up during the Outlook period to meet society’s energy needs is well recognized by some climatologists. See e.g., <http://www.cnn.com/2013/11/03/world/nuclear-energy-climate-change-scientists-letter/>. A number of these recommend nuclear as a means to address the shortfall, but nuclear power raises other considerations for society that may limit its acceptance.

choices for U.S electricity, both without and with a cost to emit CO₂, is shown in the chart below. We expect gas, nuclear, and gas with carbon capture and sequestration to remain less expensive power generation options versus wind and solar for at least several decades, particularly when considering the added cost for grid reliability associated with intermittent renewables.



8. Energy use evolves slowly due to the vast size of the global energy system

Society’s energy mix has shifted over long periods. As shown in the chart below, for much of humanity’s existence, biomass like wood was society’s primary fuel. Coal began to supplant biomass in the early 1800’s, but did not become the primary fuel source until about 1900 and it took another 50 years before oil overtook coal as the primary source of energy. Because of the vast scale of the global energy system, (as noted above, energy use today is 25 times what it was in 1800) we believe the transition to a low carbon economy will also take decades, despite rapid growth rates for lower carbon energy sources.



Key Objectives for Long Term Climate Policy

We believe it is important that as policymakers seek to provide accessible and affordable energy for all, they also carefully consider the risks posed by climate change, including climate change that may result from anthropogenic causes. The risks of climate change are serious enough to warrant cost-effective policy responses that balance mitigation, adaptation, and other social priorities. Good long-term climate change mitigation policy should adhere to the following principles:

- Promote GHG mitigation policies that are cost effective, economically efficient and science based
- Ensure a uniform and predictable cost of GHG emissions across the economy
- Let market prices drive the selection of solutions
- Promote global participation while recognizing the priorities of the developing world
- Limit consequences of differing national policies on competitiveness
- Minimize complexity, and maximize transparency to consumers and companies

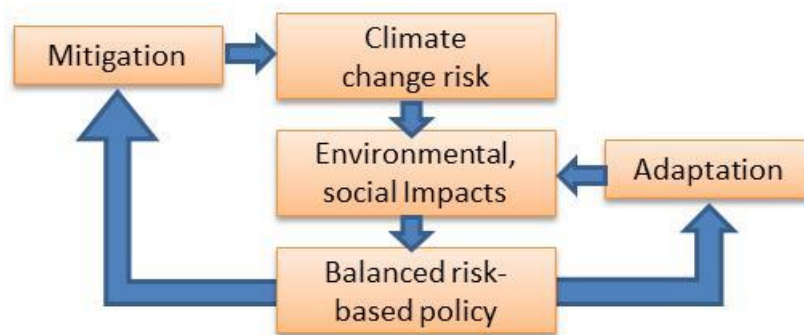
- Adjust to future developments in climate science and the economic impacts of climate policies¹⁶

Additionally, we believe policymakers should seek to encourage more rapid use of existing efficient technologies in both the developed and developing world, and seek to stimulate research and development to create innovative, affordable lower GHG technologies.¹⁷

In addition, adaptation is recognized by the international scientific community as a viable risk-management strategy, consistent with the following excerpt from the IPCC Fourth Assessment Report, published in 2007:

“.....the greater the capacity of ecosystems and society to adapt to the impacts of climate change, the higher the level at which atmospheric greenhouse-gas concentrations may be stabilized before climate change becomes dangerous. Adaptation thus complements and can, in theory and until the limits of adaptation are reached, substitute for mitigation in meeting the ultimate objective of the UNFCCC.”

Societies are exploring prudent, cost-effective steps to both mitigate and adapt to the risks of climate change, as shown in the following diagram:



Source: Adapted from Smit et al, 1999 from IPCC Fourth Assessment Report

¹⁶ See generally <http://corporate.exxonmobil.com/en/current-issues/climate-policy/climate-policy-principles/overview>.

¹⁷ For example, supporting natural gas export efforts from gas-rich countries such as the United States could further the adoption of this cleaner-burning fuel by countries that currently rely on more carbon-intensive forms of energy.

Many adaptation measures can be low cost, and prudent in their own right, particularly if they are planned and implemented incrementally as part of normal development over a long time frame. Adaptation can also improve society's resilience to potential weather extremes and offer additional response flexibility.

Lastly, it is important to bear in mind that the world has other social priorities such as access to affordable and reliable energy, poverty reduction, reductions in infant mortality, improvements in educational attainment, and increasing health care and life expectancy that compete for finite financial resources.

What ExxonMobil is doing about climate change

ExxonMobil and its Board take the issues of energy and climate change seriously and the company is taking a multitude of steps on many fronts to address these issues.

1. Engagement

ExxonMobil's business is energy and we actively engage society on requirements for the exploration, development, production and distribution of energy to meet the demands of a growing global population. This engagement is broad and multi-faceted. For example, on a technical level, ExxonMobil personnel are active in a multitude of professional organizations, such as the American Institute of Chemical Engineers, the American Chemical Society, Canada's Oil Sands Innovation Alliance, the Dutch Polymer Institute, the Global Carbon Capture and Storage Institute, the Global Gas Flaring Reduction Institute, the International Petroleum Industry Environmental Conservation Association, the United Nations Environment Programme – Society of Environmental Toxicology and Chemistry Life Cycle Initiative, the International Council of Chemical Associations – Energy and Climate Change Technology Task Force, to name just a few, whose efforts improve the efficiency, effectiveness and environmental footprint of the energy business, its processes and products. The company is also involved in proactively engaging regulators on regimes and approaches that can improve the

safety, reliability and sustainability of operations. Finally, the company engages the public and thought-leaders on energy issues.¹⁸

ExxonMobil, like many U.S. companies, labor unions and other entities, engages in lobbying to effectively explain or advocate the corporation's energy views. The corporation has an established practice to determine which public policy issues are important to ExxonMobil and reviews them at least annually with senior management and the Board. Generally speaking, we support policies that promote stable, free-market investment climates for long-term business viability. ExxonMobil's lobbying activities and political contributions comply fully with all legal requirements and are disclosed on exxonmobil.com and other public websites.

ExxonMobil also engages on climate change, both with policy makers and the public.¹⁹ Our senior executives speak often on the issue.²⁰ When considering policy options, ExxonMobil advocates an approach that most closely follows our

¹⁸ The Outlook, for example, is but one of the many ways that ExxonMobil engages society on energy requirements.

¹⁹ The company's website provides extensive materials and insights regarding climate. See <http://corporate.exxonmobil.com/en/environment/climate-change>; The company addresses climate and related environmental issues expansively in its publications and mass-media communications. See, e.g., 2012 Corporate Citizenship Report, pp 28-33, <https://www.youtube.com/watch?v=cfmycXLWoxo> and <http://www.exxonmobilperspectives.com/2013/10/29/turning-back-the-emissions-clock-to-1994/>.

²⁰ For example, the company's CEO speaks routinely on the subject. See, e.g., Address of Rex Tillerson before the Royal Institute of International Affairs at Chatham House, London, England, June 21, 2007 (<http://www.chathamhouse.org/corporate-leaders-series>); Address of Rex Tillerson before the Economic Club of Washington, D.C., October 1, 2009, (<http://corporate.exxonmobil.com/en/company/news-and-updates/speeches/promoting-energy-investment-and-innovation>); Address of Rex Tillerson to the Global Climate and Energy Project (GCEP), Stanford University, February 17, 2009 (<http://corporate.exxonmobil.com/en/company/news-and-updates/speeches/global-climate-and-energy-project>); Address of Rex Tillerson before the Woodrow Wilson International Center for Scholars, Washington D.C., January 8, 2009 (<http://corporate.exxonmobil.com/en/company/news-and-updates/speeches/strengthening-global-energy-security>); Address by Rex Tillerson to the Wall Street Journal Council on Foreign Relations, June 27, 2012 (<http://www.cfr.org/north-america/new-north-american-energy-paradigm-reshaping-future/p28630>); Address by Rex Tillerson to the World Affairs Council of Dallas Fort Worth, April 18, 2013 (<http://corporate.exxonmobil.com/en/company/news-and-updates/speeches/from-scarcity-to-abundance>); and Address by Rex Tillerson to the Asia Society Global Forum, June 13, 2013 (<http://corporate.exxonmobil.com/en/company/news-and-updates/speeches/a-business-perspective-on-global-energy-markets>).

stated policy principles.²¹ We take numerous opportunities to articulate these policy positions in our annual Energy Outlook, Corporate Citizenship Report, and Carbon Disclosure Project submission, and through executive speeches, advertising, publications, media interviews and other policy fora. These would include interactions with key government policymakers in North America, Europe and Asia, and policy think tanks like Chatham House, Brookings Institution, Center for Clean Air Policy, and Policy Exchange.

The company also has conducted and supported scientific, economic and technological research on climate change for nearly 30 years. Our research effort has been designed to improve scientific understanding, assess policy options and achieve technological breakthroughs that reduce GHG emissions. As a result of our research, ExxonMobil scientists have published more than 45 papers in peer-reviewed literature. In addition, ExxonMobil scientists have participated as authors and review editors in assessments of the IPCC since its inception. We have also supported major projects at a wide range of institutions, including the Australian Bureau of Agricultural Resource Economics, Battelle Pacific Northwest Laboratory, Carnegie Mellon, Charles River Associates, The Hadley Center for Climate Prediction, the International Energy Agency Greenhouse Gas R&D Program, Lamont Doherty Earth Observatory at Columbia University, Massachusetts Institute of Technology, Princeton, Yale, Stanford, and the University of Texas.

2. Operations

ExxonMobil is taking action to mitigate climate change risk by reducing GHGs in our operations, helping consumers reduce their emissions and supporting research into technology breakthroughs.

²¹ For example, while the company does not advocate for special fees or taxes on carbon, it does believe that a revenue neutral tax on carbon best meets these policy principles.

a. Continuously improve operations integrity and efficiency

The company constantly strives to enhance the integrity and efficiency of its operations and these factors are measured and evaluated against performance expectations across all levels of the organization. Improving energy efficiency in our operations helps us to reduce costs, improve competitiveness and reduce GHG emissions. Our comprehensive Energy Management Systems (called GEMS and POEMS) are applied across our upstream production, refining and chemical operations to drive ongoing improvements in energy efficiency of our operations. We are also a leader in cogeneration (also known as combined heat and power), with equity ownership in more than 100 cogeneration units at more than 30 sites with over 5200 MW of capacity, which is equivalent to the electricity needs of approximately 2.5 million U.S. households. We have an active pipeline of additional cogeneration projects that are under evaluation and development.

ExxonMobil has made considerable progress in reducing the emissions intensity of its operations over the years.²² Cumulative GHG emissions reductions from ExxonMobil actions, including energy efficiency, cogeneration, and flaring reduction, amount to 8.4 million metric tons of greenhouse gases from 2009 through 2012. ExxonMobil also has active programs to identify and reduce methane emissions from natural gas operations, and to reduce flaring from both upstream and downstream/chemicals operations.

b. Improve product performance to save resources

The company's products help customers and consumers conserve energy and reduce raw material use, which can reduce costs and GHG emissions for society. For example, our tire liner technology has superior air retention capabilities, thereby increasing vehicle fuel economy. Our advanced synthetic

²² See generally, <http://corporate.exxonmobil.com/en/current-issues/climate-policy/emissions-reduction/overview?parentId=dfdb24e1-090d-4900-9e84-1b931453fc66>.

lubricants not only can improve engine performance and extend oil drain intervals, but also reduce engine friction and increase mileage in cars and trucks. Lubricants can also increase the efficiency and reliability of turbines that are used in wind farms, and the company is a major supplier of specialty lubes to this emerging industry. Our plastics technology can save energy by reducing weight across a broad range of applications, including packaging, consumer products, and automobiles. Individually, these enhancements may not seem like much, but the incremental savings are significant when stretched out across the scale of society's need for energy.²³ A small change in a big base leads to significant overall savings.

c. Develop cutting edge, proprietary technologies to lower GHG emissions

The company is actively pursuing new technologies that not only improve the performance of operations while reducing environmental footprint, but offer the potential for breakthrough energy solutions. For example, the company has extensive experience in the component technologies of carbon capture and sequestration (CCS). Our LaBarge plant in Wyoming is one of the largest CO2 capture operations in the world. At LaBarge, captured CO2 is sold via pipeline to third parties for reinjection and enhanced oil recovery. We also capture and sequester CO2 at the Sleipner field in Norway (ExxonMobil is an equity partner), and are participating in the Gorgon natural gas development in Australia that includes CCS. Once operational, Gorgon will have the largest saline reservoir CO2 injection facility in the world. ExxonMobil is building on its vast experience in capturing gas impurities by exploring new methods to reduce the cost of CO2 capture through both in-house and research programs.

ExxonMobil has invested in long-term scientific research for many years, often in fields outside the company's near-term business focus, which may

²³ For example, using these fuel-saving technologies in one-third of U.S. vehicles would translate to a savings of about 5 billion gallons of gasoline and greenhouse gas emissions savings equal to taking about 8 million cars off the road. See <http://www.exxonmobilperspectives.com/2010/11/08/driving-for-better-efficiency-fewer-emissions/>.

have transformative potential for the economy and the environment. Our efforts typically start by applying a “white paper” process to explore emerging technologies. These studies help to educate the company on technologies, define our potential contribution to the science, and assess the future applicability of the technologies to the energy industry and specifically to our businesses. The Corporation has experts from a variety of disciplines within our research labs who author “white papers” on topics across a wide range of energy areas, ranging from biofuels to geothermal energy. In the course of developing these papers, we may determine a particular technology warrants future investment, a reassessment of our business strategy, or simply routine monitoring. In all cases, a more nuanced view of the technology emerges that helps the company make more informed decisions. For example, recently a white paper on photovoltaics helped refine our views on solar energy-based electricity generation as reflected in our Outlook.

For over a decade, ExxonMobil has conducted research into combustion fundamentals with automotive partners in order to devise concepts to improve the efficiency and reduce emissions of internal combustion engines. We closely monitor evolving technological advancements in the vehicle space, including battery electric vehicles, hybrid vehicles, fuel cell vehicles and alternative fuels. As an example of this research, ExxonMobil has developed an innovative, on-board hydrogen-powered fuel cell system that converts conventional hydrocarbon fuels such as gasoline or diesel into hydrogen for a fuel cell directly under a vehicle’s hood, eliminating the need for separate facilities for producing and distributing hydrogen. Measured on a “well-to-wheels” basis, this on-vehicle hydrogen fuel system could be up to 80 percent more fuel-efficient, and emit 45 percent less carbon dioxide, than an internal-combustion engine. This technology could also be used where small stationary sources of hydrogen are required. We continue to evaluate opportunities for deployment of this technology with potential partners.

ExxonMobil utilizes in-house capability to conduct life cycle assessments (LCAs). LCAs are useful in helping to understand whether a technology can result in environmental improvements across a broad range of factors (e.g., GHGs, water, solid waste) versus an existing or alternative process. Our efforts help to develop consistent comparisons of energy alternatives, as well as to build and extend the science of LCAs by working with leading national laboratories and universities. For example, in 2011, we conducted an LCA to assess the impact of algal biofuel production on GHG emissions, land use, and water use. The study, completed in partnership with Massachusetts Institute of Technology and Synthetic Genomics Inc., demonstrated that with further research and development, algae fuels can be produced with freshwater consumption equivalent to petroleum refining, and enable lower GHG emissions. More recently, we have published life cycle GHG emissions for electricity generated from shale gas including, for the first time, actual field data for Marcellus and Barnett Shales. These studies found that the “well to wire” GHG emissions from shale gas are about half that of coal, and not significantly different from the “well to wire” emissions of conventional gas.

ExxonMobil also has an active algae biofuels research program, focused on understanding the fundamental science of algae growth and product yield necessary to produce algae-based biofuels at a cost and scale that would be meaningful to global energy supply. With significant technical and economic hurdles still to be met, we would expect that commercialization, if eventually successful, would take a decade or more.

ExxonMobil was also a founding member of the Global Climate and Energy Project at Stanford University. This program, now in its 11th year of operation, seeks to develop fundamental, game-changing scientific breakthroughs that could lead to lower GHG emissions and a less carbon-intensive global energy system.

3. Evaluating climate risk in our planning

The company employs a robust process for evaluating investment opportunities and managing our portfolio of operating assets. ExxonMobil requires that all business units use a consistent corporate planning basis, including the proxy cost of carbon discussed above, in evaluating capital expenditures and developing business plans. The company also tests investment opportunities against a broad set of economic assumptions, including low price scenarios that could be representative of a carbon-constrained environment, to help ensure that the investment will perform acceptably across a broad range of economic circumstances during its lifetime. The geographic and asset diversity of the company's portfolio further helps to reduce risk and enhance profitability across a wide variety of economic conditions. Capital plans and our asset portfolio are reviewed extensively with senior management and the Board each year. The company's energy and environmental perspectives, including those relating to climate, are also reviewed with the Board yearly, to help the Board understand financial and other risks associated with its investments.

4. Engineer facilities resilient to extreme events

ExxonMobil also employs robust engineering with regard to its facilities. Local climate, as well as potential changes in local conditions over the life of the investment (such as changes to sea level or permafrost) are carefully assessed and considered. Given the spatial and temporal uncertainties of many extreme weather events, particularly with respect to future changes in climate, facilities are generally engineered to be resilient to extreme event "tails", with the inclusion of additional safety factors. Some jurisdictions, such as Singapore, have specific building standards that are employed in our designs that consider potential climate change impacts.

For existing facilities, processes and systems to manage extreme weather events (such as Gulf Coast hurricanes) are considered along with other factors in the company's Operations Integrity Management System (OIMS),²⁴ both with regard to risk management and extreme event response. These processes are drilled extensively, both internally and cooperatively with local authorities, to ensure readiness when needed, and are systematically evaluated and continuously improved as part of our ongoing OIMS system.

Our commitment

ExxonMobil is committed to exploring, developing, producing and delivering energy that the world needs. Providing accessible, affordable energy not only helps to make modern-day life possible in the developed world, it offers hope of progress and opportunities for many in the undeveloped world who have none. We are also committed to supplying energy in a sustainable and environmentally responsible manner. We engage society on important issues associated with energy, such as the risks of climate change, and look forward to continuing the dialogue as the growing world seeks to strike the careful balance between its need for energy and the concerns over climate change.

²⁴ As noted in our *Corporate Citizenship Report*, our Operations Integrity Management System (OIMS) is the cornerstone to managing all safety, security, health, and environmental risks in all of our operations worldwide, including potential physical risks from climate change. Current scientific understanding provides limited guidance on the likelihood, magnitude, and timeframe of physical risks such as sea level rise, extreme weather events, temperature extremes, and precipitation changes. There is even more scientific uncertainty at the regional or local level in comparison to global averages. Nevertheless, our facilities are designed, constructed, and operated to withstand a variety of extreme conditions, with safety factors built in to cover various engineering uncertainties, including those associated with potential climate change impacts. We engage with major engineering societies, international organizations and industry groups to develop sound engineering perspectives on managing the risks of climate change.