2020 ENERGY & CARBON SUMMARY

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Statements of future events or conditions in this report, including projections, sensitivities, targets, expectations, estimates, future technologies, and business plans, are forward-looking statements. Actual future results or conditions, including: demand growth and relative energy mix across sources, economic sections and geographic regions; the impact of new technologies; production rates and reserve growth; efficiency gains and cost savings; emission reductions; and results of investments, could differ materially due to, for example, changes in the supply and demand for crude oil, natural gas, and petroleum and petrochemical products and resulting price impacts; the outcome of exploration and development projects; the outcome of research projects and ability to scale new technologies on a cost-effective basis; changes in law or government policy, including environmental regulations and international treaties; the actions of competitors and customers; changes in the rates of population growth, economic development, and migration patterns; trade patterns and the development and enforcement of global, regional and national mandates; military build-ups or conflicts; unexpected technological developments; general economic conditions, including the occurrence and duration of economic recessions; unforeseen technical difficulties; and other factors discussed in this report and in Item 1A of ExxonMobil’s most recent Form 10-K. This document is a shareholder requested publication and is purposefully focused on unknown future events. The statements and analysis in this document represent a good faith effort by the Company to address this request despite significant unknown variables as well as incomplete and, at times, inconsistent market and government policy signals. See the 2019 Outlook for Energy for further details on the processes, challenges and assumptions underlying this analysis. Third-party scenarios discussed in this report reflect the modeling assumptions and outputs of their respective authors, not ExxonMobil, and their use or inclusion herein is not an endorsement by ExxonMobil of their likelihood or probability. Any reference to ExxonMobil’s support of a third-party organization within this document does not constitute or imply an endorsement by ExxonMobil of any or all of the positions or activities of such organization. References to “resources,” “resource base,” “recoverable resources” and similar terms refer to the total remaining estimated quantities of oil and natural gas that are expected to be ultimately recoverable. ExxonMobil refers to new discoveries and acquisitions of discovered resources as “resource additions.” The resource base includes quantities of oil and natural gas classified as proved reserves, as well as quantities that are not yet classified as proved reserves, but that are expected to be ultimately recoverable. The term resource base is not intended to correspond to SEC definitions such as “probable” or “possible” reserves. For additional information, see the "Frequently Used Terms" on the Investors page of our website at exxonmobil.com.

References to “oil” and “gas” include crude, natural gas liquids, bitumen, synthetic oil, and natural gas.

Prior years’ data have been reclassified in certain cases to conform to the 2018 presentation basis.

The term “project” as used in this publication can refer to a variety of different activities and does not necessarily have the same meaning as in any government payment transparency reports.
Energy is essential. Accessible and affordable supplies of energy support our ability to meet the basic requirements of life, and fuel society’s progress around the world.

As the world’s population grows to more than 9 billion in the next two decades, rising prosperity will increase energy demand, particularly in developing countries. Stable and affordable energy supplies will make it possible for more people to access the health care, transportation and education that contribute to quality of life and improved living standards.

With this increased energy demand comes the potential for greater environmental impacts, including greenhouse gas (GHG) emissions and the risks of climate change. As a global community, we need to manage environmental impacts as we meet this growth in demand. This is society’s dual challenge.

This Energy & Carbon Summary describes how we at ExxonMobil are doing our part in addressing the dual challenge. It describes the steps we are taking to responsibly develop new resources to ensure the world has the energy it needs while also minimizing environmental impacts. It also provides detailed information on how we view and manage the risks associated with GHG emissions and climate change.

Under the governance of ExxonMobil’s Board of Directors, we routinely evaluate business risks and strategies, which are based on our Outlook for Energy (Outlook). The Outlook aligns with the existing Nationally Determined Contributions (NDCs) that form part of the Paris Climate Agreement and contains sensitivities on the rate of penetration of wind, solar and battery technologies. The Outlook also assumes continued progress on policy and advancements in technology.

Since 2000, our company has invested nearly $10 billion to research, develop and deploy lower-emission energy solutions. In the past year, we have meaningfully advanced research and technology initiatives designed to meet society’s call for lower emissions. A few examples detailed in this report include:

- Launching an innovative relationship with the U.S. Department of Energy’s National Laboratory network to bring low-emission energy breakthroughs to commercial scale.
- Collaborating with the Indian Institute of Technology to research biofuels and bio-products, gas transport and conversion, and low-emission technologies for the power and industrial sectors.
- Evaluating the potential use of agricultural waste and residues to produce biofuels.
- Working to develop strains of algae that will convert CO2 and sunlight into energy-rich bio-oil.
- Advancing our carbon capture and storage (CCS) research portfolio.
- Expanding academic collaborations, now working with more than 80 universities and five energy centers around the world.

In this report, we provide specifics on mitigating emissions from our operations, including our goals to reduce methane emissions and flaring. We also describe how we support customers in reducing their emissions by providing advanced fuels, lubricants and lightweight plastics to improve end-user efficiency.

The ExxonMobil Energy & Carbon Summary is aligned with the core elements of the framework developed by the Financial Stability Board’s Task Force on Climate-related Financial Disclosures (TCFD), designed to encourage informed conversations.

We advocate for sound public policy that can help facilitate advances in low-emission technology. We engage with governments around the world, as well as experts and other stakeholders, to help support policies, such as a price on carbon and effective regulations to reduce methane emissions. These engagements include Board-level dialogue with our shareholders.

Meeting the world’s growing demand for energy while reducing environmental impacts is one of society’s most significant challenges. I am confident that, by working together, we can develop the necessary technologies and solutions to meet this challenge. We at ExxonMobil are committed to doing our part.

Darren Woods, Chairman and CEO
ExxonMobil has a long history of successfully meeting society’s evolving demand for energy. With a steadfast commitment to investments in technology and the ingenuity of our people, we are well positioned to continue to meet the demands of a more prosperous world.

The 2019 Outlook provides a view of energy demand and supply through 2040, based on likely trends in population growth, economic conditions, policy developments and technology advancements.

The Outlook anticipates global energy needs will increase 20 percent between today and 2040, led by non-OECD(1) countries. While the energy mix shifts toward lower-carbon-intensive fuels, the world will still need to pursue all economic energy sources to meet demand growth by 2040. Key trends through 2040 include:

- Efficiency gains and growing use of less-carbon-intensive energy sources will contribute to a nearly 45 percent decline in energy-related CO₂ emissions per unit of global GDP.
- Worldwide electricity from solar and wind will supply about 10 percent of all primary energy used in power generation.
- Natural gas will expand its role to more than 25 percent of total primary energy, led by growth in electricity generation and industrial output.
- Rising oil demand will be driven by commercial transportation and the chemical industry; fuel demand for cars and heavy-duty vehicles reflects efficiency improvements and growth in alternative fuels.

The Outlook includes sensitivities to illustrate how changes to the base Outlook assumptions might affect the energy landscape. In this report, we highlight sensitivities related to transportation and variations in supplies for the power sector.

Relative to the Outlook, a theoretical 2°C pathway would generally lower demand for oil, natural gas and coal, and increase use of nuclear and renewables.

- Because oil and natural gas production naturally declines, continued investment is needed, even under a 2°C pathway. The International Energy Agency’s (IEA’s) Sustainable Development Scenario (SDS), consistent with a 2°C target, suggests cumulative oil and natural gas investments could exceed $13 trillion (vs. $20 trillion under IEA’s Stated Policies Scenario (STEPS)) by 2040.(2)
- Production from ExxonMobil’s proved reserves and investment in our resources are needed to meet global demand and offset natural decline.

ExxonMobil’s businesses are well positioned for the continuing evolution of the energy system.

Near-term actions, consistent with society’s energy requirements and environmental objectives, include:

- Expanding the supply of cleaner-burning natural gas.
- Increasing production of chemicals, distillates and lubes needed under a broad range of demand scenarios including 2°C scenarios.
- Mitigating emissions from our own operations through energy efficiency, cogeneration, CCS, and reduced flaring, venting and fugitive emissions, including GHG intensity reduction in Imperial Oil Limited’s (Imperial) operated oil sands facilities.
- Supplying products that help consumers reduce their emissions, such as natural gas, premium lubricants and fuels, lightweight materials, and special tire liners.
- Engaging in policy discussions to address the risks of climate change at the lowest cost to society, including support for well-designed carbon pricing mechanisms.

Longer term, our business strategies are consistent with the evolving energy landscape. We are pursuing technologies to enhance existing operations and developing alternative energy solutions with lower-carbon intensity, including:

- Researching breakthroughs that make carbon-capture technology more economic for power generation, industrial applications and hydrogen production.
- Developing technologies to reduce energy requirements of refining and chemical manufacturing facilities.
- Progressing advanced biofuels for transportation and chemicals.
- Advancing fundamental knowledge and capabilities with organizations strategically to achieve technology breakthroughs for scalable GHG emission reductions.
A rigorous risk management approach is integral to ExxonMobil’s governance framework and ensures risks are appropriately identified and addressed. ExxonMobil’s Board of Directors oversees risks associated with our business, including the risks related to climate change.
Climate change risk oversight

ExxonMobil’s Board of Directors (Board) provides oversight of key risks, including strategic, reputational, financial, operational, SSHE (safety, security, health and environment) and legal compliance matters. It has a well-established and rigorous enterprise risk framework in place to oversee risks faced by the Company, including those related to climate change.

The Board routinely reviews environmental stewardship and discusses issues related to climate risks. The process includes briefings on scientific and technical research, public policy positions and analysis, and ongoing progress on Company initiatives and actions with internal and external subject-matter experts. It also includes at least one session each year when the full Board engages on the latest developments in climate science and policy. In addition, directors engage directly with shareholders to gather insights and share perspectives on issues of importance to the Company, including discussions regarding risks related to climate change.

The Board assesses the Company’s management of and response to climate change through its review of the Outlook for Energy, Energy & Carbon Summary, and other publications and regulatory filings.

As appropriate, the Board also considers climate change as it assesses research and development efforts, operating strategies, business and corporate planning, technology, current events, shareholder engagements, and Company performance.

The Board evaluates climate risks in the context of other operational, market, and financial risks and considers the interactions with these additional factors. To assist it, the Board is supported by its committees, which take more in-depth reviews of the context and interdependencies in risk evaluation. We describe the role of these committees in greater detail on the following page.

Beyond the Board, the Management Committee, including the Chief Executive Officer (CEO), provides oversight of strategic risks faced by the Company. To steward these strategic risk evaluations, the Management Committee and senior executives participate in briefings on technology developments and environmental topics throughout the year. This helps to broaden understanding of implications of the risks and assess safeguards and options to mitigate those risks, guided by the Board’s oversight.
Coordination and support of board committees

As described on the previous page, ExxonMobil’s Board oversees a broad spectrum of interrelated risks with assistance from its committees. This integrated risk management approach facilitates recognition and oversight of important risk interdependencies, more effectively than relying on risk-specific committees.

- **Audit Committee** oversees risks associated with financial and accounting matters. It also periodically reviews ExxonMobil’s overall risk management approach and structure, which is applied to risks related to climate change, among other business risks.

- **Board Affairs Committee** oversees matters of corporate governance, including Board evaluation and director refreshment. It also coordinates identification of external experts to address the Board and sets the criteria for shareholder engagement with directors.

- **Compensation Committee** reviews executive compensation, which is designed to incentivize executives to maximize long-term shareholder value, requiring a long-term view in decision-making that includes careful consideration of current and future risks, such as those related to climate change.

- **Public Issues and Contributions Committee (PICC)** oversees operational risks such as those relating to safety, security, health and environmental performance, including actions taken to address climate-related risks.

Board composition and evaluation

The Board is comprised of independent directors and the CEO. All members of the committees described above are independent. Each highly qualified director brings a diverse perspective. The majority have scientific, technical and/or research backgrounds, creating a collective skillset that is well qualified to oversee climate-related issues. In addition, the Board benefits from the experience of a director who is a recognized expert in climate science.

The Board acts as a collective body, representing the interests of all shareholders. While individual directors leverage their experience and knowledge in Board and committee deliberations, Board decisions and perspectives reflect the collective wisdom of the group. ExxonMobil values diverse experience and long-term service by directors due to the complexity of our business.

At least annually, the Board and each of the Board committees conducts a robust and thorough evaluation of their performance and effectiveness, as well as potential changes to the committees’ charters.

HIGHLIGHT: Integrating risk management into executive compensation

Senior executive compensation is determined by the Compensation Committee. The compensation program is designed such that it incentivizes effective management of all operating and financial risks associated with ExxonMobil’s business, including risks related to climate change.

Performance shares with long vesting periods and a strong tie to company performance are among the key design features to support this objective. Executive compensation is designed to support sustainability of our operations and management of all aspects of risk. Specifically, performance in managing risks related to climate change and environmental impacts is recognized in both the Progress Toward Strategic Objectives and as part of the Safety and Operations Integrity metrics outlined in the schematic below. The executive compensation program requires that these longer-term risks be considered carefully at all levels of the organization, ensuring stewardship continues beyond the Board and executive level, and is required for success throughout the Company. Details on compensation can be found in the annual Proxy Statement.
The Board of Directors, including the Chairman, and senior executives toured the petrochemical facilities on Jurong Island, Singapore, in June 2019 as part of the annual Board trip.

**UP CLOSE:**

**Public Issues and Contributions Committee**

The PICC plays an integral role in the Board’s oversight of climate-related risks. Like other committees, the PICC is able to work on key issues in greater detail than would be possible by the full Board.

The PICC, which is comprised of four independent directors who are appointed by the Board, reviews and provides guidance on the Corporation’s policies, programs and practices on key public issues of significance. It regularly reviews ExxonMobil’s safety, security, health and environmental performance, including actions taken to identify and manage risks related to climate change. The broad and diverse set of backgrounds and areas of expertise of the individual PICC members ensures the committee is able to effectively evaluate and inform the Board on dynamic and complex issues.

The PICC, along with the full Board of Directors, makes annual site visits to operating locations to observe and provide input on operating practices and external engagement. The Board and PICC visited ExxonMobil’s largest manufacturing complex, the integrated refining and petrochemical facilities on Jurong Island, Singapore, in 2019.

The visit included an overview of operations, including the fuels, lubricants and chemicals value chains, and the gas and power marketing business. The directors also met with employees responsible for operations and other commercial and business support activities. Additionally, directors met with senior government officials to discuss issues important to the Company and the country of Singapore, including risks related to climate change. In April 2019, the Board of Directors traveled to the Company’s Spring, Texas, campus to review advances in subsurface technology and gain useful insights from employees.

The PICC and Board reviewed the effectiveness of the Company’s risk management process through these visits and received additional insight into how the Operations Integrity Management System (OIMS) protects the Corporation’s employees and physical assets, as well as communities and the environment. The PICC uses this information, along with reports on safety and environmental activities of the operating functions, to provide recommendations to the full Board.

The Board of Directors, including the Chairman, and senior executives toured the petrochemical facilities on Jurong Island, Singapore, in June 2019 as part of the annual Board trip.
Our business strategies are underpinned by a deep understanding of global energy system fundamentals. These fundamentals include the scale and variety of energy needs worldwide; capability, practicality and affordability of energy alternatives; GHG emissions; and government policies. We consider these fundamentals in conjunction with our Outlook to help inform our long-term business strategies and investment plans. We are committed to providing reliable and affordable energy to support human progress while implementing and advancing effective solutions for the evolving energy landscape. Our actions to address the risks related to climate change, depicted in the pillars below, position us to responsibly meet the growing energy demand of a more prosperous world.

- **DEVELOPING AND DEPLOYING SCALABLE TECHNOLOGY SOLUTIONS**
- **ENGAGING ON CLIMATE-RELATED POLICY**
- **PROVIDING PRODUCTS TO HELP OUR CUSTOMERS REDUCE THEIR EMISSIONS**
- **MITIGATING EMISSIONS IN OUR OPERATIONS**
2019 Outlook for Energy Highlights

The Outlook is ExxonMobil’s global view of energy demand and supply through 2040. ExxonMobil uses a data-driven approach to inform our long-term business strategies, investment plans and research programs.

Energy supports rising prosperity

Access to modern technologies and abundant energy – including oil and natural gas – enables substantial gains in living standards around the world. Between now and 2040, the world population is expected to grow from 7.5 billion to 9.2 billion, with global GDP nearly doubling. Billions of people are expected to see their incomes grow to levels considered middle class.\(^{(3)}\)

Energy demand is likely to rise about 20 percent over this same time period. Efficiency gains and a shift in the energy mix – including rising penetration of wind and solar – are likely to enable nearly a 45-percent improvement in the carbon intensity of global GDP. Primary energy demand is likely to decrease in OECD (developed) nations, while demand in non-OECD (developing) nations will likely increase by almost 40 percent, led by expanding economies in the Asia Pacific region, including China and India.

- Electrification and a shift to lower-carbon energy sources are expected to be significant global trends.
- Renewables and nuclear energy see strong growth, contributing nearly 40 percent of incremental energy supplies to meet demand growth through 2040.
- Coal’s share will likely decrease as the world shifts to lower-emission energy sources, helping enable a peak in global energy-related CO₂ emissions by 2040.
- Natural gas is expected to grow the most of any energy type, reaching a quarter of all demand.
- Oil will continue to play an important role in the world’s energy mix, as commercial transportation (e.g., trucking, aviation, marine) and chemical sectors support demand growth.

Consistent with third-party reports, we expect the world to meet, in aggregate, the Nationally Determined Contributions\(^{(4)}\) of the 2030 Paris Agreement pledges. However, more effort is needed for the world to accelerate progress toward a 2°C pathway.\(^{(5-6)}\)

Further breakthroughs and technology advances are required across all sectors to achieve the Paris Agreement objectives and continue to deliver reliable and affordable energy.
Considering 2°C scenarios

According to the IEA, a “well below” 2°C pathway implies “comprehensive, systematic, immediate and ubiquitous implementation of strict energy and material efficiency measures.”(7) Given a wide range of uncertainties, no single pathway can be reasonably predicted. A key unknown relates to yet-to-be-developed advances in technology and breakthroughs that may influence the cost and potential availability of certain pathways toward a 2°C scenario. Scenarios that employ a full complement of technology options are likely to provide the most economically efficient pathways.

Considerable work has been done in the scientific and economic community to explore potential energy pathways. A comprehensive multi-model study coordinated by the Energy Modeling Forum 27 (EMF27)(8) at Stanford University brought together many energy-economic models to assess possible technology and policy pathways associated with various climate stabilization targets, partially in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

The chart (top right) illustrates potential global CO2 emission trajectories under EMF27 full-technology scenarios(9) targeting a 2°C pathway relative to the Outlook, and baseline pathways, with essentially no policy evolution beyond those that existed in 2010. The Outlook emission projection tracks within the estimated range of emissions implied by the NDCs for 2030 as currently submitted by the signatory countries of the Paris Agreement. These NDCs are not on a 2°C pathway as confirmed by the 2019 United Nations Emissions Gap report.(5-6)

The chart (lower right) illustrates potential global energy demand in 2040 under the assessed 2°C scenarios. As the chart illustrates, the scenarios suggest that predicting absolute 2040 energy demand levels in total and by energy type carries some uncertainty, with particular scenarios likely heavily influenced by technology and policy assumptions.

For comparison purposes, the chart (lower right) also includes energy demand projections in 2040 based on the IEA’s SDS. The IEA specifically notes that its SDS projects global energy-related CO2 emissions that are “fully in line with the trajectory required to meet the objectives of the Paris Agreement on climate change.” In fact, the SDS projects global energy-related CO2 emissions in 2040 at a level 55 percent lower than the IEA’s STEPS,(11) which projects emissions generally in line with the aggregation of current national commitments under the Paris Agreement.

IEA World Energy Outlook (WEO) 2019 SDS includes CCS; however, breakdown by energy type is not readily identifiable.
Considering 2°C scenarios, continued

The assessed 2°C scenarios produce a variety of views on the potential impacts on global energy demand in total and by specific types of energy. The scenarios also provide a range of possible growth rates for each type of energy. We have taken the average of the scenarios’ growth rates in order to consider potential impacts on energy demand for this report. (12)

Based on this analysis, primary energy demand on a worldwide basis is projected to increase about 0.5 percent per year on average from 2010 to 2040. Expected demand and technologies deployed in 2040 vary by model and energy type (see bottom chart on prior page):

- Natural gas demand is expected on average to increase about 0.9 percent per year, while oil demand is projected on average to decline by about 0.4 percent per year. Together their share of energy demand is projected on average to still be more than 40 percent by 2040.
- The projected growth for renewables and nuclear averages 4.5 percent per year for non-bioenergy (non-bio) (e.g., hydro, wind, solar) and about 3 percent per year for nuclear.
- The trend in demand for coal is the most negative, with an average decline of 2.4 percent per year, or about a 50-percent decrease by 2040.
- Bioenergy demand is projected on average to grow at about 4.3 percent per year, the highest growth among all energy sources alongside non-bio renewables.
- CCS is a key technology to address CO₂ emissions, enabling low emissions from industrial and power sectors. The projected energy demand that would be decarbonized by CCS would on average be nearly double that of non-bio renewables by 2040.

All energy sources remain important across all the assessed 2°C scenarios, though the mix of energy and technology shifts over time. Oil and natural gas remain foundational, even in models with the lowest level of energy demand. Oil demand is projected to decline modestly on average, and much more slowly than its natural rate of decline from existing producing fields. Natural gas demand grows on average due to its many advantages, including lower GHG emissions. As a result, substantial new investments are required in both oil and natural gas capacity to meet demand, even under the assessed 2°C scenarios.

Low-side energy growth rates for the above scenarios were also considered. The low-side scenarios see oil dropping 1.7 percent per year on average, natural gas dropping 0.8 percent per year, and coal dropping 10.2 percent per year through 2040. This is compared with high-side growth rates for bioenergy, nuclear and non-bio renewables of 14.1, 4.8 and 6.3 percent per year, respectively. Even under these extremes, significant investments in oil and natural gas capacity are required to offset the natural decline of producing fields. (13) See UP CLOSE discussion on page 14 for more information.

As shown in the chart above, from 1980 to 2015 there were large gains in efficiency, though energy-related CO₂ emissions rose. The blue circle shown for 2040 indicates that emissions are projected to be about 35 billion tonnes even with significant gains in efficiency and CO₂ emissions intensity.

To be on a 450 ppm, or hypothetical 2°C pathway, the performance in 2040 likely needs to be significantly closer to the purple line. This would increase the chance of reaching a 2°C pathway, with further gains required between 2040 and 2100.

Technology advances are expected to play a major role in accelerating progress toward a 2°C pathway. However, the IEA in 2019 estimated in its Tracking Clean Energy Progress analysis that only seven of 45 technologies and sectors assessed are on track to help reach the Paris Agreement climate goals. (15)
Sensitivities included in the *Outlook* projections

We use sensitivity analyses to provide greater perspective on how changes to our base *Outlook* assumptions could affect the energy landscape. The following sensitivities are independent of each other and are not necessarily additive.

**Light-duty vehicles sensitivity (*)**

The top chart depicts the potential impact of full electric vehicle (EV) penetration in light-duty transportation.

- Sensitivity assumes the global light-duty vehicle fleet is 100-percent electric by 2040, requiring all new light-duty vehicle sales to be electric by 2025.
- Battery manufacturing capacity for EVs would need to increase by more than 50x from recent levels by 2025.
- Total liquids demand in 2040 could be in line with levels seen in 2013.
- Total energy-related CO₂ emissions in 2040 could be reduced by about 5 percent.

(*) Further discussion on light-duty vehicles sensitivities can be found in the 2018 *Outlook* and 2019 *Energy & Carbon Summary*.

**Heavy-duty vehicles sensitivities (**)**

The heavy-duty vehicle fleet is comprised of light commercial vehicles (e.g., postal trucks), medium commercial vehicles (e.g., regional buses) and heavy commercial vehicles (e.g., long-haul trucks). Fuel economy and distance traveled for these vehicles range widely, such that heavy commercial vehicles accounted for about 15 percent of the fleet in 2015, but used about 55 percent of the fuel, due to the miles driven with heavy loads.\(^{16}\)

The base 2019 *Outlook* assumes that future efficiency gains are on average double those experienced from 2000 - 2016 for heavy-duty fuels, and alternative fuels grow to about 13 percent of heavy-duty energy demand in 2040. The bottom chart depicts the impacts of changes to these key base assumptions on heavy-duty fuels demand:

- The low-demand sensitivity assumes triple the penetration of alternative fuels with accompanying efficiency gains. By 2040, oil would still represent about 60 percent of the heavy-duty fuel demand, despite an adoption of alternative fuels by 85 percent of the fleet. This highlights the difficulty of decarbonizing heavy-duty transportation and the need for further technology development of economic, lower-carbon solutions such as biofuels.
- This sensitivity would require a rapid acceleration in the early 2020s of alternative fuels into the heavy-duty fleet as well as infrastructure build-out to support the alternatives.
- This low-demand sensitivity would result in a 6-percent reduction of total liquids demand and approximately a 1-percent reduction of total energy-related CO₂ emissions in 2040.
- The high-demand sensitivity shows that if future efficiency gains occur only at the historical rate, demand may increase about 30 percent versus the base 2019 *Outlook* and highlights the need for continued technology investments in efficiency.
- This high-demand sensitivity would lead to a total liquids demand of approximately 7 percent above the base 2019 *Outlook*.

(**)Further discussion on heavy-duty vehicles sensitivities can be found in the 2019 *Outlook*.
Sensitivities on natural gas for electricity and power generation (*)

Similar to the transportation sector, we use sensitivity analyses to provide greater perspective on how changes to the base Outlook assumptions in the power-generation sector could affect the energy landscape.

Power-generation modeling is complex and raises a number of questions regarding both demand growth and supply mix, including:

- How will electricity access expand in developing nations?
- How will technology evolve to enable more electricity use in other sectors (e.g., EVs for personal mobility instead of gasoline-fueled cars or mass transit)?
- How will developing nations transition off coal if it is the most affordable supply today?
- Will perceptions about nuclear safety challenge new builds in some countries?
- What is the optimum penetration of variable renewables before intermittency challenges create reliability and cost impacts for power grids?

There are a number of different potential outcomes for each of these questions that could yield different projections as illustrated in the top chart.

These results describe a range of potential outcomes with some common trends:

- Electricity demand grows significantly from today to 2040.
- Zero-carbon power generation grows 2-3x due to cost competitiveness and policies.
- Natural gas use for electricity grows in all cases except the IEA SDS, accompanied with coal’s decline, primarily in developed countries.

The bottom chart is a sensitivity to test the impact of alternate assumptions on natural gas:

- Lower-cost wind and solar with efficient storage to manage inherently variable production could increase penetration to 50 percent of supply (more than 2x the base Outlook). Ratable reductions in both coal and natural gas by region could reduce global natural gas demand by approximately 115 billion cubic feet per day (BCFD).
- Decline in coal-fired generation occurs predominantly in developed countries to 2040. Switching 50 percent of the remaining coal to natural gas to address issues such as air quality and emissions could increase natural gas demand by more than 20 percent.

Monitoring technology advancements, market behavior and evolving policy can identify signposts related to cost reduction, technology deployment and policy targets indicating how a different outcome may materialize.

(*)Further discussion on sensitivities can be found in the 2019 Outlook.
Signposts for the evolving energy landscape

Changes in the relative cost of new technology when compared against existing or alternative energy sources may further increase shifts in the global energy mix. Using Company and third-party sources, we monitor a variety of indicators that serve as signposts for potential acceleration in shifts to the energy landscape, such as:

- New, more ambitious NDCs and significant policy initiatives broadly implemented, such as carbon pricing
- Increasing electrification of energy systems
- Increasing penetration of intermittent renewables with technology developments that reduce costs and increase reliability of energy storage
- Development of scalable alternative energy technologies such as advanced biofuels, leading to displacement of gasoline and distillate in the fuels market
- Advances in CCS technology to lower cost
- Advances in significant new capacity expansions of multiple technologies, as well as the associated financing
- Energy efficiency gains exceeding historical trends
- Change in consumer preferences and growth in acceptance of alternative energy technologies – including potentially higher consumer costs

Further details and discussion of assessed 2°C scenarios can be found in the special section of the 2019 Outlook for Energy – Pursuing a 2°C pathway.
Potential impact on proved reserves and resources considering 2°C scenarios

Over the coming decades, oil and natural gas will continue to play a critical role in meeting the world’s energy demand, even considering the 2°C scenarios assessed. The following analysis is intended to address the potential impacts to the Company’s proved reserves\(^{(24)}\) and resources\(^{(25)}\) through 2040 and beyond, considering the average of the assessed 2°C scenarios’ oil and natural gas growth rates (2°C scenarios average).\(^{(26)}\)

**Proved reserves**

At the end of 2018, ExxonMobil’s proved reserves totaled about 24 billion oil-equivalent barrels, comprised of 64 percent oil and 36 percent natural gas. These proved reserves are assessed annually and reported in our annual report on Form 10-K in accordance with the U.S. SEC rules. Proved reserves are the main driver of intrinsic value of an integrated oil and gas company’s upstream operations.\(^{(27)}\) Based on currently anticipated production schedules, we estimate that by 2040 a substantial majority of our year-end 2018 proved reserves will have been produced. Since the 2°C scenarios average implies significant use of oil and natural gas through the middle of the century, we believe these reserves face little risk from declining demand.

For the remaining year-end 2018 proved reserves that are projected to be produced beyond 2040, the reserves are generally associated with assets where the majority of development costs are incurred before 2040. While these proved reserves may be subject to more stringent climate-related policies in the future, targeted investments could mitigate production-related emissions and associated costs. In addition, these assets have generally lower risk given the technical knowledge that accumulates over many decades of production. Accordingly, the production of these reserves will likely remain economic even under the 2°C scenarios average.

**Potential impact on proved reserves and resources considering 2°C scenarios**

Considering the 2°C scenarios average, global liquids demand is projected to decline from 97 million barrels per day in 2017 to about 78 million barrels per day in 2040. Using the lowest liquids demand growth rate among the assessed 2°C scenarios, liquids demand would still be 53 million barrels per day in 2040, as seen in the left chart below.\(^{(28)}\) However, absent future investment, world liquids production to meet demand would be expected to decrease to about 19 million barrels per day in 2040. This decrease results from natural field decline, and the associated decline rate is expected to greatly exceed the potential decline rate in global oil demand even under the lowest 2°C demand scenarios assessed. Natural gas natural field decline rates are generally similar to liquids.

With the potential 2040 imbalance (absent future investment), the substantial majority of our proved reserves that are projected to be produced by 2040 are clearly supported by ample demand, and therefore face little risk related to the 2°C scenarios average. Natural gas reserves face even less risk, as demand in 2040 is expected to increase under the 2°C scenarios average versus 2017 demand levels. Considering the IEA’s SDS (a 2°C scenario), the IEA estimated that more than $13 trillion of investment will be needed for oil and natural gas supply for 2019–2040.\(^{2}\)
Resources

ExxonMobil maintains a large and diverse portfolio of undeveloped resources that provide considerable flexibility to develop new supplies to meet future energy demand and replenish our proved reserves. We also continue to enhance the quality of this resource base through successful exploration, acquisitions, divestments, and ongoing development planning and appraisal activities.

The underlying economics of commercializing resources are dependent on a number of factors that are assessed using a dynamic resource development process, as highlighted further on the following page. We advance the best resource opportunities and monetize or exit assets offering lower potential. The world will continue to require significant investment in both liquids and natural gas, even under the assessed 2°C scenarios. Under the 2°C scenarios average, ExxonMobil still would need to replenish approximately 32 billion oil-equivalent barrels of proved reserves by 2040, assuming the Company retains its current share of global production.\(^{(29)}\)

In light of the multiple factors that influence decisions to commercialize undeveloped resources, it is not possible to identify which specific assets ultimately will be commercialized. It is possible that some higher-cost assets, which could be impacted by many factors including future climate-related policy, may not be developed. We are confident, however, that the size, diversity and continued upgrading of our undeveloped resources, along with technology developments, will enable the ongoing replenishment of our proved reserves under a range of potential future demand scenarios.

We test investments over a wide range of commodity price assumptions and market conditions. Notably, the IEA’s estimates of future prices under its 2°C pathway fall within the range we use to test our investments.\(^{(29)}\) In a commodity business, the lowest cost of supply will be advantaged. ExxonMobil’s long-standing focus on efficiency and continuous improvement positions us to compete successfully.

Potential impact on proved reserves and resources considering 2°C scenarios, continued

Examples of technology-enabled cost and environmental footprint reductions:

- Record-setting extended-reach wells in Sakhalin to significantly reduce drilling costs and environmental footprints
- Full-physics modeling and next-generation completion designs for unconventional developments to reduce drilling and improve recovery
- Combination of horizontal drilling with hydraulic fracturing to significantly reduce land surface footprint and cost

UP CLOSE:
Reducing costs using technology to improve competitive position

Trillions of dollars of investment in oil and natural gas will be needed, even considering a 2°C scenario. By leveraging high-impact technologies from our research organization, we reduce costs and environmental impacts. This positions our portfolio to compete successfully.
This process considers a wide range of variables over time, including as appropriate: the extent and quality of the resource, development concepts, fiscal terms, regulatory requirements, proximity to existing infrastructure, market conditions, enabling technologies, and policy developments, including climate-related policy.

We optimize resource development plans in line with these variables and prioritize developments that are competitively advantaged in delivering long-term shareholder value. A rigorous Decision Quality Framework is employed to inform development decisions ranging from developing the resource (which eventually moves to proved reserves), monetizing the resource by selling it to others, or exiting the asset.

With a very large resource base, this process can take decades as technologies are developed, market conditions change and competition evolves. Two examples illustrate this:

**LIZA PHASE 1 DEVELOPMENT**

The Liza field was discovered in May 2015 offshore Guyana. Our approach to development planning enabled an industry leading start-up in less than five years post-discovery.

**NORWAY SALE**

In contrast, we monetized our Norway upstream assets through a December 2019 sale. After an evaluation of our portfolio, we divested the asset to enable ExxonMobil to focus on investments with higher long-term strategic value.

Dynamic resource development planning to maximize value

- **Monetize**
- **Develop**
- **Exit acreage**

- Resource definition
- Development concept and cost
- Fiscal terms
- Regulatory requirements
- Environmental impact analysis
- Infrastructure availability
- Market development
- Enabling technology
Positioning for a lower-carbon energy future

Upstream

Oil and natural gas remain important energy sources, even in the assessed 2°C scenarios. Natural gas demand is expected to grow more than 35 percent from 2017 to 2040, largely from expanding industrial activity and increasing use in power generation as utilities switch to lower-emission fuels. We are progressing 12 million tonnes per year of low-cost liquefied natural gas (LNG) supply opportunities to meet the growing global demand. This includes potential projects in Papua New Guinea (PNG), Mozambique and the U.S. As one of the largest natural gas producers in the U.S. and a significant producer of LNG around the world, we are well positioned to support the projected demand shift from coal to natural gas for power generation and industrial use.

Downstream

Global demand for commercial transportation fuels, finished lubricants and higher-value grades of lube basestocks is expected to grow, while worldwide gasoline demand will likely peak and then begin declining. Over the past several decades, through application of advantaged technologies, capital redeployment and divestment, we have created a resilient portfolio of manufacturing sites. Since 2000, we have divested 22 of 43 refinery sites. Approximately 80 percent of our refining capacity is co-located with chemical or lube basestock manufacturing. Our average refinery capacity is 75-percent larger than industry. ExxonMobil is investing $9 billion in six major Downstream projects that will leverage our integrated manufacturing footprint, scale and proprietary process and catalyst technology to improve the mix of products consistent with demand trends. This continuous high-grading of our portfolio has positioned our Downstream business to remain competitive across a wide range of future scenarios (see top chart).

Chemical

Chemical industry growth is forecast to outpace growth in global GDP and energy demand for the next two decades. We are progressing 13 new facilities that are expected to support a 30-percent growth in sales, and also anticipate performance products to deliver approximately 60 percent of earnings by 2025. Many of our chemical products help our customers reduce their GHG emissions, particularly in high-performance products such as advanced materials that make cars lighter and more fuel efficient, and packaging materials that extend products’ shelf life and reduce the energy needed to ship goods around the world.

Potential new areas of investment

In addition to major capital investments in our base business lines, we are also investing in major research and development (R&D) programs that will create potential opportunities to enhance and expand our portfolio. These programs are discussed further in the sections ahead and include R&D efforts in CCS, advanced biofuels and energy-efficient manufacturing.
The products we provide help meet the evolving needs of societies worldwide. Natural gas provides power and heat to homes and businesses; liquid fuels enable clean and efficient transportation; and chemical products improve agriculture, automotive and consumer goods.

ExxonMobil’s sustained investment in R&D plays an important role in positioning us to develop next generation solutions across our portfolio. We are progressing fundamental science in pursuit of breakthroughs in areas such as carbon capture, biofuels and energy-efficient process technology.

ExxonMobil’s unique and sustained approach to R&D

All disciplines of science and engineering are needed to provide affordable and scalable energy. ExxonMobil is a technology company. We employ 20,000 scientists and engineers, including more than 2,200 Ph.D.s, who have a wide range of capabilities. We have authored more than 1,000 peer-reviewed publications and been awarded more than 10,000 patents over the past decade. Our patent portfolio is overseen by management to ensure an efficient and effective process is utilized to steward intellectual property.

We collaborate with more than 80 universities, including five global energy centers, to progress proof of principle experiments in emerging technologies. Our recently formed collaboration with the U.S. national laboratories will help advance technologies such as carbon capture and biofuels. Our collaboration with Synthetic Genomics Inc. (SGI) on biofuels and FuelCell Energy on carbon capture will facilitate first commercial deployment of new technologies. We can then utilize our project and engineering expertise to advance solutions to scale. Our unique approach to research, working across all parts of the innovation pipeline, puts us in an advantaged position to progress energy solutions from lab to scale.

We actively monitor the broad landscape of emerging technologies including solar, wind, nuclear and natural sinks (a natural means of removing carbon from the atmosphere). Much of this is done through academic collaborations that provide portfolio optionality.

ExxonMobil has demonstrated its commitment to R&D through various price cycles and delivered a number of energy innovations. While deployment at full scale takes time, we are confident ExxonMobil will be at the forefront of many of the future innovations to meet growing demand for energy with lower emissions.

“ExxonMobil is one of the most innovative companies.”
— The Wall Street Journal, November 2019

DEVELOPING AND DEPLOYING SCALABLE TECHNOLOGY SOLUTIONS
EXXONMOBIL COLLABORATIONS

We innovate with organizations across the technology pipeline to bring science to scale

**DISCOVERY**
We carry out and support fundamental science and novel technology generation with universities

**DEVELOPMENT**
We assess the potential of new technologies with government labs

**FIRST DEPLOYMENT**
We collaborate with small companies to prove out new technologies

**DEPLOYMENT AT SCALE**
We deploy the most promising technologies at scale

**UNIVERSITIES/ENERGY CENTERS**
- Proof of concept for CO₂ capture and sequestration technologies
- New routes to improve fuel yields from algae and cellulosic biomass

**GOVERNMENT/NATIONAL LABS**
- Demonstration of emerging CO₂ capture technologies at small scale
- Advancement of both algae and cellulosic technology options

**SMALL COMPANIES**
- First demonstration and deployment of fuel cell based CO₂ capture technology
- First demonstration and deployment of advanced biofuels technologies

EXXONMOBIL integrates technology and world-class project management to deploy new technologies at scale.
Carbon capture and storage

CCS is a technology that captures CO₂ emissions from industrial processes and the production or use of fossil fuels or biomass, and stores them deep underground in dedicated geological storage, preventing the CO₂ from entering the atmosphere. It is an important GHG emissions reduction technology that has wide applicability in the oil and natural gas production, power and industrial sectors. The IEA, in its SDS, projects a rapid deployment of carbon capture, from more than 25 million tonnes captured in 2019 to almost 2,800 million tonnes per year by 2050. CCS can also be used to achieve carbon removal or “negative emissions” when CO₂ is captured from burning biomass or directly from the atmosphere.

ExxonMobil is a leader in CCS, with more than 30 years of experience in developing and deploying CCS technologies. In recent years, we have expanded our CCS R&D portfolio. In November 2019, we extended our more than 5-year relationship with FuelCell Energy to further enhance carbonate fuel cell technology for the purpose of capturing CO₂ from power plants and industrial facilities. This technology potentially has significantly higher efficiency than conventional technology. Current efforts are focused on further understanding the fundamentals, expanding process integration options, and developing the pathway to large-scale deployment. ExxonMobil is exploring options to conduct a first demonstration of this technology at one of our operating sites.

In addition, we are progressing research in developing new materials for CO₂ capture that may offer advantages over conventional technology. In 2019, ExxonMobil and Mosaic Materials (Mosaic) entered into an agreement to evaluate Mosaic’s novel materials that may offer the potential to capture and separate CO₂ with increased energy efficiency. Also in 2019, ExxonMobil and Global Thermostat signed a joint development agreement to evaluate the ability of their direct air capture technology to capture CO₂ from the atmosphere.

Fuel cell technology for CCS

1. Industrial sites or power plants
2. The fuel cell could capture up to 90% of the CO₂ emissions while generating electricity.
3. Because fuel cells are modular, they could be deployed at a wide range of locations.
4. This CO₂ could then be compressed and piped more than 3,000 feet below the Earth’s surface.
5. The compressed CO₂ could then be safely stored underground.
Advanced biofuels

Fuels for heavy-duty transportation (trucking, aviation and marine) require an energy density that liquid hydrocarbons provide. Biofuels have the potential to meet this need. ExxonMobil continues to progress research to transform algae and cellulosic biomass into liquid fuels (biofuels) for the transportation sector. These advanced biofuels have the potential to reduce GHG emissions by more than 50 percent compared to today’s transportation fuels. They also offer advantages versus other biofuels by not competing with food and reducing fresh water use. ExxonMobil is making progress toward first demonstrations of advanced biofuels production in the next decade.

Cellulosic biodiesel program

We have made significant progress through collaborations to convert cellulosic sugars (made from sources like agricultural waste and wood) to biodiesel. To advance this technology, we are working with two companies; one focused on converting cellulosic biomass to cellulosic sugar and one focused on converting sugar to biofuel. Genomatica has developed microbes that can potentially convert cellulosic sugars to biofuel through a single bio-conversion step. We have doubled the yield of biodiesel from a variety of cellulosic sugars over the past few years, successfully validating Genomatica’s process in the lab. In early 2019, we began collaborating with Clariant, which is able to commercially produce cellulosic sugars with its sunliquid® technology. We are testing sugars made with Clariant’s process with the Genomatica microbes to understand the commercial viability of this novel integration. ExxonMobil’s unique science and engineering capabilities are critical to integrating the two technologies into a potentially more affordable and scalable option.

Algae program

We have been working with SGI for a decade to develop strains of algae that will convert CO₂ and sunlight into energy-rich bio-oil, which can then be processed at existing refineries (similar to crude oil) into renewable fuels. To increase the speed of development, we are progressing two tasks in parallel. We continue to progress needed biology modifications to the algae in the lab, while working on outdoor algae ponds to understand the process engineering aspects of growing algae in real-world environments. We are making progress on both fronts with a target to be technically ready to produce 10,000 barrels per day of biofuel by 2025. This first proof of production is a critical step towards full-scale deployment which is likely decades away.
Energy-efficient manufacturing

**Taking the emissions out of manufacturing**

The manufacturing sector of the economy – which produces fuel, plastic, steel, cement, textiles and other building blocks of modern life – accounts for about one-third of the world’s energy-related CO₂ emissions.

Demand for industrial products is expected to grow as economies expand and standards of living rise in the developing world. To meet this demand, the world will need manufacturing solutions that are more energy- and GHG-efficient than those currently available. ExxonMobil is targeting research in equipment design, advanced separations, catalysts and process configurations as part of our broader effort to develop energy-efficient manufacturing.

**Energy-efficient manufacturing efforts**

*Rethinking equipment design:* New equipment design may provide a step-change reduction in energy use and equipment size even in traditional separation processes like distillation. For instance, use of Divided Wall Columns (DWCs) – a concept discovered and developed by ExxonMobil – can combine a series of distillation towers into one, thereby providing significant energy and capital cost savings. Energy savings on the order of 50 percent were demonstrated at ExxonMobil’s Fawley Refinery xylene tower based in the U.K.⁹⁷

*Novel contactors:* Drawing upon decades of leadership in materials, advanced modeling and process design, ExxonMobil is progressing technologies that can greatly improve efficiency in natural gas processing. One example is RapAdsorb™, a novel technology that uses less energy and has a much smaller physical footprint compared with conventional gas treating. RapAdsorb™ has the potential to reduce the overall gas treating footprint by about 50 percent,⁸⁸–⁴¹ and may lead to up to a 25-percent reduction in GHG emissions.⁴²

*Reimagining separations:* New materials may provide a step-change reduction in energy use by replacing conventional separations processes, such as distillation for the refining and petrochemical industry. Distillation is highly energy intensive since it requires feedstocks to be boiled at high temperatures to separate them into their constituents. ExxonMobil and the Georgia Institute of Technology are progressing fundamental research on new materials that could be 50 percent more efficient than today’s separation techniques.⁴³–⁴⁴ We are applying our scale-up expertise to develop this technology to more efficiently process unconventional crudes while lowering GHG emissions.

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**CONVENTIONAL DESIGN**

**ENERGY-EFFICIENT DESIGN**

**XYLENES TOWER, FAWLEY (UK)**

Concept of Divided Wall Columns is applied to provide energy and capital savings by combining a series of distillation towers into one, as demonstrated at the Fawley Refinery xylene tower (picture shown above).

**NATURAL GAS TREATING**

**NOVEL SEPARATION MATERIALS**

A new natural gas treating technology, RapAdsorb™, reduces the overall gas treating footprint by about 50 percent, as shown in blue.

Specially designed nanoengineered materials can separate crude oil into naphtha and kerosene rich permeate (green) without boiling.
Life cycle analysis (LCA)

LCA is the preferred scientific method to estimate the environmental impact of energy processes and products. It is important to include all emissions across the life cycle of each option when comparing different energy technologies. Every step that emits any type of GHGs must be included to properly estimate the GHG footprint. This includes GHG emissions associated with production of the resource, conversion and transportation steps and lastly consumption of the fuel by the end user (e.g., on a vehicle or in a power plant).

ExxonMobil has a long history of conducting LCAs on energy pathways. Many of these studies are carried out through collaborations with academic institutions and are made public through scientific journal publications. LCAs are important to comprehensively evaluate the GHG emissions impacts of alternate energy system options.

CASE STUDY: Power generation from Indian domestic coal vs. imported U.S. natural gas

Electricity demand in the developing world is increasing to meet the needs of growing populations. ExxonMobil, along with the Indian Institute of Technology Bombay and the India Council on Energy, Environment and Water, published a full well-to-wire LCA comparing the GHG footprints of Indian coal and U.S. natural gas shipped to India for electricity generation.\(^{(45)}\) As shown in the figure on the bottom right, overall full-life-cycle GHG emissions for imported natural gas are more than 40 percent lower than for local coal, in spite of the GHGs associated with liquefaction, long-distance transportation and regasification of the natural gas. This demonstrates the important role that a comprehensive, transparent LCA assessment can have in determining the best option to provide energy, while reducing emissions.
ExxonMobil believes that sound policy should reduce the risks of climate change at the lowest societal cost, while balancing increased demand for affordable energy and the need to address poverty, education, health and energy security.

Climate change is a global issue that requires collaboration among governments, private companies, consumers and other stakeholders to create meaningful solutions. We engage with stakeholders directly and through trade associations around the world to encourage sound policy solutions for addressing climate change risks.

Our scientists, engineers and other experts have long contributed to the development of sound policy at both the national and international levels through important collaborations as well as the development of key insights and analysis.

For example, we have participated in the IPCC since its inception in 1988, including co-authoring chapters of IPCC scientific reports. We collaborate with top universities and national labs, and have published more than 50 papers in peer-reviewed journals. Over the past year, we played a pivotal role generating policy-relevant reports on carbon capture, utilization and storage (CCUS) and infrastructure at the request of the U.S. Department of Energy.

We actively monitor policy at the domestic and global level to inform our business planning and to assist policymakers seeking expertise about energy markets and technology. For example, we have supported the Paris Agreement, and while we recognize there are gaps between the policies called for under current NDCs and the ultimate Paris goals, our experience can assist policymakers hoping to address these gaps.

For more than a decade, ExxonMobil has supported an economy-wide price on CO₂ emissions as an efficient policy mechanism to address GHG emissions. ExxonMobil is a founding member of the Climate Leadership Council (CLC). Formed in 2017, the CLC calls for regulatory simplification and the adoption of a carbon fee. According to the CLC, if implemented in 2021, the Council’s bipartisan plan would cut the U.S. CO₂ emissions in half by 2035, as compared to 2005 levels.

ExxonMobil also provided financial support for “Americans for Carbon Dividends,” a national education and advocacy campaign launched in 2018 to promote the policy pillars of the CLC.

ExxonMobil is part of the Oil and Gas Climate Initiative (OGCI), a voluntary initiative representing 13 of the world’s largest oil and gas producers working to mitigate the risks of climate change.

This CEO-led organization focuses on developing practical solutions in areas including carbon capture and storage, methane emissions reductions, and energy and transportation efficiency. ExxonMobil supports OGCI’s investments in technology and deployment of long-term solutions to reduce GHG emissions.

<table>
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<tr>
<th>Attributes of sound policy</th>
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<tr>
<td>PUBLIC AND SHAREHOLDERS</td>
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<td>ACADEMIC INSTITUTIONS</td>
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<td>INDUSTRY</td>
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<td>NGOs</td>
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<td>POLICYMAKERS</td>
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- Promote global participation
- Let market prices drive the selection of solutions
- Ensure a uniform and predictable cost of GHG emissions across the economy
- Minimize complexity and administrative costs
- Maximize transparency
- Provide flexibility for future adjustments to react to developments in technology, climate science and policy
Natural gas
Natural gas is a versatile, abundant and lower-emission fuel. The use of natural gas in power generation plays an important role in reducing global emissions. When considering life cycle emissions, natural gas emits up to 60 percent lower GHGs and produces significantly fewer air pollutants than coal for power generation. Natural gas also provides a reliable source of power to supplement renewable energy when wind or solar power is not available. LNG enables transportation of natural gas from supply centers to customers safely and cost-effectively. ExxonMobil is one of the largest natural gas producers in the world and a leader in LNG.

Lightweight materials and packaging
Demand for auto parts, housing materials, electronics and other products made from petrochemicals continue to grow. We produce weight-reducing materials for automobiles, resulting in an estimated 7 percent fuel economy improvement for every 10 percent reduction in vehicle weight. We also provide lightweight packaging materials for consumer goods resulting in less transportation-related energy use and GHG emissions. Advanced packaging also helps extend the shelf life of fresh food by days or even weeks, improving safety and reducing food waste and agricultural inputs.

Advanced fuels and lubricants
ExxonMobil’s high-performance synthetic lubricants deliver improved vehicle efficiency and help customers reduce their emissions. Our synthetic lubricants require less frequent replacement than conventional motor oils. Mobil 1™ Advanced Fuel Economy synthetic motor oil can improve fuel economy compared to other motor oils. Premium fuels such as Synergy™ gasoline and diesel also help consumers improve gas mileage. ExxonMobil is progressing several multi-billion-dollar refinery expansion projects to supply the growing demand for these advanced products.

PROVIDING PRODUCTS TO HELP OUR CUSTOMERS REDUCE THEIR EMISSIONS

Over the next few decades, population and income growth, and an unprecedented expansion of the global middle class, are expected to create new demand for energy and hydrocarbon-based products, even under 2°C scenarios. ExxonMobil is responding to this growth in product demand by delivering solutions that enable our customers to reduce their emissions and improve energy efficiency.
ExxonMobil has a robust set of processes to improve energy efficiency and mitigate emissions. These processes include, where appropriate, setting tailored objectives at the business, site and equipment level, and then stewarding progress toward meeting those objectives. We believe this rigorous approach is effective to promote efficiencies and reduce GHG emissions in our operations.

Since 2000, ExxonMobil has invested nearly $10 billion in projects to research, develop and deploy lower-emission energy solutions. ExxonMobil also continues to expand collaborative efforts with other companies and academic institutions. See pages 18-23 for more information on these collaborations.

We are committed to further increasing energy efficiency while reducing flaring, venting and fugitive emissions. We also leverage monitoring technology to minimize and reduce GHG emissions.

In 2018, the GHG emissions from the electricity used in ExxonMobil’s operations represents more than 10 percent of our net equity GHG emissions, hence, using energy more efficiently is a powerful tool to reduce emissions. Cogeneration is a process that improves efficiency by simultaneously producing electricity while capturing useful heat or steam for industrial processes. We have interest in approximately 5,400 megawatts of cogeneration capacity in more than 100 installations around the world and are continuing to pursue additional economic cogeneration opportunities.

We have a working interest in more than one-fifth of the world’s carbon capture capacity, capturing nearly 7 million tonnes of CO2 in 2018. With the safe start-up of a gas injection project in Qatar and a CCS project in Gorgon in 2019, our annual carbon capture capacity increased to nearly 9 million tonnes (47) (see page 29). ExxonMobil continues to evaluate opportunities to further increase CCS capacity.
ExxonMobil has established programs to drive improvements in energy efficiency and mitigate GHG emissions. These programs are supported by key performance metrics, which are utilized to identify and prioritize opportunities to drive progress.
ExxonMobil is committed to mitigating emissions in our operations. As we grow our business to meet increasing demand, we are working to minimize the resulting increase in emissions.

In 2018, we announced GHG emissions reduction measures that are expected to lead to considerable improvements in emissions performance when compared with 2016 levels. These include: 

- 15 percent reduction in methane emissions by 2020,
- 25 percent reduction in flaring by 2020,
- 10 percent GHG emissions intensity reduction at Imperial operated oil sands by 2023.

In 2018, our methane emissions totaled 7 million CO₂-equivalent tonnes. Flaring from our operations dropped by 23 percent from 2016. Imperial achieved a 2 percent reduction in GHG intensity at its operated oil sands facilities.

ExxonMobil’s GHG emissions have remained relatively flat (see bottom right chart) from 2009 to 2018. The GHG emissions from the base facilities that were in operations in 2009 have decreased more than 20 percent (approximately 28 million tonnes), primarily due to portfolio optimization, energy efficiency improvements, and reductions in flaring, venting and fugitive emissions. Meanwhile, the GHG emissions from acquisitions, expansions, new developments and facilities (shown as growth) offset these decreases from the base facilities.

We are also continuing our efforts to identify opportunities to lower GHG emissions along our product value chains. As ExxonMobil grows its business to meet society’s needs, the mix and relative size of our asset portfolio, may drive changes in our GHG emissions. We strive to achieve best-in-class GHG intensity for each asset group while identifying opportunities to reduce overall GHG emissions.

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**ExxonMobil GHG emissions reductions**

(Net equity, CO₂-equivalent emissions cumulative since 2000, millions tonnes)

- Carbon capture and storage
- Energy efficiency and cogeneration
- Flare reduction

~ 400 million tonnes

**ExxonMobil GHG Emissions**

(Net equity, CO₂-equivalent emissions, million tonnes)

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<td>Base operations</td>
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<td>Growth projects</td>
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ExxonMobil is pursuing large-scale deployment of CCS needed for delivering sustainable, clean energy

**Grow CCS capacity globally**

Since 1970, ExxonMobil has cumulatively captured more CO₂ than any other company. While already a leader in CCS, we are working toward expanding capacity and are evaluating multiple opportunities that use advantaged technologies and leverage a supportive policy environment. In addition to deployments at our own facilities, we are working with Joint Ventures and other stakeholders including policymakers, and the OGCI to evaluate and deploy additional large-scale applications.

**Joint ventures – QatarGas and Gorgon**

In February 2019, QatarGas, the joint venture between ExxonMobil and Qatar Petroleum, started a gas capture and injection project. This project will initially capture and store approximately 2 million tonnes per year of CO₂ in addition to the 1 million tonnes of CO₂ currently captured annually at the base facility. In August 2019, one of the world’s largest CCS projects began operating with the Gorgon LNG project start-up. This CCS facility is expected to reduce Gorgon’s emissions by 40 percent over the life of the project. Once fully up and running, between 3 million and 4 million tonnes per year of CO₂ will be captured and stored. With the start-up of these projects, ExxonMobil’s annual carbon capture capacity increased to nearly 9 million tonnes.

**Port of Rotterdam**

In December 2019, ExxonMobil signed an agreement with the Port of Rotterdam to prepare for the capture, transport and storage of CO₂ beneath the North Sea. ExxonMobil is assessing the feasibility of constructing a carbon capture facility at the company’s Rotterdam refinery in the Netherlands.

**Port of Antwerp**

In December 2019, ExxonMobil entered into a collaboration agreement with the Port of Antwerp to explore the possible development of CCUS infrastructure.

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**Cumulative CO₂ capture volume since 1970**

(Million tonnes)

<table>
<thead>
<tr>
<th>Company</th>
<th>Capture Volume</th>
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<tbody>
<tr>
<td>ExxonMobil</td>
<td>120</td>
</tr>
<tr>
<td>Company A</td>
<td>80</td>
</tr>
<tr>
<td>Company B</td>
<td>40</td>
</tr>
<tr>
<td>Company C</td>
<td>20</td>
</tr>
<tr>
<td>Company D</td>
<td>0</td>
</tr>
<tr>
<td>Sum of remaining 43 companies</td>
<td>80</td>
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</tbody>
</table>

**National Petroleum Council (NPC)**

In 2019, the NPC completed a study at the request of the U.S. Department of Energy to define the potential pathways for integrating CCS at scale into the energy and industrial marketplace. As a member of NPC, ExxonMobil took a leadership role in developing a road map, including prioritized opportunities and associated detailed plans for additional CCS deployment of up to 500 million tonnes per annum in the U.S. over the next 25 years.

**OGCI and the Clean Energy Ministerial (CEM)**

In 2019, ExxonMobil with OGCI members launched the CCUS KickStarter program to facilitate large-scale commercial deployment of CCUS via multiple low-carbon industrial hubs. These hubs will be designed to capture CO₂ from several industrial companies enabled by shared transport and storage infrastructure. In addition, the initiative will work with governments and other industries to provide supportive market conditions to encourage investments in CCS deployment. A strategic framework has been established with the CEM CCUS Initiative, a strategic cooperation designed to facilitate commercial scale investment in CCUS around the world.
ExxonMobil is committed to reducing methane emissions in our own operations, as well as advancing technology and policy to make progress in a cost-effective manner.

**Operations**
ExxonMobil implemented a program across its U.S. unconventional production to reduce methane emissions from new and existing sources by:
- Regularly conducting leak detection and repair surveys
- Phasing out high-bleed pneumatic devices
- Monitoring liquid unloadings
- Improving facility designs
- Training operations management, superintendents, foremen, facility engineering personnel and those involved in leak inspections

Since initiating our voluntary program, we have conducted nearly 20,000 leak surveys on more than 4.6 million components at more than 8,700 production sites. We replaced approximately 90 percent of our high-bleed pneumatic devices (approximately 1,250 devices) across our U.S. unconventional production as of 2019. As a result of these actions, our observed leak rate and level of emissions substantially reduced. Since 2016, we have reduced our U.S. unconventional methane emissions by nearly 20 percent as of 2018, equivalent to about 36,000 tonnes.

**Research and technology**
Working with our industry peers, regulators, researchers and NGOs, ExxonMobil is undertaking extensive research to understand methane emission sources, and to help develop and test new detection and mitigation technologies. For example, ExxonMobil is assessing the results of a pilot field study in Freestone County, Texas, that tested advanced technologies to more efficiently detect leaks. The study, which evaluated drones, detection sensors mounted on vehicles and fixed sensors, will inform the next generation of mitigation efforts across ExxonMobil’s operations, as well as industry generally, leading to further methane emission reductions.

**Advocacy**
We are also active in pursuing sound policies, and we support reasonable, cost-effective regulations. In this regard, ExxonMobil submitted a letter to the U.S. Environmental Protection Agency rulemaking docket indicating support for reasonable, cost-effective regulations to manage methane emissions from new and existing sources. We also engaged with states advancing their own regulatory programs, most recently serving on the technical board advising New Mexico’s regulatory development. Additionally, we led the Policy and Regulatory work streams of the global Methane Guiding Principles (MGP) initiative. The MGP forum supported development of a methane information portal by the IEA and engaged with the European Commission’s development of a methane emissions strategy for Europe, as well as the United Nations Environment Programme (UNEP)’s “Global Methane Alliance.” Through this alliance, UNEP is asking governments to include methane reductions in their next round of NDCs to be submitted under the Paris Agreement.
GHG emissions performance data

We assess our performance to support continual improvements throughout the organization. Since 2011, performance data include unconventional operations information. In 2014, we started reporting our data over a 10-year period to demonstrate trends over time as part of our commitment to transparency. The reporting guidelines and indicators of International Petroleum Industry Environmental Conservation Association, the International Oil and Gas Producers Association and the American Petroleum Institute Oil and Gas Industry Guidance on Voluntary Sustainability Reporting (2015) informed what data we included in the performance table.

Managing the risks of climate change

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</thead>
<tbody>
<tr>
<td>GHG emissions, absolute (net equity, CO₂-equivalent emissions), millions of tonnes</td>
<td>123</td>
<td>126</td>
<td>128</td>
<td>126</td>
<td>127</td>
<td>124</td>
<td>122</td>
<td>125</td>
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<tr>
<td>Direct (excluding emissions from exported power and heat)</td>
<td>114</td>
<td>117</td>
<td>119</td>
<td>118</td>
<td>119</td>
<td>116</td>
<td>114</td>
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<td>Emissions associated with imported power</td>
<td>9</td>
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<td>9</td>
<td>8</td>
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<tr>
<td>CO₂ (excluding emissions from exported power and heat)</td>
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<td>122</td>
<td>124</td>
<td>120</td>
<td>119</td>
<td>116</td>
<td>115</td>
<td>118</td>
<td>116</td>
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<tr>
<td>Methane (CO₂-equivalent)</td>
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<td>3</td>
<td>5</td>
<td>7</td>
<td>7</td>
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<td>Other gases (CO₂-equivalent)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>&lt;1</td>
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<tr>
<td>Emissions from exported power and heat</td>
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<td>13</td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>3</td>
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By-region GHG emissions (net equity, CO₂-equivalent emissions), millions of tonnes

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<td>Africa/Europe/Middle East</td>
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<td>Americas</td>
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By-division GHG emissions (net equity, CO₂-equivalent emissions), millions of tonnes

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<tr>
<td>Upstream</td>
<td>47</td>
<td>50</td>
<td>54</td>
<td>56</td>
<td>58</td>
<td>56</td>
<td>56</td>
<td>59</td>
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<td>Downstream</td>
<td>56</td>
<td>55</td>
<td>54</td>
<td>51</td>
<td>49</td>
<td>47</td>
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<td>Chemical</td>
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<td>19</td>
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<td>21</td>
<td>21</td>
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<tr>
<td>Carbon dioxide – captured for storage, millions of tonnes</td>
<td>4.6</td>
<td>4.8</td>
<td>5.0</td>
<td>4.8</td>
<td>5.9</td>
<td>6.9</td>
<td>6.9</td>
<td>6.3</td>
<td>6.6</td>
<td>7.0</td>
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<tr>
<td>Energy use (billion gigajoules)</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.4</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Upstream (gigajoules per tonnes production)</td>
<td>1.9</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.1</td>
<td>2.3</td>
<td>2.4</td>
<td>2.4</td>
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<td>Refining (gigajoules per tonnes throughput)</td>
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<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.9</td>
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<td>3.0</td>
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<tr>
<td>Chemical (gigajoules per tonnes product)</td>
<td>9.8</td>
<td>9.5</td>
<td>11.4</td>
<td>12.0</td>
<td>10.9</td>
<td>10.7</td>
<td>10.9</td>
<td>10.6</td>
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<tr>
<td>Hydrocarbon flaring (worldwide activities), million standard cubic feet per day</td>
<td>470</td>
<td>380</td>
<td>430</td>
<td>380</td>
<td>390</td>
<td>470</td>
<td>570</td>
<td>530</td>
<td>410</td>
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<td>Hydrocarbon flaring (worldwide activities), millions of tonnes</td>
<td>4.4</td>
<td>3.6</td>
<td>4.0</td>
<td>3.5</td>
<td>3.7</td>
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<td>5.3</td>
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</table>

Cogeneration capacity in which we have interest, gigawatts

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</thead>
<tbody>
<tr>
<td>Cogeneration capacity</td>
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<td>4.9</td>
<td>5.0</td>
<td>5.2</td>
<td>5.3</td>
<td>5.5</td>
<td>5.5</td>
<td>5.3</td>
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</table>
ExxonMobil utilizes a risk management framework based on decades of experience to identify, manage and address risks associated with our business.
ExxonMobil’s approach to risk management

ExxonMobil’s corporate risk framework provides a structured, comprehensive approach to identify, prioritize and manage risks across the Company. It is designed to drive consistency across risk type, and monitor key risks, including risks related to climate change. The framework includes five elements: (1) a way to organize and aggregate risks (illustrated at the right); (2) robust risk identification practices; (3) a prioritization method; (4) an inventory of systems and processes to manage risk; and (5) risk governance.

ExxonMobil’s approach to risk governance includes clearly defined roles and responsibilities for managing each type of risk, utilizing a multilayered approach. This approach includes a definition of the responsibilities of risk owners, functional experts and independent verifiers. Each risk type is managed and supported by functional organizations that are responsible for specifying corporate requirements and processes. Each of these processes includes the critical elements of leadership, people, risk identification and management, and continuous improvement. Oversight responsibilities by the Management Committee and the Board and its committees, as described on pages 4-6, are a key part of risk governance.

Managing long-term risks associated with climate change is an integral part of managing strategic risks at ExxonMobil. A core element of our management of strategic risks is the annual Outlook for Energy. As described in the previous sections of this report, the Outlook reflects a long-term, data-driven approach to promote a deeper understanding of global trends and projections related to population and economic growth, energy demand and supply options, as well as assessments of key uncertainties and potential impacts of alternative assumptions. Uncertainties include changes in economic growth, the evolution of energy demand and supply, emerging and disruptive technologies, and policy goals and actions. The Outlook informs business strategies, assumptions and processes for evaluating investment opportunities. Managing risk associated with climate change is an integral part of that work, helping to ground our choices related to long-term strategies and individual investments.

ExxonMobil enterprise risk categories

<table>
<thead>
<tr>
<th>Risk type</th>
<th>Examples of potential risks that could be impacted by climate change, energy transition and extreme weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Strategic</td>
<td>Supply/demand, disruptive technology, geopolitical and government changes</td>
</tr>
<tr>
<td>2 Reputational</td>
<td>Industry reputation, corporate reputation</td>
</tr>
<tr>
<td>3 Financial</td>
<td>Price volatility, foreign exchange fluctuations, customers’ credit risk, insurance</td>
</tr>
<tr>
<td>4 Operational</td>
<td>Geological risk, project risk, product quality and brand, cybersecurity, talent, supplier</td>
</tr>
<tr>
<td>5 Safety, Security, Health &amp; Environment</td>
<td>Process safety, well control events, environmental incidents</td>
</tr>
<tr>
<td>6 Compliance &amp; Litigation</td>
<td>Litigation risks, regulatory compliance</td>
</tr>
</tbody>
</table>
ExxonMobil has extensive experience operating in a wide range of challenging physical environments around the globe. Our history of design, construction and operations provides us with a solid foundation to address risks associated with different physical environments. The Company assesses the risks posed by weather and other natural elements, and designs its facilities and operations in consideration of these risks.

ExxonMobil’s diverse portfolio requires us to work in remote and challenging environments, including flood-prone areas. Using a rigorous and comprehensive scientific assessment process and the highest quality data from measurements and advanced computer modeling, we consider the full range of potential environmental, socioeconomic and health risks associated with potential operations before pursuing a new development. In doing so, we gain a holistic understanding of our impacts, and utilize this information to implement measures to avoid environmental, socioeconomic and health risks, reduce them to acceptable levels, or remedy the impacts.

When considering physical environmental risks, including risks for our production, refining and petrochemical facilities, we evaluate the type and location of our current and planned facilities. As an example, offshore facilities could be impacted by changes in wave and wind intensity as well as by changes in ice floe patterns, while onshore facilities could be vulnerable to sea level rise, changes in storm surge, flooding, changes in wind and seismic activity, or geo-technical considerations. Environmental assessments are conducted in advance to ensure that protective measures and procedures are in place prior to building and start-up of the facilities.

We use industry standards such as ASCE 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, and historical experience with additional factors to cover a range of uncertainties. After construction of a facility, we monitor and manage ongoing facility integrity, through periodic checks on key aspects of the structures.

Our scientists and engineers are considered industry experts. Through their active participation and leadership in industry groups, they advise and gather insights from industry to inform and improve the industry standards which in turn are adopted to enhance ExxonMobil’s standards and procedures and industry practices such as the American Society of Civil Engineers’ Climate-Resilient Infrastructure Adaptive Design and Risk Management Manual of Practice.

Once facilities are in operation, we maintain disaster preparedness, response and business continuity plans. Detailed, well-practiced and continuously improved emergency response plans tailored to each facility help ExxonMobil prepare for unplanned events, including extreme weather. Regular emergency drills are practiced in partnership with appropriate government agencies and community coalitions to help ensure readiness and minimize the impacts of such events. We establish strategic emergency support groups around the world to develop and practice emergency response strategies and assist field responders. Regardless of the size or complexity of any potential incident, each ExxonMobil facility and business unit has access to readily available trained responders, including our regional response teams, to provide rapid tactical support.

ExxonMobil remains steadfast in our commitment to excellence in safety, security, health and environmental performance, referred to collectively as operations integrity. We believe the best way to manage the integrity of our business is through a capable, committed workforce coupled with policies, practices and management systems designed to enable safe, secure and environmentally responsible operations.

ExxonMobil’s comprehensive approach and established systems enable us to manage a wide variety of possible outcomes, including risks associated with climate change.
How are ExxonMobil’s operations and investments aligned with the Paris Agreement?

ExxonMobil supports the goals of the Paris Agreement, an agreement among national governments to reduce carbon emissions from their economies. The Company’s Outlook for Energy, which forecasts future energy supply and demand, aligns in aggregate with the NDCs submitted by Paris Agreement signatories, which represent each country’s plans to reduce its emissions.

ExxonMobil bases its business strategy and investments on its Outlook, which assumes progress in technologies, infrastructure and policies to meet the NDCs. These business strategies and investment plans are therefore aligned with the aggregate of the agreement’s national targets.

The Company’s strategy focuses on the dual challenge of meeting the growing demand for energy to support economic development around the world while minimizing environmental impacts and the risks of climate change. ExxonMobil believes it has an important role to play in helping reduce climate risks through its commitment to manage operational emissions, produce cleaner, more advanced products, conduct fundamental research into new technology solutions, and engage in climate policy discussions.

Over the past two decades, ExxonMobil has invested nearly $10 billion in technology and programs to reduce emissions, resulting in highly efficient operations that have eliminated or avoided more than 400 million tonnes of CO₂ emissions.

As governments around the world implement policies to meet their respective emission-reduction goals, demand for more carbon-intensive energy products will be reduced. However, even under 1.5°C and 2°C scenarios, a growing and increasingly prosperous global population will increase energy demand and still require significant investment in new supplies of oil and natural gas.

The IEA’s most aggressive forecast for the implementation of emission reduction policies, the SDS, estimates the world will still need 67 million barrels of oil per day in 2040. However, without further investment, the impact of depletion would result in oil production of just 19 million barrels of oil per day in 2040. The IEA estimates $20 trillion of additional oil and natural gas investment is needed, just to keep pace with demand, and avoid a shortfall in supply. Based on ExxonMobil’s current market position, this suggests an average investment of $30 billion to $35 billion per year over this time frame, which is consistent with the Company’s investment outlook. Because ExxonMobil is a highly efficient operator, it is positioned to continue to play a prominent role in meeting these future needs.

Importantly, the Company continues to deploy its competencies in breakthrough technology development to pursue advances in the high-emission sectors where current technologies are insufficient to achieve deep reductions. These sectors – power generation, commercial transportation and industry – represent about 80 percent of current energy-related CO₂ emissions and are projected to increase with population growth and economic development. Breakthroughs in these areas are critical to reducing emissions and would make a meaningful contribution to achieving the goals of the Paris Agreement.

Does ExxonMobil have to reduce its production to align with the Paris Agreement?

The Paris Agreement does not contemplate or require individual companies to decrease production to align with the goal of maintaining global temperature rise to below 2°C. The structure of the agreement recognizes that energy-related emissions are driven by society’s demand for energy – not its supply. Improved efficiency, effective government policies and informed consumer choices are more effective measures to address demand.

With respect to energy supply, production reductions by individual companies would have no impact on demand or consumption of energy, and would simply result in production shifting from one producer to another. And shifting of production would not necessarily reduce the amount of greenhouse gases produced and, in some cases, the opposite could be true. The transfer of production from well-run, highly efficient operators to less-efficient producers, for example, could actually increase emissions associated with the production of oil and natural gas, and finished products. Society benefits when the most efficient operators lead energy development efforts.

ExxonMobil has a long history of industry-leading operational performance. For example, the Company’s refining operations have consistently ranked in the top quartile for energy efficiency in the key refining industry benchmark survey by Solomon Associates. In ExxonMobil’s chemical business, advanced efficiency technologies and techniques have reduced net equity greenhouse gas emissions intensity by nearly 4 percent since 2013.
Technology innovation is critical because the current solution set is insufficient to reduce emissions to targeted levels at an acceptable cost to society. According to the IEA, only seven of 45 important technologies and sectors are on track to help society reach the Paris Agreement goals. Meeting these goals will require large-scale deployment of new technologies in key areas – power generation, commercial transportation and industrial processes – where emissions are most significant and forecast to increase.

Near-term actions the Company is taking to prepare for a lower-carbon future, include:

- Expanding supplies of cleaner-burning natural gas
- Improving energy efficiency in operations
- Operating and investing in carbon capture and storage
- Reducing flaring and methane emissions from operations
- Developing products, such as premium lubricants, light-weight plastics, and special tire liners to help consumers improve efficiency and reduce emissions
- Supporting effective climate policy to address the risk of climate change at the lowest societal cost

Longer-term efforts include:

- Progressing advanced biofuels from algae and agricultural waste for commercial transportation and petrochemicals
- Researching breakthroughs to improve commerciality of carbon capture and storage technology for power generation and industrial applications
- Developing new and efficient technologies that reduce emissions in refining and chemical facilities

More information can be found in the Strategy section of this 2020 Energy & Carbon Summary.

What is ExxonMobil doing to prepare for a lower-carbon future while meeting energy needs of a growing population?

ExxonMobil plays a critical role in providing the energy that supports economic growth and improves the quality of life for people around the world. Major forecasts project energy demand to increase as the global population rises to 9.2 billion by 2040 from 7.5 billion today, and because of growing prosperity and an expanding middle class. Even under 1.5°C and 2°C scenarios, meeting this increase in energy demand will require significant investment in new supplies of oil and natural gas, generally consistent with ExxonMobil’s investment levels. At the same time, there is a need to pursue further emission-reduction efforts and technologies in support of the goals of the Paris Agreement.

The Company supports market-based approaches to reduce emissions, including further cost-effective regulation of methane and an economy-wide price on carbon. ExxonMobil believes market-based policies that place a uniform, predictable cost on carbon will drive emissions reductions at the lowest cost to society while supporting technology innovation and deployment.

Has ExxonMobil set long-term emissions targets consistent with 2°C scenarios?

In 2018, ExxonMobil announced a series of emissions-reduction targets relative to 2016 performance.
ExxonMobil will continue to apply new technologies and approaches to successfully meet future energy and environmental challenges, and will consider additional targets as appropriate.

See page 27-31 in this 2020 Energy & Carbon Summary for further information on metrics and targets.

Why doesn’t ExxonMobil report Scope 3 emissions?

The Company believes that it is important to report on Scope 1 emissions (direct GHG emissions from Company operations) and Scope 2 emissions (indirect GHG emissions from energy purchased by the Company) because these metrics provide an accurate reflection of the Company’s efforts to efficiently manage energy use and reduce emissions.

ExxonMobil’s Scope 1 emissions demonstrate the efficiency of its operations, portfolio of products, business sectors served, and resource type. Its Scope 2 emissions reflect its choice of energy sources, primarily purchases of electrical power to run its operations. By reporting both types of emissions, stakeholders can clearly evaluate the efficiency of ExxonMobil’s operations compared to others within industry with a similar product portfolio, serving similar sectors, and developing similar resources.

ExxonMobil has a long history of highly efficient operational performance enabled by key investments at its manufacturing sites. For example, the Company has extensive combined heat and power cogeneration facilities in more than 100 installations with a gross capacity of 5,400 megawatts, which avoids 7 million CO₂-equivalent tonnes per year of GHG emissions. These measures build upon established programs that deliver sustainable greenhouse gas reductions at operating sites. Setting targets with the aim of reducing production from a highly efficient operator such as ExxonMobil will do nothing to curb demand. Instead, it could result in shifting production to a less-efficient operator, having the effect of actually increasing overall emissions.

The Paris Agreement does not contemplate or require individual companies to decrease production in order to align with the goal of maintaining global temperature rise to below 2°C. The structure of the Paris Agreement recognizes that energy-related emissions are driven by society’s demand for energy – not its supply. Improved efficiency, effective government policies and informed consumer choices are more effective measures to address demand, and therefore energy-related emissions.

ExxonMobil bases its business strategy and investments on its Outlook, which assumes progress in technologies, infrastructure and policies to meet the NDCs. Therefore, these business strategies and investment plans are aligned with the aggregate of the Paris Agreement NDCs.
The Company’s technology development program focuses on three distinct high-emitting sectors where there are currently limited viable solutions for broad deployment: commercial transportation, power generation and industrial processes. These sectors represent about 80 percent of current energy-related CO$_2$ emissions and are projected to increase with population growth and economic development.

In transportation, ExxonMobil is making progress in the development of advanced algae and cellulosic liquid biofuels. Because of their energy density, liquid fuel solutions are currently needed for commercial transportation where battery capacity is an issue for heavy loads and long distances.

In power generation and for industrial processes, the Company is working to make carbon capture and storage technology more economic, to potentially enable wider deployment. ExxonMobil currently has more than 20 percent of the world’s total carbon capture capacity.

In the industrial sector, ExxonMobil is developing new processes for refining and chemical facilities to reduce energy use through advanced separations processes, catalysts and process configurations.

Breakthroughs in these areas are critical to reducing emissions and would make a meaningful contribution to achieving the goals of the Paris Agreement.

It should also be noted that ExxonMobil was one of the top purchasers in 2018 of renewable energy, including wind and solar, to support its operations.
The Energy & Carbon Summary is aligned with the core elements of the TCFD framework.

This year’s Energy & Carbon Summary is aligned with the core elements of the framework developed by the Financial Stability Board’s Task Force on Climate-related Financial Disclosures (TCFD), designed to encourage the informed conversation society needs on these important issues.

## TCFD core elements and recommended disclosures

<table>
<thead>
<tr>
<th>Governance</th>
<th>ExxonMobil disclosures</th>
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<tbody>
<tr>
<td>a. Describe the Board’s oversight of climate-related risks and opportunities.</td>
<td>Page 3 - 6, 33</td>
</tr>
<tr>
<td>b. Describe management’s role in assessing and managing risks and opportunities.</td>
<td>Page 3 - 6, 33</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>a. Describe the climate-related risks and opportunities the organization has identified over the short, medium and long term.</td>
<td>Page 7 - 26</td>
</tr>
<tr>
<td>b. Describe the impact of climate-related risks and opportunities on the organization’s businesses, strategy and financial planning.</td>
<td>Page 7 - 26</td>
</tr>
<tr>
<td>c. Describe the resilience of the organization’s strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.</td>
<td>Page 7 - 26</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Metrics &amp; targets</th>
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<tbody>
<tr>
<td>a. Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.</td>
<td>Page 27 - 31</td>
</tr>
<tr>
<td>b. Disclose Scope 1, Scope 2 and, if appropriate, Scope 3 GHG emissions, and the related risks.</td>
<td>Page 27 - 31</td>
</tr>
<tr>
<td>c. Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.</td>
<td>Page 27 - 28, 30</td>
</tr>
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<th>Risk management</th>
<th>ExxonMobil disclosures</th>
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Disclosures

ExxonMobil is committed to providing our shareholders with disclosures that impart meaningful insights about our business, including how we manage climate-related risks. This report, along with the rest of our comprehensive set of disclosures relating to climate-related matters, follow the framework established by IPIECA, including IPIECA’s Climate Change Reporting Framework. In addition, this year’s report continues to be aligned with the core elements of the TCFD framework. IPIECA members represent a significant portion of the world’s oil and natural gas production, including state oil companies, and is the industry’s principal channel of communication with the United Nations. This broad, global membership enables a reporting framework that is tailored to the petroleum industry and better permits comparisons of member companies on a more consistent and standardized basis.

Web links to our other various climate-related disclosures are highlighted below:

- **Sustainability Report** (exxonmobil.com/sustainabilityreport)
- **Outlook for Energy** (exxonmobil.com/energyoutlook)
- **Technology** (exxonmobil.com/technology)
- **Enhanced Methane Emissions Reduction Program** (exxonmobil.com/methanereduction)
- **Climate-related materials** (exxonmobil.com/climate)
- **SEC Form 10-K** (exxonmobil.com/secfilings)

Existing policy frameworks (including the Paris NDCs), financial flows, and the availability of cost-effective technologies indicate that society is not currently on a 2°C pathway. Should society choose to more aggressively pursue a 2°C pathway, we will be positioned to contribute through our engagement on policy, development of needed technologies, improved operations and customer solutions.
(1) OECD – Organisation for Economic Co-operation and Development.

(2) IEA World Energy Outlook 2019, page 146.

(3) BROOKINGS INSTITUTION, There are many definitions of “middle class”—here’s ours, Richard V. Reeves and Katherine Guyot Tuesday, September 4, 2018, January 2020, https://www.brookings.edu/blog/up-front/2018/09/04/there-are-many-definitions-of-middle-class-heres-ours/


(5) IEA, Perspectives for the Energy Transition, page 57.


(8) “EMF was established at Stanford in 1976 to bring together leading experts and decision makers from government, industry, universities, and other research organizations to study important energy and environmental issues. For each study, the Forum organizes a working group to develop the study design, analyze and compare each model’s results and discuss key conclusions.” https://emf.stanford.edu/about

EMF is supported by grants from the U.S. Department of Energy, the U.S. Environmental Protection Agency as well as industry affiliates including ExxonMobil.

https://emf.stanford.edu/industry-affiliates

(9) To understand some of the characteristics of future transition pathways, we analyzed energy and emissions data from a range of EMF27 stabilization, policy and technology targets, primarily focusing on 450 and 550 stabilization targets, as well as no-policy cases that utilize a full suite of technologies. The suite of full technologies (FT) includes a range of options, including: energy efficiency, nuclear, carbon capture and storage (CCS), biofuels and non-bio renewables such as solar and wind. The EMF27 study considered other technology-limited scenarios, but a key finding was that the unavailability of carbon capture and storage and limited availability of bioenergy had a large impact on feasibility and cost. Given the potential advantages to society of utilizing all available technology options, we focused on capturing the results of different EMF27 models that ran 450-FT cases; we were able to download data for 13 such scenarios, and utilized that data as provided for analysis purposes (most of the scenarios had projections extending from 2010 to 2100). Data downloaded from: https://secure.iiasa.ac.at/web-apps/ene/AR5DB

(10) EMF27 cases include CO₂ emissions from energy and industrial processes.


(12) The assessed 2°C scenarios produce a variety of views on the potential impacts on global energy demand in total and by specific types of energy, with a range of possible growth rates for each type of energy as illustrated in this report. Since it is impossible to know which elements, if any, of these models are correct, we used an average of all 13 scenarios to approximate growth rates for various energy types as a means to estimate trends to 2040 indicative of hypothetical 2°C pathways.

(13) The IPCC 1.5 Special Report would result in even stronger reductions of oil and natural gas demand by 2040 compared to the 2°C scenarios, yet would still require additional investments in oil and natural gas capacity.

(14) Based on the average of assessed 2°C scenarios’ CO₂ emissions (~20 billion tonnes including energy and industrial processes), ExxonMobil GDP assumptions are consistent with 2019 Outlook for Energy.


(17) Based on the average of the assessed 2°C scenarios referenced in this report, the combination of renewables, nuclear and fossil fuels using CCS is estimated in these scenarios to increase significantly as a percentage of total primary energy demand, rising from approximately 10% in 2010 to roughly 40% in 2040.

(18) Electricity delivered from fossil fuels without CCS as a percentage of total electricity delivered decreases from 66% to 20% on average from 2010 to 2040 under the assessed 2°C scenarios. Share of electricity from non-bioenergy renewables (e.g., wind, solar, hydro) increases from less than 20% to ~35%. Share of electricity generation utilizing CCS increases to about 20%. Share of electricity from nuclear increases from ~15% to ~20% (implies double the level of nuclear capacity from 2016 to 900 GW).

(19) Total electricity delivered as a percentage of total final energy demand increases from 18% to 28% on average across the 13 assessed 2°C scenarios referenced in this report.
(20) Under the assessed 2°C scenarios, the average growth rate for oil demand is 0.36% from 2010 to 2040, which implies a decrease in absolute level of demand in 2040 by ~10% relative to 2010 levels, which is near 2000 levels. Oil demand has increased about 11% since 2010, hence it would require a demand decrease of ~20% to reach the same 2040 level relative to today’s demand. Trends toward a level close to 2000 would imply oil used in road transportation trends toward 30 Mboe/d, and oil used for aviation and marine trends toward 9 Mboe/d.

(21) Based on average global demand growth rates under assessed 2°C scenarios.

(22) Based on average global demand growth rates under 9 Moebd.


(24) For the purposes of this report, proved reserves are year-end 2018 proved oil and gas reserves for consolidated subsidiaries and equity companies as reported in the Corporation’s Annual Report on Form 10-K. Proved oil and gas reserves are determined in accordance with Securities and Exchange Commission (SEC) requirements. Proved reserves are those quantities of oil and gas which, by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be economically producible under existing economic and operating conditions and government regulations. Proved reserves are determined using the average of first-of-month oil and natural gas prices during the reporting year.

(25) For the purposes of this disclosure, resources are total remaining estimated quantities of discovered quantities of oil and gas that are expected to be ultimately recoverable. The resource base includes proved reserves and quantities of oil and gas that are not yet classified as proved reserves.

(26) To estimate global demand in 2040 for oil and natural gas, the average of the assessed 2°C scenarios’ growth rates for oil and natural gas covering the period 2010-2040 have been applied to standard baseline estimates of oil and natural gas demand in 2010.

(27) IHS: Climate-Related Financial Risk and the Oil and Gas Sector, page 23.

(28) The assessed 2°C scenarios growth rates imply a range in 2040 global oil demand from about 53 to 103 Mboe/d and for 2040 global natural gas demand from about 265 to 625 BCFD.

(29) Hypothetical cumulative production determined by proportioning ExxonMobil’s 2017 average daily production (Form 10-K, page 8) and 2017 average daily global oil and gas production to estimated 2040 average daily production (assuming ExxonMobil’s current market share and 100% proved reserves replacement to maintain its proved reserves consistent with its production ratio at the end of 2017) and implied oil and gas demand from the 2°C scenarios average. Assumed linear decline of estimated average daily production through 2040.


(31) As used here, “carrying value” is our property, plant and equipment (PPE) net of accumulated depreciation. ExxonMobil’s carrying value of property, plant and equipment as of September 30, 2019, was approximately $251 billion. The reference to “less than 5 percent of ExxonMobil’s total carrying value of property, plant and equipment” is calculated by taking the PPE carrying value of ExxonMobil’s resource base and subtracting from it the PPE carrying values of ExxonMobil’s proved reserves, its unconventional liquids assets and its natural gas assets, and comparing this resulting value against ExxonMobil’s total PPE carrying value as of September 30, 2019.

(32) Basis presented at the ExxonMobil 2018 Investor Day ($60/bbl Brent 2017 flat real, 2017 margins); excludes impact.

(33) Exxon only before 1999. The average is based upon a 10-year interval.

(34) Global CCS Institute, Global Status of CCS 2019, page 18.


(36) ExxonMobil estimates.


(43) D.S. Sholl, R.P. Lively, Seven chemical separations to change the world, Nature 532 (2016) 435-437.

(44) ExxonMobil estimates.


(47) Design capacity.

(48) ExxonMobil estimates.

(49) Governmental, legal or regulatory changes could directly or indirectly delay or otherwise impact GHG emission reduction measures.

(50) Our calculations are based on the guidance provided in API's Compendium of Greenhouse Gas Emission Estimation Methodologies for the Oil and Gas Industry and IPIECA's Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions. We report GHG emissions on a net equity basis for our business operations, demonstrating a share of emissions from any facility or operation in which ExxonMobil holds a financial interest, with the share reflecting the equity interest.

(51) Source: Global CCS Institute. Data updated as of April 2019 and based on cumulative anthropogenic carbon dioxide capture volume. Anthropogenic CO$_2$, for the purposes of this calculation, means CO$_2$ that without carbon capture and storage would have been emitted to the atmosphere, including, but not limited to: reservoir CO$_2$ from gas fields; CO$_2$ emitted during production and CO$_2$ emitted during combustion. It does not include natural CO$_2$ produced solely for enhanced oil recovery.

(52) ExxonMobil-operated emission estimates are based on a combination of measured and estimated emissions data using best available information. Our calculations are based on industry standards and best practices, including guidance from the American Petroleum Institute (API) and IPIECA. The uncertainty associated with the emission estimates depends on variation in the processes and operations, the availability of sufficient data, the quality of those data and methodology used for measurement and estimation. Changes to the estimates may be reported as updated data and/or emission methodologies become available. We work with industry, including API and IPIECA, to improve emission factors and methodologies. Emission estimates from non-ExxonMobil-operated facilities are included in the equity data. The data includes XTO Energy performance beginning in 2011.

(53) The net equity greenhouse gas emissions metric was introduced in 2011 as a replacement for the direct equity greenhouse gas metric. Information has been restated back to 2009 according to the new metric. The net equity greenhouse gas metric includes direct and imported greenhouse gas emissions and excludes emissions from exports (including Hong Kong Power through mid-2014). ExxonMobil reports greenhouse gas emissions on a net equity basis for all our business operations, reflecting our percent ownership in an asset.

(54) The addition of direct emissions and emissions associated with exported power and heat is equivalent to World Resources Institute (WRI) Scope 1.

(55) These emissions are equivalent to WRI Scope 2.

(56) Cumulative figure.


(58) IEA, ExxonMobil analysis.

(59) ExxonMobil estimates.

(60) Solomon Associates. Solomon Associates fuels and lubes refining data available for even years only.


(62) OGCI, Scaling up action aiming for net zero emissions, September 2019.

(63) BloombergNEF. The data were downloaded from BloombergNEF on Dec 13, 2018, and based on total wind and solar power purchase agreements signed in 2018.

(64) IPIECA climate change reporting framework: Supplementary guidance for the oil and gas industry on voluntary sustainability reporting. Published by IPIECA in 2017.