

2018 Economic Report Series
**CANADA'S ROLE IN THE WORLD'S
FUTURE ENERGY MIX**



CANADA'S OIL & NATURAL GAS PRODUCERS

Global economies are growing and the world will need more energy in all forms, including oil and natural gas.

Canada has an opportunity to ensure this demand is met by responsibly produced fuels.

This report outlines the projected future global energy mix based on the International Energy Agency's (IEA) New Policies Scenario (NPS) from today to 2040. Given these projections for energy demand, the report identifies Canada's potential role in the world's future energy mix and defines a vision for Canadian oil and natural gas within the context of future global energy demand.

Forthcoming reports will examine the role of innovation and technology in reducing greenhouse gas emissions and improving other aspects of environmental performance; the urgent need for infrastructure that facilitates market access for Canadian oil and natural gas; fiscal and economic policies; the social benefits arising from the oil and natural gas industry; and an overall summary with forward-looking recommendations.

Book two.



Total energy demand is expected to increase by

30%
from today to 2040.

Canada's role

Canada has enormous oil and natural gas resources. We have an opportunity to meet growing global demand in an environmentally and socially responsible manner. But this can only be achieved if Canadian oil and natural gas remain competitive and are able to attract investment and spur innovation.

The Canadian Association of Petroleum Producers (CAPP) believes Canada's oil and natural gas industry can and should become the world's energy supplier of choice. We further believe that governments can play a key role in seizing this opportunity by putting competitive and supportive policies into place.

There is a clear and growing demand for oil and natural gas, especially in developing countries such as India, China and throughout Southeast Asia. Canada could serve these emerging markets with responsibly produced fuels that displace production from other less regulated sources. The Canadian oil and natural gas industry is implementing innovative technologies to improve efficiency and reduce environmental impacts, demonstrating what it takes to be a responsible energy developer. Through substantial investments in innovation and implementation of new technologies, Canada's performance will continuously improve.

Canada can play a significant role in meeting the world's future energy demand. Through innovation and technology, Canada can leverage our leadership in environmental stewardship and responsible energy production to help address growing global carbon emissions. At the same time, ensuring a healthy oil and natural gas industry with access to global markets also ensures ongoing prosperity and economic benefits across our country.

However, Canada's policies and environmental regulations must be developed in parallel with attracting investment, spurring innovation, growing jobs and maintaining economic benefits across the country. At present this is not the case and Canada risks falling behind other global energy supply competitors.

For example, with some notable exceptions such as Norway's Statoil, the majority of global oil and natural gas reserves are held by nationally owned companies that face little to no climate legislation and associated costs. If Canadian production is constrained due to the cumulative effects of regulatory burden and lack of market access, global energy demand will simply be met from other jurisdictions that have less stringent to no environmental policies. This is effectively a wealth transfer to other countries with poorer environmental standards.

Therefore, CAPP recommends that:

- The federal government take a leadership role in defining Canada's vision for oil and natural gas that positions Canada as the supplier of choice to meet the world's growing oil and natural gas needs.
 - This vision should be supported through a co-ordinated effort with industry, provincial and territorial governments, and individual Canadians to create an effective policy and regulatory environment that encourages investment in Canada's oil and natural gas resources, ensuring those resources are produced the Canadian way – with environmental and social responsibility.
 - This vision must include a focus on accessing world markets (particularly lower- to middle-income countries), a commitment to innovation, and global environmental stewardship.
 - This vision must also seek action on the part of the federal government to undertake efforts that enhance energy awareness and actively cultivate and grow support from Canadians for the responsible development of Canada's resources.
 - Finally, the vision must encourage governments to align costs associated with environmental policies in other jurisdictions, to support industry competitiveness and technological advancements that allow for continued innovation in the sector.

The competitiveness of Canada's oil and natural gas industry is at risk. Canada has the opportunity to responsibly meet growing global energy demand but the cumulative effect of policies and regulations are rapidly diminishing this opportunity by thwarting industry growth, competitiveness and market access.



Canada can become

the world's energy supplier of choice.

Total energy demand is expected to increase by **30%** from today to 2040.

Canada can become the world's energy supplier of choice – generating economic benefits across the country, and minimizing environmental impacts at home and around the world.



GROWING POPULATION, GROWING ENERGY DEMAND

The world's population is expected to exceed nine billion by 2040. Over that same time period, as emerging economies urbanize and industrialize, the global middle class is expected to almost double. A larger population, combined with rising gross domestic product and more disposable income, will drive the need for more energy from all sources: total energy demand is expected to increase by 30 per cent from today to 2040. Although each fuel type's share in the total energy mix is likely to change, energy usage from all sources, including oil and natural gas, will increase.

Key findings about the growth of global energy requirements include:

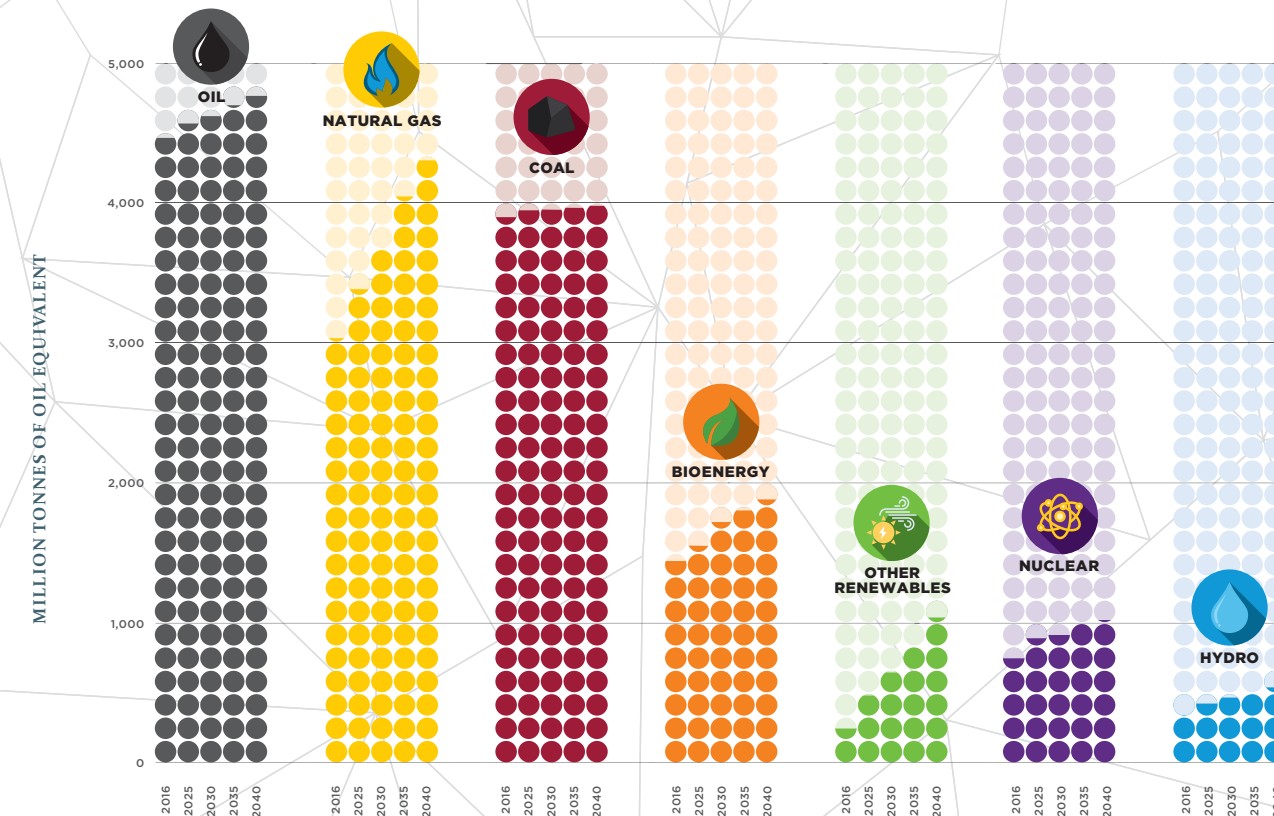
- As the world's population grows, total energy demand will also increase.
 - A larger population, combined with global gross domestic product (GDP) growth and an expanding middle class worldwide, means that by 2040 the world will consume substantially more energy than today.
 - The future energy mix will reflect industrialization and urbanization trends in emerging economies as their per-capita energy intensity increases to developed-economy levels.
- Although there will be shifts in the overall global energy mix, growing demand is expected to be met by all available forms of energy.
- Energy efficiency is expected to moderate global demand. The International Energy Agency (IEA) estimates that the projected rise in global energy consumption by 2040 could more than double without substantial expected improvements in energy efficiency.

“Canada will remain a crucial supplier of oil and gas for the global marketplace and the industry is making efforts to improve its environmental performance.”

Fatih Birol, Executive Director, International Energy Agency, speaking at the Generation Energy Forum, Winnipeg, Manitoba, October 2017

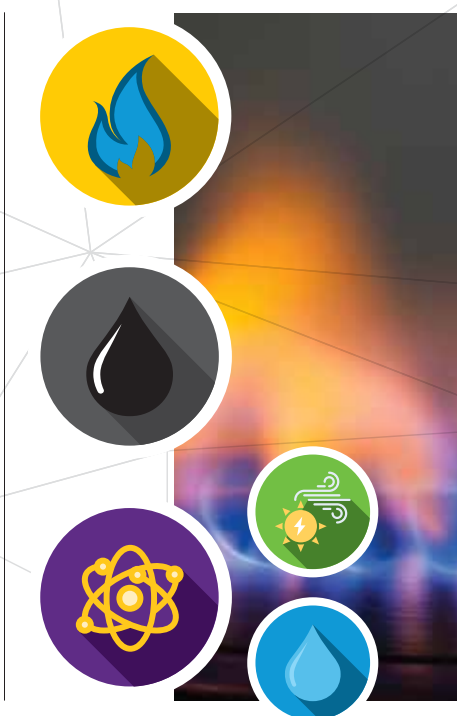
Growth in the Global Energy Mix from 2016-2040

Source: IEA 2017 World Energy Outlook, New Policies Scenario



Regarding specific energy sources, key findings include:

- Natural gas is expected to grow in both volume and market share to become the world's second-largest energy source overall.
 - The industrial sector will likely account for more than 40 per cent of additional natural gas uses by 2040, as natural gas becomes essential to the development of emerging economies.
- The world energy mix is certainly changing, but oil is expected to continue as the predominant energy source to at least 2040.
 - The IEA estimates that oil will continue to have the largest share of any fuel source.
 - This continued high demand for oil will be driven largely by the transportation sector, including aviation and shipping, plus industrial and petrochemical uses. The IEA projects that oil will be a significant energy source even with the rise of electric vehicles.
- Electricity generation is the primary use for energy sources such as nuclear, hydro and renewables. While the market share of these sources for electricity generation is expected to increase, government targets and support policies remain the driving force behind much of this growth. Hydro is projected to remain the largest source of renewable-based power generation.



Canada's role

Canada has enormous oil and natural gas resources. We have an opportunity to meet growing global demand in an environmentally and socially responsible manner. But this can only be achieved if Canadian oil and natural gas remain competitive and are able to attract investment and spur innovation.

The Canadian Association of Petroleum Producers (CAPP) believes Canada's oil and natural gas industry can and should become the world's energy supplier of choice. We further believe that governments can play a key role in seizing this opportunity by putting competitive and supportive policies into place.

There is a clear and growing demand for oil and natural gas, especially in developing countries such as India, China and throughout Southeast Asia. Canada could serve these emerging markets with responsibly produced fuels that displace production from other less regulated sources. The Canadian oil and natural gas industry is implementing innovative technologies to improve efficiency and reduce environmental impacts, demonstrating what it takes to be a responsible energy developer. Through substantial investments in innovation and implementation of new technologies, Canada's performance will continuously improve.

Canada can play a significant role in meeting the world's future energy demand. Through innovation and technology, Canada can leverage our leadership in environmental stewardship and responsible energy production to help address growing global carbon emissions. At the same time, ensuring a healthy oil and natural gas industry with access to global markets also ensures ongoing prosperity and economic benefits across our country.

However, Canada's policies and environmental regulations must be developed in parallel with attracting investment, spurring innovation, growing jobs and maintaining economic benefits across the country. At present this is not the case and Canada risks falling behind other global energy supply competitors.

For example, with some notable exceptions such as Norway's Statoil, the majority of global oil and natural gas reserves are held by nationally owned companies that face little to no climate legislation and associated costs. If Canadian production is constrained due to the cumulative effects of regulatory burden and lack of market access, global energy demand will simply be met from other jurisdictions that have less stringent to no environmental policies. This is effectively a wealth transfer to other countries with poorer environmental standards.

Therefore, CAPP recommends that:

- The federal government take a leadership role in defining Canada's vision for oil and natural gas that positions Canada as the supplier of choice to meet the world's growing oil and natural gas needs.
 - This vision should be supported through a co-ordinated effort with industry, provincial and territorial governments, and individual Canadians to create an effective policy and regulatory environment that encourages investment in Canada's oil and natural gas resources, ensuring those resources are produced the Canadian way – with environmental and social responsibility.
 - This vision must include a focus on accessing world markets (particularly lower- to middle-income countries), a commitment to innovation, and global environmental stewardship.
 - This vision must also seek action on the part of the federal government to undertake efforts that enhance energy awareness and actively cultivate and grow support from Canadians for the responsible development of Canada's resources.
 - Finally, the vision must encourage governments to align costs associated with environmental policies in other jurisdictions, to support industry competitiveness and technological advancements that allow for continued innovation in the sector.

The competitiveness of Canada's oil and natural gas industry is at risk. Canada has the opportunity to responsibly meet growing global energy demand but the cumulative effect of policies and regulations are rapidly diminishing this opportunity by thwarting industry growth, competitiveness and market access.



TRENDS IN GLOBAL ENERGY CONSUMPTION AND DEMAND

Energy consumption and demand is a complex, dynamic and evolving issue, and a key topic of policy debate in Canada and elsewhere. This report provides an overview of the current global energy mix, assesses trends in current and future energy demand and consumption, identifies the opportunity for Canadian oil and natural gas to responsibly meet growing global energy needs, and presents recommendations to government.

The International Energy Agency (IEA) prepares a number of scenarios that project future global energy use. This report is based on the IEA's New Policies Scenario (NPS), which outlines an energy mix that "incorporates not just the policies and measures that governments around the world have already put in place, but also the likely effects of announced policies, as expressed in official targets or plans."¹ The NPS represents current world ambitions that may be expected to shape the future energy mix. The outlook period extends to 2040.

CAPP chose the NPS scenario because it not only uses current energy policies in place, but also includes country pledges for GHG reduction, even if these pledges are yet to be implemented. It serves as the IEA baseline scenario.

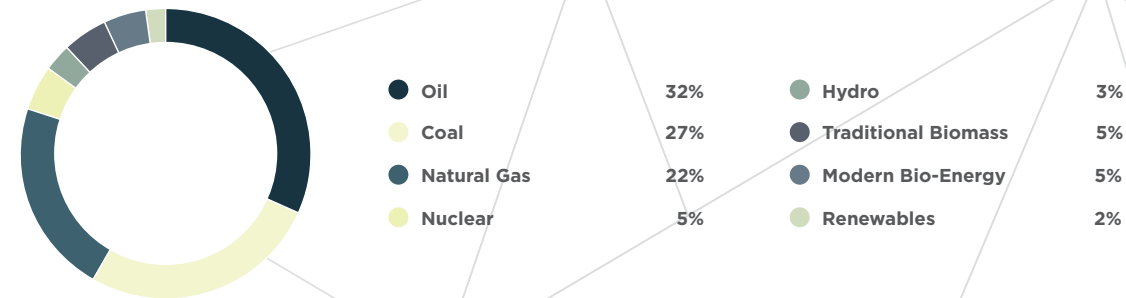
Other scenarios are available for comparison. The IEA's Sustainable Development Scenario is based on an end goal for GHG emissions reduction required to address climate change and works backward from that goal. This scenario does not represent real commitments and pledges but provides one possible path to achieve a result. Industry players such as BP, ExxonMobil, Shell and others offer energy outlooks based on their expertise and deep understanding of the industry and global energy trends. Academics and think-tank organizations also offer energy outlooks, while environmental advocacy groups such as Greenpeace offer scenarios leading to a zero-carbon future.

1.1 Current Energy Demand and Consumption

This report distinguishes between traditional energy sources – natural gas, oil and coal – and other energy sources including nuclear, hydro, traditional biomass, modern bio-energy, and renewables such as solar, wind and geothermal energy.

2016 Total Share of Energy Demand by Fuel Type

Source: IEA World Energy Outlook, 2017 *Figures may not add up due to rounding

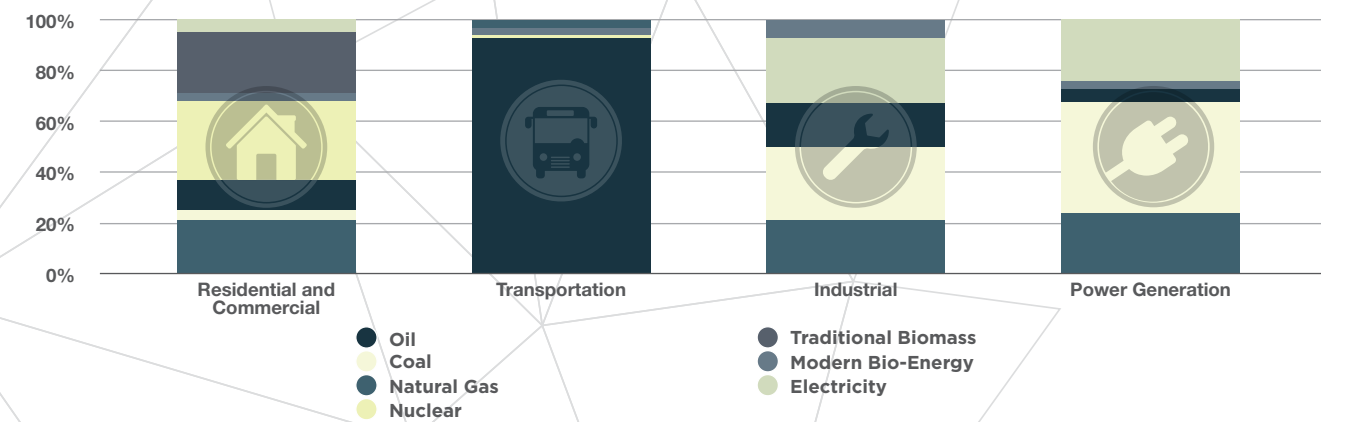


NOTE: All data and figures in this report reflect projections in the International Energy Agency's New Policies Scenario (NPS), unless otherwise stated.

Energy use can be broken into four sectors: industrial; transportation; residential and commercial use; and power generation. These sectors have different fuel mix profiles. For example, the majority of coal is consumed for industrial and power generation purposes, particularly in undeveloped and emerging countries, while the majority of oil is used for transportation and industrial and petrochemical uses. Natural gas use is widespread as it is consumed across a variety of sectors such as agriculture, residential, commercial and industrial. Renewable energy sources are primarily used to generate electricity, which is used throughout the global economy.

Sector Makeup by Fuel Type*

Source: IEA, BP and ExxonMobil



1.2 Growing Energy Demand

The world's population is expected to grow by nearly two billion, reaching about 9.2 billion people by 2040,^{2,3} while the global middle class is expected to almost double in the same period.⁴ A larger population, combined with global GDP growth forecast to grow on average by 3.4 per cent annually,⁵ means that countries will be more urbanized and industrialized, and will consume more energy than today. Industry, academics and government institutions, including the IEA's New Policies Scenario (NPS), have generally projected the average energy demand is expected to increase by about 30 per cent by 2040 from today's level.⁶ As the IEA indicates, this is the equivalent to adding another China or India to current consumption.

About 54 per cent of global energy consumed today is generated from oil and natural gas. As the world's population continues to grow, total energy demand will also increase. That demand will be met by all available forms of energy, and although the share of each individual fuel type is expected to change in the total energy mix, all energy sources will increase in usage.

The future energy profile and demand in developed economies such as Canada, the United States, Japan, and Europe looks very different from that of developing and emerging economies. Average per-capita incomes are several times higher in Organization of Economic Co-operation and Development (OECD) countries, and a much lower proportion of these countries' populations live in rural areas. Relative to non-OECD countries, a larger portion of the population in developed nations is already a part of the middle class and is likely to maintain this standard of living through to 2040.

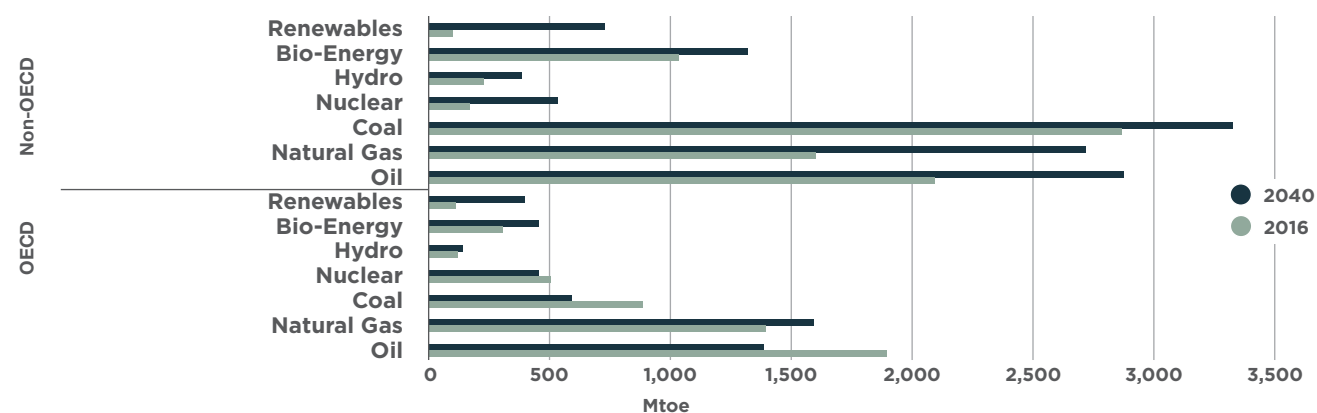
Overall, economies such as those within the OECD are, on net, expected to experience a decline in energy demand but this will be more than offset by increases elsewhere, with growing incomes and improved access to energy, particularly electricity. Global residential electricity use will likely increase about 75 per cent by 2040, driven by a nearly 150 per cent increase in electricity use in non-OECD nations.⁷ Africa and India are likely to increase about 250 per cent.⁸ Even then, it's likely that more than 1.2 billion people will continue to lack access to energy,⁹ and more than two billion people around the world will continue to rely on biomass for heating and cooking.

***NOTE:** From each forecast, CAPP took data in the units provided and determined the percentage share of each fuel in each sector and averaged the percent share across BP, Exxon, and IEA. We did not convert the units into a single metric, but instead used percentages. Although it would be more concise to convert fuel types into a single metric, then taking the average, we are simply seeking to illustrate a high-level representation of sector makeup by fuel type.

Improved energy efficiency through innovation and technological advances is expected to have the greatest impact on reducing global emissions. The expected 30 per cent increase in worldwide energy demand by 2040 is actually half what it would be without improved energy efficiency. By 2040, the industrial sector is expected to account for about half of the avoided energy demand due to better energy efficiency. However, energy efficiency arises from innovation and technological advances, which are stifled by cumulative regulatory cost burdens that drive investment to countries with less commitment to advancing energy efficiency.

Historical and Demand by Fuel Type

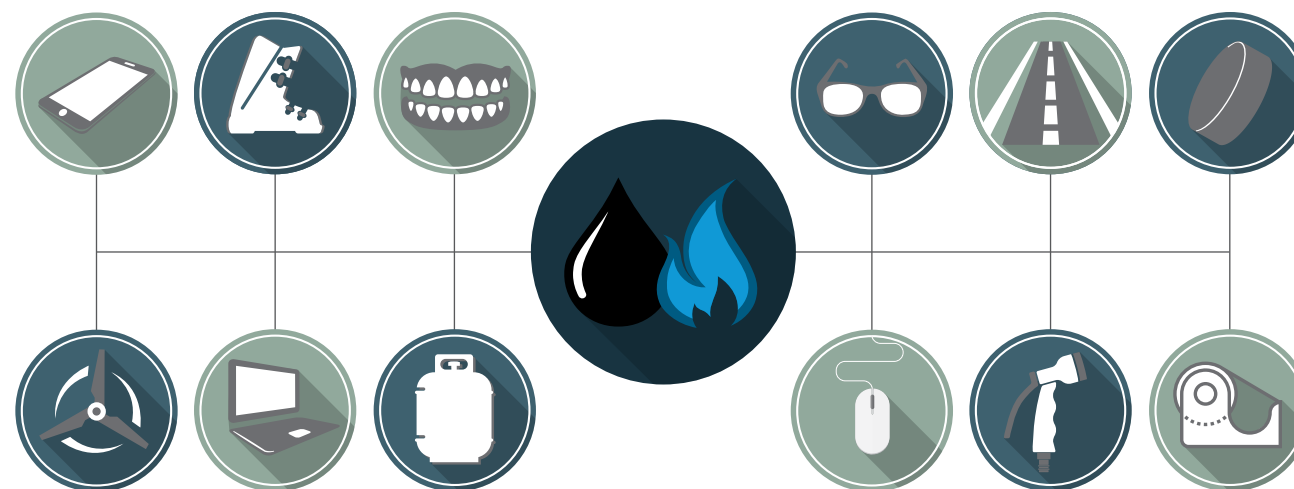
Source: IEA World Energy Outlook, 2017



There is no simple energy substitution – there is only energy growth. All energy sources will be required to meet growing energy demand.

FUTURE GLOBAL ENERGY MIX: TRADITIONAL ENERGY SOURCES

Everyday products are derived from oil and natural gas. The list of everyday products derived in whole or in part from oil and natural gas is enormous. This is just a start:



2.1 Natural Gas

In 2016, the world consumed about 129 trillion cubic feet of natural gas. By 2040, global natural gas demand is expected to reach 199 trillion cubic feet – a 45 per cent increase. The World Energy Council – a United Nations accredited global energy body – forecasts that natural gas is expected to grow the fastest of all emitting energy sources, calling natural gas “the fossil fuel with the potential to play an important role in the world’s transition to a cleaner energy future.”¹⁰ According to the IEA’s New Policies Scenario, natural gas is projected to increase its share of global energy markets to 25 per cent by 2040 from 22 per cent today.

2.1.1 Electrical Power Generation

As millions of new middle-class families in developing countries buy appliances, install heating or cooling, and experience digitalization of their lives (computers and other electronics), global electricity generation is projected to increase 60 per cent by 2040 from 2016. Natural gas used to generate electricity is likely to increase 57 per cent. While renewable energy sources are also expected to play an increasing role in meeting the electricity demand, natural gas will continue to be a base-load energy source, as it is a reliable and affordable electricity generation source and enables generation from intermittent renewable sources.

2.1.2 Transportation

By 2040, the share of natural gas as a transportation fuel is expected to grow to 11 per cent from three per cent today.¹¹ Abundant resources and robust production can be expected to contribute to the strong position of natural gas among other energy sources. As a result of favourable fuel economics, a strong increase is projected for natural gas’ share of total energy use for fuelling large trucks. Liquefied natural gas demand is likely to be pushed upwards by an increase in long-distance global trade and shipping.

2.1.3 Industrial Uses

The industrial sector will likely account for more than 40 per cent of additional natural gas uses by 2040, as natural gas becomes essential to the development of emerging economies while also helping to achieve global GHG reductions. Demand from rising natural gas needs in Asian industries could be accompanied by increased demand in the U.S. and the Middle East, where natural gas is increasingly used in petrochemical industries. Since it is relatively clean and flexible, natural gas is often seen as a fuel that can help to reduce the carbon intensity of the global energy system and also contribute to improving air quality, particularly where it replaces coal.

2.2 Oil

In 2016, the world consumed about 94 million barrels of oil per day (b/d) – or about 32 per cent of total energy demand from all sources. By 2040, the IEA estimates total world oil consumption will be about 105 million b/d, or about 27 per cent of the future energy mix – the largest share of any fuel source.

The IEA's NPS outlines two distinct phases in the trajectory of global oil demand. Between 2016 and 2025, average annual growth is projected to exceed 700,000 b/d and then slow between 2025 and 2040 to an average increase of about 300,000 b/d annually. Notably, there is no forecasted peak in oil demand before 2040. Oil maintains its dominant share in the future energy mix largely due to its position in the transportation sector, and as an input in the industrial, chemical and manufacturing sectors.

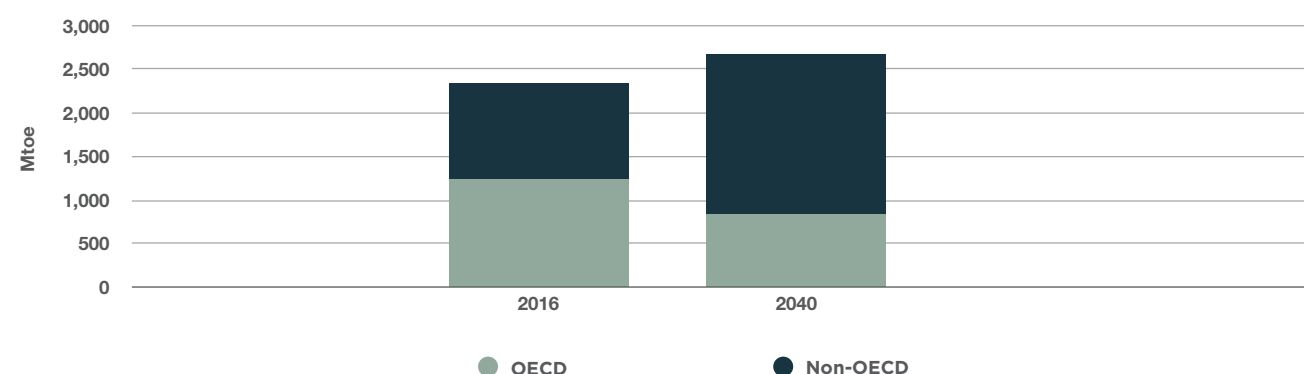
The world energy mix is certainly changing, but oil is expected to continue as the predominant energy source.

2.2.1 Transportation

Currently, about 65 per cent of oil is consumed for transportation.¹² As a result of a larger worldwide middle class with more disposable income, the demand will likely increase for personal travel and global trade shipments due to rising demand for consumer goods.

Transportation Sector Energy Consumption Estimate, OECD vs. non-OECD

Source: IEA World Energy Outlook, 2017



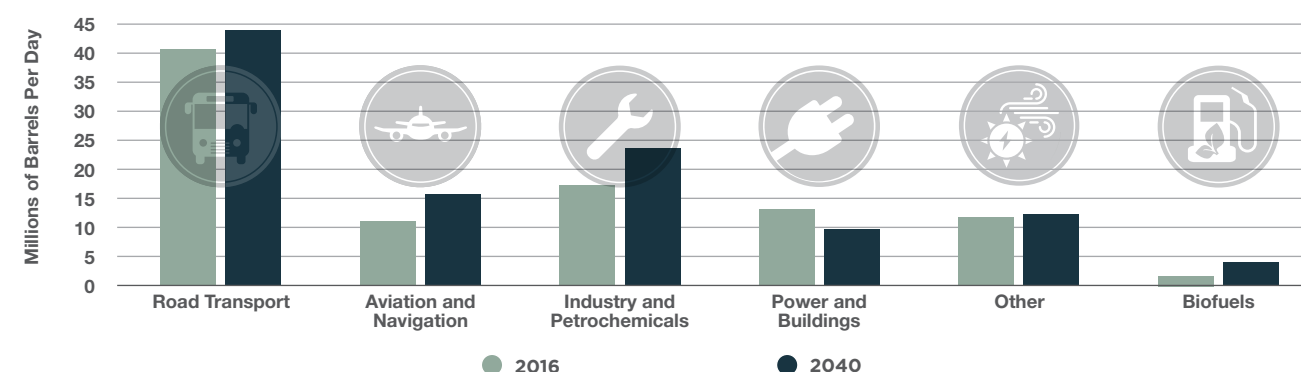
Passenger car travel is the dominant transport mode, accounting for more than 70 per cent of all types of transport. The number of passenger cars around the world is expected to double by 2040. While the use of non-conventional vehicles such as electric vehicles (EVs) is expected to increase, conventional internal combustion engine (ICE) vehicles are expected to continue to form the vast majority of the global fleet. Although advanced economies could see a contraction in oil demand due in part to the penetration of EVs and improved fuel economy standards, this is likely to be more than offset by emerging economies. India alone is set to double its oil consumption by 2040 as the IEA projects the number of cars per household will increase.

According to the IEA's NPS, by 2040 about 15 per cent of all cars on the road are projected to be electric, up from 0.2 per cent today. China is projected to maintain its current leadership in electric car sales and by 2040 could be home to almost half of the EVs in the world, or about 140 million electric cars. The NPS also takes into account the announced phase-out of gasoline and diesel vehicles in France, the Netherlands and the United Kingdom.

Some of the most aggressive forecasts of EV penetration, such as Bloomberg's New Energy Finance, estimate 54 per cent of new car sales will be electric by 2040.¹³ Even if this proves to be the case, oil demand would still need to increase six per cent, to more than 100 million b/d, to meet demand from a growing middle class and serve growing global energy demand in transportation and industrial / petrochemical uses.

Oil and Liquids Demand by Sector

Source: IEA World Energy Outlook, 2017



Air travel is also expected to significantly increase and the additional demand is expected to add another 4.7 million b/d of oil to consumption by 2040. There is no readily available alternative fuel source for aviation. The OECD projects an annual increase in air passenger traffic of between three and six per cent annually, with intra-Asian routes growing the fastest.¹⁴

Trucking and shipping – vital to economic growth – are also expected to drive oil demand. The IEA estimates that the worldwide shipping fleet will experience notable improvements in fuel efficiency. Energy use in this sector is projected to increase by nearly two per cent annually, whereas the distance travelled by ships increases by more than three per cent each year.

2.2.2 Industrial and Petrochemical Uses

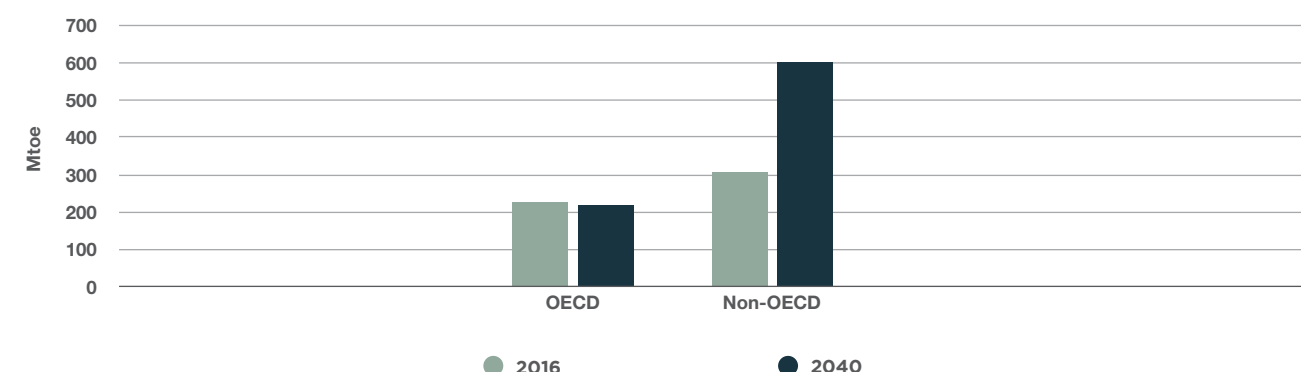
Oil is also expected to see increasing demand for industrial uses, as rising prosperity around the world propels demand for chemical products and plastics for a myriad of uses such as electronics, cars and even clothing, among others.

Industry uses oil as a chemical feedstock and fuel to produce parts and technologies. The petrochemical sector is expected to grow by 45 per cent between 2015 and 2040.

There are very few substitution options available in the petrochemical industry. The IEA notes that bio-based feedstocks have a considerable cost disadvantage today. Also, over many decades, industries have been working to capture efficiencies from using oil in industrial processes.

Petrochemical Feedstock Consumption by Region

Source: IEA World Energy Outlook, 2017



2.3 Coal

Coal is projected to decline its percentage share of the energy mix as other energy sources increase their market share, but by 2040 the overall global volume of coal consumed is projected to increase by five per cent. Coal consumption in OECD nations will likely decline by 30 per cent as there is strong competition from natural gas and renewable sources, especially for electricity generation. However, by 2040 non-OECD countries are projected to increase coal consumption by 16 per cent; demand in India is expected to more than double. Coal is an inexpensive source of energy that will likely be used to support significant population growth and economic development in emerging economies.

Of the almost 10 billion tonnes of carbon dioxide (CO₂) emitted globally from energy sources in 2015, almost half came from coal.¹⁵ Coal has higher emissions compared to other emitting sources, and numerous countries including France, the Netherlands, Mexico and the U.K. are looking to phase out coal use. Yet in Germany, an advanced economy, the abandonment of nuclear power sources has led to continued dependence on coal.¹⁶

“Between 2011 and 2015 Germany will open about 10.7 gigawatts of new coal-fired power stations. This is more new coal capacity than was constructed in the entire two decades after the fall of the Berlin Wall [1989 to 2009].”

The expected annual electricity production of these power stations will far exceed that of existing solar panels and will be approximately the same as that of Germany’s existing solar panels and wind turbines combined.”

Robert Wilson, The Energy Collective, 2014

In Canada, coal has been phased out in Ontario and is being phased out in Alberta. Saskatchewan and New Brunswick continue to use coal for power generation. The National Energy Board states, “Over the past 20 years, the use of coal in electricity generation has fallen significantly, from 15 per cent of total generation in 1996, to 11 per cent by 2015. The use of natural gas in electricity generation has increased significantly, from three per cent of total generation in 1996 to 11 per cent by 2015.”¹⁷

2.3.1 Industrial Uses

Coal makes up about 30 per cent of the global industrial sector’s fuel consumption. The demand for coal in this sector is expected to increase about 15 per cent globally by 2040. China’s heavy-industry coal demand may be expected to drop by 30 per cent by 2040, but coal is expected to continue to play a role in steel and cement manufacturing. This expected decline in coal consumption in China and the OECD nations will likely be offset by growing demand among emerging countries, particularly in India and Southeast Asia. Non-OECD countries’ coal demand could increase 20 per cent via the industrial sector. India is expected to increase coal use in industrial settings two-fold.



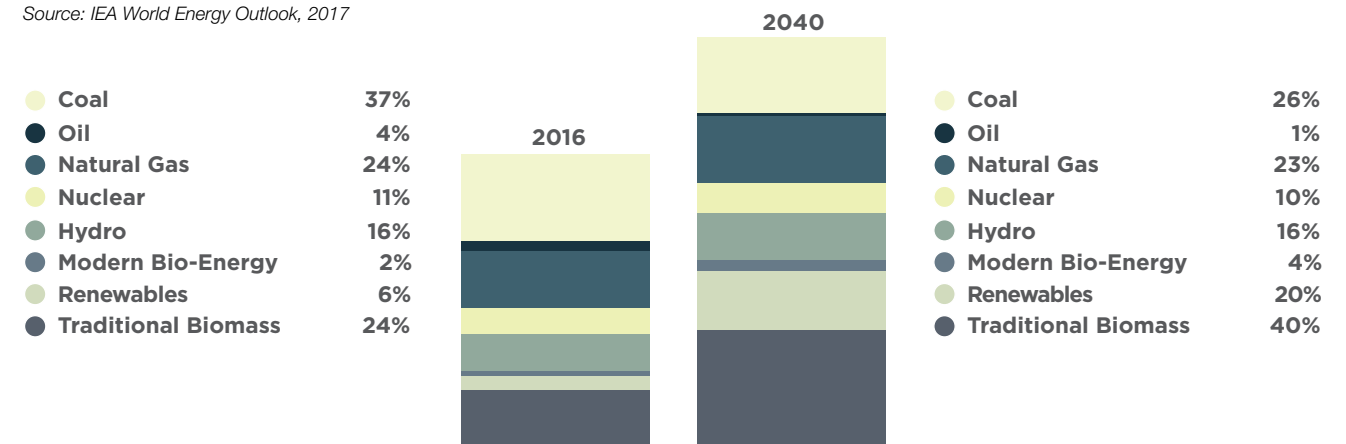
2.3.2 Electrical Power Generation

Today, the power sector is responsible for close to 60 per cent of the world’s coal use and 36 per cent of natural gas use. As countries seek to reduce emissions by reducing coal-fired power generation, a backstop – such as natural gas – will be needed to enable reliable power generation from intermittent renewable energy sources.

Global electricity demand is set to rise by about 60 per cent by 2040. More than 85 per cent of this growth will occur in developing economies. Electricity generation will likely see a combination of coal and other sources; as electricity from coal generation remains largely flat, generation from natural gas, nuclear, wind and solar are expected to increase. Coal is forecast to generate about 10,000 TWh of electricity, or about 26 per cent of total demand. By 2040, wind- and solar-generated electricity will meet about 15 per cent of global electricity demand, or 7,500 TWh, growing by 360 per cent from today.¹⁸

Electricity Generation by Fuel Type, Current and 2040

Source: IEA World Energy Outlook, 2017





Transitioning to a lower-carbon future: A perspective from Shell

The IEA is not the only global organization that foresees a strong and ongoing role for oil and natural gas. Shell also recognizes both the importance of mitigating climate change and the critical role energy must play in enabling improved quality of life for people around the world. The challenge: how to provide more energy while significantly reducing CO₂ emissions. Shell has prepared a variety of scenarios, including one that illustrates a technically possible, but challenging pathway to achieve society's ambition for net-zero emissions by 2070. (www.shell.com/scenarios)

"The energy system is transitioning," says Andrew Brown, Global Upstream Director. "How do we manage growing and becoming more prosperous while moving to a lower-carbon energy system? Very complex yet fundamental change is needed – and this will take time."

This issue affects the entire global economy, including consumers of energy. Industry's role is often misunderstood, but oil and natural gas producers have a vital role in this transition. Equipment used by many industries is and will continue to be powered by oil, natural gas and coal; renewable energy technologies still cannot provide the intense energy required by heavy industry, aviation and mass transport. There are currently no easy replacements for hydrocarbons in these sectors.

The energy transition will require enormous investment across all economies. Major changes to electricity systems, industrial and residential infrastructure, and vehicle fleets will be required. Throughout this transition, oil and natural gas will remain integral to the global economy.

"Developing nations are seeking the lifestyles we enjoy," Brown comments. "It's important to note that CO₂ reductions must take place not only in Europe and North America, but globally as well. Fundamental change is needed in the developing world at the same pace as it's starting to happen in developed nations."

A successful energy transition will require vision, urgency and realism: vision for a long-term approach to policy setting, business planning, and investment; urgency and realism about the scale and costs of orderly transformations, both for energy suppliers and consumers. Society has to be ambitious to achieve climate-change and development goals. Decisions must tackle the breadth and complexity of the challenge. Conversely, rapid, poorly considered policy-driven changes could result in unexpected consequences and fail to achieve their intended goals.

Brown concludes, "The energy industry must unlock the potential we have for new technology through collaboration and innovation. Thought leadership and advocacy are needed to support government policy."

Andy Brown was appointed to the Executive Committee of Royal Dutch Shell in April 2012. He is responsible for Shell's global Upstream business, which includes the exploration and production of oil and natural gas from conventional, shale and deep-water sources. He has been with Shell since 1984 and has worked in locations from New Zealand to the Middle East.

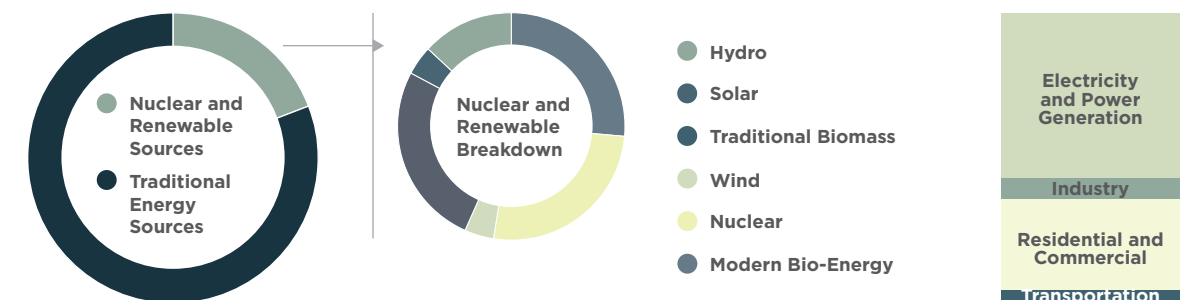
FUTURE GLOBAL ENERGY MIX: NUCLEAR AND RENEWABLE SOURCES

The IEA estimates that about 19 per cent of world energy consumption currently comes from nuclear and renewable sources. However, if traditional biomass use is excluded – wood and waste used largely for cooking in developing countries – these sources account for 14 per cent of the energy mix.

Electricity generation is the primary use for nuclear and renewable energy sources, accounting for nearly 60 per cent of end use. In the IEA's NPS, electricity generation from all these sources rises to 40 per cent from 24 per cent today; power generation from renewable sources, largely wind and solar photo-voltaic (PV) cells, grows almost three-fold by 2040.

Breakdown of Today's Nuclear and Renewable Energy Sources | Percentage of Renewable Usage by Sector

Source: IEA World Energy Outlook 2017



3.1 Nuclear

Nuclear energy is expected to see an increase in demand of about 45 per cent, although its share among energy sources are projected to increase only marginally, to about six per cent of the world's total energy mix by 2040. More than half of this anticipated growth will come from China as it increases nuclear energy consumption by more than four-fold. Although India currently uses very little nuclear power compared with China, India is projected to increase demand for nuclear energy about six-fold by 2040. In 2016, nuclear power plants generated about 10 per cent of total power generation worldwide.¹⁹

Concerns about nuclear energy waste management and radiation risks influence public opinion and have caused a wide divergence regarding acceptance or rejection of nuclear energy. There are also significant front-end capital costs and long construction times for nuclear projects. Some countries that have adopted a negative stance on nuclear programs, such as Germany, are having to rely more heavily on coal for electricity generation. In South Africa, the proposed nuclear program was seen as too costly, so coal is likely to remain over 80 per cent of that country's electricity generation.²⁰

3.2 Biomass and Biofuels

Traditional and modern biomass can be used for cooking, heating, to produce electricity and as transportation fuels. The Environmental and Energy Study Institute defines biomass as "living or recently dead organisms and any byproducts of those organisms, plant or animal."²¹ At about 10 per cent, the share of biomass in the global energy mix has been steady since 2000 and continues to be the largest source of direct renewable energy for heating.

Currently, about 50 per cent of total bio-energy usage comes from traditional solid biomass such as wood and animal waste that have serious negative health side effects. In general the use of traditional solid biomass in developing countries is neither sustainable nor desirable, as nearly three million premature deaths annually are attributed to air pollution from these energy sources. With increases in prosperity and energy access, by 2040 the use of traditional solid biomass is expected to decrease to about 31 per cent of bio-energy. Biomass is the only energy source expected to decrease in India's future energy mix.

Modern bio-energies, such as bio-ethanol and bio-diesel, are projected to be the most important form of renewable energy in the transportation sector, accounting for four per cent of total transportation fuels by 2040. Like traditional biomass, there are some negative consequences with modern bio-energy. There are concerns regarding producing large quantities of biofuels from food crops such as corn, which could cause fundamental shifts in agricultural markets worldwide. Additionally, ethanol production has high energy requirements that can negate ethanol's lower emissions benefits.

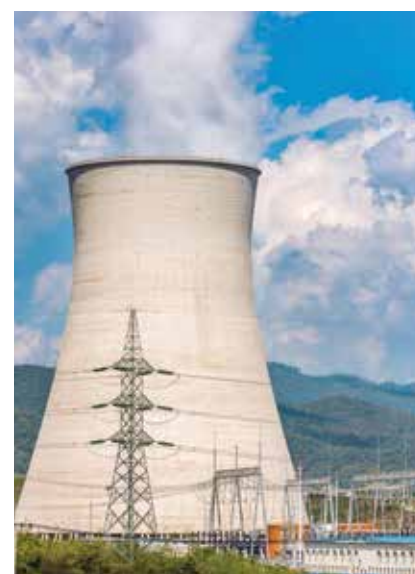
3.3 Hydro

In the IEA's NPS, global demand for electricity generated from water increases by 52 per cent, making hydro the largest renewable energy source for electricity generation by 2040. However, because other energy sources are expected to evolve, over the projection period hydro maintains its overall market share relative to other energy sources – neither increasing nor decreasing. Used for electricity generation, hydro is expected to account for about half of renewable electricity output in 2040 and will be about three per cent of the total energy mix. Hydro and wind are expected to be the two largest contributors to the increase in world electricity generation from renewable energy sources.

Flowing water is the most important renewable energy source in Canada, providing 59 per cent of Canada's electricity generation. In fact, Canada is the second-largest producer of hydroelectricity in the world.²² China is the largest and Brazil is third.

3.4 Wind, Solar and Geothermal

Wind and solar are expected to see tremendous growth in the future as they displace some coal as a source of electricity generation in many countries, primarily mature economies. The largest contribution to this growth is expected to come from wind, which could increase four-fold from today; solar is expected to grow ten-fold. The rate of growth of electricity from geothermal resources will likely also accelerate, albeit supplying less than one per cent of total electricity generation by 2040. The share of renewable sources in the global energy mix (not including nuclear, bio-energy and hydro) is anticipated to be about six per cent by 2040.

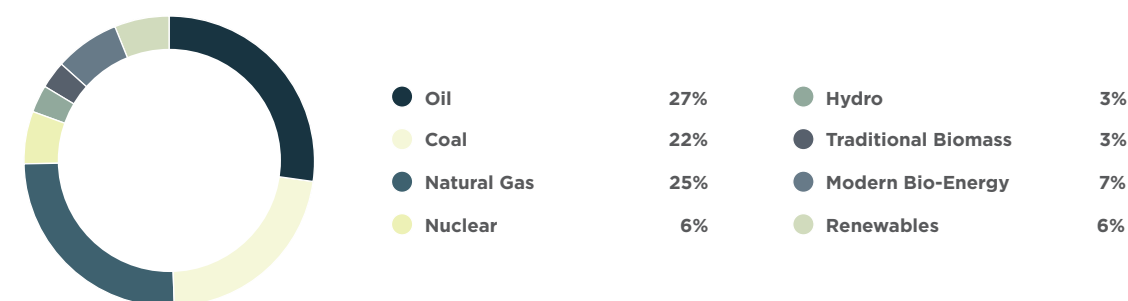


CONCLUSION: CANADA'S ROLE IN THE WORLD'S ENERGY FUTURE

As developing economies industrialize and the worldwide middle class expands, global demand for all forms of energy will continue to grow, especially in developing nations. Although the relative market share of most energy sources can be expected to change, oil and natural gas will continue to be the most significant sources for meeting global energy needs. While there is little doubt the role of renewable energy sources will expand, increasing GDP and population accompanied by greater demand for consumer goods, transportation, heating, cooling, and other hallmarks of the lifestyles enjoyed in developed nations, will continue to drive demand for oil and natural gas for decades to come.

2040 Global Energy Mix

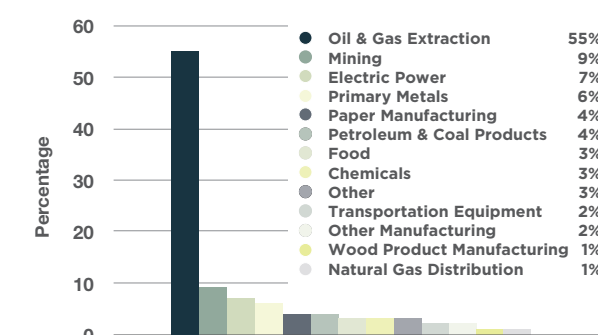
Source: IEA World Energy Outlook, 2017



Canada has tremendous oil and natural gas resources and could respond to this growing global demand for energy. The Canadian oil and natural gas industry is developing and implementing innovative technologies to modernize, improve efficiency and reduce environmental impacts. As many of the world's oil and natural gas producers struggle to meet environmental standards, or operate in jurisdictions with minimal or no standards, Canada is already demonstrating what it takes to be a responsible energy developer; Canada has already set standards that are more stringent than those in most countries, and in many instances Canadian oil and natural gas producers are operating above and beyond regulatory standards. Furthermore, industry continuously invests in innovation that can move environmental performance beyond compliance.

Environmental Protection Spending by Industry

Source: Statistics Canada, 2014



Global Energy Pulse: The World Wants More Canadian Energy

In 2017, CAPP commissioned a report titled Global Energy Pulse. Researchers surveyed 22,000 people in 32 countries about their views on energy in general and on Canada as an energy supplier in particular. A key finding was that while respondents prefer to obtain energy from their own country's resources, 31 per cent ranked Canada first among 11 producing nations as the preferred supplier of oil and natural gas, based largely on perception that Canada's industry is inventing and using leading-edge technologies to minimize environmental impacts. Clearly, the world wants more Canadian energy.

Canadians across the country benefit economically from a healthy oil and natural gas sector, but the positive impact of Canada's industry could be even broader. The opportunity is clear: in order to remain competitive and be able to continue investment in the innovation necessary for a successful transition and economic diversification, Canada urgently needs to develop facilities and infrastructure to get our resources to emerging global markets before other suppliers – with weaker environmental standards – capture these markets. Accessing global markets will also help Canada obtain higher value for our resources.

However, the federal and provincial governments have not facilitated Canada's role in this regard. The cumulative effect of inefficient policies and regulations are damaging the industry's competitiveness and erode investor confidence. While capital investments in oil and natural gas globally increased in 2017, investment in Canada decreased. CAPP estimates total capital spending in 2017 was \$45 billion – a 44 per cent decline compared to \$81 billion in 2014.

As a result, countries that would otherwise prefer Canada's responsibly produced oil and natural gas are turning to other sources to meet their energy needs – sources that likely have higher GHG emissions, contributing to overall global emissions. Under current government policies, Canada is exporting jobs – not oil and natural gas.

Canada's oil and natural gas industry faces a tremendous opportunity for providing energy to emerging and developing countries. However, Canada's policies and environmental regulations must be developed in parallel with attracting investment, spurring innovation, growing jobs and maintaining economic benefits across the country. At present this is not the case and Canada risks falling behind other global energy supply competitors.



Therefore, CAPP recommends that:

- **The federal government take a leadership role in defining Canada's vision for oil and natural gas that positions Canada as the supplier of choice to meet the world's growing oil and natural gas needs.**
 - This vision should be supported through a co-ordinated effort with industry, provincial and territorial governments and individual Canadians to create an effective policy and regulatory environment that encourages investment in Canada's oil and natural gas resources, ensuring those resources are produced the Canadian way – with environmental and social responsibility.
 - This vision must include a focus on accessing world markets (particularly lower- to middle-income countries), a commitment to innovation, and global environmental stewardship.
 - This vision must also seek action on the part of the federal government to undertake efforts that enhance energy awareness and actively cultivate and grow support from Canadians for the responsible development of Canada's resources.
 - Finally, the vision must encourage governments to align costs associated with environmental policies with other jurisdictions to support industry competitiveness and technological advancements that allow for continued innovation in the sector.

The competitiveness of Canada's oil and natural gas industry is at risk. Canada has the opportunity to responsibly meet growing global energy demand but the cumulative effect of policies and regulations are rapidly diminishing this opportunity by thwarting industry growth, competitiveness and market access.



APPENDIX

NOTE – this is a list only, these are not “live” linked to the footnote numbers throughout the text.

1. *World Energy Outlook 2017*, International Energy Agency, November 14, 2017, <https://www.iea.org/weo2017>
2. *The World Population Prospects, 2017 Revision*, UN Department of Economic and Social Affairs, 2017
3. According to the medium variant projection.
4. Homi Kharas, “The Unprecedented Expansion of the Global Middle Class: An Update,” *Global Economy and Development*. Brookings. 2017.
5. *World Economic Outlook*, International Monetary Fund, Washington, DC, 2015
6. Average of forecasts: “Outlook for Energy,” ExxonMobil, 2017; “Energy Outlook,” BP, 2017; “World Energy Outlook,” IEA, 2017; “Asia/World Energy Outlook 2016 - Consideration of 3Es + S under new energy circumstances in the world,” IEEJ, 2016; “World Energy Scenarios,” WEC, 2016; “International Energy Outlook,” EIA, 2017; “MIT Joint Program on the Science and Policy of Global Change, 2016 Food, Water, Energy and Climate Outlook,” MIT, 2016
7. “Energy Outlook,” ExxonMobil, 2017, <http://corporate.exxonmobil.com/en/energy/energy-outlook/download-the-report/download-the-outlook-for-energy-reports>
8. Ibid.
9. Ibid.
10. *World Energy Resources*, World Energy Council, London, UK, 2016, https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Resources_SummaryReport_2016.10.03.pdf
11. “International Energy Outlook 2017,” Department of Energy, Washington, USA, 2017, <https://www.eia.gov/outlooks/aeo>
12. “Outlook for Energy,” ExxonMobil, 2017, <http://cdn.exxonmobil.com/~media/global/files/outlook-for-energy/2017/2017-outlook-for-energy.pdf>
13. Bloomberg New Energy Finance. “Electric Vehicle Outlook 2017.” Bloomberg. <https://about.bnef.com/electric-vehicle-outlook>
14. *ITF Transport Outlook 2017*, Organization for Economic Cooperation and Development, France, 2017, <http://www.oecd.org/about/publishing/itf-transport-outlook-2017-9789282108000-en.htm>
15. Roz Pidcock, “Analysis: What global emissions in 2016 mean for climate change goals,” *Carbon Brief*, London, UK, 2016, <https://www.carbonbrief.org/what-global-co2-emissions-2016-mean-climate-change>
16. The Editors. “Germany is burning too much coal.” Bloomberg. November 2017. <https://www.bloomberg.com/view/articles/2017-11-14/germany-is-burning-too-much-coal>
17. <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/04-02cndpwrgrnrt-eng.html>
18. Ibid.
19. “World Nuclear Performance Report,” World Nuclear Association, UK, 2016, <http://world-nuclear.org/getmedia/b9d08b97-53f9-4450-92ff-945ced6d5471/world-nuclear-performance-report-2016.pdf.aspx>
20. Allan Secombe. “Why prospects for coal are looking up.” *Business Day*. February 2018. <https://www.businesslive.co.za/bd/companies/mining/2018-02-08-why-prospects-for-coal-are-looking-up>
21. <http://www.eesi.org/topics/bioenergy-biofuels-biomass/description>
22. <http://www.nrcan.gc.ca/energy/facts/renewable-energy/20069>

BIBLIOGRAPHY

- Africa development Indicators 2007*, The World Bank and International Bank for Reconstruction and Development, Washington, DC., 2008
http://siteresources.worldbank.org/INTSTATINAFR/Resources/adi2007_final.pdf
- BP Statistical Review of World Energy 2016*, BP P.L.C., London, 2016, <https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-full-report.pdf>
- Covert, Thomas, et al. “Will We Ever Stop Using Fossil Fuels?” *The Journal of Economic Perspectives*, vol. 30, no. 1, pp. 117–137. JSTOR. 2016
- Discussion Guide, Citizen Dialogues on Canada’s Energy Future*, Simon Fraser University’s Centre for Dialogue, Burnaby, 2017, <http://www.canadaenergyfuture.ca/wp-content/uploads/2017/08/Citizen-Dialogues-on-Canadas-Energy-Future-Discussion-Guide.pdf>
- “Electric Vehicles to be 35% of Global New Car Sales by 2040,” *Bloomberg New Energy Finance*, New York, USA, 2016, <https://about.bnef.com/blog/electric-vehicles-to-be-35-of-global-new-car-sales-by-2040>
- Energy Perspectives 2016 Long-term macro and market outlook*, StatOil, Norway, 2016, <https://www.statoil.com/content/dam/statoil/documents/energy-perspectives/energy-perspectives-2016.pdf>
- Energy Outlook*, BP P.L.C., London, 2017, <https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf>
- Energy Outlook 2050*, CNPC Economics & Technology Research Institute, China, 2016.
- Energy Revolution, September 2015*, Greenpeace, Amsterdam, Netherlands, 2015, <http://www.greenpeace.org/international/en/publications/Campaign-reports/Climate-Reports/Energy-Revolution-2015>
- International Energy Outlook 2016*, Department of Energy, Washington, USA, 2016, <https://www.eia.gov/outlooks/ieo>
- International Energy Outlook 2017*, Department of Energy, Washington, USA, 2017, <https://www.eia.gov/outlooks/aeo>
- ITF Transport Outlook 2017*, Organization for Economic Cooperation and Development, France, 2017, <http://www.oecd.org/about/publishing/itf-transport-outlook-2017-9789282108000-en.htm>
- MIT Joint Program on the Science and Policy of Global Change, 2016 Food, Water, Energy and Climate Outlook*, The Massachusetts Institute of Technology, Cambridge, 2016, <https://globalchange.mit.edu/publications/signature/2016-food-water-energy-climate-outlook>
- Kharas, Homi. “*The Emerging Middle Class in Developing Countries*,” OECD Development Centre/Brookings, working paper 285, 2010
- Kharas, Homi. “*The Unprecedented Expansion of the Global Middle Class*,” *Global Economy and Development* at Brookings, working paper 100, 2017
- Key world energy statistics*, OECD/IEA, Paris, 2016, <https://www.iea.org/publications/freepublications/publication/KeyWorld2016.pdf>
- P. Levay, Y. Drossinos, C. Thiel. “The effect of fiscal incentives on market penetration of electric vehicles: A pairwise comparison of total cost of ownership.” Elsevier. *Energy Policy*.
- Passenger transport demand*, European Environment Agency, Copenhagen, Denmark, 2016, <https://www.eea.europa.eu/data-and-maps/indicators/passenger-transport-demand-version-2/assessment-6>
- Pidcock, Roz. *Analysis: What global emissions in 2016 mean for climate change goals*, Carbon Brief, UK, 2017, <https://www.carbonbrief.org/what-global-co2-emissions-2016-mean-climate-change>

BIBLIOGRAPHY

Political Risk Outlook: Oil and Gas 2018, Verisk Maplecroft 2018.

Puddington, Arch and Roylance, Tyler. *Freedom in the World 2017*, Freedom House, 2017, https://freedomhouse.org/sites/default/files/FH_FIW_2017_Report_Final.pdf

Renewables 2017 Global Status Report, Renewable Energy Policy Network Secretariat, Paris, France, 2017, <http://www.ren21.net/gsr-2017>

Rivalry: the IHS Planning Scenario, July 2016, IHS CERA, Cambridge, MA, 2016, <https://www.ihs.com/products/long-term-energy-planning-scenarios.html>

Short-Term Energy Outlook, U.S. Energy Information Administration, Washington, USA, 2016, <https://www.eia.gov/outlooks/steo>

Smil, Vaclav, *Energy Transitions: Global and National Perspective, 2nd Edition*, Praeger Frederick, MB, 2016.

Suehiro, Shigeru et al. *Asia/World Energy Outlook 2016 - Consideration of 3Es + S under new energy circumstances in the world*, The Institute of Energy Economics Japan, Tokyo, 2016, <http://eneken.ieej.or.jp/data/7110.pdf>

"The Cost of Inaction: Recognising the Value at Risk from Climate Change," *The Economist* Intelligence Unit, London, UK, 2015, https://www.eiuperspectives.economist.com/sites/default/files/The%20cost%20of%20inaction_0.pdf

The Outlook for Energy: A View to 2040, ExxonMobil Corporation, Irving, CA, USA, 2017, <http://cdn.exxonmobil.com/~media/global/files/outlook-for-energy/2017/2017-outlook-for-energy.pdf>

"*The 2015 Revision, Key Findings and Advance Tables*," United Nations, Department of Economic and Social Affairs, Population Division, working paper no. ESA/P/WP/248, 2015.

World Energy Issues Monitor 2017, World Energy Council, London, 2017, <https://www.worldenergy.org/publications/2017/world-energy-issues-monitor-2017>

Wilson, Robert. "Why Germany's Nuclear Phase Out is Leading to More Coal Burning," The Energy Collective, January 20, 2014. <http://www.theenergycollective.com/robertwilson190/328841/why-germanys-nuclear-phase-out-leading-more-coal-burning>

World Energy Outlook 2015, OECD/IEA, Paris, 2015, <https://www.iea.org/newsroom/news/2015/november/world-energy-outlook-2015.html>

World Energy Outlook 2016, OECD/IEA, Paris, 2016, <https://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html>

World Energy Resources 2016, World Energy Council, London, 2016m, <https://www.worldenergy.org/publications/2016/world-energy-resources-2016>

World Energy Scenarios, World Energy Council, London, 2016, https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Scenarios-2016_Full-Report.pdf

World Nuclear Performance Report, World Nuclear Association, England, UK, 2016, <http://world-nuclear.org/getmedia/b9d08b97-53f9-4450-92ff-945ced6d5471/world-nuclear-performance-report-2016.pdf.aspx>

World Oil Outlook, Organization of Petroleum Exporting Countries Secretariat, Vienna, 2016, http://www.opec.org/opec_web/en/publications/340.htm

Where Will Transportation Drive Global Oil (and Oil Sands) Demand, IHS Markit Canadian Oil Sands Dialogue, 2016

GLOSSARY

b/d – barrels per day

BP – British Petroleum

CAPP – Canadian Association of Petroleum Producers

CO₂ – carbon dioxide

EIA – Energy Information Administration

GDP – gross domestic product

GHG – greenhouse gases

IEA – International Energy Agency

IEEJ – Institute of Energy Economics Japan

MIT – Massachusetts Institute of Technology

NPS – New Policies Scenario, developed by the IEA

OECD – Organization for Economic Cooperation and Development

OPEC – Organization of the Petroleum Exporting Countries

WEC – World Energy Council

**The Canadian Association
of Petroleum Producers
(CAPP)**

represents companies, large and small, that explore for, develop and produce natural gas and crude oil throughout Canada. CAPP's member companies produce about 80 per cent of Canada's natural gas and crude oil. CAPP's associate members provide a wide range of services that support the upstream crude oil and natural gas industry. Together CAPP's members and associate members are an important part of a national industry with revenues from crude oil and natural gas production of about \$110 billion a year. CAPP's mission, on behalf of the Canadian upstream crude oil and natural gas industry, is to advocate for and enable economic competitiveness and safe, environmentally and socially responsible performance.





CANADA'S OIL & NATURAL GAS PRODUCERS

capp.ca/economicseries

2018-9303