

The Outlook for Energy: A View to 2040

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Introduction

The Outlook for Energy: A View to 2040

The Outlook for Energy is our long-term global view of energy demand and supply. Its findings help guide our long-term investments, and we share *The Outlook* to help promote better understanding of the issues shaping the world's energy future.

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Energy today

Energy is integral to our lives in the 21st century.

Energy keeps us warm, cools us down, and cooks our meals. It helps us connect with our children, and lights the garages and labs of entrepreneurs and inventors building a better world. Energy harvests our food, fuels our factories, builds our cities, and cleans our water. It keeps us mobile and connected with others near and far.

The 21st century already has witnessed major changes in how people use energy – for example, Internet-connected smartphones were introduced only around 2000; today there are more than 2.5 billion of them worldwide.

This century also has seen tremendous advances in energy technology – including the ones that unlocked North America’s vast resources of unconventional oil and natural gas.

Together, these **technologies have ushered in a new era of energy abundance – and diversity.** Today, our energy can come from deep below the ocean floor, beds of shale rock, nuclear fission, biofuels, the wind and the sun. And importantly, development and use of each of these energy sources continues to evolve in ways that reduce impacts on the environment.

While energy supplies are evolving, fundamentals on the demand side have been undergoing their own dynamics. Many economies continue to struggle, even more than five years after the global recession, while others, including that of China, continue to expand significantly, albeit at a more modest pace. Even so, global economic output has risen about 50 percent since 2000, with better living standards for hundreds of millions of people.

Another positive trend is our ability to find ways to use energy far more efficiently, curbing growth in energy usage and emissions. The world uses about 10 percent less energy per unit of economic output than it did in 2000, with half of this gain occurring since 2010.

Still, **the need for energy remains vast.** Global demand for energy rose by about one-third from 2000 to 2014, with China accounting for about half of this growth.

Meeting growing energy demand is an ongoing challenge, recognizing the scale of supplies required to meet the needs of 7 billion people each day. The use of oil alone – representing just one-third of the world’s energy consumption – is now approaching 95 million barrels a day, enough to power a car 100 billion miles, or 4 million times around the world.

Several themes remain true today: Modern energy is fundamental to our standards of living; practical options for meeting people’s energy needs continue to expand, including those related to efficiency; and the energy industry is huge, growing and connecting regions through trade.

Energy tomorrow

Over *The Outlook* period to 2040, consumers and businesses will drive an ongoing evolution in energy needs, shaped by waves of economic growth and advances in technology. At the same time, both supply and demand will be affected by a wide range of government policies, including ones that seek to expand access to modern energy and those that aim to reduce the risks of global climate change.

In this time frame, we expect oil, natural gas and coal to continue to meet about 80 percent of global demand. For a century, these sources have been the foundation of the modern energy that has enabled modern living. Today, they remain abundant, reliable and affordable, and available on the scale required to serve 7 billion people 24 hours a day.

Still, **significant changes are coming**. The biggest expected growth will be in natural gas, which provides a practical energy solution for many applications while also providing a significant cost advantage versus other options to help reduce climate change risks. Renewable energy and nuclear power also are expected to see significant growth over this period, together accounting for about two-thirds of the increase in energy demand for power generation.

Policies to address greenhouse gas (GHG) emissions will increasingly influence the energy landscape. In our view, **after rising more than 50 percent from 1990 to 2014, global energy-related CO₂ emissions will likely peak around 2030**.

We expect the member nations of the Organisation for Economic Co-operation and Development (OECD), where CO₂ emissions are declining, to lead this shift. However, China will also play a significant role as its emissions peak around 2030. We see this global shift being enabled in large part by substantial gains in energy efficiency in all regions.

With strong gains in energy efficiency and significant changes in the world's energy mix – driven by economics and climate policies – **we expect the CO₂ intensity of the global economy to be cut in half by 2040**.

Thanks to economic development opportunities powered by abundant energy, we see the world standing at the cusp of decades of enormous growth and better living standards for billions of people.

The period to 2040 is expected to reflect a dramatic expansion of the world's population and the global middle class. Living conditions will improve as millions of people gain access to electricity, which will lead to benefits such as better education and modern healthcare.

From 2014 to 2040, we see global demand for energy rising by 25 percent. This increase is equivalent to the total energy used in North America and Latin America today.

We expect energy demand growth to be led by a 45 percent increase across non-OECD countries, while demand in OECD countries will be essentially flat. Energy efficiency will play a huge role in slowing the growth in global demand, as energy use per unit of economic output is likely to fall by 40 percent.

To keep pace with demand, **the world will need to pursue all economic energy sources.** In 2040, oil and natural gas will likely be nearly 60 percent of global supplies, while nuclear and renewables will be approaching a 25 percent share.

We can expect that new technologies will continue to create new energy options for our growing world. We don't know yet what all those technologies will be, but history tells us that the best ones will be affordable, available on a commercial scale, and not overly reliant on government support. Enabling these technologies will require policies that promote innovation, investments and free trade.

One of the constants in life is change. Another is energy. By understanding the trends described in *The Outlook*, we can better anticipate how much – and which kinds of – energy the world will need in the future. This insight helps guide our investments as we work to help safely meet the world's need for affordable, reliable energy – the energy that helps create and add value to modern living for people everywhere.

Base year switches to 2014

This year's *Outlook* forecasts growth in energy demand of about 25 percent from 2014 to 2040. The use of 2014 as the base year in this year's report is a change from recent *Outlooks*, which used 2010. We made this adjustment to help provide a better perspective on expected changes in energy demand and supply to 2040, since energy markets have evolved quite a bit since 2010. For comparison, this year's *Outlook* also forecasts energy demand growth of about 35 percent from 2010 to 2040, consistent with recent *Outlooks*.

Our energy to 2040: Seven things to know

Modern energy is one of mankind's most complex endeavors, and its path is shaped by countless forces. However, we see seven key themes that will play a major role in defining our global energy landscape through 2040.

Energy is fundamental to standards of living

As incomes rise, billions of people in developing nations will rise into the middle class; many of them will be able to afford amenities that already are commonplace elsewhere, such as temperature-controlled homes, cars, and appliances like refrigerators, washing machines and computers.

In 2014, there were about 10 cars per 100 people in China. By 2040, this is expected to rise to about 30.



Developing nations will lead gains in GDP and living standards

While developed economies still enjoy the world's highest standards of living, we expect that China, India and many other nations will see strong growth in GDP and living standards to 2040. Not coincidentally, developing nations also are expected to lead the world in energy demand growth.

Per capita income in OECD nations is expected to rise by almost 60 percent 2014-2040; non-OECD nations rise about 135%.



Economics and policies will impact the energy mix

Increasingly, the mix of fuels that consumers use to meet their energy needs will be reshaped by economics and government policies, especially those aimed at reducing CO₂ emissions associated with energy use. In general, demand will shift toward cleaner fuels like natural gas, renewables and nuclear.

The share of the world's electricity that is generated by coal will likely drop to about 30 percent in 2040, from over 40 percent in 2014.



Natural gas grows more than any other energy source

Demand for natural gas is growing rapidly in part because it is the cleanest-burning major fuel. Gas also is abundant and versatile; it is used heavily in the power generation and industrial sectors, and also is emerging as a fuel for certain types of transportation.

40%
of the growth in global energy demand from 2014-2040 is projected to be met by natural gas.

Technology has the highest potential and the greatest uncertainty

Advances in technology have tremendous potential to help meet our energy and environmental goals, but the pace of change is difficult to predict. Recent breakthroughs in unconventional oil and gas production are already reshaping the world's energy supply. There is also significant emphasis on technology advances to improve energy efficiency and the prospects for batteries, renewables and nuclear power.

Oil will remain the world's primary fuel

We expect oil to continue to be the world's leading fuel, driven by demand for transportation fuels and by the chemical industry, where oil provides the feedstock to make plastics and other advanced materials.

1/3
of the world's energy is expected to be provided by oil in 2040.



CO₂ intensity of the global economy to be cut in half

We expect that as economies continue to grow, improved efficiency and lower-carbon fuels will mean that by 2040, the amount of energy-related CO₂ emissions associated with a dollar of global GDP will have dropped by half.

Global energy-related CO₂ emissions are expected to peak by about 2030 and then begin declining.

CO₂

Global average fuel economy for light-duty vehicles is expected to improve by 80%.



Global fundamentals

What will the world's energy needs look like in 2040 and beyond?

Answering this question begins with recognizing the fundamental forces that continue to shape long-term energy trends in nations around the world. These forces include population growth, demographic shifts and economic expansion.

Through 2040, we see China, India and other non-OECD countries – home to seven-eighths of the world's population – needing much more energy to fuel economic development and rising living standards. On the other hand, the U.S., Europe and other OECD nations will see declines in overall energy demand and emissions, even as their economic output continues to grow.

All around the world, we expect energy efficiency to continue to improve, and a greater share of demand to be met by cleaner fuels. In part, these gains will be the result of governments and consumers seeking to meet their demand for energy while also addressing the risks of climate change.



The world's demand for energy is driven by many factors, but the two biggest are population and economic growth.

By 2040, the world's population will have reached 9 billion – up from about 7.2 billion today – and global GDP will have more than doubled. This growth will create more need for affordable, reliable energy – energy for homes, transportation, business and industry.

We see global energy demand rising by about 25 percent from 2014 to 2040. This is a significant increase, but would have been far higher (exceeding 110 percent) if we did not foresee steep improvements in energy efficiency across all demand sectors.

China and India lead growth in energy demand

Although energy demand worldwide is projected to rise by 25 percent, global totals can be misleading because trends will vary greatly by nation. We anticipate some developed economies to see net declines in overall energy demand through 2040. We believe that at this point in time, the future of energy is best understood by looking at three distinct groups of nations:

- **China and India.** By 2040, India will have passed China as the world's most populous nation, with 1.6 billion people. China and India also lead the developing world in raising standards of living and achieving technology improvements. Both nations are starting to take steps toward adopting additional policies on energy and climate change. Together, we see China and India accounting for almost half the projected growth in global energy demand to 2040.
- **A group of 10 Key Growth** countries whose rising populations and living standards will drive strong increases in energy demand. This group comprises Brazil, Mexico, South Africa, Nigeria, Egypt, Turkey, Saudi Arabia, Iran, Thailand and Indonesia. Collectively, these 10 nations account for about 30 percent of the projected growth in energy demand through 2040.
- **OECD32 is a group of developed nations including** the United States and all other OECD members except Mexico and Turkey, which we include in Key Growth. Already enjoying relatively high living standards and widespread use of advanced technology, these economies are expected to expand at a relatively moderate pace, while their populations remain stable. OECD32 nations have some of the most aggressive policies on improving efficiency and curbing emissions. Energy demand in the OECD32 group is expected to decline by 5 percent from 2014 to 2040.

While population and GDP are reliable indicators of a country's energy demand, they don't tell the whole story. We also need to look at the citizens themselves. Are they young or old? Rich or poor? Living in a modern city or a rural community? The answers to these questions help determine how much a country's economy will grow, and how much energy its citizens will need.

Long-term trends in demographics, productivity and income

Countries with a relatively high percentage of working-age citizens (ages 15 to 64) tend to have faster economic growth, provided there are sufficient job opportunities in those economies.

A relatively large working-age group is an important factor supporting future economic growth in India, the Key Growth group and other developing nations. On the other hand, aging populations will continue to pose a challenge to economic growth in the OECD32. Aging will also impact China's potential growth. By 2040, more than 20 percent of China's population will be age 65 or older, up from just 9 percent today.

But for people and families everywhere, what matters most economically is incomes – and the living standards those incomes can support. A simple measure of income is GDP per capita. Through 2040, per capita GDP will rise widely across the globe, but we expect that the gains will be strongest in the non-OECD, particularly China and India. By 2040, per capita income in China and India is expected to be more than three times today's level; in Key Growth countries, it will be on average almost twice as high.

Because of these rising incomes, we expect the world to see the largest expansion of the global middle class in history. The Brookings Institution estimates that the number of people earning enough to be considered middle class will grow from just over 2 billion in 2014 to nearly 5 billion in 2030, with most of the growth centered in India and China.

At the same time, China, India and other developing nations continue to experience the urbanization shift that permeated the developed world in the 20th century. By 2040, close to 65 percent of the world's population will live in cities, up from under 55 percent today.

These shifts in developing nations are expected to have significant impacts on energy demand. As people rise into the middle class and move from rural to city settings, their per capita consumption of modern energy tends to increase rapidly. This growth is tied to a wide range of uses – everything from refrigerators to cars to office buildings to the energy needed to manufacture consumer goods.



25%

increase in energy demand by 2040.

That's like adding another North and Latin America.



Near-term dynamics in the global economy and energy market

In 2009, the world economy experienced the worst global recession in the post-World War II years. Since then, apart from an initial rebound in 2010, recovery has been slow and uneven across various regions of the world. Today, there are limited signs of improvement in developed economies, led by the United States. On the other hand, there have been economic headwinds coming from developing countries, including slowing growth in China, and declines in the prices of commodities, including energy, upon which many developing economies depend.

Times like these are a reminder of how energy and the economy are intertwined. In the pre-industrial era, lack of access to modern energy constrained economic growth and living standards. That condition unfortunately still holds today in some less-developed countries. But for much of the world, modern energy continues to move the economy and society forward. At the same time, the ups and downs of the global economy inevitably feed back to the energy market. These cycles are the norm, not the exception.

While we recognize the importance of looking at short-term dynamics of the energy market at this juncture of world economic recovery, we also believe that by focusing more on the long-term forces shaping energy trends, the public and policymakers can have a stronger foundation upon which to meet future energy needs in a safe, secure and environmentally responsible way.

Charting the numbers

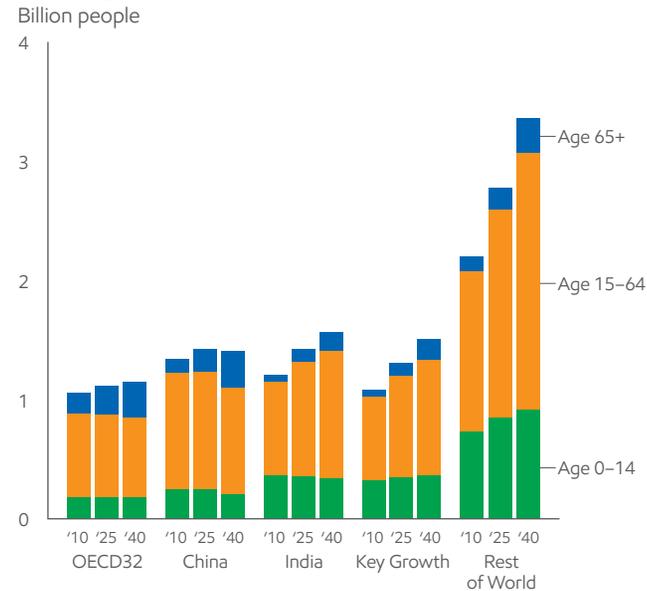
Population is growing, life spans are increasing and birth rates are slowing. Incomes are rising and poverty is on the decline. In non-OECD countries, where seven-eighths of the world lives, billions are about to join the middle class. The percentage of people living in urban settings continues to rise.

These fundamentals are the starting point for *The Outlook*, because they are the megatrends that drive energy demand. Using data from the United Nations, World Bank, the International Monetary Fund and other sources, together with our own analysis, we seek to understand how population, demographic and economic shifts will shape the world in years to come.

Our conclusion: Global energy demand will rise by about 25 percent from 2014 to 2040, with all of the growth coming from the non-OECD.

Global fundamentals – projections

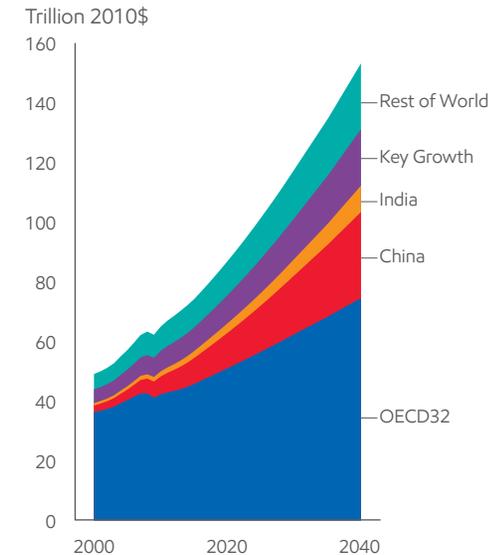
Demographics



Source: World Bank, ExxonMobil estimates

- World population grows 25 percent, from 7.2 to 9 billion 2014-2040
- India has nearly 1.6 billion people by 2040, passes China as most populous
- OECD32, China see working-age group (15-64) shrink to 2040, while others see large gains
- In most regions, under-14 group shrinks or decelerates due to declining birth rates
- In all regions, population age 65 and older expands as life expectancy rises

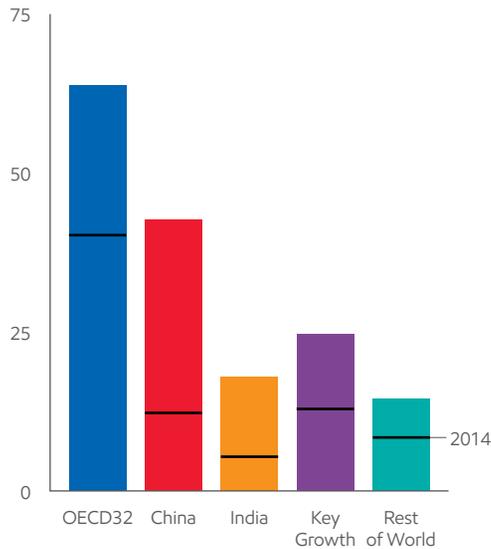
GDP



- Economic growth drives increased need for energy
- Global GDP more than doubles 2014-2040; developing countries lead growth
- OECD32 grows about 65 percent, but share of world GDP shrinks almost 15 percent by 2040
- China rises to almost 20 percent of world GDP, close to U.S.; India exceeds 5 percent

2040 GDP per capita

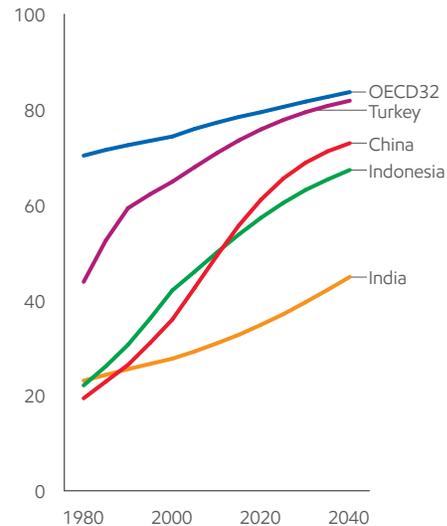
Thousand PPP\$



- OECD32 has highest income of any region; up almost 60 percent 2014-2040
- China's GDP per capita more than triples to 2040, reaches today's OECD level
- India's GDP per capita also triples, while Key Growth nearly doubles
- Global middle class expands by billions; leads to new energy demand

Urbanization ratio

Percent

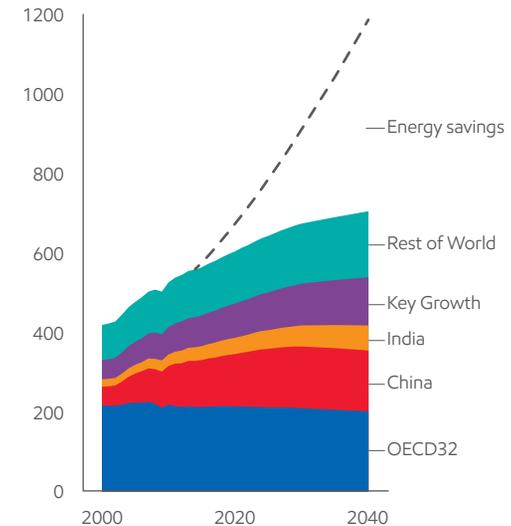


Source: United Nations

- Close to 65 percent of world population lives in cities by 2040; OECD32 tops 80 percent
- Developing nations will experience large rural-to-urban shifts
- China's urbanization rate hits nearly 75 percent in 2040, up from about 20 percent in 1980
- India rises, but over half its people still live in rural settings by 2040

Energy demand

Quadrillion BTUs



- Global demand for energy rises by 25 percent 2014-2040
- Demand could have more than doubled without efficiency gains
- All demand growth comes from developing world, but China plateaus around 2030
- Demand in OECD32 falls by 5 percent 2014-2040

Meeting growing demand

People use energy in many ways every single day. These needs will grow in coming decades as populations and living standards continue to rise.

Income growth and urbanization in developing economies are expected to spur demand for fuels used in the home, as well as the energy needed to produce and ship all types of manufactured goods. The number of cars on the world's roads will rise by 80 percent.

But, we see the biggest growth coming from electricity, the invisible energy that the modern world expects 24/7 to provide light, heat and power to our homes, buildings and industries. By 2040, the generation of electricity is expected to account for 40 percent of all the energy used in the world.



Transportation

We want this to go there...
We want that to come here...
I need to go there...
You need to come here.

Such are the patterns of modern life that stimulate demand for the energy that allows us to drive to work, take the train to visit friends, or fly to another city to close a business deal or spend time with loved ones.

Modern living also drives demand for the energy that fuels global commerce. It is the energy that delivers raw materials to a manufacturing plant, and the energy that makes it possible for food, medicine or the latest modern conveniences to travel thousands of miles to a local market or even directly to your home.

In the coming decades, advances in technology will continue to create cleaner, more efficient transportation and significant fuel savings. Even so, we see global demand for transportation continuing to rise as a growing middle class and higher incomes mean more cars on the road and increased commercial activity. **Global energy demand for transportation is projected to increase by about 30 percent from 2014 to 2040.**

Essentially all of this growth is projected to come from non-OECD countries, where transportation demand will likely rise by about two-thirds. In these countries, more cars and increased use of heavy-duty vehicles is likely to more than offset the impact of better fuel efficiency, while increased economic activity will promote a rise in marine, aviation and rail transportation.

In OECD32 countries, transportation demand is expected to decline about 10 percent through 2040, reflecting relatively mature levels of economic development, modest population growth, and the rising use of advanced technologies that boost fuel efficiency without sacrificing mobility.

More cars on the road, but more miles per gallon

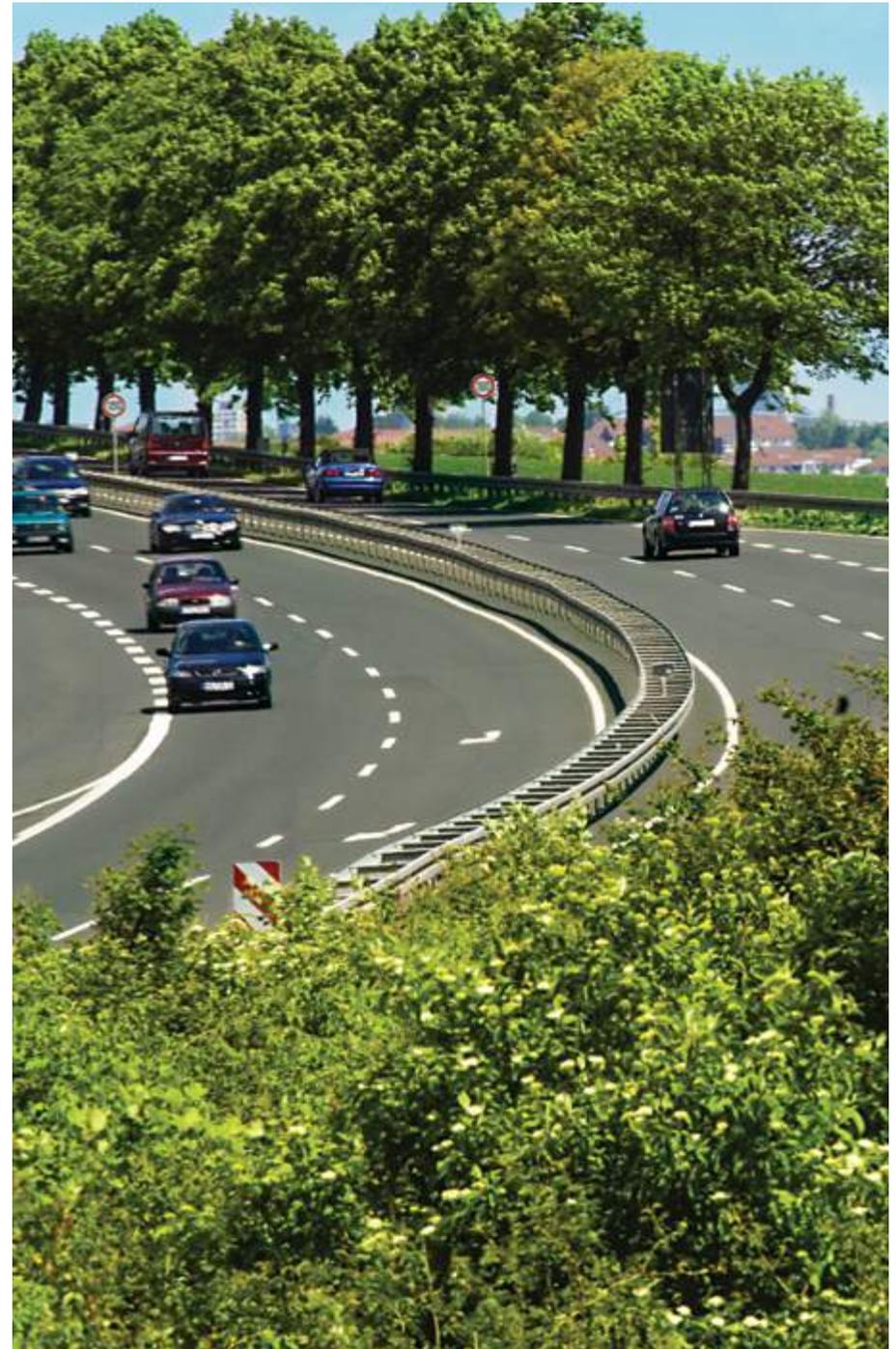
Today, there are close to 1 billion light-duty vehicles (LDVs) in the world.

OECD32 nations have about 570 cars per 1,000 people, a level that reflects relatively high incomes, mature automobile markets and modern road networks. But in less-developed nations, vehicle penetration is far lower – at only about 70 cars per 1,000 people on average. As incomes rise in these countries, people are likely to purchase a lot more cars, many for the first time. In fact, **we expect the global light-duty fleet to rise by close to 800 million vehicles by 2040 with about 90 percent of this growth outside the OECD32 countries.**

Even so, vehicle penetration in developing countries is projected to be only about one quarter of OECD32 levels by 2040. Lower incomes account for much of this gap, but other factors include extensive and growing use of motorcycles in non-OECD countries, as well as access to expanding public transportation networks.

In general, **cars and other light-duty vehicles are becoming much more fuel efficient**, thanks to changes in personal preferences and ongoing advances in technology, stimulated in part by regulations such as stricter fuel economy standards. The average car on the road will likely travel about 45 miles per gallon (mpg) in 2040, compared to about 25 mpg in 2014.

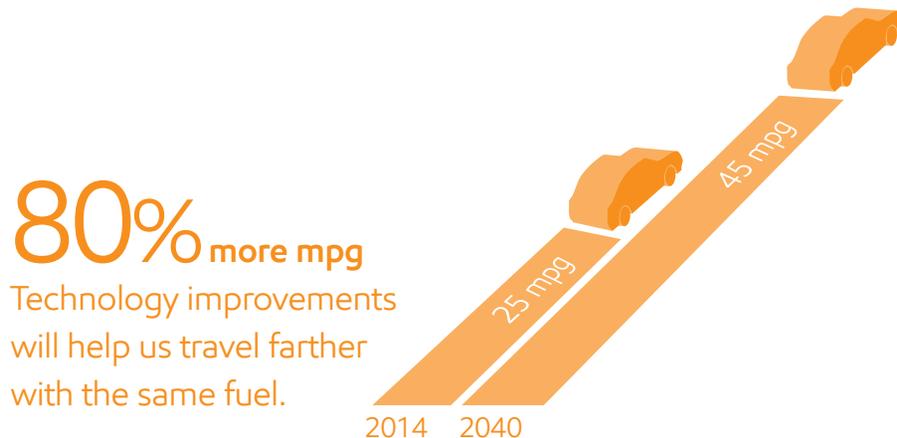
Because of this improved fuel economy, demand for fuel for light-duty vehicles is expected to decline by about 40 percent in the OECD32 even as its number of cars rises by about 95 million (about 15 percent). In developing countries, however, light-duty demand is expected to rise by about 50 percent, as better fuel economy only partially offsets a near tripling of cars on the road. **Globally, energy demand for light-duty vehicles will likely peak around 2020, then decline close to 10 percent to 2040.**



Improved fuel economy is tied to advances in technology. Examples include vehicle light-weighting through durable plastic components, better tire liners, and advanced engine and powertrain systems.

Customer preferences drive innovation as well. Today's new cars offer a wide range of functionality and performance, and buyers continue to seek vehicles that best meet their needs. Conventional (non-plug-in) hybrid-electric vehicles tend to be the most practical and affordable of the advanced models, providing about 30 percent better fuel economy compared to conventional gasoline-powered cars, even as these cars also improve. In fact, **improving fuel economy in gasoline-fueled cars is one of the most cost-effective ways to reduce GHG emissions, especially when compared to electric cars.**

We expect conventional hybrids to jump from about 2 percent of new-car sales in 2014 to more than 40 percent by 2040. In contrast, plug-in hybrids and fully electric cars are likely to account for less than 10 percent of new-car sales globally in 2040.



Heavy-duty transport grows with trade

Driving the growth in energy for transportation – in every region – is commercial transportation.

We see heavy-duty vehicles becoming the largest energy-consuming segment of the transportation sector by 2030. This is not surprising given the role of trucking in sustaining modern life, and the projected growth in economic activity and trade. **Global energy demand for heavy-duty vehicles is expected to increase by about 45 percent from 2014 to 2040, with about 85 percent of the growth coming from non-OECD32 countries, where economic activity is increasing most rapidly.**

We anticipate demand in China increasing by about 50 percent, while demand in India more than doubles. Key Growth countries' demand is expected to increase by more than 50 percent. To put this in perspective, the expected increase in these 12 countries is more than the current demand in North America.

Aviation, marine and rail – the fastest-growing subsectors

Just as economic growth and trade will spur demand for energy for heavy-duty vehicles, **we also expect the world to see more demand for ships, planes and trains to carry supplies to factories and goods to markets.** In total, energy demand from these three subsectors will likely grow by about 65 percent.

In fact, the use of aviation, marine and rail transportation will likely increase to such an extent that their combined energy demand is expected to equal about 85 percent of the amount used by light-duty vehicles in 2040, up from about 50 percent in 2014.

We expect over 90 percent of the demand to be met by oil through 2040, reflecting its advantages as a practical, energy-dense and cost-effective source of fuel to meet the needs in these sectors.



Led by heavy-duty trucking, commercial transportation demand expected to increase about

55%.

Growing diesel demand

The vast majority of transportation energy needs today are met by oil, with gasoline being the most prominent fuel.

We expect that oil will still be predominant in 2040 – close to 90 percent of transportation energy – though we expect the product mix to shift significantly toward diesel fuel, driven in large part by strong growth in commercial transportation and relatively flat gasoline demand. **Today, diesel accounts for about 35 percent of the total energy used for transportation. By 2040, we expect this share to be about 40 percent, surpassing gasoline,** reflecting growth of about 8 MBDOE or close to 45 percent.

Most of the diesel fuel used for transportation – about 80 percent – is consumed by heavy-duty vehicles. Diesel engines are well-suited to pulling heavy loads, and for the foreseeable future, we expect diesel to remain predominant in the heavy-duty sector.

Diesel also is used to power some light-duty vehicles, as well as marine vessels and trains. Among these uses, the most significant growth is likely to occur in the marine sector, where new emission standards will encourage greater penetration of low-sulfur diesel fuels in place of fuel oil. Partially offsetting this growth will likely be a decline in diesel use among light-duty vehicles, reflecting growing favor toward conventional and hybrid gasoline cars.



The promise of natural gas fuel

Natural gas holds great promise for the transportation sector due to its potential to reduce fuel costs and also help meet emerging emission requirements. **Today, natural gas represents about 2 percent of total transportation demand, but this share is likely to rise to about 5 percent in 2040.**

Most of this growth will come from heavy-duty vehicles, a segment where natural gas may present a practical option to reduce fuel costs. Although trucks designed to run on natural gas are significantly more expensive than diesel trucks, economic opportunities to use compressed natural gas (CNG) or liquefied natural gas (LNG) may exist in regions where supply is abundant. We expect natural gas use in trucking will increase by almost 300 percent from 2014 to 2040, with its share of global heavy-duty vehicle demand rising to about 7 percent, up from 3 percent. We expect China and the United States to account for about 50 percent of this global demand in 2040.

We also anticipate natural gas demand in the marine sector to increase significantly, stimulated by new emission standards. By 2040, gas is likely to account for about 10 percent of total marine fuels, up from less than 1 percent now, with about two-thirds of the growth in developing countries.

Charting the numbers

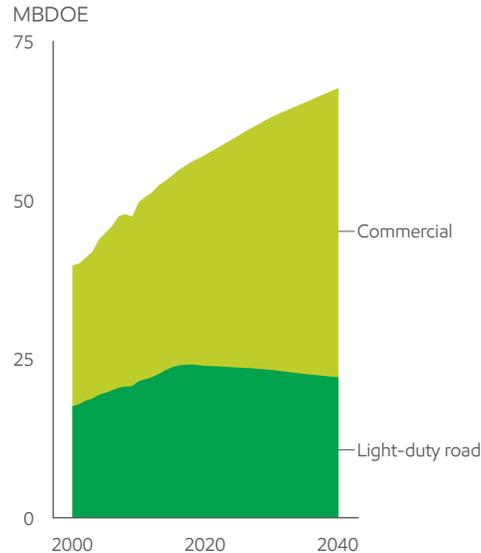
When we look at the transportation sector, one feature is clear: increasingly, demand growth is led by heavy-duty trucks and other commercial transportation (airplanes, ships and trains).

For decades, energy for personal vehicles has been growing strongly. But by 2040, in terms of fuel consumption, commercial transportation will double that of light-duty vehicles.

We anticipate the vast majority of vehicles to continue to run on products made from oil. However, we also see natural gas making significant headway as fuel for fleet vehicles, such as trucks and buses, as well as ships.

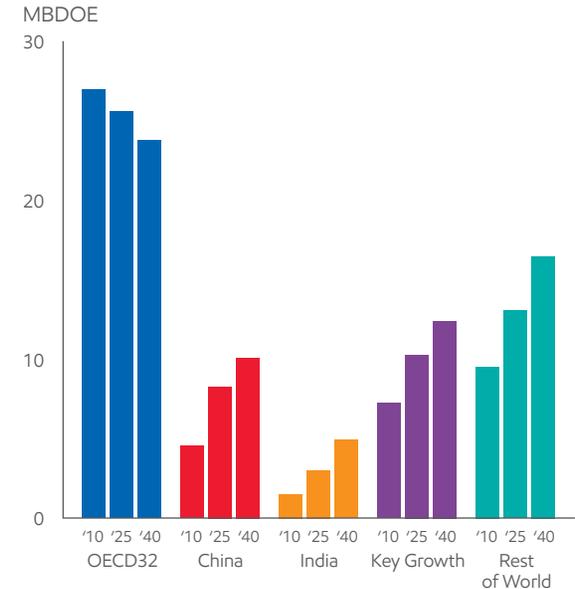
Transportation – projections

Global transportation demand



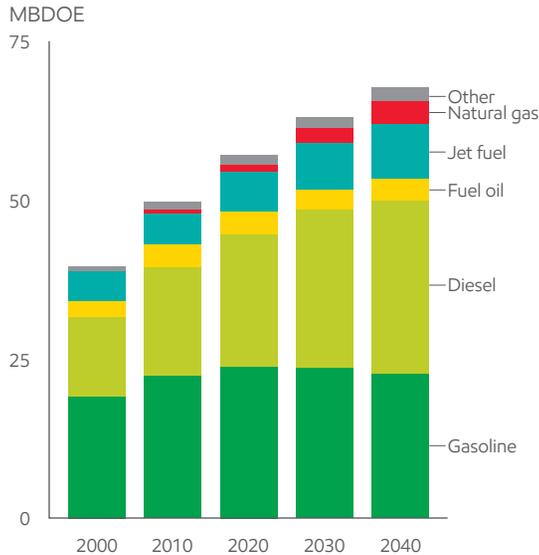
- Global energy demand for transportation to rise by about 30 percent 2014-2040
- Commercial transport (trucks, air, rail, ships) up about 55 percent as economic output doubles
- By 2040, commercial activity accounts for two-thirds of global transportation demand
- Light-duty fuel usage holds steady as fuel economy gains offset larger fleet

Transportation demand by region



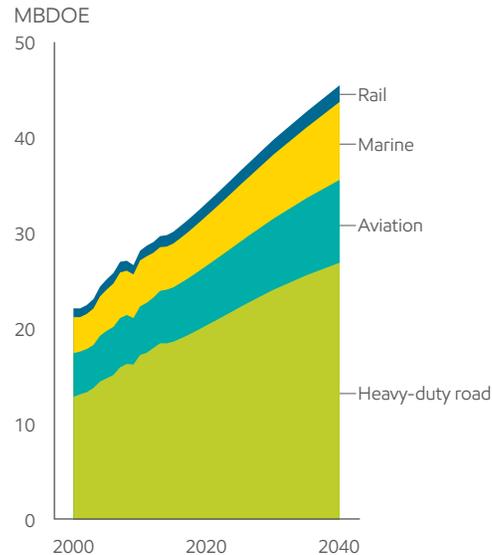
- OECD32 countries account for half of global transportation demand today
- Growth in transport demand 2014-2040 will come from outside OECD32
- China's demand will rise by about 80 percent, while India's will nearly triple
- Demand in Key Growth countries, Rest of World will rise about 50 percent
- OECD32 demand will fall by close to 10 percent 2014-2040

Global transportation demand by fuel



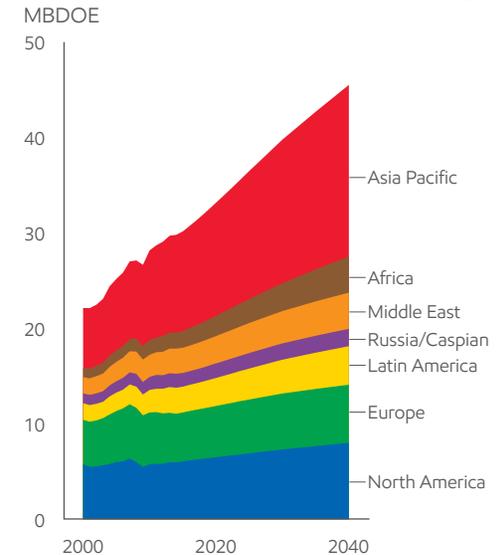
- Close to 95 percent of current transportation energy needs are met by oil
- Gasoline demand flattens as vehicle fuel economy improves rapidly
- Demand for diesel grows 45 percent 2014-2040 as truck and marine needs expand
- Jet fuel demand to rise by 55 percent as air travel keeps increasing worldwide
- Natural gas grows as a transport fuel, mainly for commercial fleets

Commercial transportation demand by sector



- Trade, economic growth spur close to 55 percent rise in commercial transport needs
- Demand for on-road heavy-duty vehicles (trucks, buses) rises 45 percent 2014-2040
- Aviation, marine, rail demand also grow, rising about 65 percent in total
- Heavy-duty vehicles close to 60 percent of commercial demand through 2040

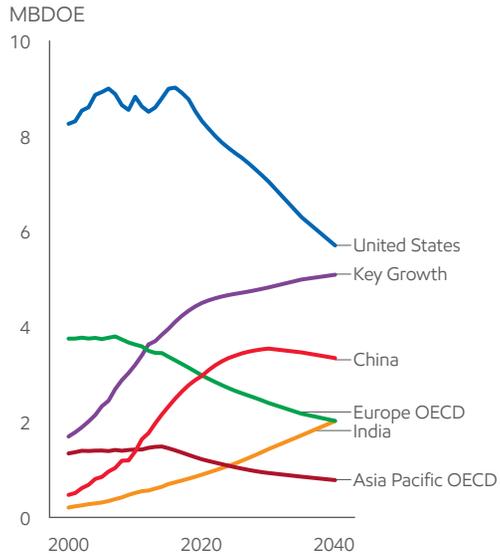
Commercial transportation by region



- Commercial transportation is driven by economic growth and trade
- All areas see rising commercial transport; OECD32 up 20 percent 2014-2040
- Asia Pacific accounts for 50 percent of commercial transport energy growth
- By 2040, 40 percent of commercial transportation demand is in Asia Pacific
- North America and Africa combine for 25 percent of global demand growth

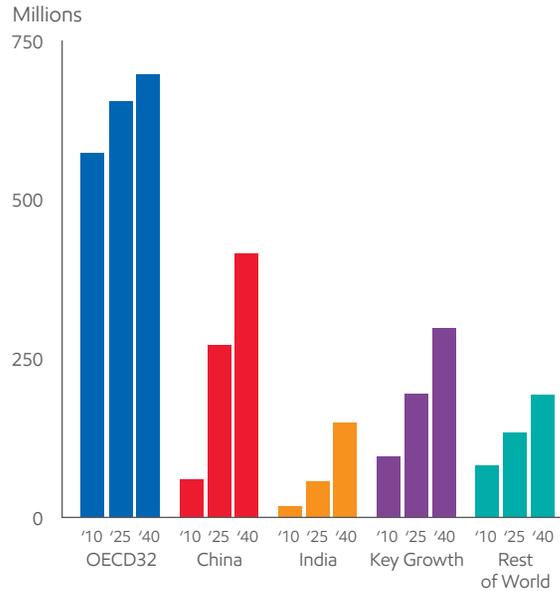
Transportation – projections

Light-duty vehicle demand trends



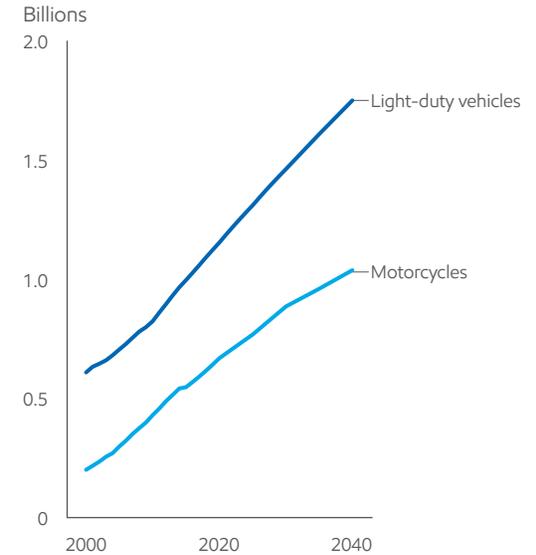
- Amount of fuel used by light-duty vehicles to decline in U.S., other OECD
- Non-OECD share of global light-duty demand rises from 40 percent now to 60 percent in 2040
- China's LDV demand grows, then flattens as fuel economy improves and car penetration slows
- LDV demand outside the OECD and China will grow about 50 percent

Light-duty vehicle fleet by region



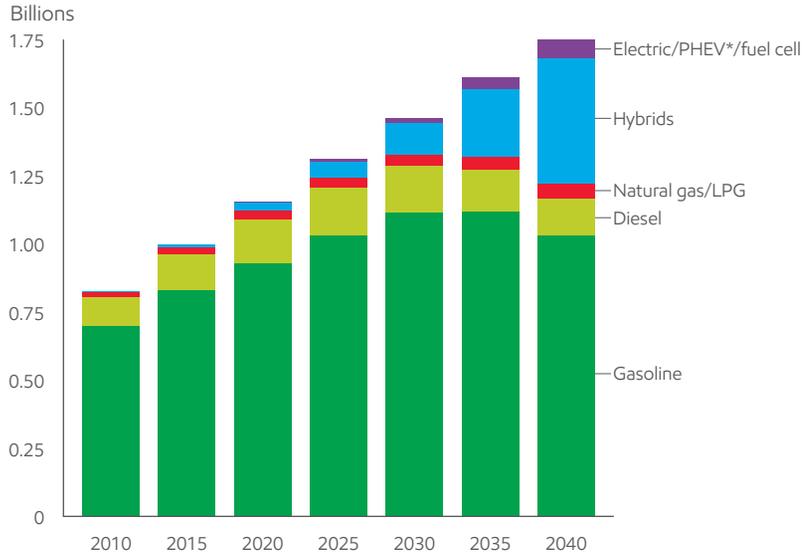
- All regions will add more light-duty vehicles through 2040
- Expanding middle class means more people can afford cars
- Growth led by China, whose fleet grows 250 percent to more than 400 million
- Around 2025, China will pass the U.S. as the nation with most LDVs

Light-duty vehicles and motorcycles



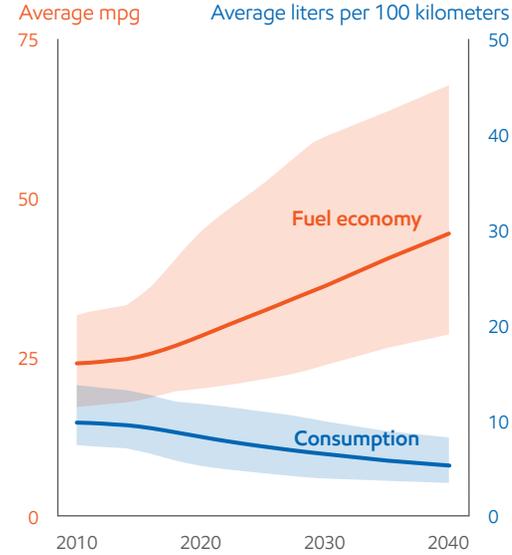
- Global LDV fleet will likely grow by 80 percent from 2014 to 2040, reaching about 1.7 billion
- Non-OECD has only about one-third of LDVs worldwide today but will likely account for about 80 percent of the increase to 2040
- Global motorcycle fleet is likely to nearly double, reaching 1 billion by 2040, led by India, China and Indonesia
- About 90 percent of motorcycles are in the non-OECD, where car penetration is relatively low and motorcycles offer an affordable alternative

Light-duty vehicle fleet by type



*Plug-in hybrid electric vehicles

Global vehicle fuel efficiency



- Hybrid vehicles become more commonplace by 2040
- By 2040, one of every four cars on the world's roads will be a hybrid
- Conventional cars (primarily gasoline-powered) will remain most popular to 2040
- Plug-in electric cars see modest gains; cost and functionality remain barriers
- Natural gas remains challenged as a fuel for most personal vehicles

- Cars and other LDVs to become more fuel-efficient through 2040
- Average fuel economy will rise from 25 mpg to about 45 mpg
- Average fuel consumption will drop by half, to about 5 liters/100 km
- On-road fuel economy varies significantly by region

Residential & commercial

Every time we turn on the lights, turn on a computer, or turn up the thermostat, we create demand in the residential and commercial sector.

Residential and commercial energy demand is the energy we consume at home and in commercial buildings – places like offices, stores, shopping centers, schools, churches and hospitals.

Even with increases in efficiency, the world will need much more of this energy to serve population growth and rising prosperity around the world. Combined residential and commercial energy demand is projected to rise by nearly 25 percent from 2014 to 2040.

More homes = more energy

A boom in households in Asia and other developing regions will likely be the largest driver of demand growth in the residential sector.

Over *The Outlook* period, the total number of households worldwide is expected to increase by almost 40 percent, with 90 percent of this growth occurring in developing countries. This growth will create new demands for energy used in the home, including heating and air conditioning, televisions and other appliances, and electricity to power computers and smartphones.

As consumers gain wealth, they typically seek new and larger homes. And they can afford to buy energy-consuming technologies that improve their standard of living. Consider that in 1990, virtually no Chinese homes had air conditioners or water heaters. Today, almost every urban home in China has a water heater and there is on average more than one air conditioner for every household.

More efficient homes

While the future will be filled with bigger cities populated with more households, many of these households will be more energy-efficient.

Were it not for projected efficiency gains, global residential energy demand growth would have been twice the current projection.

According to the Energy Information Administration (EIA), the energy intensity for a detached home in the U.S. declined by nearly 20 percent from 1980 to 2009. This decline occurred despite home size increasing by almost 25 percent. Developing countries also are making strides in residential energy efficiency. For instance, China has design standards that vary by climate zone and seek to improve insulation and window efficiency.

More diverse fuels at home

An unfortunate fact is that many parts of the world, particularly Africa and India, continue to rely on biomass fuels like wood and charcoal for their residential energy needs. Biomass accounted for nearly 40 percent of global residential energy demand in 2014.

By 2040, however, that share will likely drop to 30 percent as millions of people entering the middle class – and moving from the country to the city – gain access to modern fuels like electricity, natural gas and liquefied petroleum gas (LPG). We anticipate renewable sources like solar to play a greater role in meeting residential energy needs.

This shift is positive for people and the environment, because modern fuels like electricity and natural gas are about five times more efficient than traditional biomass fuels.

More commercial needs

We see rising prosperity and increased urbanization creating demand for more commercial buildings, and all of these buildings will require energy. By 2040, commercial energy demand is expected to increase by 40 percent. Most of this growth will occur in non-OECD countries, where commercial energy demand is expected to double, including an increase in electricity demand of more than 150 percent.

Lighting is one of the biggest consumers of energy in commercial buildings. The introduction of compact fluorescent lights –and, more recently, LED lights – has helped reduce growth in demand in this sector. Through 2040, energy savings from expanded use of LED lights should help slow the growth in energy demand due to increased commercial floor space, especially in developing countries.



An expected rise in urban living across Asia Pacific – from 45% in 2010 to 60% in 2040 – is a key driver for global residential and commercial demand.

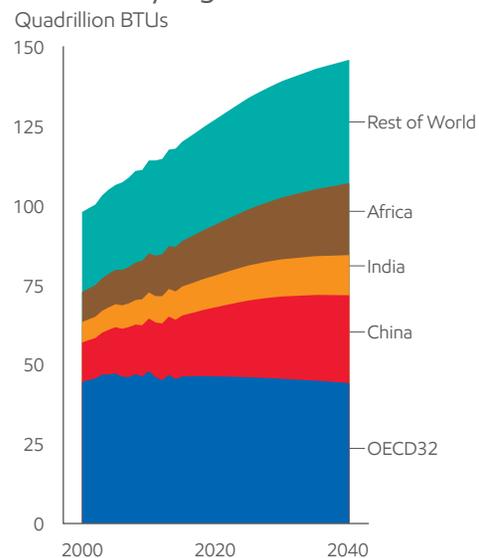
Charting the numbers

Surveys have shown that people can spend up to 90 percent of their day indoors, be it at home or work or other public spaces. Each of these indoor spaces are likely to have lighting, heat, hot water, refrigeration and electricity. Many have air conditioning. All of this energy is accounted for in the residential and commercial sector, which represents about 15 percent of global primary energy use, and half of global electricity demand.

On the residential side, population and income growth, as well as urbanization, will create many more households (800 million more from 2014 to 2040) that need energy, especially in non-OECD nations. Similar factors are at work in the commercial sector, where we see electricity becoming the dominant source of energy as living standards improve in developing nations.

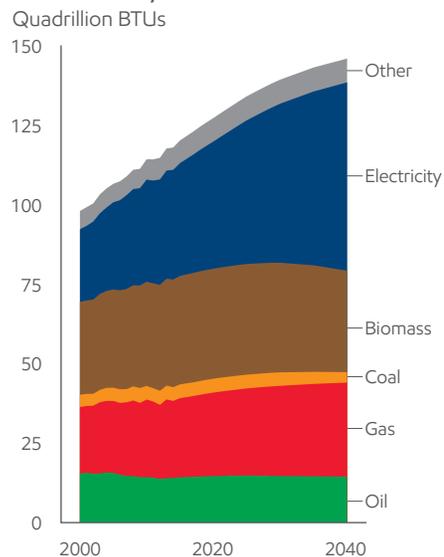
Residential & commercial – projections

Residential & commercial demand by region

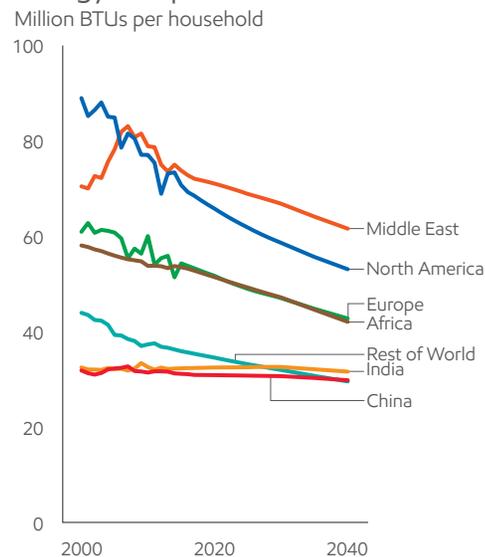


- More energy needed for light, heat, power in homes/offices
- More households, urbanization spur growth in demand
- Globally, energy demand seen rising by 25 percent 2014-2040
- Growth will come from non-OECD nations, where residential and commercial demand rises 40 percent; OECD flat
- China, Africa to see largest volume growth to 2040

Residential & commercial demand by fuel



Energy use per household



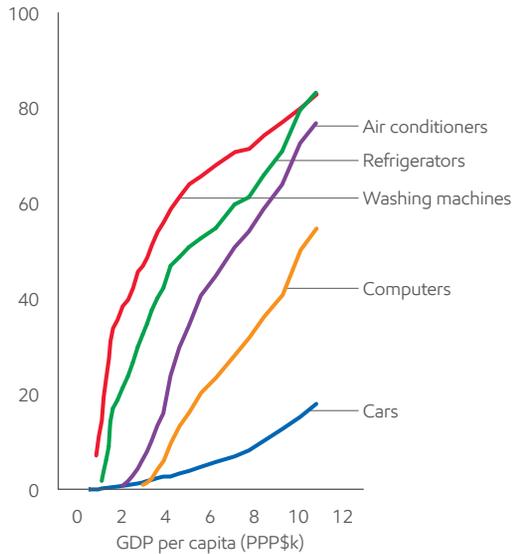
- Electricity accounts for nearly all demand growth 2014-2040
- Electricity use up 70 percent, reaches 40 percent share
- Biomass fuels decline to about 20 percent of demand by 2040
- Natural gas rises 20 percent 2014-2040 as coal declines, oil loses share
- Fuel shifts reflect rising living standards, urbanization in non-OECD

- Middle East, North America use the most energy per household
- Households in India, China among the world's lowest energy users
- Declining household energy use is tied to improved efficiency
- China intensity is relatively flat as efficiency offsets growth from more household appliances

Residential & commercial – projections

China's durable goods ownership

Average ownership per 100 households

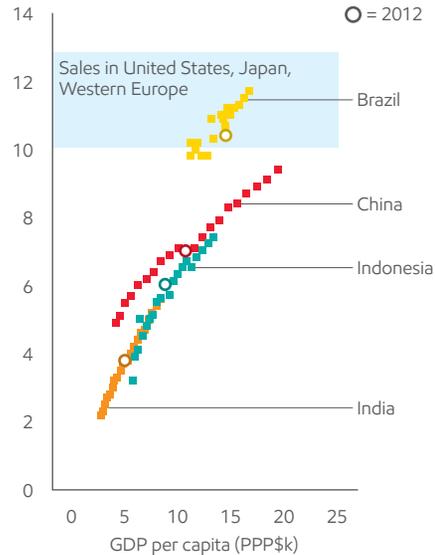


Source: China Statistical Yearbook; ExxonMobil estimates

- China data illustrate how higher incomes spur demand for durable goods
- As incomes rise, appliances and air conditioners lead list of purchases
- In 1985, 1 in 50 Chinese homes had refrigerators; 40 out of 50 today
- By 2012, washing machine and refrigerator ownership reached 8 out of 10 Chinese homes

Refrigerator sales, 2002–2022

Units per 100 households

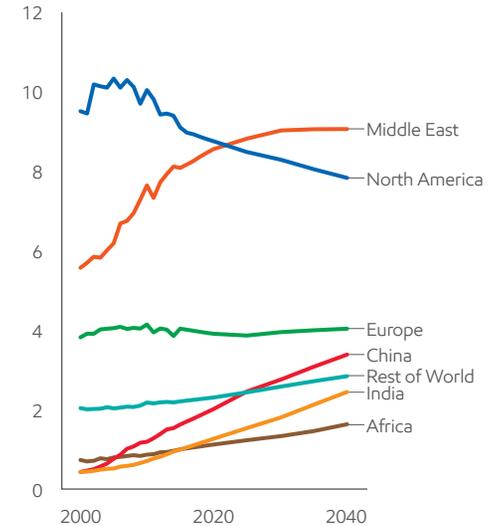


Source: Freedonia Group, Inc.; ExxonMobil estimates

- Refrigerator sales data show China on trend to reach U.S., OECD levels
- India and Indonesia have lower income level starting points than China, but follow similar paths
- High urbanization in Brazil equates to refrigerator sales resembling OECD countries

Electricity use per household

Thousand kilowatt hours per household



- Middle East to pass North America as top electricity user per household
- Air conditioning is a major driver of electricity used in the home
- North America demand to fall 15 percent 2014–2040; Europe stays flat
- China continues to see strong growth in household electricity
- India and Africa also see growth in home electricity use

China and Africa: a closer look

From 2014 through 2040, we expect China and Africa to lead the world in gains in residential and commercial energy demand; each will account for about 30 percent of global growth in this sector. But while the increases are similar, the reasons behind them are very different, and illustrate how many factors can influence demand in the residential and commercial sector.

In China, key drivers are income growth and urbanization. By 2040, China's GDP per capita is expected to exceed \$40,000 per year – similar to OECD32 levels today.

In the residential subsector, urbanization and rising incomes encourage people to start new, less crowded households with more amenities that require energy and electricity. By 2040, almost 75 percent of China's residents are expected to live in cities. As that occurs, China's total number of households is expected to grow by 30 percent to 2040 even as its population grows by less than 5 percent. By 2040, the average household in China is anticipated to have just over two residents.

While we see residential energy demand in China rising by 25 percent from 2014 to 2040, even faster growth is expected in China's commercial subsector, where we see energy use nearly tripling to meet demand for retail, medical, educational and other services tied to personal income levels.

In Africa, on the other hand, we see the main driver as population growth. We anticipate that the vast majority of gains in residential and commercial energy demand in Africa to 2040 will come from the residential subsector, where the number of households is expected to double to nearly 500 million.

Africa's population is projected to grow by 75 percent. By 2040, the continent of Africa will have surpassed both China and India, and have a total population of nearly 2 billion. Nearly 50 percent of Africa residents are expected to live in cities, about the same rate as China today. But at a projected \$6,500 per year, Africa's GDP per capita will be one-sixth the level of China in 2040, which is one reason why its household size will continue to be relatively high, with more than four people per household in 2040.

Urbanization and income trends also help explain the difference between China and Africa in terms of the fuels used in homes and businesses. In general, China's higher incomes allow it to rely more on electricity and less on biomass used directly in homes. And electricity is essential for commercial buildings such as schools and hospitals. We expect electricity to account for most of the growth in China's residential and commercial demand through 2040, but only 30 percent of Africa's.

Industrial

Toyota, GE, Samsung, Bayer... and thousands more. The industrial sector represents the companies that manufacture the wide array of goods that characterize modern life.

Industry makes steel, cement and asphalt for our cities. It makes the appliances, vehicles and electronics that serve people and their families, and the agricultural products that safely feed a growing population. The industrial sector also includes companies that produce energy, such as ExxonMobil.

Given the scale of global industry, it is no surprise that the industrial sector is the largest direct user of energy. Globally, industrial activity accounts for 30 percent of primary energy demand and 50 percent of electricity demand.

And given the growth in urbanization and the global middle class in the coming decades, it also is not surprising that industrial energy demand is expected to grow significantly. **Industrial energy usage is projected to rise by about 30 percent from 2014 to 2040. Most of this growth will come from two subsectors: heavy industry and chemicals.**

China manufacturing shifts focus

China has dominated the industrial sector since around 2000, when it began to rapidly expand its economy and build out its infrastructure, particularly in its coastal cities. From the 1970s to 2000, global industrial energy demand grew at about 1.6 percent a year; but from 2000-2014 it accelerated to an average of 2.3 percent a year, with more than half that growth coming from China.

Over the past decade China accounted for about half the world's steel and cement production. These two industries are among the most energy-intensive. The majority of this steel and cement was used domestically to build roads, bridges, apartment buildings and factories as China's urban population expanded and its middle class grew. In fact, from 2000 to 2014, 70 percent of the growth in China's end-use energy demand was attributed to industrial activity.

China's economy continues to grow at a relatively strong rate, about 2.5 times that of the OECD³². However, **China's economy is maturing and energy demand from its industrial sector is expected to peak around 2030.**

Over *The Outlook* period, we expect gains in industrial demand to be led by India and the Key Growth countries – especially Brazil, Indonesia and Saudi Arabia. We forecast global industrial growth averaging 1 percent a year from 2014 to 2040, with two-thirds of the growth occurring before 2025.



Making more with less energy, cleaner fuels

Just as today's new cars and homes are more energy-efficient than ones from previous generations, industries continue to "make more with less" through new technologies and processes. For example, the World Steel Association estimates it takes about 60 percent less energy to produce a tonne of crude steel today than it did in 1960. According to the International Energy Agency (IEA), the energy intensity for producing cement will improve by 0.5 percent per year as optimization and modified production processes continue to be more widely adopted.

Industrial efficiency has improved in all regions. But the most dramatic change has been in China; the energy intensity of its industrial sector has improved markedly over the past 20 years.

From 2014 to 2040, India and the Key Growth countries are expected to account for over half the growth in industrial energy demand.

The energy and emissions saved through efficiency is positive for the environment, as is the fact that the mix of fuels used by industry continues to grow less carbon-intense.

Consider the trends underway in heavy industry, a category that includes iron, steel, cement, aluminum and general manufacturing. Through 2040, heavy industries are likely to derive a greater share of their energy from natural gas and electricity, and less from oil and coal. Coal, which accounted for over 35 percent of global heavy industry energy demand in 2014, will have dropped to around 25 percent by 2040. In China, the world's largest user of coal, heavy industry will get about 45 percent of its energy from coal in 2040, down from more than 60 percent in 2014.

The versatility and ease of use that natural gas provides are expected to help gas increase its share of heavy industry demand from 15 percent today to over 20 percent by 2040. Using electricity to power motors, control systems and robotics has the dual benefit of improving efficiency while also increasing productivity through modern manufacturing methods, especially in the many non-OECD countries that today rely on coal.

Chemicals and the middle class

Chemicals are a part of modern life. They are the building blocks for plastics, which are found in nearly every consumer product. For example, today's new cars are about 50 percent plastic by volume. Plastics also are used in packaging, electronics, building materials and medical supplies.

Energy demand in the chemical sector is expected to rise by about 50 percent from 2014 to 2040, driven by rising living standards in developing economies.

Most of this increase is expected to occur in China, India and the Key Growth countries. The United States also is likely to see demand growth as its chemical industry expands to capture the benefit of rising shale gas and tight oil production. This benefit is twofold, since chemical producers use oil and natural gas in two ways: as a fuel, and also as a feedstock.

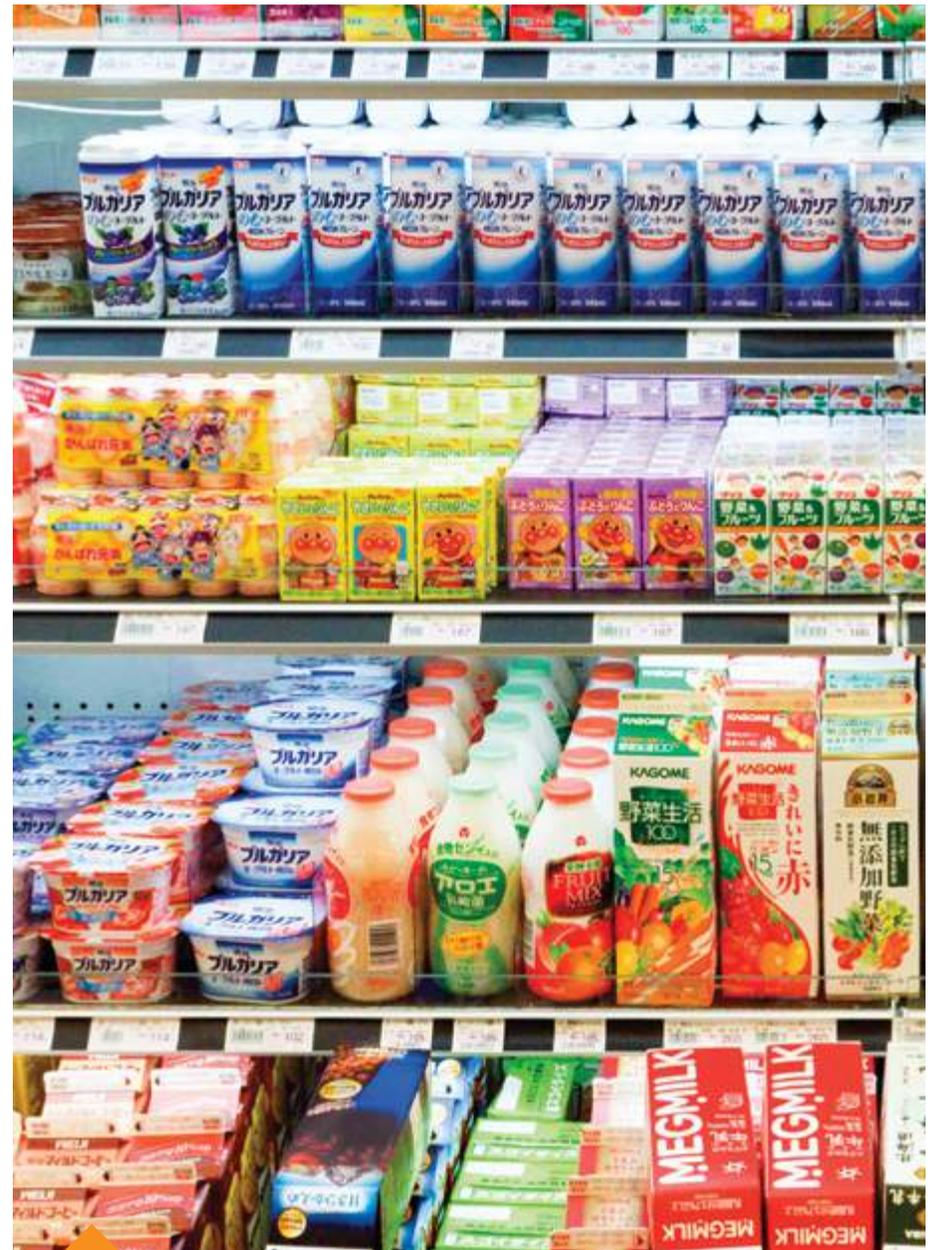


“ Plastic insulation materials consume approximately 16% less energy and emit 9% less GHG than alternative materials. Across their whole life cycle, plastic insulation boards save 150 times the energy used for their manufacture. ”

– *PlasticsEurope*

Globally, about 60 percent of the energy in the chemical sector is used as feedstock. Naphtha, an oil derivative, had been the world's primary feedstock for decades, and still accounts for about 55 percent of the market. But relatively strong growth in natural gas production is helping to shift the global feedstock mix toward ethane and other natural gas liquids (NGLs).

NGLs account for more than 40 percent of chemical feedstock today, and by 2040 they are expected to be nearly equal with naphtha on a global basis. Regional differences will remain, however; North America and the Middle East will continue to rely on natural gas liquids for chemical feedstock, while Asia Pacific will continue to use mostly naphtha.



Naphtha has been the main feedstock in Asia Pacific for decades, used to create plastics and inks for food containers and labels as well as many other products.

Charting the numbers

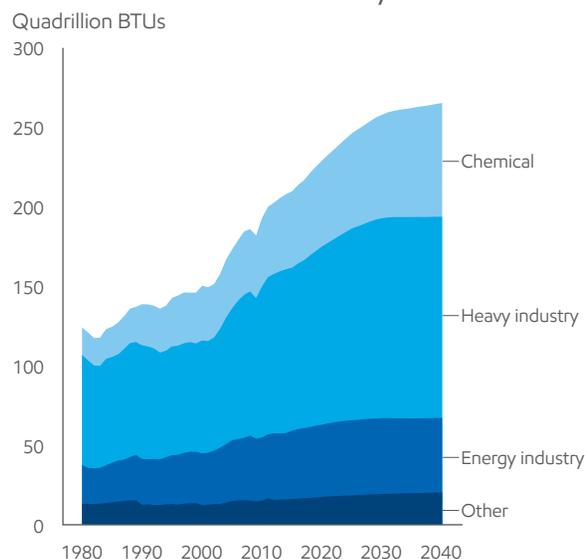
When we look at industrial energy trends, we still start with China. Over the past 15 years, China saw astounding growth in its economy and infrastructure, and became the world's largest industrial energy user. Because of what was happening in China during that time, the rate of global industrial energy demand growth was about 50 percent higher than historical averages.

Today we see China's economy maturing, and its industrial energy demand peaking around 2030. Afterward, global industrial demand will grow at a more modest pace, and leadership is expected to shift to India.

One thing that has not changed: chemicals production is the fastest-growing source of industrial energy usage. Demand for plastics and other chemical products remains strong. Also, more than half the energy that goes into the chemical sector is used not as fuel, but as feedstock, and thus is not impacted by the gains in efficiency that are curbing demand elsewhere.

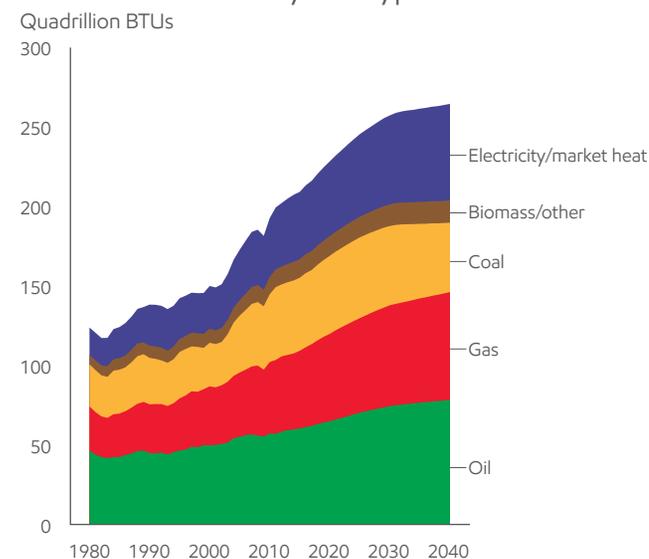
Industrial – projections

Global industrial demand by sector



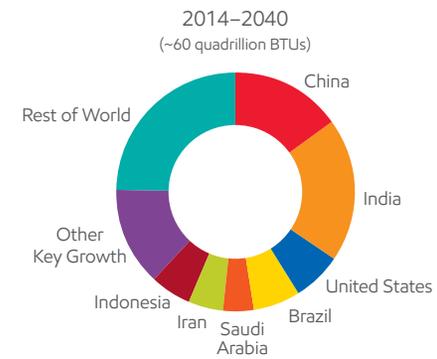
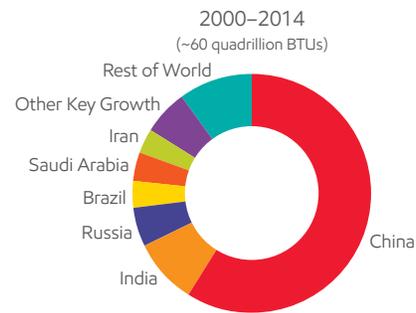
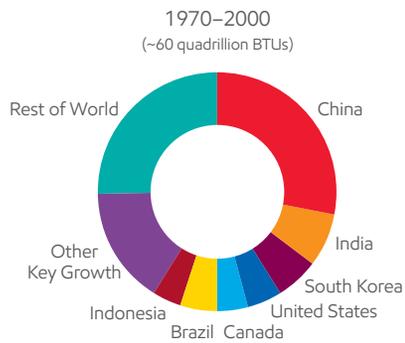
- Industrial activity expands to serve non-OECD growth
- Growth tapers post-2025 as China's economy shifts focus
- Global industrial energy usage to rise by 30 percent 2014-2040
- Heavy industry (steel, cement, etc.) grows 25 percent; chemicals 50 percent
- Energy-industry demand will mirror trends in fossil fuels production

Industrial demand by fuel type



- Industries use a variety of fuels for their energy needs
- Industrial fuel mix will shift toward lower-carbon sources
- Coal's fuel share drops from over 20 percent to about 15 percent 2014-2040
- Natural gas, electricity each rise to about a 25 percent share by 2040
- Oil remains flat as a fuel, but its use as a chemical feedstock grows

Industrial demand growth

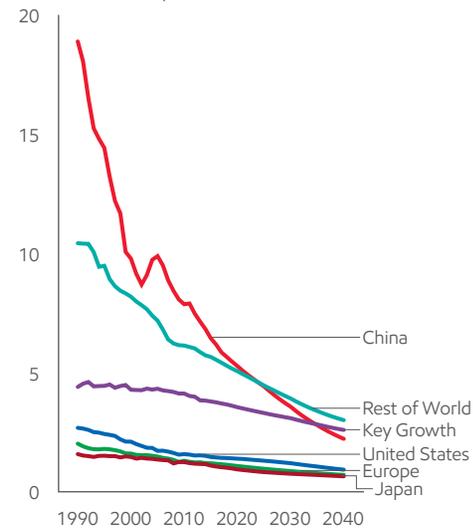


- Trends in industrial energy demand continue to be shaped by China
- As China's industry boomed 2000–2014, global demand rose 2.3 percent a year
- China accounted for more than half the growth in demand 2000–2014
- Global demand seen averaging 1 percent a year 2014–2040 as China moderates
- Post-2014 rise in industrial demand will be led by India; U.S. re-emerges

Industrial – projections

Industrial energy intensity

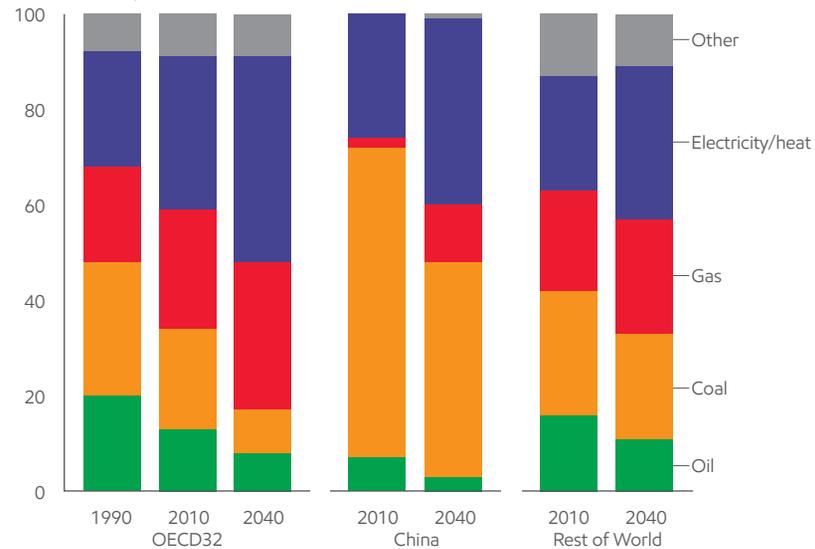
Thousand BTUs per dollar of GDP (2010\$)



- Industries in all regions continue to grow less energy-intensive
- “Intensity” measures amount of energy to produce \$1 of GDP
- Japan has had the least energy-intensive industry for decades
- China makes big strides as it modernizes technologies, processes
- OECD industries continue to improve industrial energy efficiency

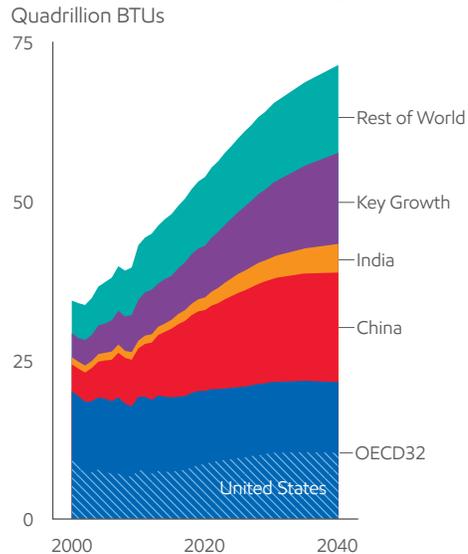
Heavy industry fuel mix transition

Fuel share in percent



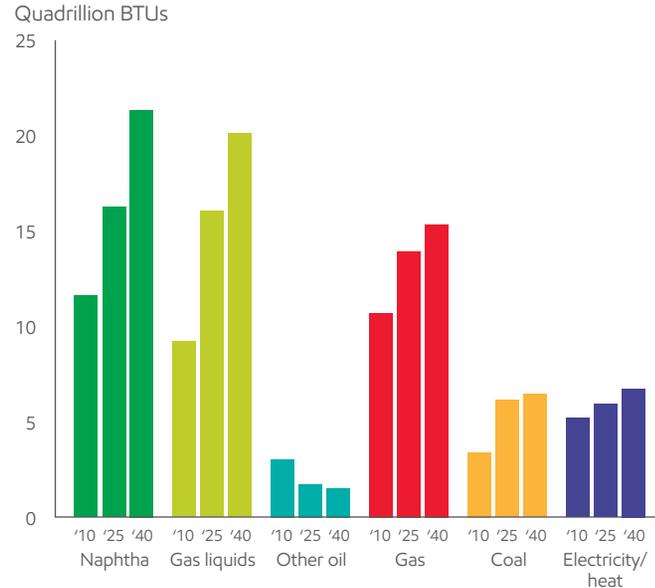
- OECD32 leads the shift away from coal and oil as fuels for industry
- By 2040, gas/electricity are 75 percent of OECD32; coal drops to under 10 percent
- China’s industries use 45 percent coal in 2040, down from 60 percent in 2014
- Natural gas emerges as an industrial fuel in China; 10 percent by 2040
- Electricity sees strong demand as global industry modernizes

Chemical demand by region



- Chemicals is one of the fastest-growing energy-demand sectors
- Rising prosperity spurs demand for plastics, other chemical products
- Energy demand in the chemicals sector to rise 50 percent 2014-2040
- Gains led by China, India, Saudi Arabia, other Key Growth
- U.S. chemicals expand due to access to low-cost NGL feedstocks

Chemical demand by fuel type



- Chemical sector uses oil and gas two ways: as fuel and as feedstock
- Use of naphtha, an oil-based feedstock, to grow by 70 percent to 2040
- Gas liquids (NGLs) rise 90 percent, as shale gas helps expand supplies
- By 2040, NGLs and naphtha roughly even as chemical feedstocks
- China uses coal as fuel, and as an alternative chemical feedstock

Electricity generation

Thomas Edison probably could not have envisioned all the ways people would use electricity in the 21st century.

Electricity powers the factories that make the world's goods. It provides light, heat and air conditioning for homes and commercial buildings. And electricity runs the Internet and everything that connects to it.

Today, power generation accounts for more than 35 percent of global energy use. That percentage will continue to grow as technology evolves, and more people in developing nations gain access to electricity. **Global demand for electricity is expected to rise by 65 percent from 2014 to 2040.**



85%

of electricity demand growth will come from developing nations.



Electricity demand driven by non-OECD growth

The need for electricity is rising in all parts of the world, but growth is being led by non-OECD countries, many of which are entering (or already have entered) a period much like what the OECD experienced in the 20th century – modern fuels are replacing traditional ones, people are moving from rural settings to modern cities with the latest technologies, and more people are gaining access to electricity.

About half of global electricity usage comes from the industrial sector, driven in part by the spread of advanced manufacturing and processing. The other half comes from residential and commercial buildings. While electric cars are available, even by 2040 we expect that only about 2 percent of global electricity demand will come from the transportation sector.



Natural gas expected to pull even with coal in electricity generation

Electricity is a secondary form of energy, meaning it must be generated through the use of some other energy source. Today, on a global basis, the fuels used to generate electricity are (in order): coal, natural gas, hydroelectric power, nuclear and modern renewables like wind and solar. But much variation exists among nations and regions. For example, China gets about 70 percent of its electricity from coal, while Europe about 25 percent.

Each nation and region will continue to choose the mix of fuels that best suits its needs. These decisions will be based on a host of factors, including: energy security, the cost and availability of fuels, air quality and emissions. **Many regions will seek to lower their carbon emissions, often by switching from coal to gas. By 2040, we expect the share of electricity generated by natural gas to rise to about 30 percent and be about even with coal-fired generation.** We also anticipate coal to remain important in some areas, especially where gas is not readily available and bottom-line economics are most important. For example, the amount of electricity generated from coal in India is seen rising 150 percent from 2014 to 2040.

The world's continued reliance on coal for power generation will keep up pressure to reduce power sector emissions. As nations look for ways to curb emissions, particularly from coal, some are considering capturing CO₂ and storing it underground; however, carbon-capture-and-storage technologies continue to face substantial economic and practical hurdles that will likely limit their deployment.

Nuclear, wind, solar also grow

The amount of electricity from nuclear power is expected to more than double from 2014 to 2040. Much of this growth is projected to come from China, which is expanding nuclear to reduce its reliance on coal.

We also expect wind and solar to see strong growth, aided by policies that favor or mandate their use. We see wind and solar accounting for more than 10 percent of global electricity generation in 2040, up from 4 percent in 2014. It is important to remember that these are global averages – the use of wind and solar will vary widely by region.

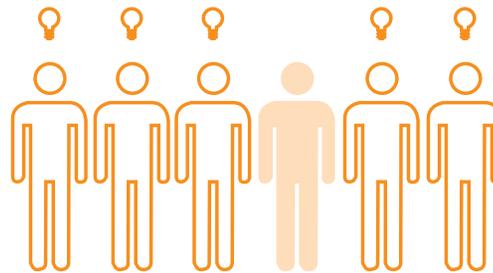
While wind and solar energy may seem free, significant investment is required to build the facilities that turn this energy into electricity. Moreover, **because wind and solar energy are intermittent, these facilities use only a fraction of their capacity and must be backed up by other sources – typically gas – to ensure a reliable flow of electricity.** Although battery costs have fallen considerably, they remain too expensive to be considered with renewables as a replacement for reliable baseload generation.

Nations choose different paths on emissions

The generation of electricity is the world's single largest source of CO₂ emissions, so it's not surprising that nations are looking for ways to curb emissions in this sector. While many options are available, the best are usually the ones that deliver the most emissions-savings at the lowest cost to consumers.

We believe that in some countries, such as the United States, the best option right now is natural gas. The U.S. EIA found that of the 1.6 billion metric tonnes of CO₂ emissions avoided in the U.S. power sector from 2005 to 2013, more than 60 percent came from substituting natural gas for coal and petroleum, while less than 40 percent came from growth in non-carbon generation, particularly renewables such as wind and solar.

The idea that natural gas, a fossil fuel, would be a powerful tool for reducing emissions might seem counterintuitive, but reliable gas avoids the intermittency issue and emits up to 60 percent less CO₂ than coal when used for power generation.



17%

While economic growth continues to widen the gap globally, about 1 in 6 people still live without any electricity, based on IEA data.

In the United States, utilities and other power generators increased their use of natural gas over the past decade as they took advantage of the rapid growth in domestic unconventional gas production. During this period, the attractive economics of gas-fired power generation encouraged U.S. power generators to substitute natural gas for coal, and this fuel-switching helped produce a 15 percent drop in CO₂ emissions from the power sector.

Other nations have taken a more top-down approach – favoring certain technologies over others – to change the mix of fuels used to generate electricity. For instance, Germany has implemented strong policy measures to increase use of renewables, while also phasing out nuclear power.

Both the U.S. and Germany have seen a drop in emissions. **Based on government data, by 2012, the CO₂ intensity of delivered electricity in the U.S. was lower than that of Germany** because the U.S. saw an improvement about three and a half times that of Germany between 2005 and 2012. While these transitions were occurring, electricity costs have risen much faster in Germany than the U.S. over the past decade.



Electricity generated using natural gas avoids intermittency issues and emits up to 60 percent less CO₂ than coal.

Charting the numbers

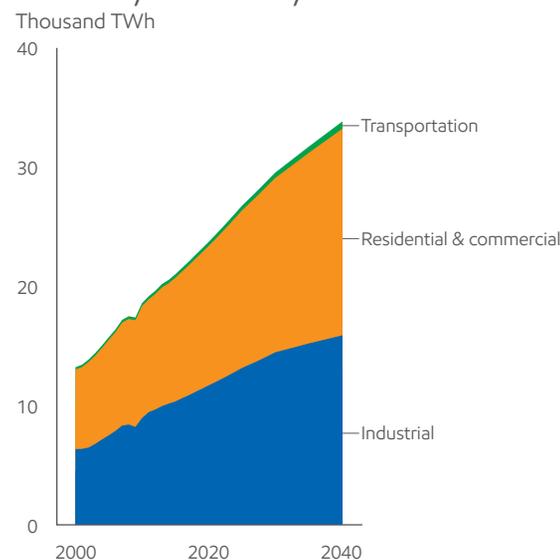
Of all the energy-demand sectors we study when preparing *The Outlook*, power generation is perhaps the most dynamic and complex. It is the fastest-growing sector, driven by strong global demand for electricity. It uses the broadest array of fuels: coal, gas, nuclear, wind, solar and hydroelectric. It is also the sector most impacted by policies seeking to address climate change.

The most striking development in power generation is expected to be the shift away from coal – the dominant energy source in this sector – and the rise in cleaner fuels such as natural gas and renewables.

But as our charts show, trends are likely to vary widely by region. Each nation will choose a different mix of fuels for making electricity, and different paths to reducing CO₂ and other GHGs associated with power generation.

Electricity generation – projections

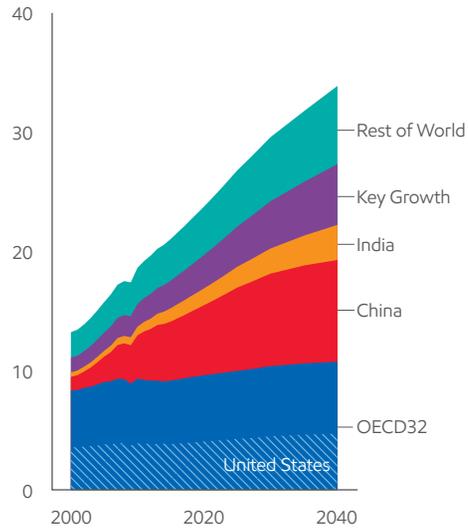
Electricity demand by sector



- Global electricity demand seen rising by 65 percent 2014-2040; 2.5 times faster than overall energy demand
- Residential and commercial electricity demand rises by 70 percent 2014-2040; industry up 55 percent
- Industrial growth eases post-2030 as China's economy shifts from manufacturing
- Transportation electricity demand doubles 2014-2040, but only 2 percent of total use

Electricity demand by region

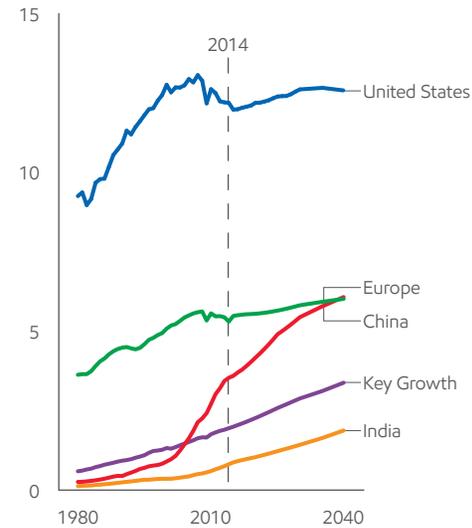
Thousand TWh



- 85 percent of the rise in electricity demand will come from non-OECD
- China leads growth; will use one-fourth of the world's electricity by 2040
- India's electricity usage to soar, rising 185 percent 2014-2040
- Brazil, Indonesia have largest gains among Key Growth countries
- U.S. share of global electricity demand falls from 20 percent to 15 percent 2014-2040

Per capita electricity demand by region

MWh per person

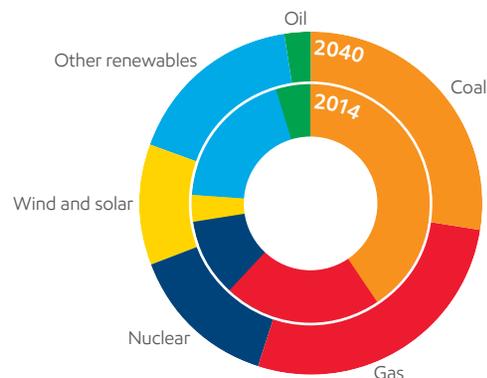


- U.S. leads per capita electricity use, driven by air conditioning and larger homes
- China's per capita electricity use is seen climbing 70 percent 2014-2040
- By 2040, China will use as much electricity per person as Europe
- India, Key Growth also climb as incomes, urbanization and industry expand

Electricity generation – projections

Share of global electricity generation

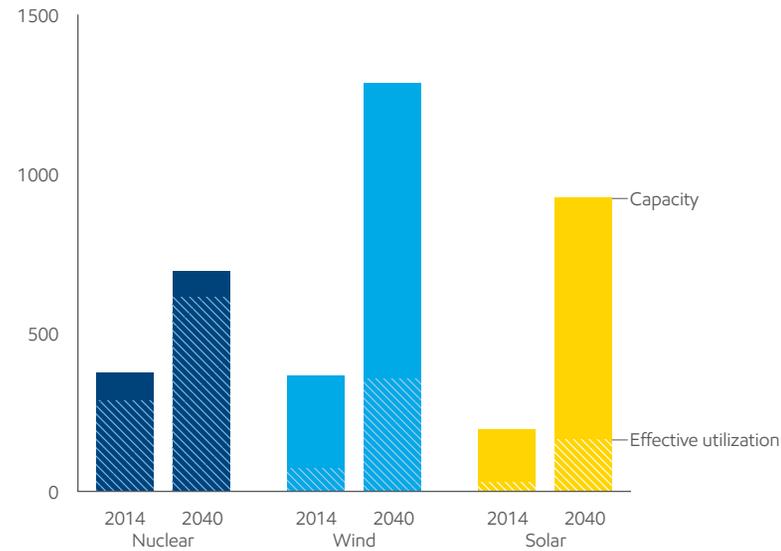
Share of TWh



- World shifting to cleaner fuels for electricity generation, led by gas
- Coal's share to shrink while natural gas, nuclear, wind, solar gain
- Coal provides about 30 percent of world's electricity in 2040, vs. 40 percent in 2014
- Wind, solar provide more than 10 percent of electricity by 2040, vs. 4 percent in 2014
- Shift to cleaner fuels driven by tighter CO₂ emissions and air quality policies

Global capacity

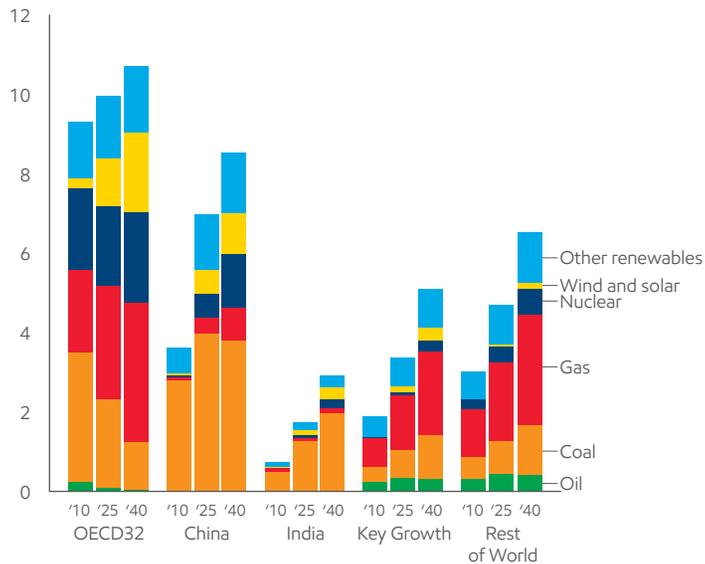
GW



- Global nuclear, wind, solar all see big capacity additions
- Nuclear capacity to grow by 85 percent 2014-2040, led by China
- Intermittency limits the utilization of wind, solar capacity
- Globally, less than 30 percent of wind capacity is utilized; solar less than 20 percent
- Wind, solar provide less electricity in 2040 than nuclear despite 3 times the capacity

Electricity generation by region

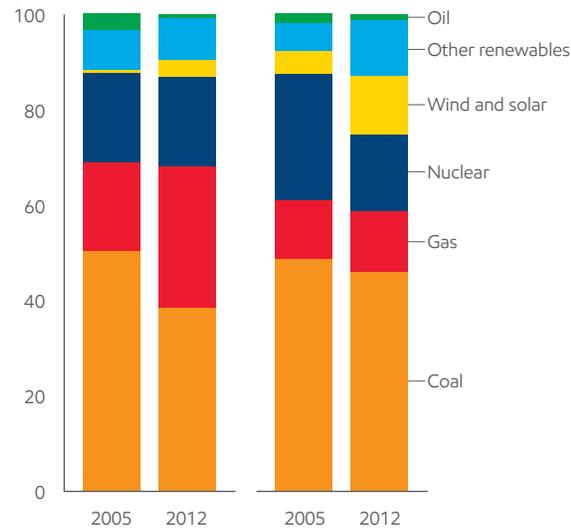
Thousand TWh



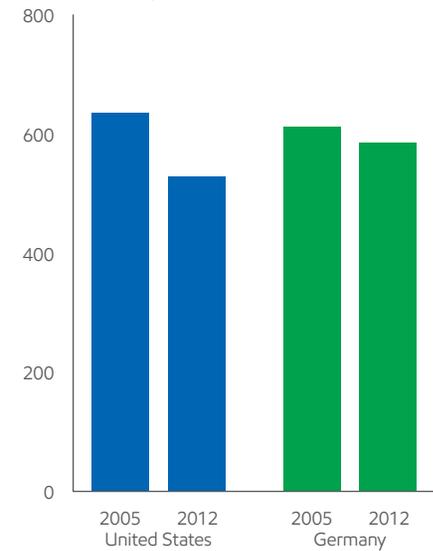
Two paths to CO₂ reduction

U.S. generation share, percent

Germany generation share, percent



CO₂ intensity of consumed electricity, grams of CO₂ per kilowatt hour delivered



Source: EIA, UBA

- Mix of electricity generation sources will vary significantly by region
- OECD32 to lead the shift from coal; sees big gains in gas, wind, solar
- China looks to nuclear, renewables, gas to meet electricity growth
- India's coal-fired electricity use more than doubles 2014-2040
- Key Growth and Rest of World draw on gas when domestically available

- The U.S. and Germany illustrate how different options are available to reduce CO₂ emissions from power generation
- The U.S. saw a shift to natural gas, much smaller growth in wind, solar
- Germany targeted rising use of wind, solar, while phasing out nuclear power
- Both nations' power sectors cut CO₂ intensity, but the U.S. dropped about 3.5 times as much
- U.S. power-related CO₂ emissions fell 15 percent 2005-2012, while Germany's fell less than 5 percent

Lowering emissions

Energy and human progress are closely linked, with expanding access to reliable, affordable and cleaner fuels helping power substantial gains in living standards over the past two centuries.

Today, as always, a key element of continuing to advance human progress is managing the environmental impact of that progress.

In coming decades, although populations and living standards will rise significantly, ongoing improvements to energy efficiency – and increasing efforts to use lower-carbon fuels wherever practical – will slow the growth in energy-related CO₂ emissions. In our view, global CO₂ emissions are likely to peak around 2030, and then begin declining.



Emissions

As people and nations look for ways to reduce risks of global climate change, they will continue to need practical solutions that do not jeopardize the affordability or reliability of the energy they need.

The 2015 United Nations Climate Change Conference in Paris highlighted this important issue.

Many nations are already reducing their level of CO₂ emissions relative to their GDP. **By 2040, the carbon-intensity of the global economy is likely to fall by half**, with substantial contributions from OECD and non-OECD nations alike. Energy efficiency gains are expected to be a major contributor to this achievement, supported by a gradual but significant transition to less-carbon-intensive energy types.

As a result of these changes, **we expect global energy-related CO₂ emissions to peak around 2030, and then begin declining**. Global CO₂ emissions are expected to be only about 10 percent higher in 2040 versus 2014, despite the fact that population will have risen by about 25 percent and global GDP will have more than doubled.

OECD leads transition in emissions

For purposes of *The Outlook*, we continue to assume that governments will enact policies that impose rising costs on energy-related CO₂ emissions, reaching an implied cost in OECD nations of about \$80 per tonne in 2040. China and other leading non-OECD nations are expected to trail OECD policy initiatives.

Energy-related CO₂ emissions already are falling in OECD nations, where efficiency and cleaner fuels are more than offsetting the rate of economic growth. **Emissions in the OECD are projected to fall by about 20 percent from 2014 to 2040**, with the OECD's share of global emissions falling from less than 40 percent to less than 30 percent. Europe will likely remain the least carbon-intensive economy of any major region.

In the non-OECD however, CO₂ emissions are expected to rise one-third by 2040. China's emissions are likely to peak by 2030, and then decline by 10 percent to 2040, when its share of global emissions will be about 25 percent, more than double that of the United States or India. Emissions will continue to rise in India and other developing countries through 2040, but around 2030, the downward trends in the OECD and China are expected to more than offset those increases.

By 2040, the carbon intensity of the global economy is likely to fall by

1/2.

Options for addressing long-term climate change risks

Progress on energy and climate objectives requires practical approaches that will contribute to both. Practical solutions will be not only reliable and affordable, but also provide economic value. In this regard, nations and consumers will want to target their limited financial resources to get the best value on energy-related purchases while also minimizing the cost of GHG emissions reduction.

We expect that in most nations, the biggest value will not be found via subsidies or mandates of high-cost alternative technologies, but rather through open-market competition among a wide range of practical, lower-carbon options. To that end, the U.S. Congressional Budget Office suggested years ago that putting a transparent and reliable price on CO₂ emissions would be society's most cost-effective approach to reduce emissions.

Under a cost-of-carbon approach, the incentives for reducing GHG emissions – as well as the most cost-effective solutions – would become readily apparent. For example, in the United States it is clear that improving the fuel efficiency of conventional gasoline vehicles will reduce more emissions – at a lower cost – than expanding the use of expensive electric vehicles. Also, in the power generation sector, substituting natural gas for coal is a far more cost-effective option for curbing emissions than building new wind or solar facilities for electricity generation. By focusing on market-based solutions, governments can avoid requiring consumers and taxpayers to pay for high-cost solutions when better options abound.

“Hydrofracking has certainly changed the energy dynamic considerably. You are absolutely right, it has created an opportunity for a shift away from coal into natural gas, and that shift has been enormously beneficial from a clean air perspective, as well as from a climate perspective.”

– U.S. Environmental Protection Agency Administrator Gina McCarthy



Need for flexibility, transparency

The challenge of meeting global energy needs and managing the risks of climate change is real – and daunting. But it is not the only challenge. In fact, the United Nations recently adopted a set of 17 Sustainable Development Goals, with action on climate of course representing one of these goals. Other goals include improving conditions for people in all countries related to poverty, health, education, clean water and sanitation, economic opportunities, and community and social development.

Since every society and every person have limited resources to address their various priorities, it's no wonder that everyone wants to avoid paying more than necessary for something to meet a particular need. The logical drive to pursue the most cost-effective options helps ensure that precious financial resources are managed wisely, and not wasted on one priority to the detriment of other needs.

Because the costs are substantial, nations have a compelling reason to adopt climate policies that promote transparency and market-based solutions. The long-term nature of the climate challenge also promises an evolution of available solutions as knowledge expands, technology advances and markets adapt. Therefore, policies that promote innovation and flexibility afforded by competition and free markets will be critical to help ensure the world pursues the most cost-effective opportunities to meet people's energy needs and reduce global GHG emissions.

Charting the numbers

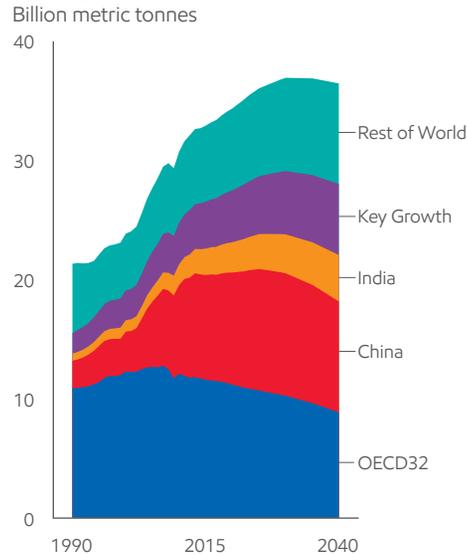
Forecasting emissions requires us to consider not just how much energy the world will consume, but also the carbon intensity of the fuels that people and businesses choose to meet their needs. We also must consider how various climate-change policies might evolve.

As shown by the chart to the right, global energy-related CO₂ emissions are expected to peak around 2030 and then decline. A host of trends contribute to this downturn, including slowing population growth, maturing economies, and a shift to cleaner fuels like natural gas and renewables (some voluntary, and some the result of policy).

But the biggest factor actually is energy efficiency, which continues to improve as technology evolves. Better efficiency – in vehicles, industries, buildings and elsewhere – enables the world to do more with less energy and therefore fewer emissions.

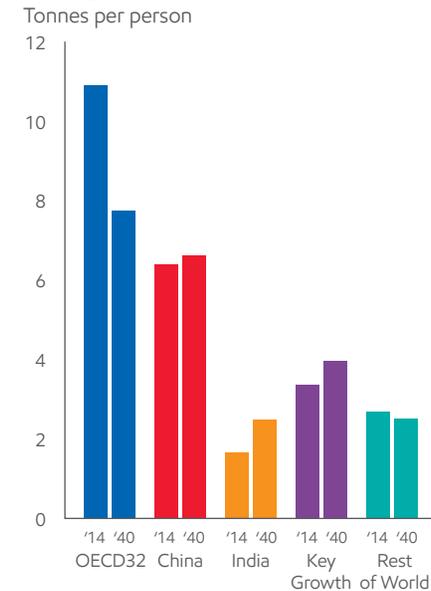
Emissions – projections

Energy-related CO₂ emissions by region



- Global CO₂ emissions to peak around 2030, then decline
- Emissions already falling in OECD32; will drop 20 percent 2014-2040
- China's surge in emissions is slowing; seen peaking around 2030
- Emissions keep rising to 2040 in India, Key Growth, Rest of World
- Efficiency, lower-carbon fuels are key factors in curbing emissions

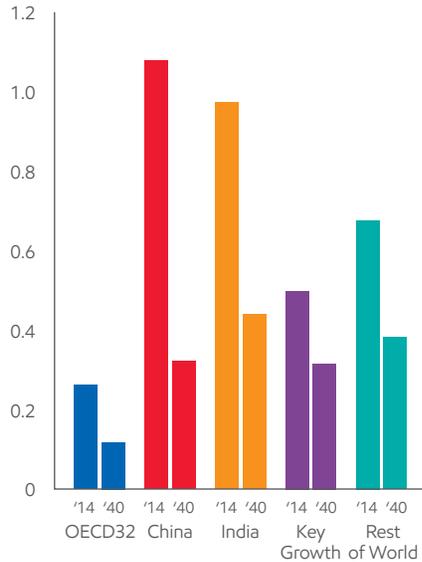
Energy-related CO₂ emissions per capita



- OECD32 has highest per capita emissions, but falls 30 percent 2014-2040
- By 2040, China's per capita CO₂ emissions will be nearing OECD32 levels
- India, Key Growth per capita emissions grow to 2040
- Global per capita emissions fall 10 percent 2014-2040 on efficiency, cleaner fuels

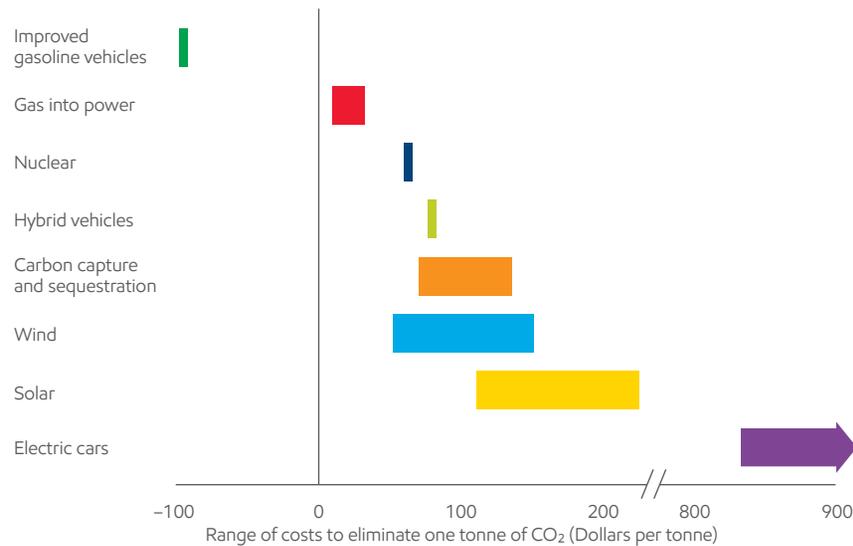
Energy-related CO₂ intensity

Tonnes per thousand dollars of GDP (2010\$)



- Economies in all regions will become less CO₂ emissions-intense through 2040
- OECD32 has the lowest CO₂ emissions relative to the size of its economy
- OECD32 economies today are about 75 percent less CO₂ emissions-intense than China's
- China's emissions intensity improves as coal use drops, economy less reliant on industry
- India's emissions intensity to improve more than 50 percent even as coal use increases

United States CO₂ abatement costs



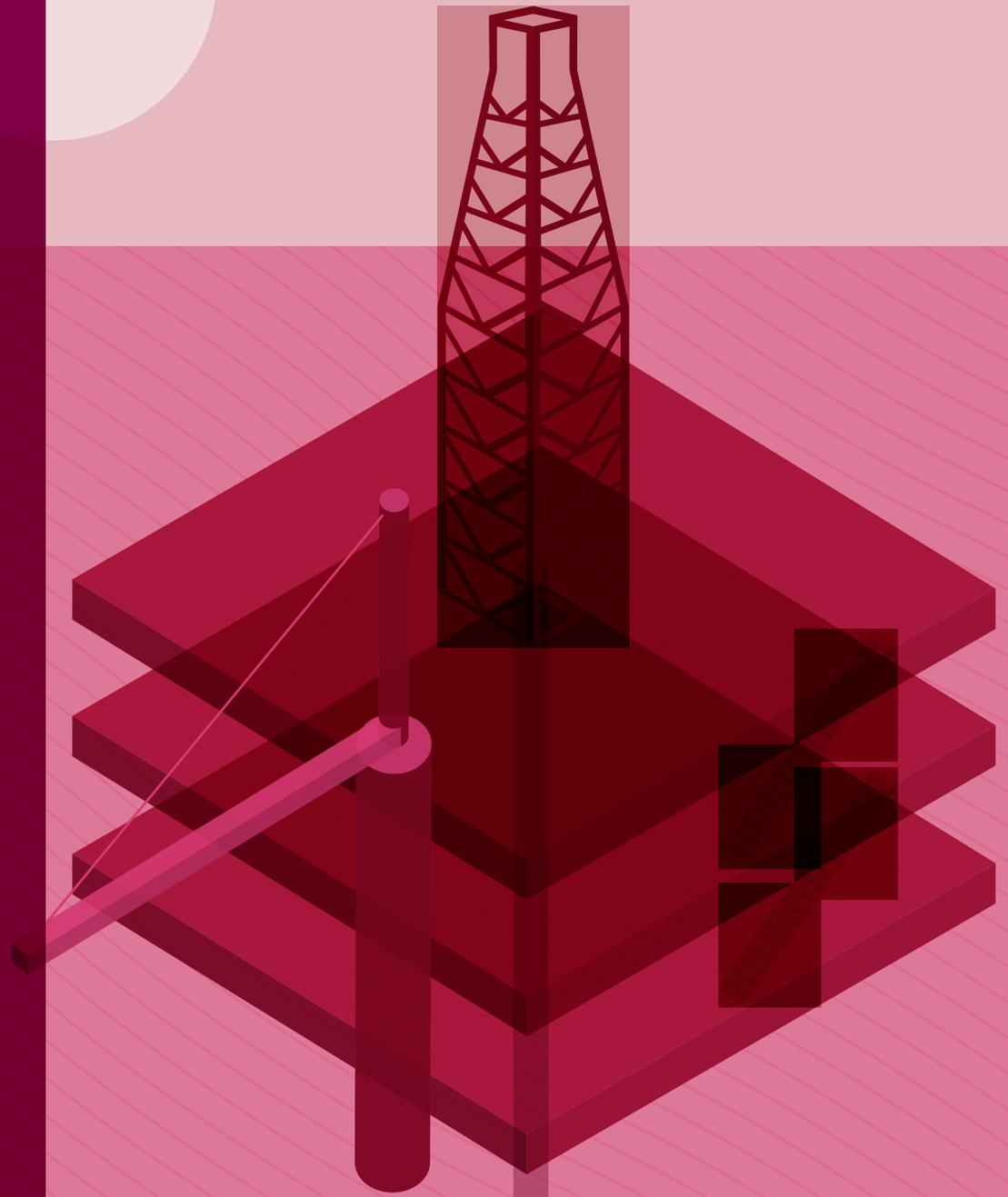
- Many options exist to reduce CO₂ emissions, each with different costs
- Best value is improving fuel economy of conventional gasoline vehicles
- Switching to natural gas (vs. coal) in power generation also offers low-cost results
- Solar energy is about double the cost of wind for curbing emissions (vs. coal) in U.S.
- Electric cars offer the worst return, costing upwards of \$800/tonne of CO₂ abated

Fulfilling future supply

Our energy choices have never been as plentiful or diverse.

Thanks to advances in energy technology, today we have access to shale gas and tight oil from North America, LNG from the Middle East, oil from deepwater fields off the African coast, and arrays of wind and solar facilities. Our growing capacity to move energy between nations – even ones on opposite sides of the world – also will expand energy choice and energy security.

All of the world's energy sources will be needed to meet rising demand to 2040, but there will be a marked shift toward cleaner fuels, particularly natural gas. Oil will remain the world's top energy source, essential for transportation and chemical production.



As a result of advances in technology, and the cumulative accomplishments of the men and women of the energy industry over decades, the world today has an abundance of supply and an unprecedented range of energy choices.

For example, until this century, energy producers had not yet figured out how to economically tap the vast amounts of oil and natural gas that were known to exist in shale and other “tight” rock formations. But by 2040, these unconventional and other technology-driven sources of oil and gas are expected to meet about one-fifth of the world’s energy needs.

All practical and economically viable energy sources, both conventional and unconventional, will be needed to continue meeting global energy needs – because the scale of this demand is tremendous.

In 2014, the global economy consumed about 550 quadrillion BTUs of energy – equivalent to using the energy in about 12 billion gallons of gasoline every single day. And demand is projected to rise by another 25 percent through 2040, as the impact of population growth and rising living standards more than offsets the energy saved through improved efficiency.

We expect that oil, natural gas and coal – the three fuels that together built the modern economy – will continue to meet almost 80 percent of the world’s energy needs through 2040. These fuels are reliable, affordable, versatile, transportable and provide a lot of energy in a relatively small volume.

However, the desire to address the risks of climate change – at both an individual and government level – is likely to produce significant changes in global energy supply as consumers shift toward energy sources that help curb CO₂ emissions.

Oil remains top fuel, gas moves to the No. 2 position ahead of coal

We expect oil to remain the world's largest energy source, essential to transportation and as a feedstock for the petrochemicals industry. Global demand for oil and other liquids is projected to rise by about 20 percent from 2014 to 2040.

Coal, currently the world's second-largest fuel, is expected to see global demand peak around 2025 and then begin to decline. This decline will be led by the industrial and power generation sectors, as businesses improve energy efficiency and switch to fuels with lower CO₂ emissions. By 2040, coal will account for 20 percent of global energy demand, down from about 25 percent in 2014.

Natural gas, on the other hand, is projected to continue to expand rapidly – surpassing coal as the world's second-largest fuel in about a decade.

We expect 40 percent of the projected growth in global energy demand from 2014 to 2040 will be met by natural gas.

Natural gas is a versatile fuel that can run everything from electricity generators to industrial kilns to residential hot-water heaters to delivery trucks. Gas is abundant and performs better than coal in terms of air quality and CO₂ emissions. Global demand for natural gas is projected to rise by 50 percent from 2014 to 2040.

Nuclear, renewables see strong growth

Nuclear energy is a mainstay of electricity generation in many countries and accounts for about 10 percent of all the world's electricity today. Because nuclear plants provide reliable electricity while emitting no CO₂, and expanding nuclear capacity enables nations to diversify their energy supplies, nuclear will see strong gains in coming decades. **We expect the demand for nuclear energy to more than double from 2014 to 2040, with China accounting for nearly half this growth.**

Modern renewable fuels – wind, solar and biofuels – also will grow rapidly. Globally, these sources will more than triple from 2014 to 2040. The largest volume growth will come from wind, which by 2040 is projected to supply about 2 percent of the world's energy and nearly 10 percent of its electricity.

Together, nuclear and renewables are likely to account for almost 40 percent of the growth in global energy demand from 2014 to 2040.

Oil, natural gas and coal are expected to provide about 80% of global energy through 2040.

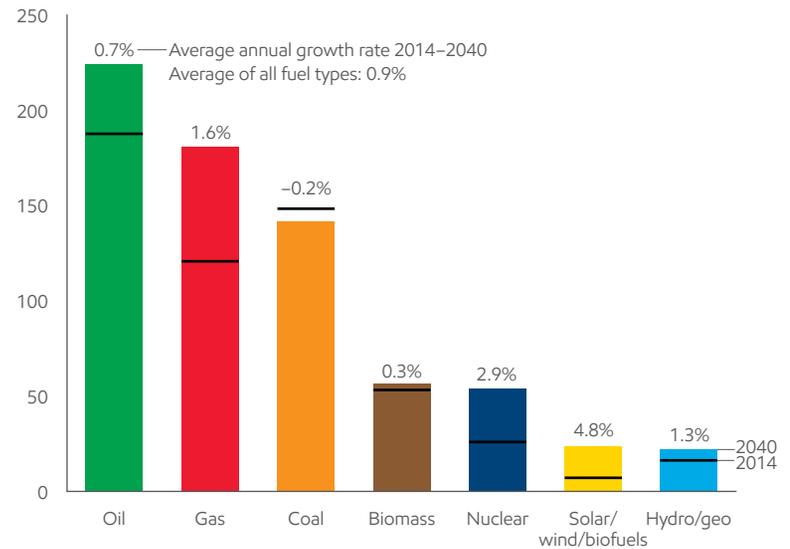
Growing global trade in energy helps consumers

In addition to expanding its energy supplies, the world also continues to enhance its ability to trade energy among regions. Much of this growth is related to the expanding global LNG network – the liquefaction plants, tankers and re-gasification terminals that enable abundant natural gas to reach markets around the world.

Through 2040, most of the world's oil and gas exports will likely be headed to the Asia Pacific region, where demand for energy is expected to grow far faster than local production. We anticipate that several regions of the world will be both importers and exporters, a fact that highlights the important role of trade in optimizing energy flows in a global marketplace.

Global fuel demand in 2040 – projections

Quadrillion BTUs



- Oil remains the world's top fuel, but natural gas grows the most
- Oil remains essential to transportation and chemicals
- Gas overtakes coal, driven by need for cleaner, reliable fuel
- Nuclear, renewables see strong growth; total more than 20 percent of supply by 2040
- All energy sources needed to meet rising demand to 2040 and beyond

Liquids

Ever since the first modern oil well was drilled in Pennsylvania more than 150 years ago, advances in technology have continued to expand the world's supply of oil and other liquid fuels.

Global liquids output is seen rising to 112 million barrels a day in 2040, up from 93 MBD in 2014, keeping pace with a projected 20 percent rise in global demand. Both non-OPEC and OPEC nations are expected to play key roles in delivering this additional supply.

While conventional oil deposits continue to account for the majority of the world's production, **we expect most of the growth through 2040 to come from technology-driven supplies including tight oil, NGLs, oil sands and deepwater production.** These supplies are projected to represent 40 percent of global liquid production by 2040, up from 25 percent in 2014.

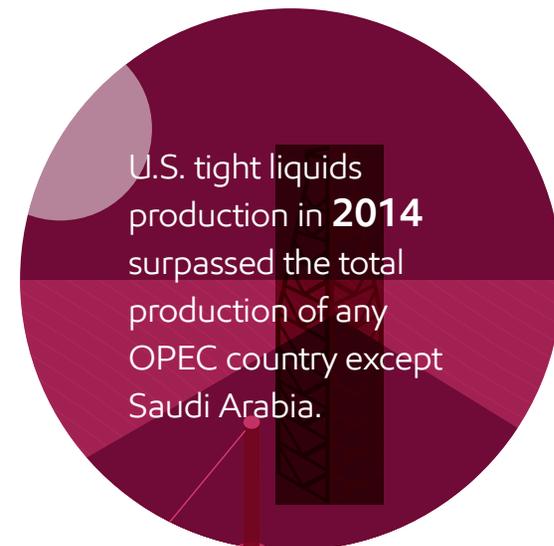
Output from developed conventional oil fields is expected to decline through 2040, but will be mostly offset by gains from the development of new conventional fields. In fact, new conventional crude and condensate development will likely represent almost 30 percent of global liquid production by 2040.

Significant growth from tight oil

Barely on the radar screen a decade ago, tight oil – oil dispersed in shale and other tight rock formations – is expected to account for 10 percent of world liquids production by 2040.

Most of this oil will come from North America, the birthplace of the tight oil industry. Around 2010, U.S. producers took the same techniques that had unlocked shale gas – horizontal drilling and hydraulic fracturing – and applied them to tight oil, with tremendous success. **In fact, U.S. crude output has risen by about 75 percent since 2010.**

The past few years have seen considerable improvements in tight oil well performance and drilling efficiency, and tight oil is now an established, globally competitive source of liquid supply. Unlike some conventional or more complex projects, tight oil production also can adjust relatively quickly to changes in demand.





Technology-driven supplies including tight oil, natural gas liquids, oil sands and deepwater production will represent 40 percent of global liquids by 2040.

Natural gas liquids, deepwater, oil sands also gain share

We expect production of NGLs to also expand significantly through 2040. Because NGLs are produced in association with natural gas, rising gas production will increase supply of NGLs, particularly in North America due to shale. NGLs will likely account for nearly 15 percent of global liquids supply in 2040, up from 10 percent in 2014.

Deepwater production is seen increasing by around 70 percent from 2014, with global output exceeding 10 MBD by 2040. Key deepwater areas include Angola, Brazil, Nigeria, and the U.S. Gulf of Mexico.

Supply from oil sands is also projected to grow. By 2040, oil sands production is expected to grow to nearly 7 MBD, which is about two and a half times higher than it was in 2014. Near-term gains will likely be led by Canada, while longer-term growth will likely be led by Venezuela.

Tight oil will account for 10 percent of the world's liquids production by 2040.

North America could emerge as an oil exporter

Not only is oil production expanding, so is the amount of oil traded between nations; about half of global liquid-fuel demand is expected to continue to be met through international trade. This is positive news for consumers. By enabling supplies to flow smoothly between nations, a robust global trading network helps meet the need for liquid fuels efficiently and affordably. Also, it is important to remember that some nations can be both importers and exporters, depending on their mix of domestic production and refining capacity.

Through 2040, there are likely to be significant shifts in the global trade balance. One of the biggest will be seen in North America, where liquids production is projected to climb by almost 40 percent through 2040 on growth in tight oil, oil sands and NGLs. **North America, which for decades had been an oil importer, is on pace to become a net exporter around 2020.** The United States should have the capacity to become a net liquids exporter around 2025.

“ Ever since Adam Smith there has been virtual unanimity among economists, whatever their ideological position on other issues, that international free trade is in the best interests of trading countries and of the world. ”

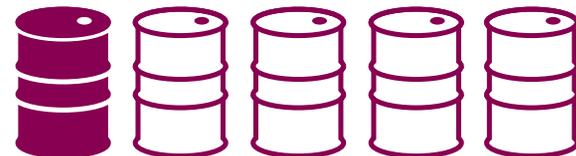
— Milton Friedman

Another major shift will be seen in Asia Pacific. Already the world's largest oil-importing region, **Asia Pacific's net imports are projected to rise by over 50 percent between 2014 and 2040** as domestic production stays flat but demand increases with rising prosperity creating new oil demand for transportation and other uses.

We expect other regions to see less drastic shifts. Europe is likely to remain the second-largest oil importing region, with imports meeting 75 percent of demand by 2040. The Middle East is expected to expand its lead as the world's largest oil-exporting region as production outpaces growth in demand. We anticipate that the Russia/Caspian region will remain the second-largest oil exporter. And in Africa, we expect liquids demand to grow significantly while supply remains relatively flat; as a result, Africa's supply and demand will be roughly balanced by 2040.

4/5

of Asia Pacific oil needs will likely be fulfilled from imports in 2040.



Scale of global energy supply is enormous

Technology is not just expanding our daily oil production; it also continues to increase the amount of oil and liquid fuels we can count on for the future.

In 1981, the U.S. Geological Survey estimated that remaining global recoverable crude and condensate resources were 1 trillion barrels; today, the IEA estimates that it is 4.5 trillion barrels – enough to meet global oil demand beyond the 21st century. By 2040, the amount of resources yet to be produced will still be far higher than total production prior to 2040, even with a 20 percent rise in global oil demand.

Delivering global energy supply is a tremendous technological challenge and one that requires investment on a grand scale. **Of the approximately \$750 billion a year of upstream oil and gas investment the IEA estimates will be required, almost 85 percent will be needed to simply keep production at current levels.** Yet the global oil and gas industry continues to demonstrate that through investment and innovation, it can keep pace with global energy needs.



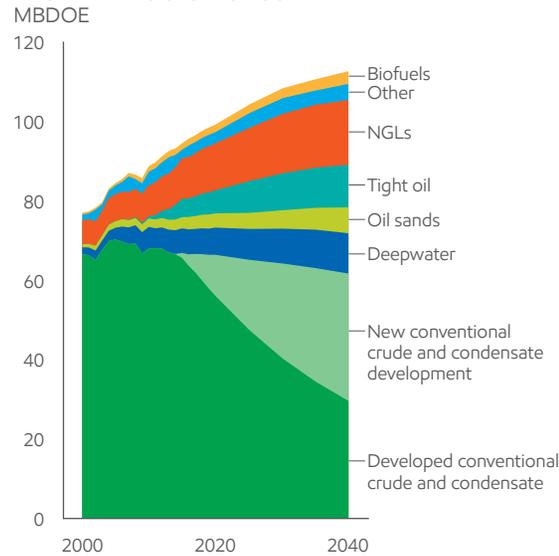
Charting the numbers

In this year's *Outlook*, we continue to see a clear trend in liquid fuels: sources driven by advances in technology – most recently oil from tight rock – are becoming a mainstay of global supply. We see these sources as being instrumental in meeting rising oil demand for transportation and other purposes through 2040.

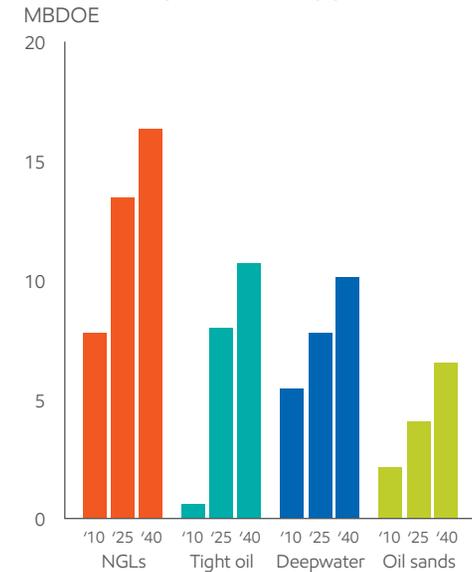
The largest “technology-driven” source is expected to continue to be NGLs, the liquids produced in association with natural gas. By 2040, global NGL supply is projected to increase by around 70 percent from 2014 levels.

Liquids – projections

Liquids supply by type



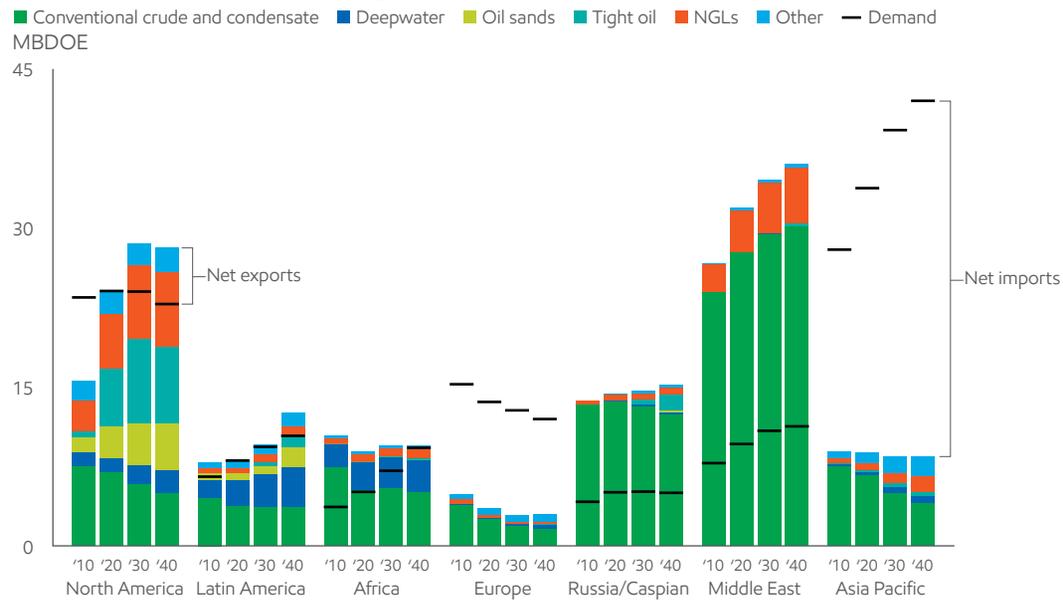
Technology-driven supplies



- Global liquids production to rise by 20 percent 2014-2040
- Growth comes mostly from non-conventional supply
- Tight oil reaches 10 percent of global liquids supply in 2040
- Conventional oil still biggest, but drops to a 55 percent share

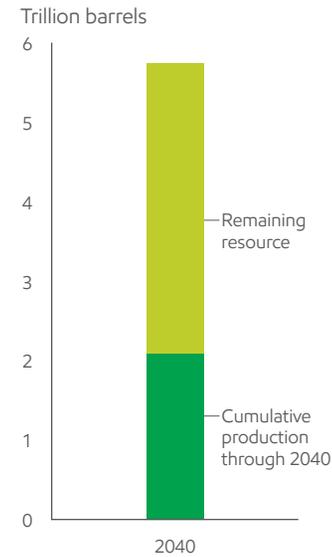
- NGLs, tight oil, deepwater, oil sands see strong gains
- Growth in NGLs and tight oil enabled by hydraulic fracturing
- Rapid tight oil growth from 2010 to 2025
- Deepwater growth driven by Africa, North America, South America
- Oil sands growth mostly from Canada, Venezuela

Liquids trade balance by region



- North America swings to a net exporter as shale growth continues
- North America to export 5 million barrels a day by 2040
- Asia Pacific will need more oil imports to meet its surging demand
- By 2040, about 80 percent of oil demand in Asia Pacific will be met by imports
- Middle East, Russia remain major oil exporters to 2040, but Africa shifts
- Europe remains a net oil importer as its demand and production decline

Crude and condensate resources



Source: IEA

- Global oil resources are abundant
- Resource estimates keep rising as technologies evolve
- Technology has added tight oil, deepwater, oil sands
- The world has 150 years of supply at current demand levels

Natural gas

Global demand for natural gas is seen rising by 50 percent from 2014 to 2040, faster than most other fuels and more than twice as fast as oil.

One reason is versatility. Natural gas can run generators that make electricity, or be used directly in homes, offices and factories. Gas also is emerging as a fuel for heavy-duty trucks and marine transportation.

Additionally, a key reason why gas is growing so fast is its relatively low carbon content, which makes it an effective and proven tool for curbing CO₂ emissions, particularly in the electricity generation sector. Natural gas emits up to 60 percent less CO₂ than coal, currently the world's top fuel for generating electricity. Demand for natural gas is expected to grow in all regions of the world.

Gas resources: abundant and geographically diverse

The world has an abundance of natural gas. With production technologies that exist today – including those that recently unlocked shale gas – **technically recoverable natural gas resources, as estimated by IEA, would last for over 200 years at current demand levels.** By 2040, we expect that only about 25 percent of total recoverable gas resources will have been produced, leaving the remaining 75 percent to serve longer-term needs.

Natural gas is geographically diverse; North America, Latin America, Russia/Caspian, Asia Pacific, the Middle East and Africa each hold 10 percent or more of the world's remaining gas resources based on IEA estimates. In terms of production, every region except Europe will likely grow through 2040, but we expect the largest gains in North America, where output is projected to rise by 65 percent due to unconventional gas.

40%

of global energy demand growth from 2014 to 2040 is projected to be met by natural gas.



Unconventional gas shakes up the supply picture

Unconventional gas resources have radically altered the supply picture in North America. **By 2040, we expect unconventional supplies to account for nearly 90 percent of North America gas production.**

Unconventional supply – including shale gas, tight gas, coal bed methane and coal-to-gas – is also anticipated to make an impact in other regions, notably Asia Pacific, where one-third of production will be unconventional by 2040. In total, 60 percent of the projected rise in global natural gas demand is expected to be met by unconventional supply, mostly from North America, but also from Asia Pacific, which accounts for 20 percent of the projected growth in unconventional production.

However, we expect conventionally-produced natural gas to remain the cornerstone of supply, meeting two-thirds of global demand in 2040. Most of the projected 25 percent rise in conventional production to 2040 is expected to come from Russia/Caspian, the Middle East and Africa. Of particular note is Africa, where we project that conventional gas production will more than double, mostly from development of resources in East Africa.

Global trade, LNG expanding

Inter-regional trading will play a key role in meeting natural gas demand through 2040, particularly in the Asia Pacific region where demand is rising fastest.

Nearly half the growth in global gas demand through 2040 is expected to be met through inter-regional trade, most of it using LNG. Until the first LNG shipping and receiving terminals opened in 1964, inter-regional gas trading was confined to areas connected by pipeline. But with LNG, natural gas can be super-cooled to liquid form and safely shipped via tanker to receiving terminals anywhere in the world. LNG exports are expected to almost triple by 2040, reaching nearly 100 BCFD. Most of this LNG will be headed to Asia Pacific. By 2040, almost half of Asia Pacific's gas demand is likely to be satisfied by LNG, up from 35 percent in 2014.

Significant new LNG exports are expected from the United States, East Africa and Australia. However, with abundant global gas resources and many aspiring gas exporters, we expect LNG to remain a highly competitive market. We anticipate that low-cost supply will be a determining factor for new LNG supply sources, especially in the second half of *The Outlook* period as capacity expands.

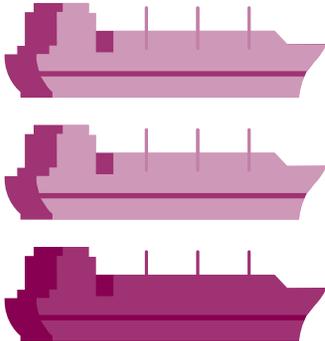
Inter-regional pipeline exports also are expected to grow, increasing by about 70 percent from 2014 to 2040 to about 40 BCFD; most of this growth is projected to come from the Russia/Caspian region, which serves both Europe and Asia. Europe's dependence on imports will likely increase as its local production declines.

Asia Pacific's gas imports rise to meet demand growth

With a large and growing population and rapid economic growth, we expect Asia Pacific to see by far the largest rise in natural gas demand, with usage doubling from 2014 to 2040.

As its demand rises, we see Asia Pacific becoming increasingly reliant on natural gas imports. **By 2040, Asia Pacific is expected to get more than 40 percent of its gas from other regions, and likely will have overtaken Europe as the world's largest net gas importer.**

It is interesting to note that despite the strong growth in gas demand in Asia Pacific, even by 2040 it is likely to remain the region with the lowest percentage of natural gas in its overall energy mix.



LNG exports expected to triple globally by 2040.



North America emerges as a gas exporter

While Asia's need for imports rises, a different story is developing in North America. A decade ago, North America was planning to import significant amounts of gas to meet its rising demand. But the advent of shale gas production over the past decade has reversed that picture.

North America is on track to export natural gas from newly constructed LNG export facilities by 2016, and by 2040 it is expected to surpass Asia Pacific, Africa and the Middle East to become the world's second-largest gas exporter. We see the Russia/Caspian region remaining the world's largest gas exporter as its net exports more than double due to growth in both LNG and pipeline exports.

Charting the numbers

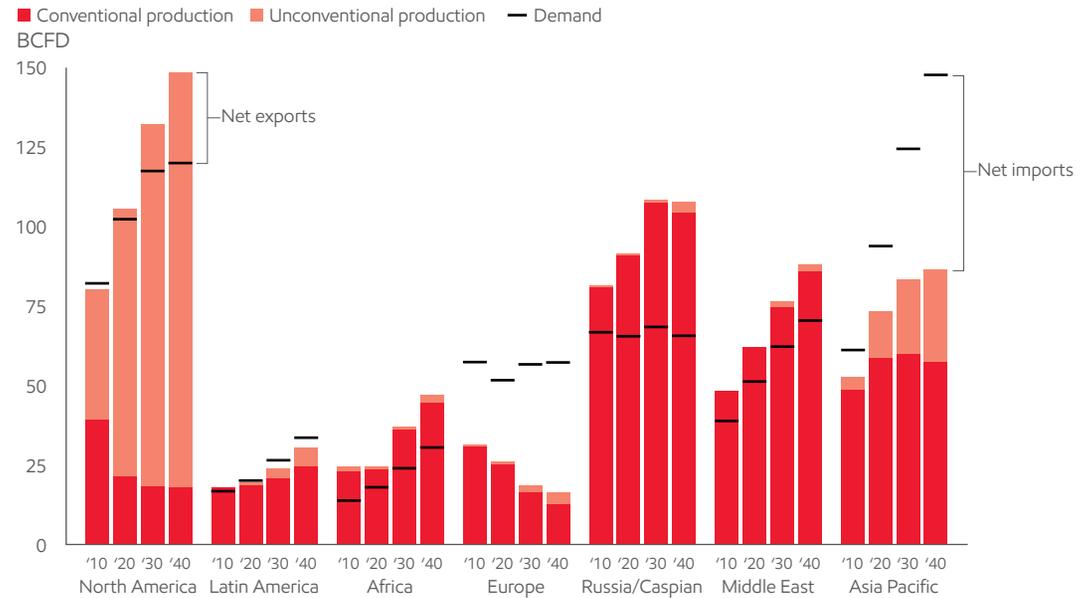
Natural gas has long been a staple of global energy supply. But its relatively low carbon content – and the success of unconventional gas production – has lifted gas to a new level of prominence on the world energy stage.

Demand for natural gas is rising much faster than overall energy demand; in fact, gas is poised to overtake coal as the world's second-largest energy source. Natural gas is a significant – and growing – fuel for power generation, as well as for the industrial, residential and commercial sectors. Gas is even gaining ground as a fuel for commercial transportation.

Natural gas also is growing more global. Due to growth in LNG infrastructure and markets, the volume of natural gas being traded around the world continues to expand – and is expected to be particularly critical to meeting demand in Europe and Asia Pacific.

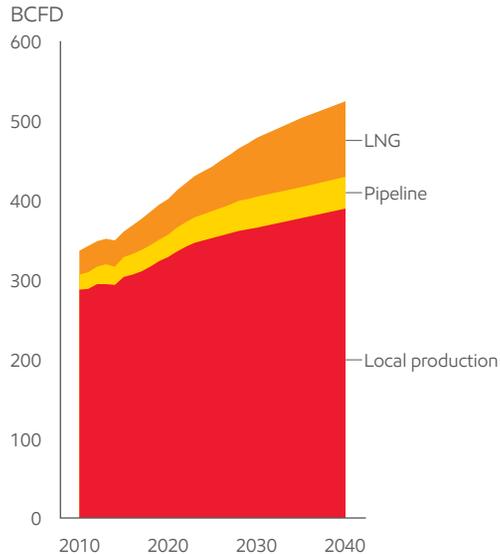
Natural gas – projections

Gas trade balance by region

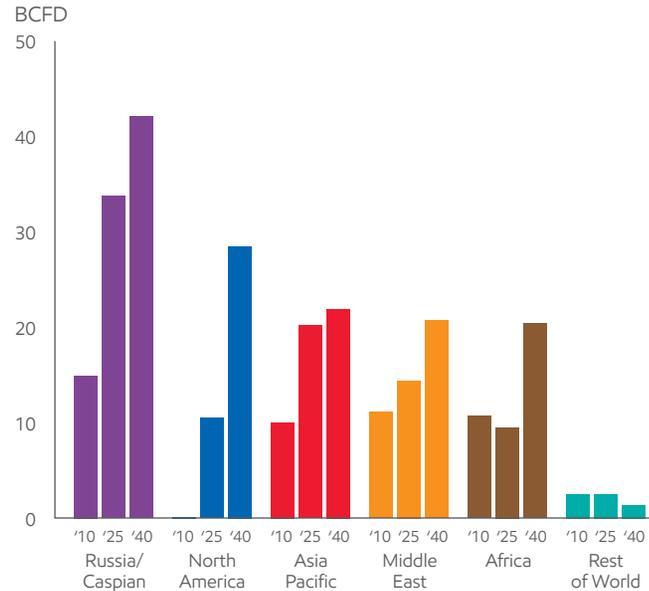


- North America's gas exports grow as its unconventional production more than doubles
- Unconventional gas also makes its mark in Asia; one-third of production by 2040
- Europe's need for gas imports keeps rising as domestic output falls
- Asia Pacific gas production and imports grow to meet rapidly rising demand
- By 2040, unconventional gas will account for about one-third of global gas production

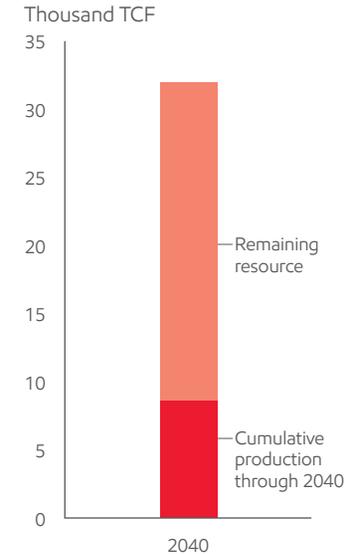
Gas supply by source



Gas exports by region



Natural gas resources



Source: IEA

- Global natural gas demand to rise by 50 percent 2014-2040
- Rising gas demand met by LNG, pipelines, local production
- LNG almost triples, primarily to serve Asia demand growth
- LNG share doubles to almost 20 percent of gas demand in 2040
- Inter-regional natural gas pipeline exports rise by 70 percent

- Russia/Caspian expands lead as top natural gas exporter
- North America emerges as a major exporter due to unconventional gas
- Asia Pacific LNG exports grow, mostly serving intra-Asia demand
- Middle East gas exports rise with new pipeline and LNG investments
- Africa gas exports about double

- Global natural gas resources are abundant
- Only a quarter of global gas resources will be produced by 2040
- Gas resources equal more than 200 years of supply at current demand
- Resource estimates keep rising as technologies evolve
- Technology has unlocked shale gas in the last decade

Energy today and tomorrow

With more people using energy to improve their lives, we estimate that global energy demand will be 25 percent higher in 2040 than it was in 2014.

Meeting energy demand safely, reliably and affordably – while also minimizing risk and environmental impact – will require advanced technology and expanded trade and investment. It will require innovation. And it also will require smart, practical energy choices by governments, individuals and businesses.

Understanding the factors that drive the world's energy needs – and likely choices to meet those needs – is the mission of *The Outlook*. By sharing *The Outlook* with the public, we hope to broaden that understanding among individuals, businesses and governments. Because energy matters to everyone, and we all play a role in shaping its future.





Data

Energy demand (quadrillion BTUs, unless otherwise noted)														
Regions	2000	2010	2014	2025	2040	Average annual change			% change			Share of total		
						2014 2025	2025 2040	2014 2040	2014 2025	2025 2040	2014 2040	2014	2025	2040
World	418	525	557	643	703	1.3%	0.6%	0.9%	15%	9%	26%	100%	100%	100%
OECD	225	230	225	227	220	0.1%	-0.2%	-0.1%	1%	-3%	-2%	40%	35%	31%
Non-OECD	192	295	332	416	483	2.1%	1.0%	1.5%	25%	16%	46%	60%	65%	69%
Africa	22	30	33	43	60	2.5%	2.2%	2.3%	31%	39%	83%	6%	7%	9%
Asia Pacific	128	202	227	284	319	2.0%	0.8%	1.3%	25%	12%	40%	41%	44%	45%
China	47	97	116	147	153	2.2%	0.2%	1.1%	27%	3%	32%	21%	23%	22%
India	19	29	34	47	63	3.0%	2.0%	2.4%	39%	34%	86%	6%	7%	9%
Europe	78	81	75	74	70	-0.1%	-0.4%	-0.3%	-2%	-6%	-7%	14%	12%	10%
European Union	72	73	67	65	60	-0.3%	-0.5%	-0.4%	-3%	-8%	-11%	12%	10%	9%
Latin America	20	27	29	36	45	1.9%	1.4%	1.6%	23%	23%	51%	5%	6%	6%
Middle East	18	30	34	42	50	2.0%	1.1%	1.5%	25%	18%	47%	6%	7%	7%
North America	114	113	114	118	116	0.3%	-0.2%	0.0%	4%	-2%	1%	21%	18%	16%
United States	96	94	95	96	92	0.1%	-0.3%	-0.1%	2%	-5%	-3%	17%	15%	13%
Russia/Caspian	38	43	44	45	44	0.3%	-0.2%	0.0%	4%	-3%	1%	8%	7%	6%
Energy by type - World														
Primary	418	525	557	643	703	1.3%	0.6%	0.9%	15%	9%	26%	100%	100%	100%
Oil	157	179	187	208	223	1.0%	0.5%	0.7%	11%	7%	19%	34%	32%	32%
Gas	89	116	120	152	181	2.2%	1.1%	1.6%	27%	18%	50%	22%	24%	26%
Coal	93	135	148	155	142	0.4%	-0.6%	-0.2%	5%	-8%	-4%	26%	24%	20%
Nuclear	27	29	26	37	54	3.2%	2.6%	2.9%	42%	47%	109%	5%	6%	8%
Biomass/waste	40	49	53	57	57	0.6%	0.0%	0.3%	7%	0%	7%	10%	9%	8%
Hydro	9	12	13	16	18	1.8%	0.8%	1.2%	21%	12%	36%	2%	3%	3%
Other renewables	3	7	10	18	28	5.5%	3.1%	4.1%	81%	59%	187%	2%	3%	4%
End-use sectors - World														
Residential/commercial														
Total	98	114	118	134	146	1.2%	0.6%	0.8%	14%	9%	24%	100%	100%	100%
Oil	15	14	14	15	14	0.5%	-0.2%	0.1%	6%	-2%	3%	12%	11%	10%
Gas	21	24	24	27	30	1.1%	0.5%	0.8%	13%	8%	22%	21%	20%	20%
Biomass/waste	29	33	34	35	32	0.2%	-0.6%	-0.2%	3%	-8%	-6%	29%	26%	22%
Electricity	23	32	34	45	59	2.5%	1.8%	2.1%	31%	31%	72%	29%	34%	41%
Other	10	11	11	12	11	0.4%	-0.6%	-0.2%	5%	-9%	-5%	10%	9%	7%
Transportation														
Total	81	101	108	123	138	1.2%	0.8%	0.9%	13%	12%	28%	100%	100%	100%
Oil	80	97	102	113	122	0.9%	0.5%	0.7%	11%	8%	20%	94%	92%	89%
Biofuels	0	3	3	4	6	2.9%	2.6%	2.8%	38%	48%	104%	3%	4%	5%
Gas	0	1	2	4	7	7.2%	4.5%	5.7%	116%	94%	319%	2%	3%	5%
Other	1	1	1	1	2	2.5%	2.6%	2.6%	31%	48%	94%	1%	1%	2%
Industrial														
Total	150	193	207	246	265	1.6%	0.5%	0.9%	18%	8%	28%	100%	100%	100%
Oil	50	57	60	70	78	1.5%	0.7%	1.0%	18%	11%	31%	29%	29%	30%
Gas	37	45	48	59	68	2.0%	0.9%	1.4%	24%	14%	42%	23%	24%	26%
Coal	27	43	46	51	44	0.9%	-1.0%	-0.2%	11%	-14%	-5%	22%	21%	16%
Electricity	22	31	35	45	54	2.4%	1.3%	1.7%	29%	21%	56%	17%	18%	20%
Other	14	17	19	20	21	0.4%	0.1%	0.2%	5%	2%	7%	9%	8%	8%
Power generation - World														
Primary	144	193	207	245	281	1.5%	0.9%	1.2%	18%	15%	36%	100%	100%	100%
Oil	12	10	11	10	8	-0.9%	-1.3%	-1.1%	-9%	-17%	-25%	5%	4%	3%
Gas	31	46	47	62	76	2.6%	1.4%	1.9%	33%	23%	63%	23%	25%	27%
Coal	62	88	97	100	95	0.2%	-0.3%	-0.1%	2%	-5%	-2%	47%	41%	34%
Nuclear	27	29	26	37	54	3.2%	2.6%	2.9%	42%	47%	109%	13%	15%	19%
Hydro	9	12	13	16	18	1.8%	0.8%	1.2%	21%	12%	36%	6%	7%	6%
Wind	0	1	2	6	11	9.4%	4.0%	6.2%	168%	79%	381%	1%	2%	4%
Other renewables	4	8	11	14	19	2.7%	2.0%	2.3%	35%	35%	82%	5%	6%	7%
Electricity demand (terawatt hours)														
World	13216	18604	20548	26771	33855	2.4%	1.6%	1.9%	30%	26%	65%	100%	100%	100%
OECD	8601	9706	9526	10610	11582	1.0%	0.6%	0.8%	11%	9%	22%	46%	40%	34%
Non-OECD	4615	8897	11021	16161	22273	3.5%	2.2%	2.7%	47%	38%	102%	54%	60%	66%

Energy demand (quadrillion BTUs)															
OECD Energy by type	2000	2010	2014	2025	2040	Average annual change			2014 2025	% change		Share of total			
						2014 2025	2025 2040	2014 2040		2014 2025	2025 2040	2014	2025	2040	
Primary	225	230	225	227	220	0.1%	-0.2%	-0.1%	1%	-3%	-2%	100%	100%	100%	
Oil	98	93	90	87	79	-0.4%	-0.6%	-0.5%	-4%	-9%	-12%	40%	38%	36%	
Gas	47	54	55	65	70	1.6%	0.5%	1.0%	19%	8%	29%	24%	29%	32%	
Coal	43	42	40	29	16	-2.8%	-3.8%	-3.4%	-27%	-44%	-59%	18%	13%	7%	
Nuclear	23	24	20	23	27	1.3%	0.9%	1.1%	15%	15%	32%	9%	10%	12%	
Biomass/waste	7	9	10	9	8	-0.2%	-0.7%	-0.5%	-2%	-10%	-11%	4%	4%	4%	
Hydro	5	5	5	5	5	0.3%	0.3%	0.3%	4%	5%	9%	2%	2%	2%	
Other renewables	2	4	6	9	14	4.3%	2.7%	3.4%	59%	49%	136%	3%	4%	6%	
End-use sectors															
Residential/commercial															
Total	46	50	48	49	47	0.2%	-0.2%	0.0%	2%	-3%	-1%	100%	100%	100%	
Oil	9	7	6	5	3	-1.7%	-2.4%	-2.1%	-17%	-31%	-42%	12%	10%	7%	
Gas	16	17	16	17	16	0.2%	-0.3%	-0.1%	2%	-4%	-2%	34%	34%	34%	
Biomass/waste	2	3	3	3	2	-0.5%	-1.7%	-1.2%	-5%	-23%	-27%	6%	5%	4%	
Electricity	17	21	20	22	24	0.7%	0.4%	0.6%	9%	7%	16%	43%	45%	50%	
Other	2	3	2	3	2	0.4%	-0.5%	-0.1%	5%	-8%	-3%	5%	5%	5%	
Transportation															
Total	55	58	58	56	53	-0.2%	-0.4%	-0.3%	-3%	-5%	-8%	100%	100%	100%	
Oil	55	56	55	53	48	-0.4%	-0.7%	-0.6%	-5%	-9%	-14%	96%	94%	89%	
Biofuels	0	2	2	2	3	1.4%	1.7%	1.6%	16%	29%	50%	4%	4%	6%	
Gas	0	0	0	1	2	16.1%	6.6%	10.5%	415%	161%	1244%	0%	1%	4%	
Other	0	0	0	0	1	1.0%	2.4%	1.8%	12%	43%	59%	1%	1%	1%	
Industrial															
Total	71	68	69	74	74	0.6%	0.0%	0.3%	7%	0%	7%	100%	100%	100%	
Oil	29	27	27	28	27	0.4%	-0.1%	0.1%	4%	-2%	2%	39%	38%	37%	
Gas	18	18	19	23	24	1.9%	0.2%	0.9%	22%	3%	27%	27%	31%	32%	
Coal	8	7	7	5	3	-3.4%	-2.8%	-3.1%	-32%	-35%	-56%	10%	7%	4%	
Electricity	12	12	12	14	15	1.4%	0.7%	1.0%	16%	12%	30%	17%	19%	21%	
Other	4	4	4	4	4	0.0%	-0.6%	-0.3%	0%	-8%	-8%	6%	6%	5%	
Power generation															
Primary	84	90	86	88	87	0.2%	0.0%	0.1%	2%	0%	1%	100%	100%	100%	
Oil	5	3	3	1	1	-6.1%	-2.7%	-4.2%	-50%	-34%	-67%	3%	1%	1%	
Gas	13	20	19	25	29	2.2%	1.0%	1.5%	28%	16%	48%	23%	28%	33%	
Coal	35	34	32	23	12	-2.8%	-4.1%	-3.6%	-27%	-47%	-61%	37%	27%	14%	
Nuclear	23	24	20	23	27	1.3%	0.9%	1.1%	15%	15%	32%	24%	27%	31%	
Hydro	5	5	5	5	5	0.3%	0.3%	0.3%	4%	5%	9%	5%	6%	6%	
Wind	0	1	2	3	6	7.5%	3.6%	5.3%	122%	71%	279%	2%	4%	7%	
Other renewables	3	4	6	7	7	1.3%	0.9%	1.1%	15%	14%	32%	7%	7%	9%	

General note on data tables: Rounding may lead to minor differences between totals and the sum of their individual parts.

Energy demand (quadrillion BTUs)														
Non-OECD Energy by type	2000	2010	2014	2025	2040	Average annual change			% change			Share of total		
						2014 2025	2025 2040	2014 2040	2014 2025	2025 2040	2014 2040	2014	2025	2040
Primary	192	295	332	416	483	2.1%	1.0%	1.5%	25%	16%	46%	100%	100%	100%
Oil	58	85	97	122	144	2.1%	1.1%	1.6%	26%	18%	49%	29%	29%	30%
Gas	42	62	66	87	110	2.6%	1.6%	2.0%	33%	26%	68%	20%	21%	23%
Coal	50	93	108	126	126	1.4%	0.0%	0.6%	17%	0%	16%	33%	30%	26%
Nuclear	4	5	6	13	27	8.2%	4.8%	6.3%	139%	103%	385%	2%	3%	6%
Biomass/waste	33	40	43	47	48	0.8%	0.1%	0.4%	9%	2%	11%	13%	11%	10%
Hydro	4	7	9	11	13	2.4%	0.9%	1.6%	30%	15%	50%	3%	3%	3%
Other renewables	1	3	4	9	15	7.0%	3.6%	5.0%	111%	70%	259%	1%	2%	3%
End-use sectors														
Residential/commercial														
Total	52	64	70	85	98	1.8%	1.0%	1.3%	21%	16%	40%	100%	100%	100%
Oil	6	7	8	10	11	1.8%	0.7%	1.2%	22%	12%	36%	12%	12%	11%
Gas	5	7	8	11	14	2.8%	1.6%	2.1%	36%	26%	71%	11%	13%	14%
Biomass/waste	27	30	31	32	30	0.3%	-0.5%	-0.2%	3%	-7%	-4%	44%	38%	30%
Electricity	6	11	14	23	36	4.6%	2.9%	3.6%	63%	55%	153%	20%	27%	36%
Other	8	8	9	9	8	0.4%	-0.7%	-0.2%	5%	-10%	-5%	13%	11%	9%
Transportation														
Total	26	43	51	67	85	2.5%	1.6%	2.0%	32%	27%	68%	100%	100%	100%
Oil	25	41	47	61	75	2.3%	1.4%	1.8%	29%	23%	59%	93%	91%	88%
Biofuels	0	1	1	2	3	5.3%	3.6%	4.3%	76%	71%	200%	2%	3%	4%
Gas	0	1	2	3	5	5.9%	3.9%	4.7%	88%	77%	232%	3%	4%	6%
Other	0	1	1	1	2	3.1%	2.7%	2.9%	41%	50%	110%	1%	2%	2%
Industrial														
Total	79	124	139	172	191	2.0%	0.7%	1.2%	24%	11%	38%	100%	100%	100%
Oil	21	30	33	42	51	2.3%	1.2%	1.7%	29%	20%	55%	24%	25%	27%
Gas	19	27	29	36	44	2.1%	1.3%	1.6%	26%	21%	52%	21%	21%	23%
Coal	19	35	39	46	40	1.6%	-0.8%	0.2%	18%	-12%	4%	28%	27%	21%
Electricity	9	19	23	31	39	2.9%	1.5%	2.1%	36%	25%	70%	17%	18%	20%
Other	10	13	15	16	17	0.5%	0.3%	0.4%	6%	4%	11%	11%	9%	9%
Power generation														
Primary	60	103	121	157	194	2.4%	1.4%	1.8%	30%	23%	60%	100%	100%	100%
Oil	7	7	8	9	7	0.3%	-1.1%	-0.5%	3%	-15%	-12%	7%	6%	4%
Gas	17	26	27	37	47	2.9%	1.6%	2.2%	37%	27%	75%	22%	24%	24%
Coal	27	54	66	76	82	1.4%	0.5%	0.9%	17%	8%	26%	54%	49%	42%
Nuclear	4	5	6	13	27	8.2%	4.8%	6.3%	139%	103%	385%	5%	9%	14%
Hydro	4	7	9	11	13	2.4%	0.9%	1.6%	30%	15%	50%	7%	7%	7%
Wind	0	0	1	2	5	12.9%	4.4%	7.9%	280%	91%	627%	1%	2%	2%
Other renewables	1	3	5	8	12	4.2%	2.9%	3.4%	57%	53%	140%	4%	5%	6%

Energy demand (quadrillion BTUs)														
Regions	2000	2010	2014	2025	2040	Average annual change			% change			Share of total		
						2014-2025	2025-2040	2014-2040	2014-2025	2025-2040	2014-2040	2014	2025	2040
AFRICA														
Primary	22	30	33	43	60	2.5%	2.2%	2.3%	31%	39%	83%	100%	100%	100%
Oil	5	8	8	12	19	3.9%	2.8%	3.3%	52%	52%	131%	25%	29%	31%
Gas	4	5	5	7	10	3.1%	2.5%	2.8%	40%	46%	104%	16%	17%	18%
Coal	3	4	4	5	7	1.9%	2.7%	2.4%	23%	49%	83%	12%	11%	12%
Nuclear	0	0	0	0	1	2.0%	13.5%	8.5%	24%	571%	732%	0%	0%	2%
Biomass/waste	10	13	15	17	20	1.3%	1.0%	1.1%	15%	16%	34%	46%	40%	33%
Hydro	0	0	0	1	1	6.4%	3.4%	4.6%	97%	65%	225%	1%	2%	2%
Other renewables	0	0	0	0	1	11.7%	5.7%	8.2%	238%	130%	677%	0%	1%	1%
Demand by sector														
Total end-use (including electricity)	20	26	29	37	51	2.3%	2.0%	2.2%	29%	35%	75%	100%	100%	100%
Residential/commercial	9	12	14	18	23	2.2%	1.6%	1.9%	27%	28%	62%	48%	47%	45%
Transportation	3	4	5	7	10	3.6%	2.6%	3.0%	47%	46%	115%	17%	19%	21%
Industrial	7	10	10	13	18	2.0%	2.3%	2.1%	24%	40%	73%	35%	34%	35%
Memo: electricity demand	1	2	2	4	7	4.9%	4.4%	4.6%	70%	90%	222%	7%	10%	14%
Power generation fuel ¹	4	6	6	9	16	4.0%	3.8%	3.9%	54%	76%	172%	18%	22%	27%
ASIA PACIFIC														
Primary	128	202	227	284	319	2.0%	0.8%	1.3%	25%	12%	40%	100%	100%	100%
Oil	43	57	62	75	85	1.6%	0.8%	1.2%	19%	13%	35%	27%	26%	27%
Gas	12	21	24	38	51	4.1%	2.0%	2.9%	55%	34%	108%	11%	13%	16%
Coal	45	89	104	119	117	1.2%	-0.1%	0.4%	14%	-2%	12%	46%	42%	37%
Nuclear	5	6	4	13	24	12.0%	4.1%	7.4%	249%	83%	539%	2%	5%	8%
Biomass/waste	20	23	24	25	24	0.4%	-0.5%	-0.1%	5%	-7%	-3%	11%	9%	7%
Hydro	2	4	5	7	7	2.6%	0.4%	1.4%	33%	7%	42%	2%	2%	2%
Other renewables	1	2	3	7	12	7.0%	3.4%	4.9%	111%	65%	249%	1%	2%	4%
Demand by sector														
Total end-use (including electricity)	100	152	170	211	235	2.0%	0.7%	1.3%	24%	11%	38%	100%	100%	100%
Residential/commercial	33	41	44	53	60	1.8%	0.8%	1.2%	22%	12%	37%	26%	25%	26%
Transportation	18	28	32	42	53	2.4%	1.5%	1.9%	29%	26%	63%	19%	20%	22%
Industrial	49	83	94	116	122	2.0%	0.3%	1.0%	24%	5%	30%	55%	55%	52%
Memo: electricity demand	12	24	30	43	56	3.3%	1.8%	2.5%	43%	31%	88%	18%	20%	24%
Power generation fuel ¹	41	77	91	119	144	2.4%	1.3%	1.8%	30%	21%	58%	40%	42%	45%
EUROPE														
Primary	78	81	75	74	70	-0.1%	-0.4%	-0.3%	-2%	-6%	-7%	100%	100%	100%
Oil	32	31	28	26	24	-0.6%	-0.7%	-0.7%	-7%	-10%	-16%	37%	35%	34%
Gas	17	20	16	19	20	1.4%	0.4%	0.8%	17%	6%	23%	21%	25%	28%
Coal	14	13	12	9	4	-2.8%	-4.6%	-3.9%	-27%	-51%	-64%	16%	12%	6%
Nuclear	10	10	9	9	10	-0.3%	0.6%	0.2%	-4%	10%	6%	12%	12%	14%
Biomass/waste	3	5	5	6	5	0.5%	-0.7%	-0.2%	5%	-9%	-5%	7%	8%	7%
Hydro	2	2	2	2	2	0.0%	0.2%	0.2%	0%	4%	4%	3%	3%	3%
Other renewables	0	2	2	4	5	4.3%	2.2%	3.1%	60%	38%	120%	3%	5%	7%
Demand by sector														
Total end-use (including electricity)	61	64	59	59	57	0.0%	-0.3%	-0.2%	1%	-5%	-4%	100%	100%	100%
Residential/commercial	18	21	19	20	19	0.5%	-0.4%	0.0%	5%	-6%	-1%	32%	33%	33%
Transportation	17	19	18	17	17	-0.3%	-0.2%	-0.2%	-3%	-2%	-5%	30%	29%	29%
Industrial	25	24	23	23	21	-0.1%	-0.4%	-0.3%	-1%	-6%	-6%	39%	38%	38%
Memo: electricity demand	10	12	11	12	13	0.8%	0.5%	0.6%	9%	7%	17%	19%	20%	23%
Power generation fuel ¹	29	32	30	29	28	-0.1%	-0.2%	-0.2%	-2%	-3%	-4%	39%	39%	40%

¹Share based on total primary energy

Energy demand (quadrillion BTUs)														
Regions	2000	2010	2014	2025	2040	Average annual change			% change			Share of total		
						2014 2025	2025 2040	2014 2040	2014 2025	2025 2040	2014 2040	2014	2025	2040
LATIN AMERICA														
Primary	20	27	29	36	45	1.9%	1.4%	1.6%	23%	23%	51%	100%	100%	100%
Oil	10	13	14	16	19	1.5%	0.9%	1.2%	17%	15%	35%	47%	45%	42%
Gas	4	6	6	8	12	2.6%	2.5%	2.5%	32%	44%	91%	21%	22%	26%
Coal	1	1	1	2	2	2.4%	1.3%	1.8%	29%	22%	57%	4%	4%	4%
Nuclear	0	0	0	0	0	5.1%	1.7%	3.2%	73%	30%	125%	1%	1%	1%
Biomass/waste	3	4	5	5	5	0.6%	0.1%	0.3%	6%	2%	8%	15%	13%	11%
Hydro	2	2	2	3	4	1.9%	1.3%	1.6%	23%	22%	49%	8%	8%	8%
Other renewables	0	1	1	2	3	6.1%	3.5%	4.6%	91%	67%	219%	3%	5%	7%
Demand by sector														
Total end-use (including electricity)	18	24	26	32	39	1.7%	1.4%	1.6%	21%	24%	49%	100%	100%	100%
Residential/commercial	4	4	5	5	6	1.5%	1.1%	1.3%	18%	17%	38%	18%	17%	16%
Transportation	5	7	9	11	13	1.9%	1.2%	1.5%	23%	20%	47%	33%	34%	33%
Industrial	9	12	13	15	20	1.7%	1.7%	1.7%	21%	29%	55%	49%	49%	51%
Memo: electricity demand	2	3	4	5	7	3.0%	2.3%	2.6%	38%	40%	93%	14%	16%	18%
Power generation fuel ¹	4	6	7	10	13	2.9%	1.8%	2.3%	37%	32%	80%	24%	27%	28%
MIDDLE EAST														
Primary	18	30	34	42	50	2.0%	1.1%	1.5%	25%	18%	47%	100%	100%	100%
Oil	11	16	18	21	23	1.6%	0.6%	1.0%	19%	9%	30%	52%	50%	46%
Gas	7	13	15	20	24	2.3%	1.4%	1.8%	28%	23%	57%	46%	47%	49%
Coal	0	0	0	0	0	-3.0%	-3.8%	-3.5%	-28%	-44%	-60%	1%	1%	0%
Nuclear	0	0	0	0	1	24.8%	7.4%	14.5%	1048%	192%	3258%	0%	1%	3%
Biomass/waste	0	0	0	0	0	7.3%	6.3%	6.7%	117%	150%	441%	0%	0%	0%
Hydro	0	0	0	0	0	2.4%	2.2%	2.3%	30%	38%	80%	0%	0%	0%
Other renewables	0	0	0	0	1	9.2%	5.8%	7.2%	163%	132%	510%	0%	1%	1%
Demand by sector														
Total end-use (including electricity)	14	23	26	33	40	2.0%	1.2%	1.6%	25%	20%	50%	100%	100%	100%
Residential/commercial	3	4	5	6	7	2.0%	1.5%	1.7%	25%	25%	56%	18%	18%	19%
Transportation	4	6	7	9	10	1.5%	0.9%	1.2%	18%	15%	36%	28%	26%	25%
Industrial	7	12	14	18	22	2.3%	1.3%	1.7%	28%	22%	56%	54%	56%	56%
Memo: electricity demand	1	3	3	5	7	4.1%	2.3%	3.1%	55%	41%	119%	12%	14%	17%
Power generation fuel ¹	5	9	10	14	17	2.6%	1.2%	1.8%	33%	20%	60%	31%	33%	34%
NORTH AMERICA														
Primary	114	113	114	118	116	0.3%	-0.2%	0.0%	4%	-2%	1%	100%	100%	100%
Oil	49	47	46	47	44	0.2%	-0.4%	-0.2%	2%	-6%	-4%	40%	40%	38%
Gas	26	28	31	38	41	1.8%	0.6%	1.1%	21%	9%	32%	27%	32%	35%
Coal	23	21	19	14	6	-2.8%	-5.2%	-4.2%	-26%	-55%	-67%	17%	12%	5%
Nuclear	9	10	10	10	13	0.2%	1.5%	1.0%	2%	26%	28%	9%	8%	11%
Biomass/waste	4	3	3	3	2	-1.5%	-1.0%	-1.2%	-15%	-14%	-27%	3%	2%	2%
Hydro	2	2	2	2	3	0.6%	0.4%	0.5%	6%	7%	14%	2%	2%	2%
Other renewables	1	2	3	4	7	3.8%	2.9%	3.3%	51%	54%	132%	3%	4%	6%
Demand by sector														
Total end-use (including electricity)	86	86	88	94	93	0.5%	-0.1%	0.2%	6%	-1%	5%	100%	100%	100%
Residential/commercial	22	23	23	23	23	0.0%	0.0%	0.0%	0%	0%	0%	26%	24%	25%
Transportation	31	32	33	33	31	-0.1%	-0.4%	-0.3%	-1%	-6%	-7%	37%	35%	33%
Industrial	34	32	33	38	39	1.4%	0.2%	0.7%	17%	3%	20%	37%	41%	42%
Memo: electricity demand	15	16	16	18	20	1.1%	0.7%	0.8%	12%	11%	24%	18%	19%	21%
Power generation fuel ¹	42	43	42	43	43	0.2%	0.0%	0.1%	2%	0%	2%	37%	36%	37%

¹Share based on total primary energy

Energy demand (quadrillion BTUs)														
Regions	2000	2010	2014	2025	2040	Average annual change			% change			Share of total		
						2014 2025	2025 2040	2014 2040	2014 2025	2025 2040	2014 2040	2014	2025	2040
RUSSIA/CASPIAN														
Primary	38	43	44	45	44	0.3%	-0.2%	0.0%	4%	-3%	1%	100%	100%	100%
Oil	8	8	10	10	10	0.0%	-0.1%	-0.1%	0%	-2%	-2%	24%	23%	23%
Gas	20	23	22	23	23	0.4%	-0.2%	0.1%	5%	-3%	2%	51%	51%	51%
Coal	7	7	7	7	5	-0.4%	-1.6%	-1.1%	-5%	-21%	-25%	16%	15%	12%
Nuclear	2	3	3	4	4	2.7%	1.2%	1.8%	34%	20%	61%	6%	8%	10%
Biomass/waste	0	0	0	0	0	0.5%	-0.1%	0.1%	5%	-2%	3%	1%	1%	1%
Hydro	1	1	1	1	1	0.1%	0.2%	0.1%	1%	3%	3%	2%	2%	2%
Other renewables	0	0	0	0	0	6.1%	4.6%	5.2%	91%	96%	274%	0%	0%	0%
Demand by sector														
Total end-use (including electricity)	29	33	35	36	35	0.4%	-0.2%	0.1%	5%	-3%	1%	100%	100%	100%
Residential/commercial	9	9	9	9	8	-0.2%	-0.6%	-0.4%	-2%	-9%	-11%	26%	24%	23%
Transportation	3	4	4	5	5	0.3%	0.3%	0.3%	4%	4%	8%	13%	13%	14%
Industrial	17	20	21	23	22	0.7%	-0.1%	0.2%	8%	-2%	5%	61%	63%	64%
Memo: electricity demand	3	4	4	5	6	1.6%	1.0%	1.2%	19%	16%	38%	12%	14%	17%
Power generation fuel ¹	19	20	20	21	20	0.2%	-0.2%	0.0%	2%	-3%	0%	46%	45%	46%
GDP by region (2010\$, trillions)														
World	49	65	72	101	153	3.1%	2.8%	2.9%	41%	51%	113%	100%	100%	100%
OECD	38	44	47	59	79	2.2%	1.9%	2.1%	27%	33%	70%	65%	59%	52%
Non-OECD	11	21	25	42	74	4.7%	3.9%	4.2%	65%	77%	192%	35%	41%	48%
Africa	1	2	2	4	6	4.4%	4.0%	4.2%	61%	80%	190%	3%	4%	4%
Asia Pacific	12	19	22	36	60	4.4%	3.6%	3.9%	60%	69%	170%	31%	35%	39%
China	2	6	8	15	29	6.1%	4.2%	5.0%	91%	86%	256%	11%	15%	19%
India	1	2	2	4	9	6.1%	5.1%	5.5%	92%	111%	307%	3%	4%	6%
Europe	16	18	19	23	30	1.9%	1.7%	1.8%	23%	29%	59%	26%	23%	20%
European Union	14	17	17	21	26	1.8%	1.6%	1.7%	22%	27%	55%	24%	21%	17%
Latin America	3	4	5	6	10	2.9%	2.9%	2.9%	37%	54%	112%	6%	6%	6%
Middle East	1	2	2	4	6	3.7%	3.2%	3.4%	49%	61%	141%	3%	4%	4%
North America	15	18	19	26	36	2.6%	2.3%	2.5%	33%	41%	88%	27%	25%	24%
United States	13	15	16	22	30	2.6%	2.3%	2.4%	33%	41%	87%	23%	21%	20%
Russia/Caspian	1	2	2	3	4	2.4%	2.7%	2.6%	30%	50%	95%	3%	3%	3%
Energy intensity (thousand BTU per \$ GDP)														
World	8.5	8.1	7.7	6.4	4.6	-1.8%	-2.1%	-2.0%	-18%	-28%	-41%			
OECD	6.0	5.2	4.8	3.8	2.8	-2.1%	-2.1%	-2.1%	-21%	-28%	-42%			
Non-OECD	16.9	14.1	13.1	10.0	6.6	-2.5%	-2.8%	-2.6%	-24%	-34%	-50%			
Africa	19.7	15.4	14.8	12.1	9.4	-1.8%	-1.7%	-1.8%	-18%	-23%	-37%			
Asia Pacific	10.9	10.8	10.2	7.9	5.3	-2.2%	-2.7%	-2.5%	-22%	-33%	-48%			
China	21.6	16.4	14.3	9.5	5.3	-3.6%	-3.8%	-3.8%	-33%	-44%	-63%			
India	22.4	17.0	15.6	11.2	7.1	-2.9%	-3.0%	-3.0%	-28%	-37%	-54%			
Europe	5.0	4.4	4.0	3.2	2.3	-2.0%	-2.1%	-2.0%	-20%	-27%	-42%			
European Union	5.0	4.4	3.9	3.1	2.3	-2.1%	-2.1%	-2.1%	-21%	-27%	-42%			
Latin America	6.9	6.5	6.4	5.7	4.6	-1.0%	-1.5%	-1.3%	-11%	-20%	-29%			
Middle East	14.0	14.3	14.1	11.8	8.6	-1.6%	-2.1%	-1.9%	-17%	-27%	-39%			
North America	7.6	6.4	6.0	4.6	3.2	-2.3%	-2.4%	-2.4%	-22%	-31%	-46%			
United States	7.6	6.3	5.8	4.4	3.0	-2.4%	-2.6%	-2.5%	-24%	-32%	-48%			
Russia/Caspian	31.6	21.1	19.5	15.6	10.1	-2.0%	-2.9%	-2.5%	-20%	-35%	-48%			
Energy-related CO₂ emissions (billion tonnes)														
World	23.8	30.7	32.7	36.0	36.4	0.9%	0.1%	0.4%	10%	1%	12%	100%	100%	100%
OECD	12.8	12.8	12.4	11.6	9.8	-0.7%	-1.1%	-0.9%	-7%	-15%	-21%	38%	32%	27%
Non-OECD	11.0	17.9	20.2	24.4	26.6	1.7%	0.6%	1.1%	21%	9%	32%	62%	68%	73%
Africa	0.9	1.2	1.2	1.7	2.5	3.1%	2.6%	2.8%	39%	48%	106%	4%	5%	7%
Asia Pacific	7.7	13.3	15.2	17.9	18.8	1.5%	0.3%	0.8%	18%	5%	23%	47%	50%	51%
China	3.3	7.4	8.7	10.2	9.3	1.4%	-0.6%	0.2%	17%	-9%	7%	27%	28%	26%
India	1.0	1.7	2.1	2.9	3.9	3.0%	1.9%	2.4%	38%	33%	84%	6%	8%	11%
Europe	4.3	4.3	3.9	3.5	2.9	-0.8%	-1.3%	-1.1%	-8%	-18%	-25%	12%	10%	8%
European Union	4.0	3.9	3.4	3.0	2.4	-1.1%	-1.5%	-1.3%	-11%	-21%	-29%	10%	8%	7%
Latin America	0.9	1.3	1.4	1.7	2.1	1.8%	1.4%	1.6%	22%	22%	49%	4%	5%	6%
Middle East	1.1	1.8	2.0	2.3	2.5	1.4%	0.5%	0.9%	16%	8%	25%	6%	6%	7%
North America	6.6	6.5	6.4	6.3	5.3	-0.2%	-1.1%	-0.8%	-3%	-16%	-18%	20%	17%	15%
United States	5.7	5.5	5.5	5.1	4.2	-0.5%	-1.4%	-1.0%	-6%	-19%	-24%	17%	14%	11%
Russia/Caspian	2.3	2.5	2.6	2.6	2.4	0.1%	-0.5%	-0.3%	1%	-8%	-7%	8%	7%	7%

¹Share based on total primary energy

Glossary

Billion cubic feet per day (BCFD) This is used to define volumetric rates of natural gas. One billion cubic feet per day of natural gas is enough to meet about 2 percent of the natural gas used in homes around the world. Six billion cubic feet per day of natural gas is equivalent to about 1 million oil-equivalent barrels per day.

British thermal unit (BTU) A BTU is a standard unit of energy that can be used to measure any type of energy source. The energy content of one gallon of gasoline is about 125,000 BTUs. "Quad" refers to a quadrillion BTUs.

Hydrogen fuel cell vehicle A type of light-duty vehicle where the fuel is hydrogen contained in a 10,000 psi tank. This hydrogen is passed through a fuel cell that then provides electricity to power the vehicle.

Key Growth A grouping of 10 countries expected to represent an increasingly significant share of the global energy market due to rising populations and living standards. These countries include Brazil, Egypt, Indonesia, Iran, Mexico, Nigeria, Saudi Arabia, South Africa, Thailand and Turkey.

Light-duty vehicle (LDV) A classification of road vehicles that includes cars, light trucks and sport-utility vehicles (SUV).

Liquefied natural gas (LNG) Natural gas (predominantly methane) that has been super-chilled for conversion to liquid form for ease of transport.

Liquefied petroleum gas (LPG) A classification of hydrocarbon fuel including propane, butane and other similar hydrocarbons with low molecular weight.

Million oil-equivalent barrels per day (MBOE) This term provides a standardized unit of measure for different types of energy sources (oil, gas, coal, etc.) based on energy content relative to a typical barrel of oil. One million oil-equivalent barrels per day is enough energy to fuel about 5 percent of the light-duty vehicles on the world's roads today.

Natural Gas Liquids (NGL) A liquid fuel produced in association with natural gas. NGLs are components of natural gas that are separated from the gaseous state into liquid form during natural gas processing.

Organisation for Economic Co-operation and Development (OECD) A forum of 34 member nations that promote policies that will improve the economic and social well-being of people around the world.

OECD32 Although Mexico and Turkey are OECD member countries, their significant population, economic and energy demand growth closely resemble that of the other countries in the Key Growth group so they have been included there. As such, the OECD32 is used to denote the remaining countries of the OECD when a comparison to the Key Growth countries is made.

Plug-in Hybrid Electric Vehicle (PHEV) A type of light duty vehicle that uses an electric motor to drive the wheels. Unlike other electric vehicles, a PHEV also has a conventional internal combustion engine (ICE) that can charge its battery using petroleum fuels if needed.

Primary energy Includes energy in the form of oil, natural gas, coal, nuclear, hydro, geothermal, wind, solar and bioenergy sources (biofuels, municipal solid waste, traditional biomass). It does not include electricity or market heat, which are secondary energy types reflecting conversion/production from primary energy sources.

Secondary energy Energy types reflecting the conversion or production of energy from primary energy sources such as electricity produced using natural gas.

Watt A unit of electrical power, equal to one joule per second. A 1-gigawatt power plant can meet the electricity demand of more than 500,000 homes in the U.S. (Kilowatt (kW) = 1,000 watts; Gigawatt (GW) = 1,000,000,000 watts; Terawatt (TW) = 10^{12} watts). 300 terawatt hours is equivalent to about 1 quadrillion BTUs (Quad).



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