

BP Energy Outlook

Focus on North America

2016 edition



Outlook
to 2035

Disclaimer



This presentation contains forward-looking statements, particularly those regarding global economic growth, population and productivity growth, energy consumption, energy efficiency, policy support for renewable energies, sources of energy supply and growth of carbon emissions. Forward-looking statements involve risks and uncertainties because they relate to events, and depend on circumstances, that will or may occur in the future. Actual outcomes may differ depending on a variety of factors, including product supply, demand and pricing; political stability; general economic conditions; demographic changes; legal and regulatory developments; availability of new technologies; natural disasters and adverse weather conditions; wars and acts of terrorism or sabotage; and other factors discussed elsewhere in this presentation. BP disclaims any obligation to update this presentation. Neither BP p.l.c. nor any of its subsidiaries (nor their respective officers, employees and agents) accept liability for any inaccuracies or omissions or for any direct, indirect, special, consequential or other losses or damages of whatsoever kind in connection to this presentation or any information contained in it.

Unless noted otherwise, data definitions are based on the BP Statistical Review of World Energy, and historical energy data up to 2014 are consistent with the 2015 edition of the Review. Gross Domestic Product (GDP) is expressed in terms of real Purchasing Power Parity (PPP) at 2010 prices.

This regional perspective is drawn from the global BP Energy Outlook available at: www.bp.com/energyoutlook.

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Executive summary

- The Energy Outlook considers a base case, outlining the 'most likely' path for energy demand by fuel based on assumptions and judgements about future changes in policy, technology and the economy, and develops a number of alternative cases to explore key uncertainties.
- In the base case, North American GDP grows by more than 60%, but solid gains in energy efficiency mean that the energy required to fuel the higher level of activity grows by just 6% over the Outlook.
- Even though renewables account for all of the (modest) net increase in energy consumption, fossil fuels remain the dominant forms of energy in North America's energy mix, accounting for 78% of total energy consumption in 2035, down from 83% today.
- Gas is the only fossil fuel with a growing market share, supported by strong supply growth, particularly of US shale gas, and by environment policies.



Executive summary

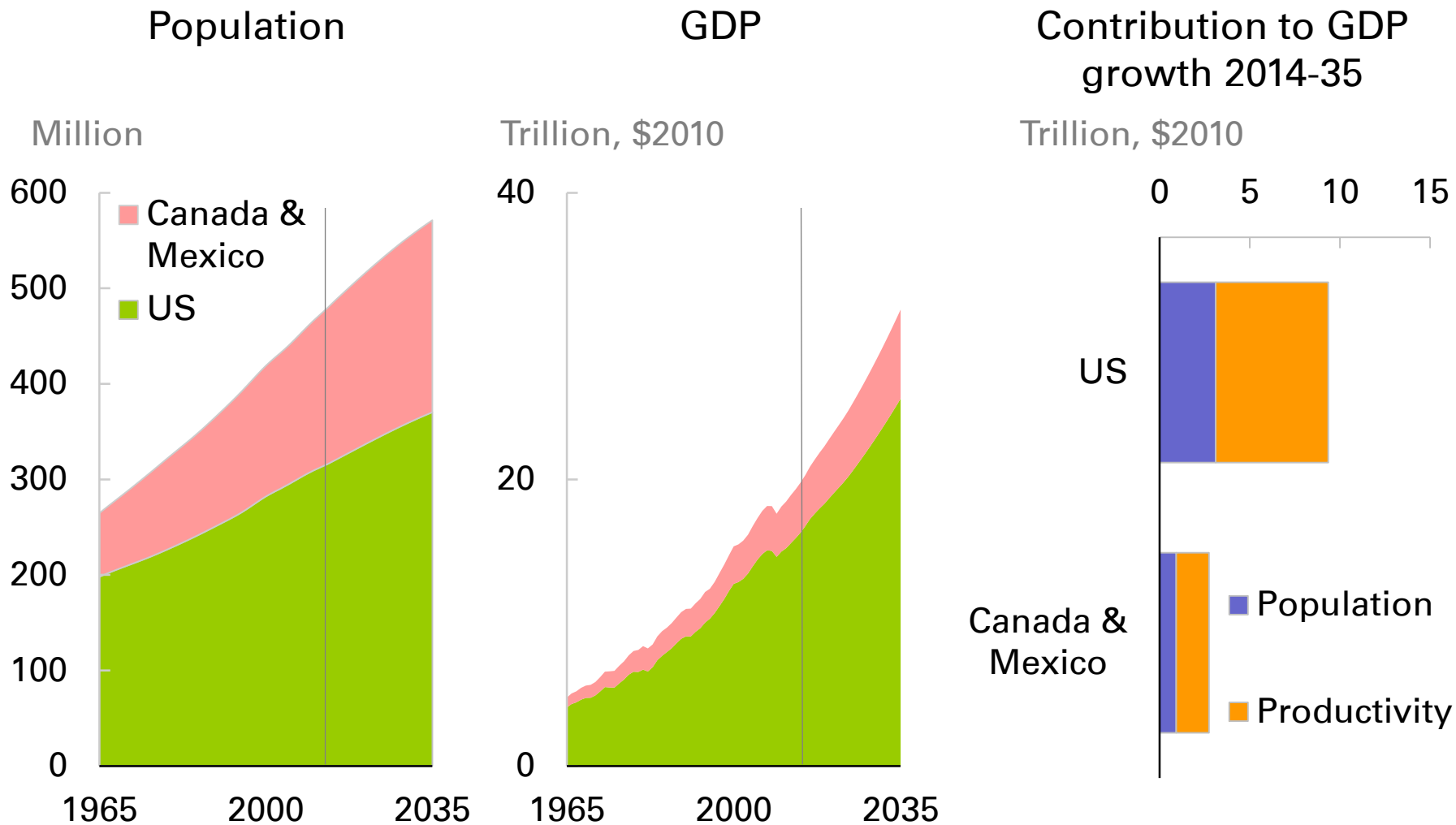
- Oil demand declines by 1 Mb/d over the Outlook. US tight oil production continues to grow, although at a gradually moderating pace. Combined with rising Canadian production, this allows North America to become a net oil exporting region by 2021.
- Coal demand declines by 51% over the Outlook, to the lowest level in our dataset going back to 1965.
- Hydro power grows by 8% by 2035, while nuclear output declines by 13%.
- Renewables grow rapidly, increasing 5.1% p.a. throughout the Outlook. By 2035 renewables' share in power generation reaches 20% compared to just 6% today.
- North American carbon emissions decline by 8% by 2035.
- The uncertainty around the base case is explored in three alternative cases: slower global GDP growth; a faster transition to a lower-carbon world; and shale oil and gas having even greater potential.

Base case

Primary energy



North American population and GDP grow...





...with a faster rate of increase in Canada & Mexico

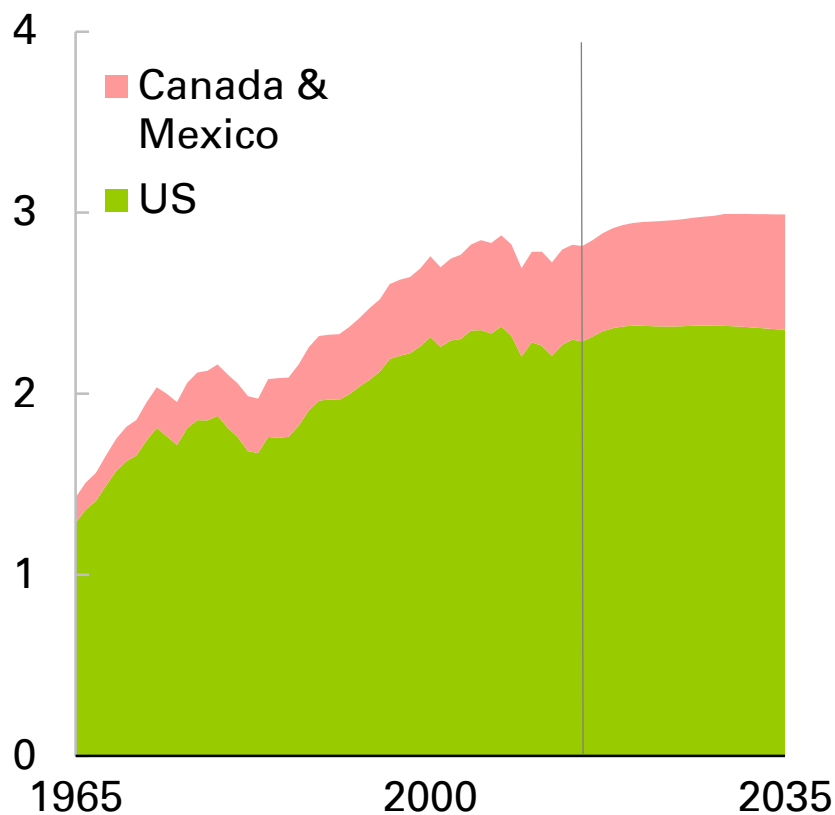
- Population and income are the key drivers of energy demand.
- North America's population is projected to increase by 18% over the Outlook to reach over 570 million people by 2035, slightly slower growth than total world population which increases by 21% over the Outlook. US population grows by 16% by 2035, while Canada's & Mexico's population grows by 21%.
- Over the same period, North American GDP is expected to increase by 61% by 2035, with growth of 57% in the US and 78% in Canada & Mexico.
- Roughly one-third of the increase in GDP comes from population growth and two-thirds from improvements in productivity (i.e. GDP per person).



North American energy consumption growth slows...

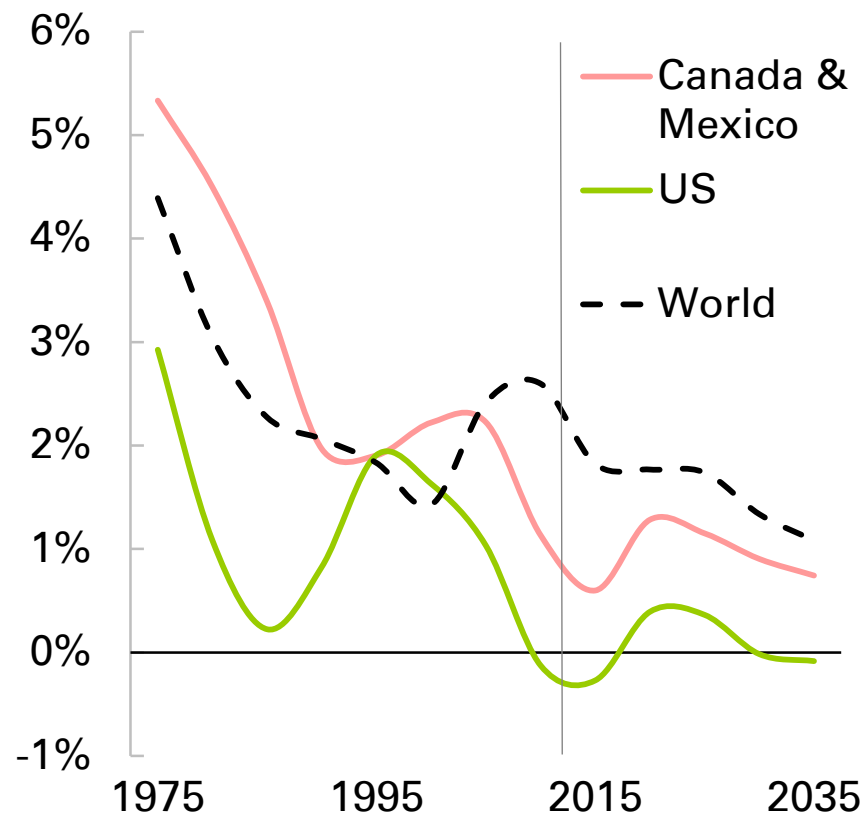
Consumption by region

Billion toe



Consumption growth by region

10 year average, % per annum





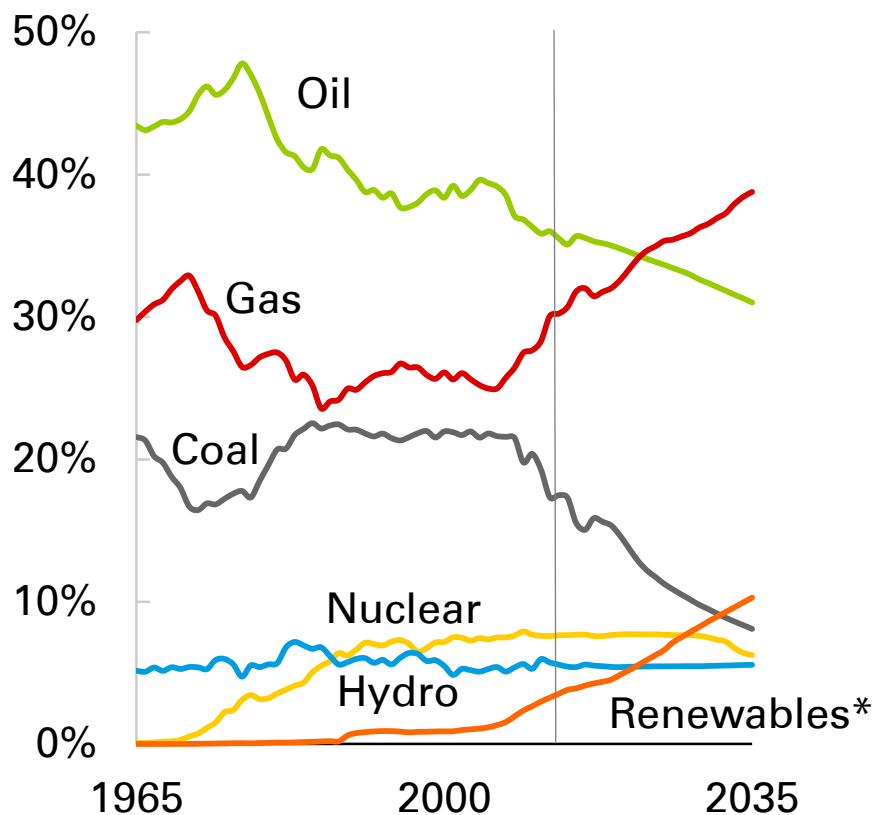
...with US consumption essentially flat

- North American primary energy consumption increases by just 6% between 2014 and 2035, with growth averaging 0.3% p.a..
- This compares to global growth of 34% over the Outlook and a global average of 1.4% p.a.. As a result, North America's share of global demand declines from 22%, in 2014 to 17% by 2035.
- Regional demand growth is concentrated in Canada & Mexico, where consumption expands by 22% or 0.9% p.a.. In the US, energy use is basically flat, expanding just 0.1% p.a. from 2014 to 2035.
- US energy demand is expected to reach a new peak by 2027 and decline from that point through the end of the Outlook.



The fuel mix is set to change significantly...

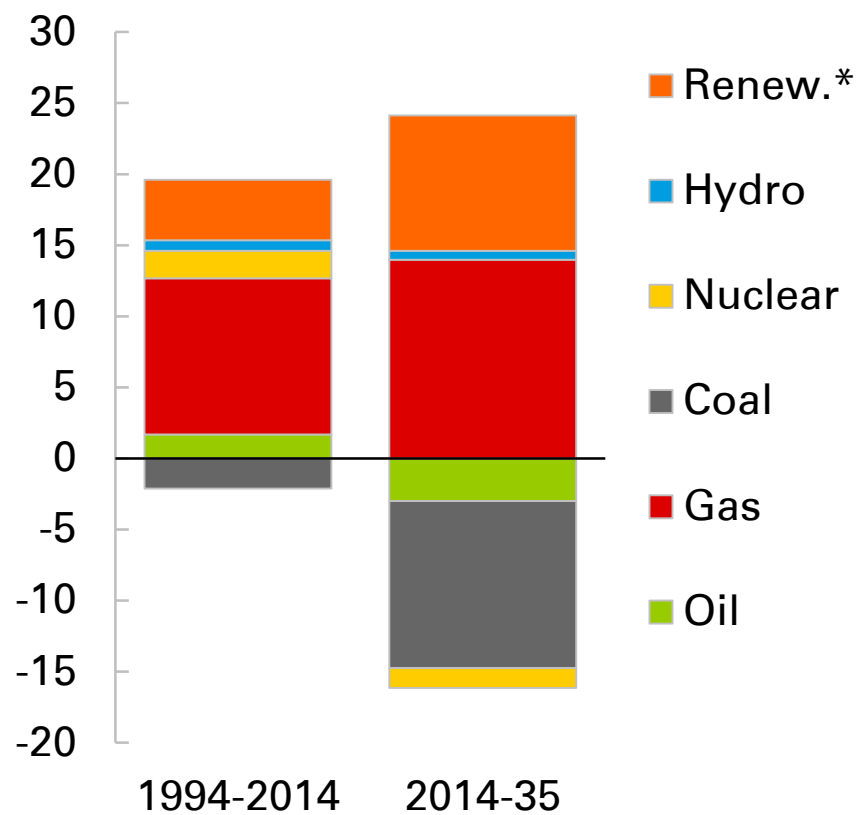
Shares of primary energy



*Includes biofuels

Annual demand growth by fuel

Mtoe per annum





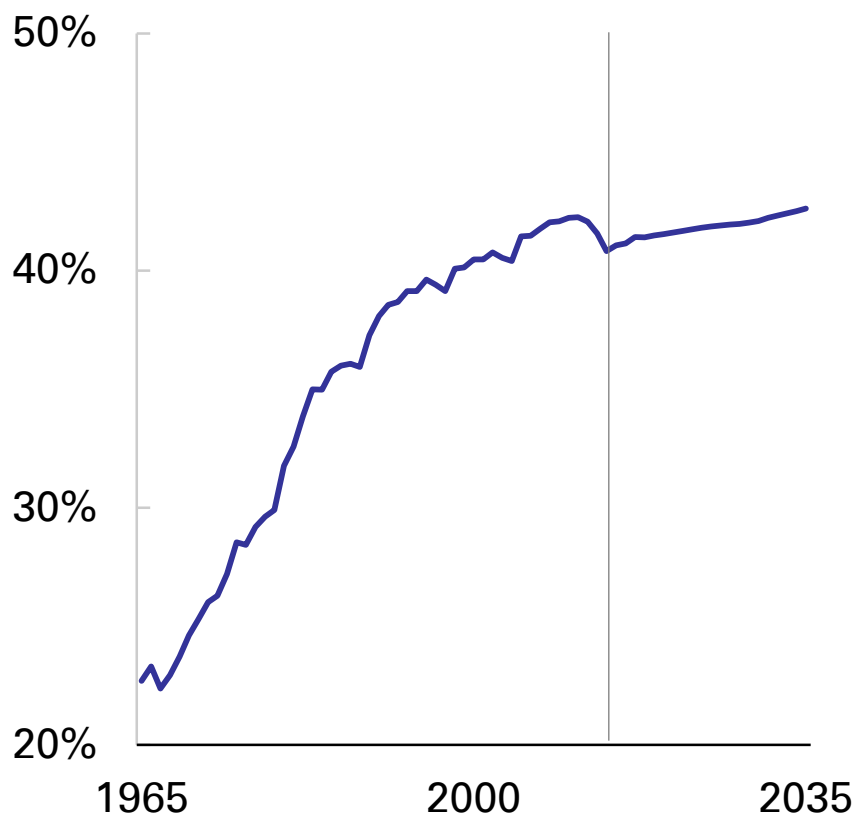
...with natural gas overtaking oil as the dominant fuel

- Shares of fossil fuels in the energy mix decline from 83% today to 78% by 2035. Shares of renewables (including biofuels) increase from 4% in 2014 to 10% in 2035, while hydro remains relatively stable throughout the Outlook at around 5% and nuclear remains near 8% until losing market share in the last few years of the Outlook.
- Gas is the only growing fossil fuel (1.4% p.a.), with its share growing from 31% in 2014 to 39% in 2035. Gas overtakes oil as the leading fuel around 2023. The entire increase in energy demand from 2014-35 could be met by the increase in natural gas.
- Oil's market share declines throughout the Outlook, reaching just 31% by 2035, the lowest share on record and down from a high of 48% in 1977. Coal's share drops to just 8% by 2035, also the lowest on record. Renewables overtake coal as the third largest fuel by market share by 2032.

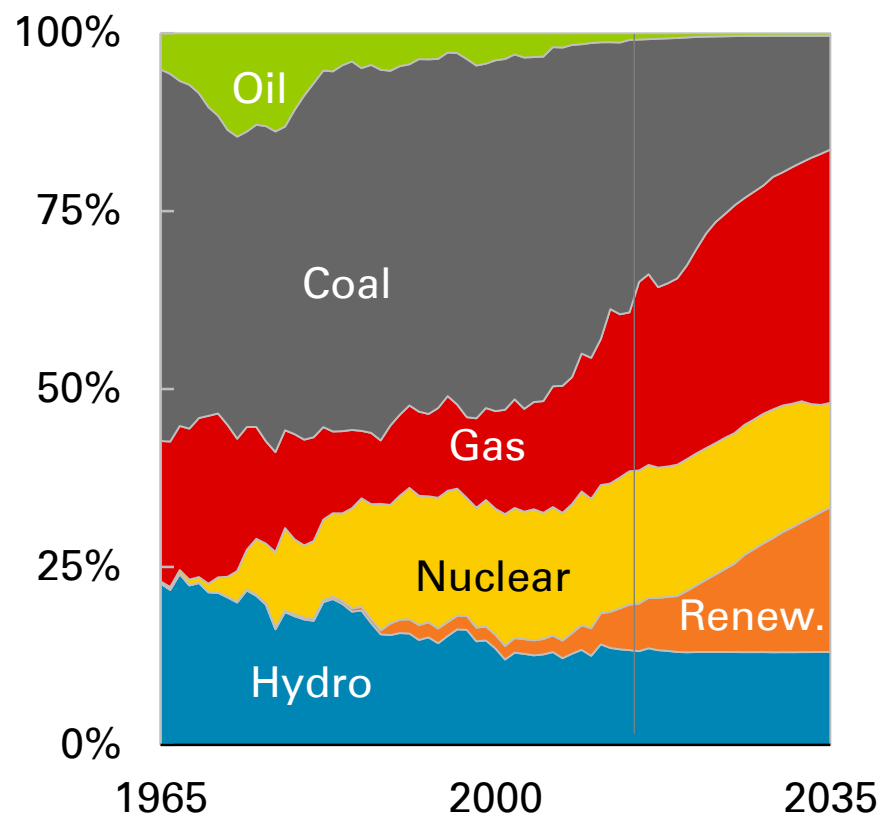


Power sector drives North American energy demand...

Inputs to power as a share of total primary energy



Primary inputs to power





...while the fuel mix in the power sector evolves

- The share of primary energy devoted to power generation in North America is expected to increase just slightly over the Outlook, rising from 41% today to 43% by 2035, below the OECD average of 46% by 2035. Power generation accounts for over 70% of net energy demand growth.
- Power generation is the main sector where all fuels compete and so it plays a major role in the evolution of the North American fuel mix.
- Coal was the largest contributor to power generation with a 38% market share in 2014. But coal's market share declines steadily to reach 16% by 2035, the lowest share on record. Natural gas overtakes coal in 2022, and becomes the largest input to power generation, rising from a 22% share in 2014 to 36% in 2035. Renewables also contribute to the displacement of coal, reaching a market share of 20% by 2035.
- Carbon-free sources (renewables, hydro and nuclear) increase their combined share of power generation from 38% in 2014 to 48% by 2035.

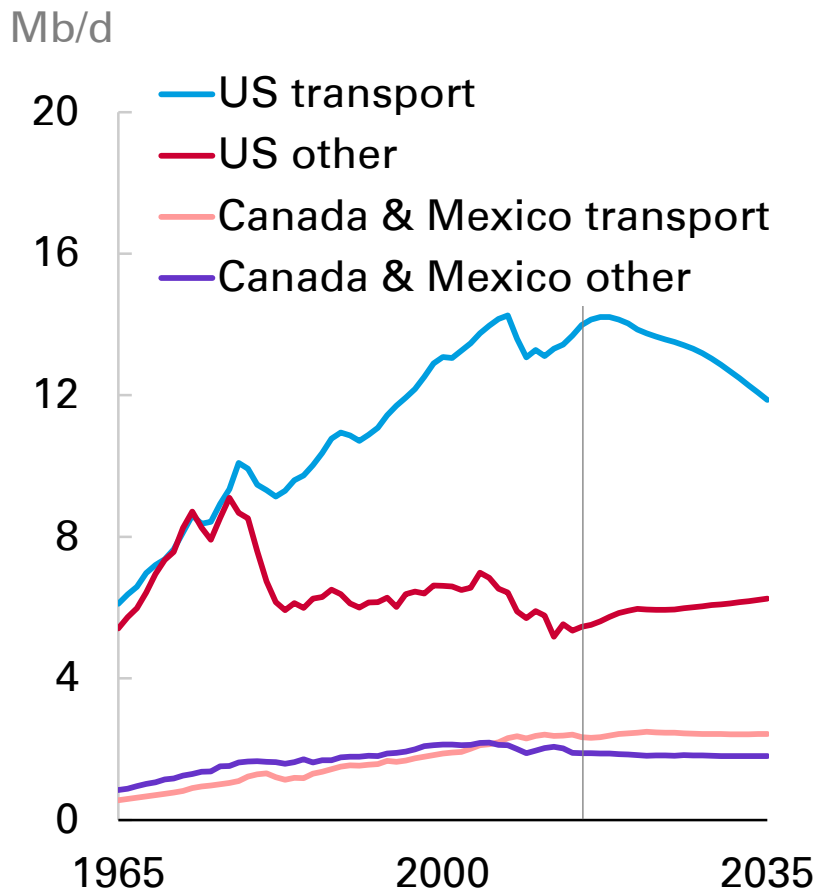
Base case

Fuel by fuel detail

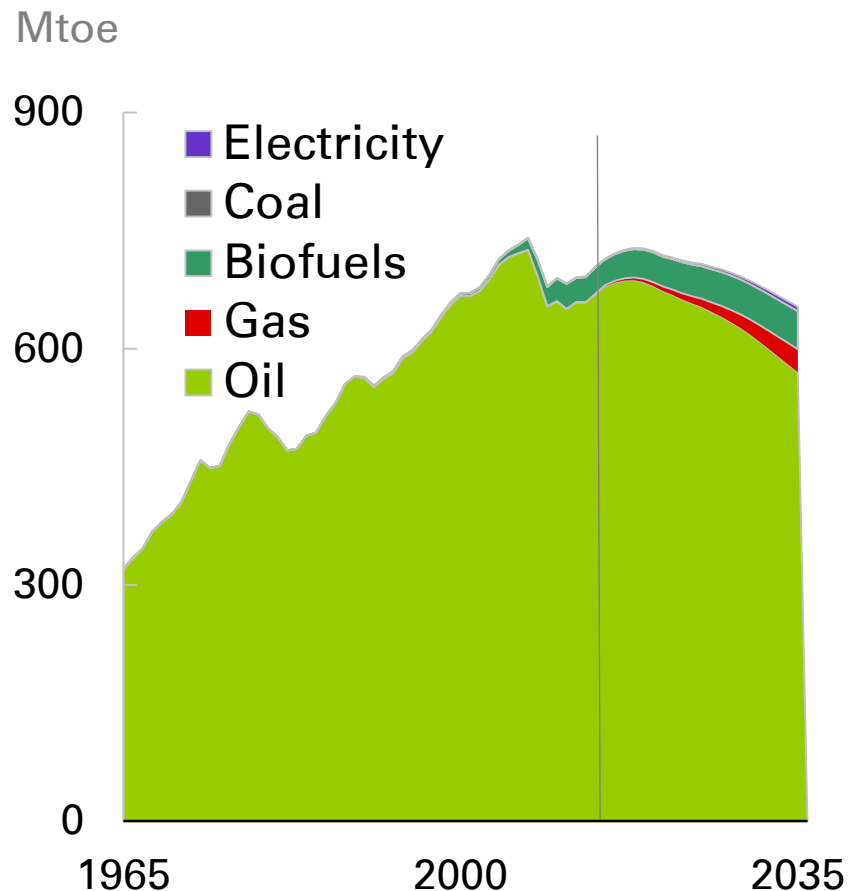


North American liquids demand declines...

Liquids demand by sector



Transport demand by fuel





...lead by a decline in transport demand

- Liquids consumption (oil, biofuels, and other liquids) is expected to decline by 1 Mb/d by 2035 to around 22 Mb/d, the lowest level since 1996. The decline in demand is driven by US transport demand, which declines by 1.8 Mb/d by 2035, while demand in Canada & Mexico remains flat.
- By sector, transport accounts for 64% of total North American liquids demand in 2035, down from 69% in 2014. Within the transport sector, oil continues to dominate (87% in 2035). The share of non-oil alternatives increases from 5% in 2014 to 13% in 2035, with natural gas the fastest growing transport fuel (16.7% p.a.).
- Industry is the only sector where liquids fuel demand grows, especially in petrochemicals. Demand in industry grows by 1.2 Mb/d by 2035.



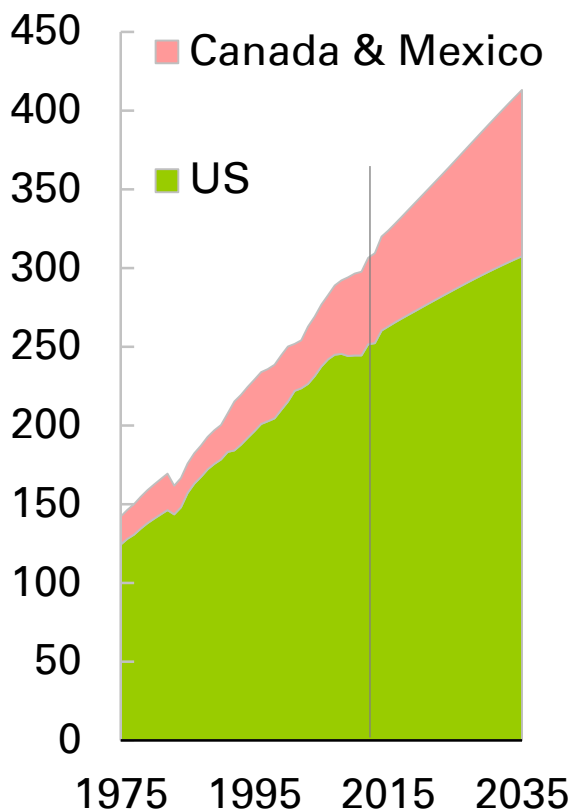
Vehicle numbers continue to grow over the Outlook...

Vehicle fleet

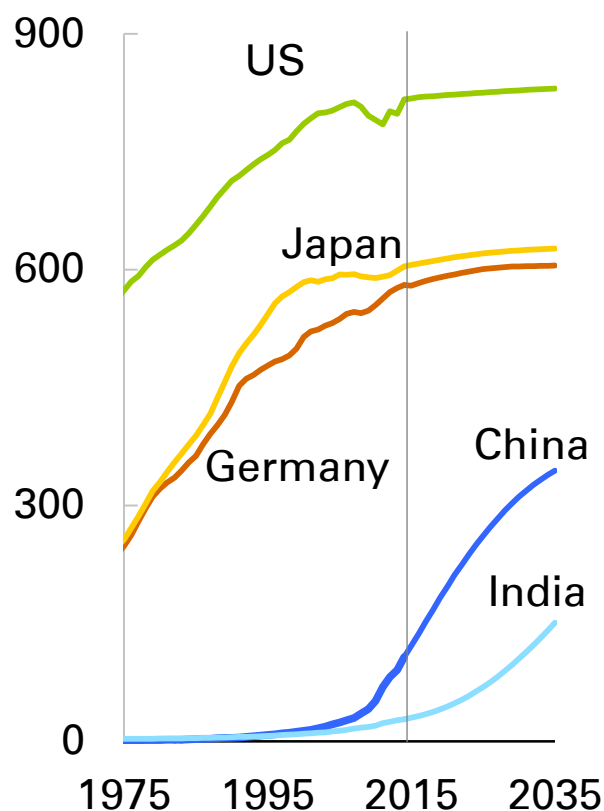
Vehicle ownership

Fuel economy of new cars

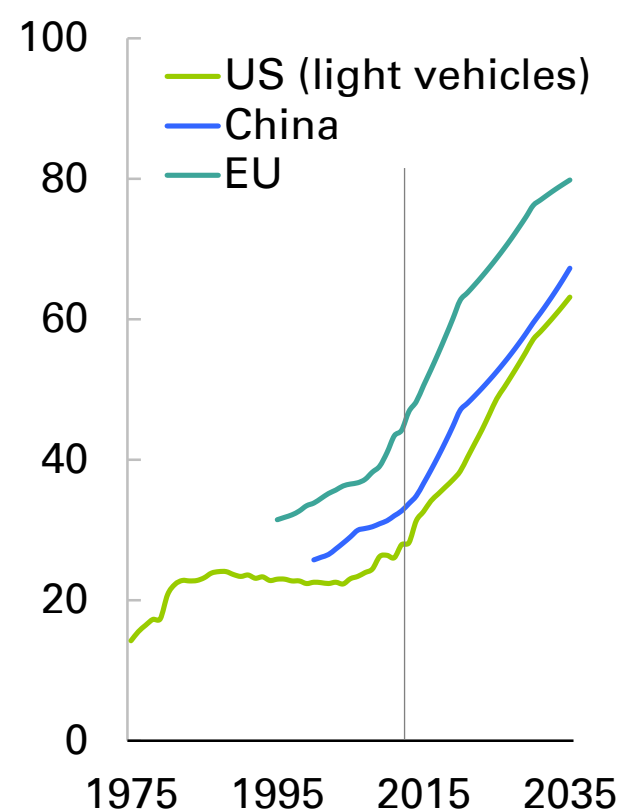
Million vehicles



Vehicles per 1000 people



Miles per gallon





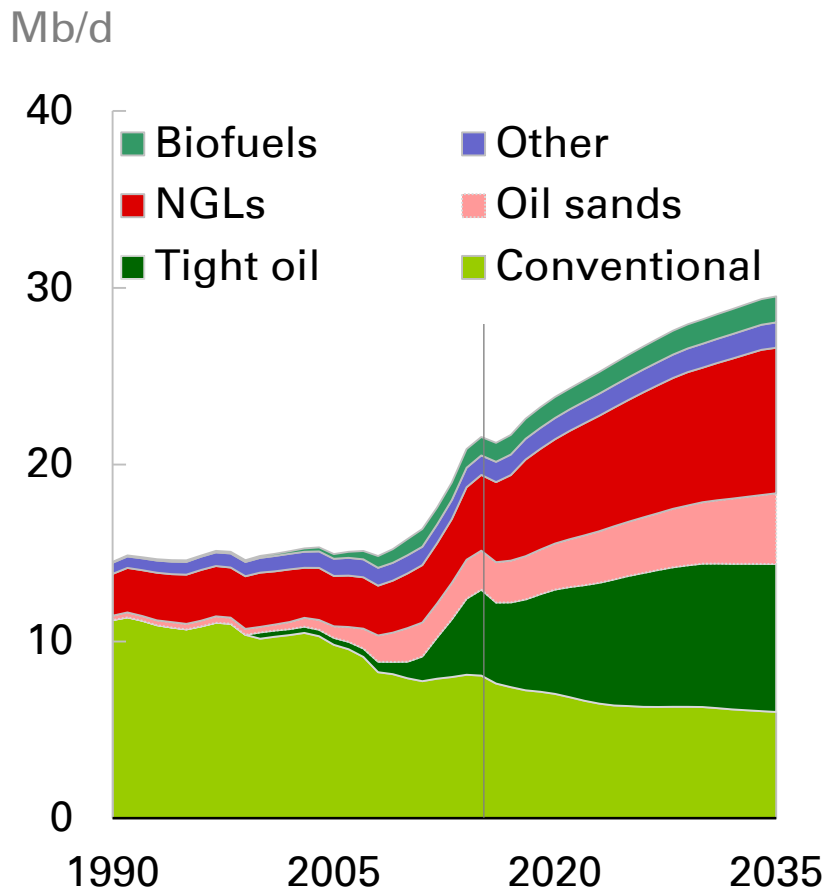
...and fuel economy of new cars improves greatly

- The North American vehicle fleet (commercial vehicles and passenger cars) grows by nearly 30% over the Outlook, from around 320 million today to over 413 million by 2035.
- But with more rapid growth elsewhere, North America accounts for 17% of the global vehicle fleet in 2035, compared with 26% today.
- Efficiency gains are likely to accelerate over the Outlook, with US light vehicle fuel economy forecast to improve by 3.4% p.a. between 2014 and 2035, up from an average of 1.6% p.a. over the past twenty years.
- As a result, in 2035, an average North American passenger car is expected to achieve nearly 50 miles per gallon, compared with only 23 miles per gallon today.

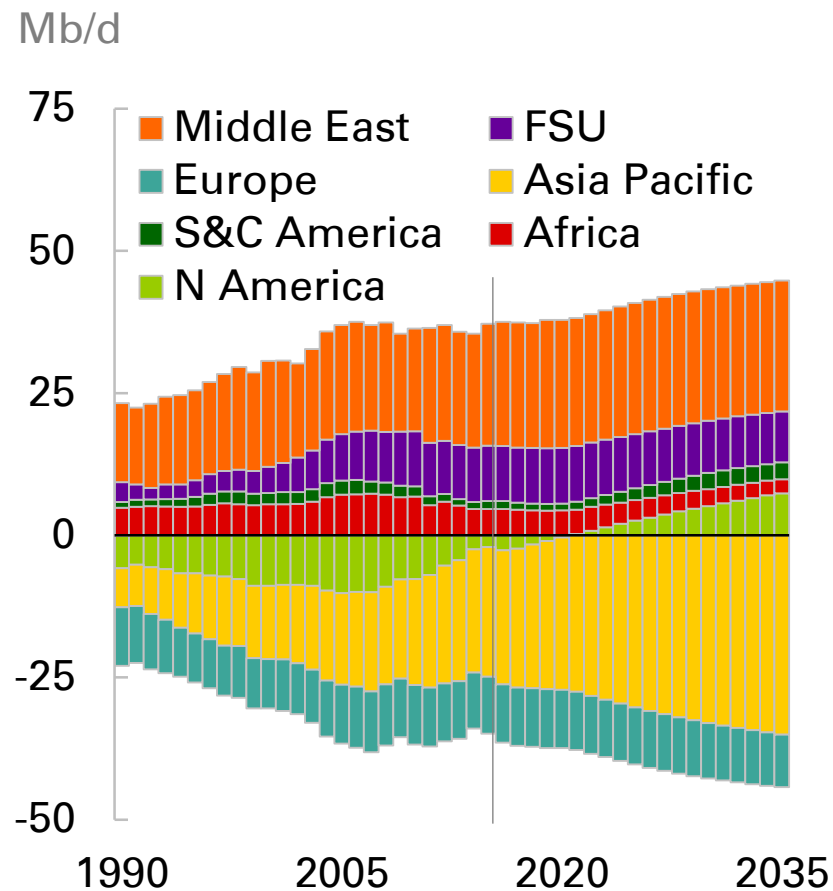


North American liquids supply grows strongly...

Liquids supply by type



Regional net balances





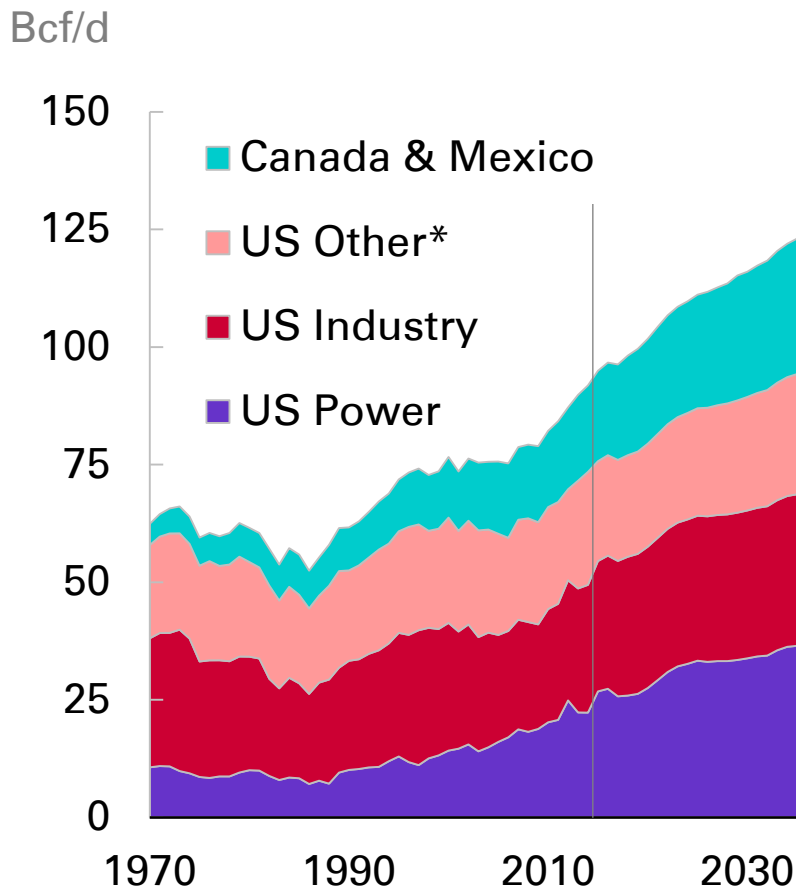
...shifting the global pattern of supply and regional trade

- North American liquids supply expands by nearly 9 Mb/d by 2035. Growth is driven by US tight oil (4 Mb/d), NGLs (4 Mb/d), and Canadian oil sands (2 Mb/d).
- By 2035, North America supplies 26% of global liquids supply, compared to 22% today.
- The shifting pattern of global demand and supply cause regional oil imbalances to shift and become more concentrated.
- In particular, the increase in tight oil production, coupled with declining demand, further reduces North America's reliance on oil imports, with the region set to become self-sufficient by 2021. The removal of the US crude export ban helps this adjustment process.
- In contrast, Asia's dependence on oil imports increases significantly, accounting for virtually all of the growth in global imports over the Outlook and for nearly 80% of inter-regional net imports by 2035.



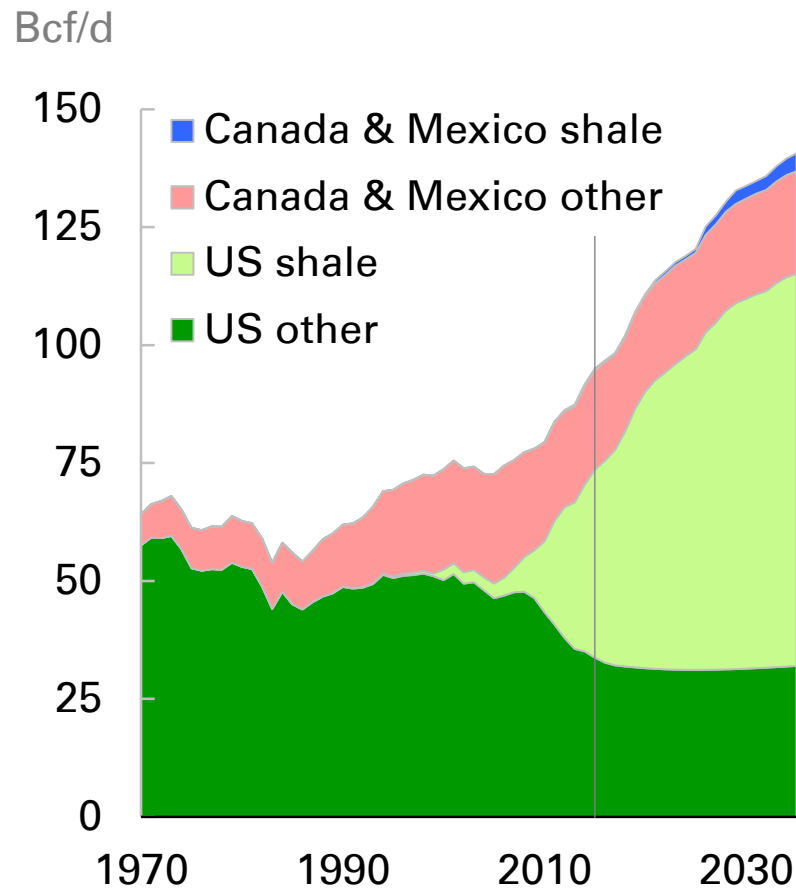
Demand for natural gas grows strongly...

Demand by sector



* Includes transport

Production by type





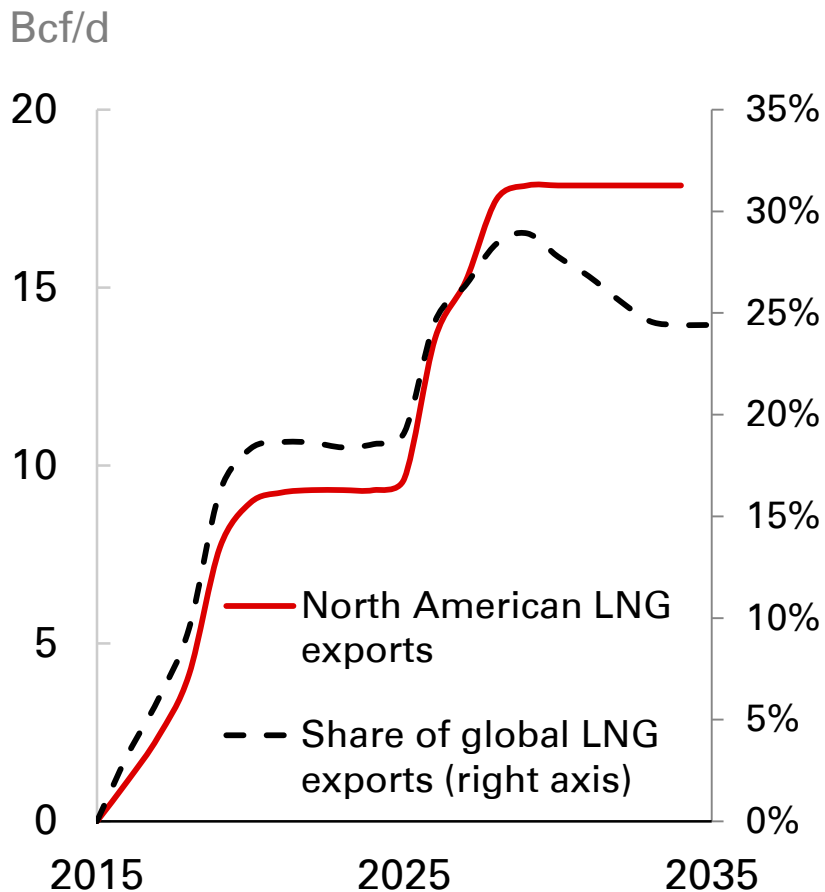
...while US shale gas drives supply growth

- Demand for natural gas grows by 1.4% p.a., making it the only growing fossil fuel over the Outlook. This robust growth is helped by ample supplies and supportive environmental policies.
- US demand is expected to grow by almost 21 Bcf/d by 2035, with power generation increasing by 14 Bcf/d, industry by 5 Bcf/d, and transport by 3 Bcf/d, while “other” declines by 1 Bcf/d. Demand in Canada & Mexico increases by 10 Bcf/d, driven mostly by power generation and industry.
- In North America, natural gas (and renewables) displace coal in power generation. The share of gas in power generation reaches 36% by 2035, compared to 22% today. Gas in industry has a 46% market share by 2035. Gas in transport reaches a 4% market share by 2035.
- Shale gas production continues to grow strongly in the US (48 Bcf/d); later in the Outlook shale gas production grows in Canada & Mexico (3 Bcf/d). Growth in shale gas offsets declines in regional conventional supplies (-2 Bcf/d). The US remains the largest producer of natural gas in the world, accounting for 25% of production in 2035.

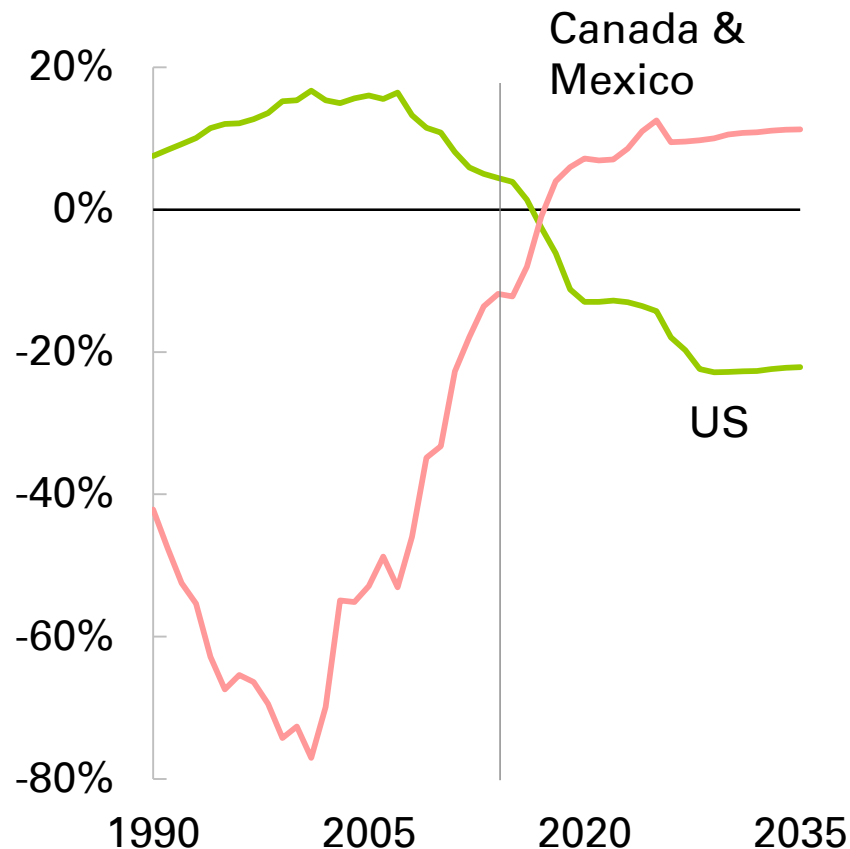


North America's gas exports grow...

North America LNG exports



Imports as share of consumption





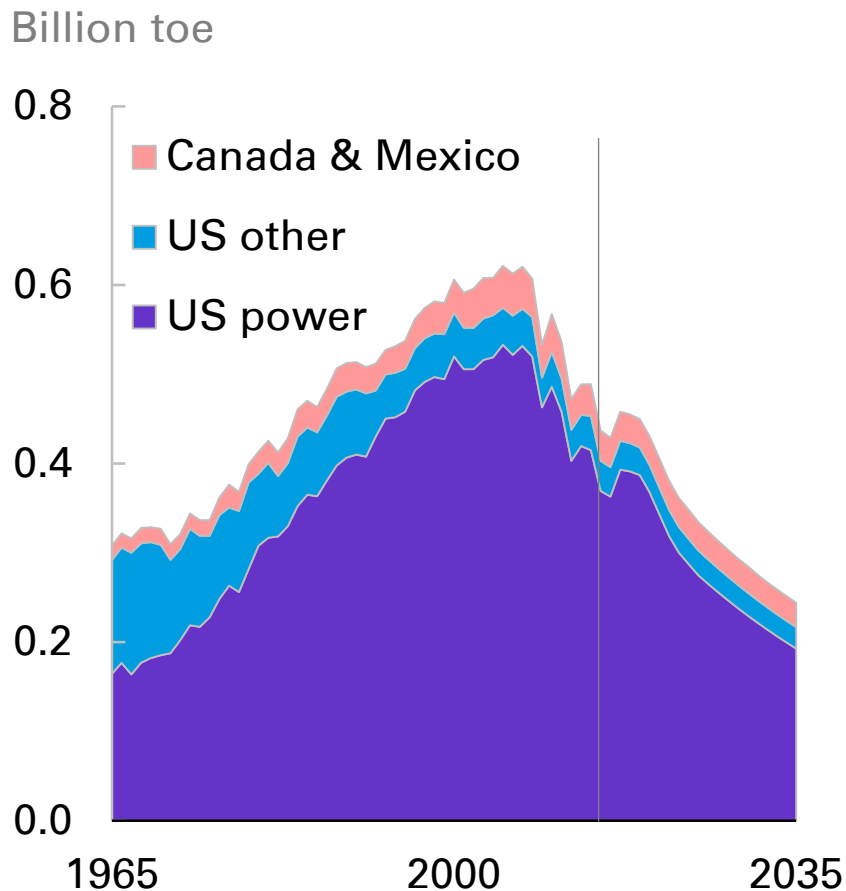
...with LNG playing an increasingly important role

- Exports of North American LNG grow over the Outlook and reach nearly 18 Bcf/d by 2035.
- North America's share of global LNG exports peak around 2030 at nearly 30%, and in 2035 North American LNG exports account for a quarter of global LNG trade.
- The growth in LNG coincides with a significant shift in the regional pattern of trade. The US is likely to become a net exporter of gas later this decade, while the dependence of Europe and China on imported gas is projected to increase further.
- North America switches to being a net exporter. In particular, the US, supported by 135% growth in shale gas production, becomes a net natural gas exporter in 2017 and exports over 20 Bcf/d by 2035.
- In Canada & Mexico, imports as a share of consumption grow, reaching slightly more than 10% by 2035, due to rising Mexican imports.

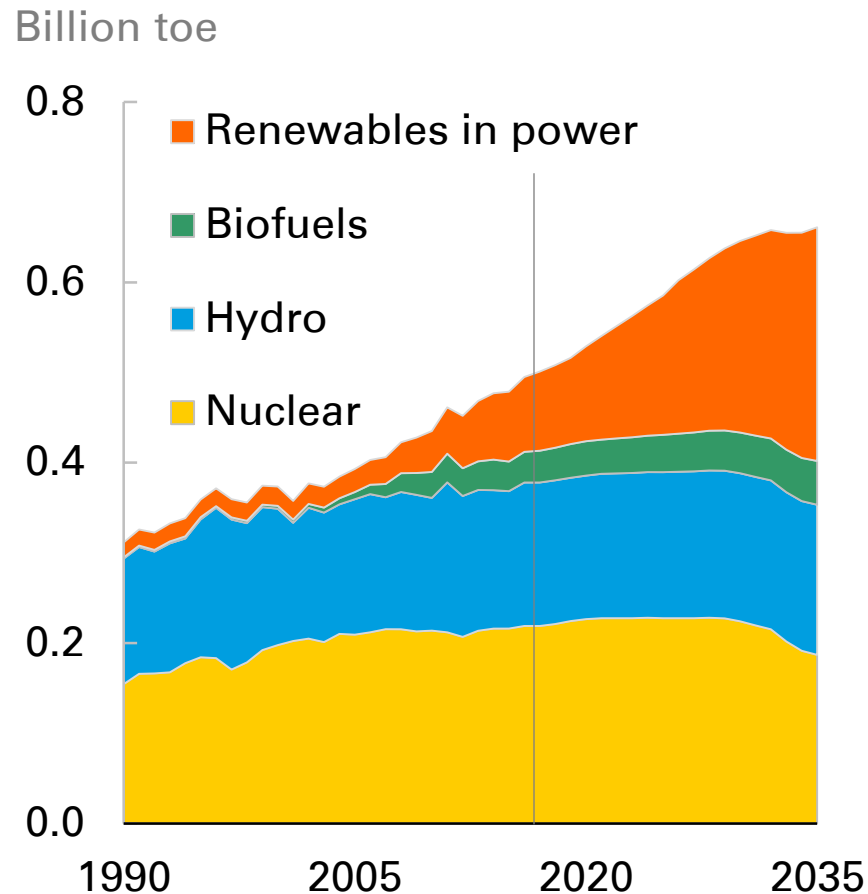


North American coal demand continues to fall sharply...

Coal consumption by sector



Non-fossil fuel demand





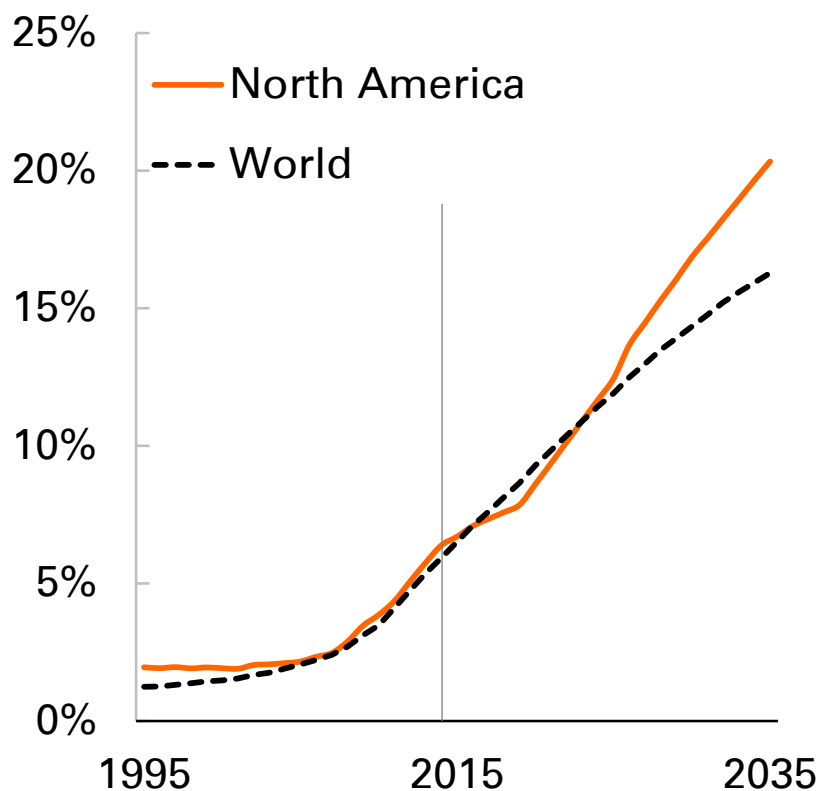
...while renewables and hydro expand during the Outlook

- North American coal consumption declines by 3.3% p.a. over the Outlook, reaching its lowest level in our dataset. Coal demand is over 50% lower in 2035 than it is today, despite a 7% increase in overall power demand (as natural gas and renewables gain market share).
- In the US, competitively-priced natural gas, rapidly growing renewables, and regulatory pressures on coal-fired power plants all limit coal's use. By 2023 natural gas overtakes coal as the dominant fuel in power generation and coal's market share declines from 44% today to 19% by 2035.
- North American renewables (including biofuels) grow by 5.1% p.a. from 2014 to 2035. Renewables in power generation reach a 20% market share by 2035, while biofuels reach a 7% share in transport.
- Nuclear generation declines by 13% by 2035 due to plant retirements at the end of the Outlook, while hydro increases by 8% by 2035.

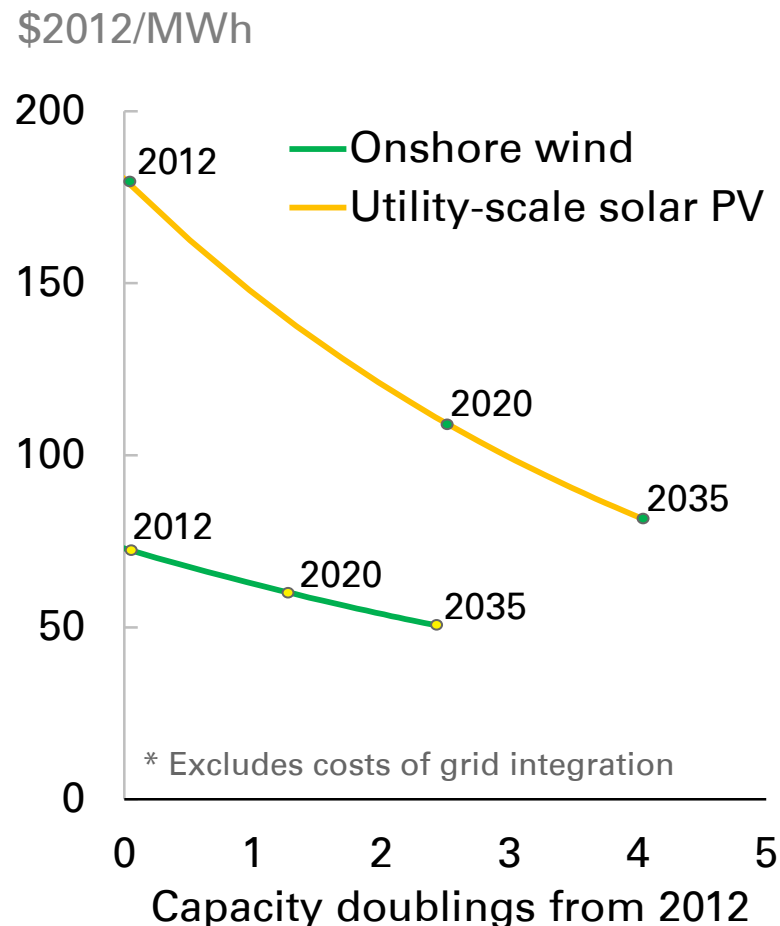


Renewables continue to grow rapidly...

Renewables share of power generation



Levelized cost* of electricity in North America





...supported by significant cost reductions

- Renewables are projected to be the fastest growing fuel (5.1% p.a.), almost tripling over the Outlook.
- All of the increased demand in the power sector can be met by the increase in renewables. Their share in power generation increases to 20% by 2035, compared to a global average of 16%. Renewables in power generation grow by 6.2% p.a. from 2014 to 2035.
- The rapid growth in renewables is supported by the expected pace of cost reductions: the costs of onshore wind and utility-scale solar PV are likely to fall by around 25% and 40% over the next 20 years.

Base case

Key issues

What drives energy demand?

The changing outlook for carbon emissions

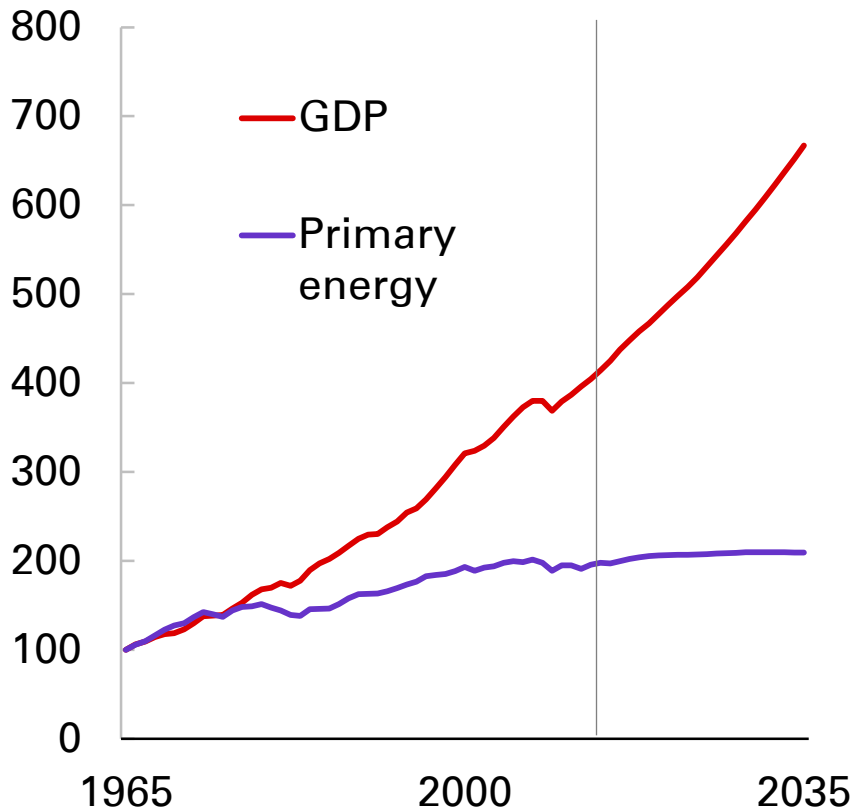
What have we learned about US shale?



Increases in energy demand are driven by economic growth...

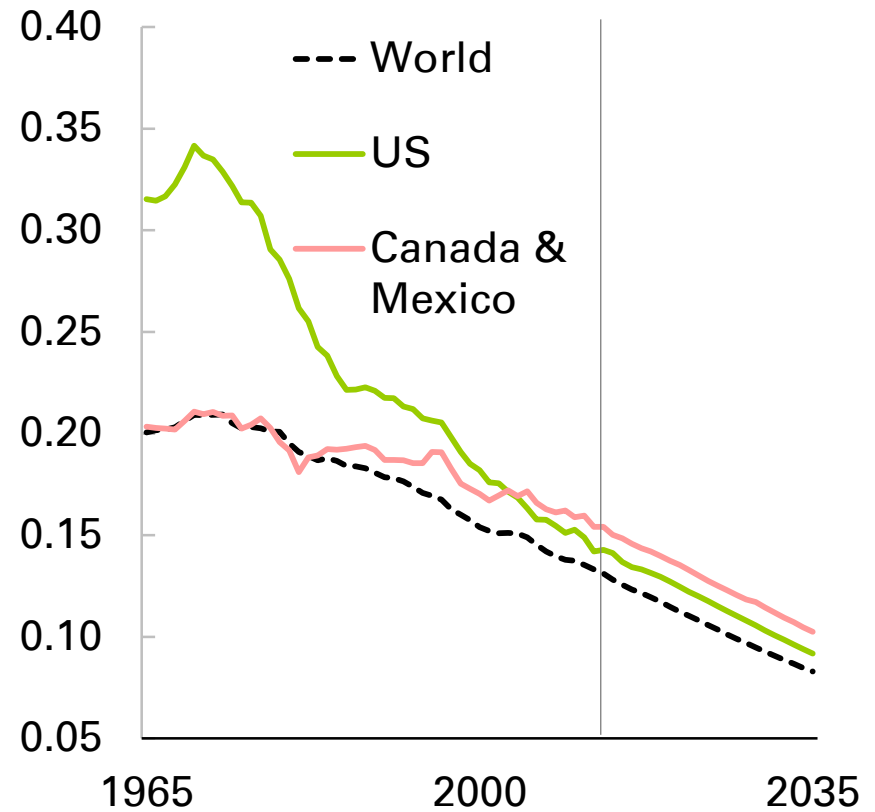
North America GDP and energy demand

Index (1965=100)



Energy intensity by region

Toe per thousand \$2010 GDP





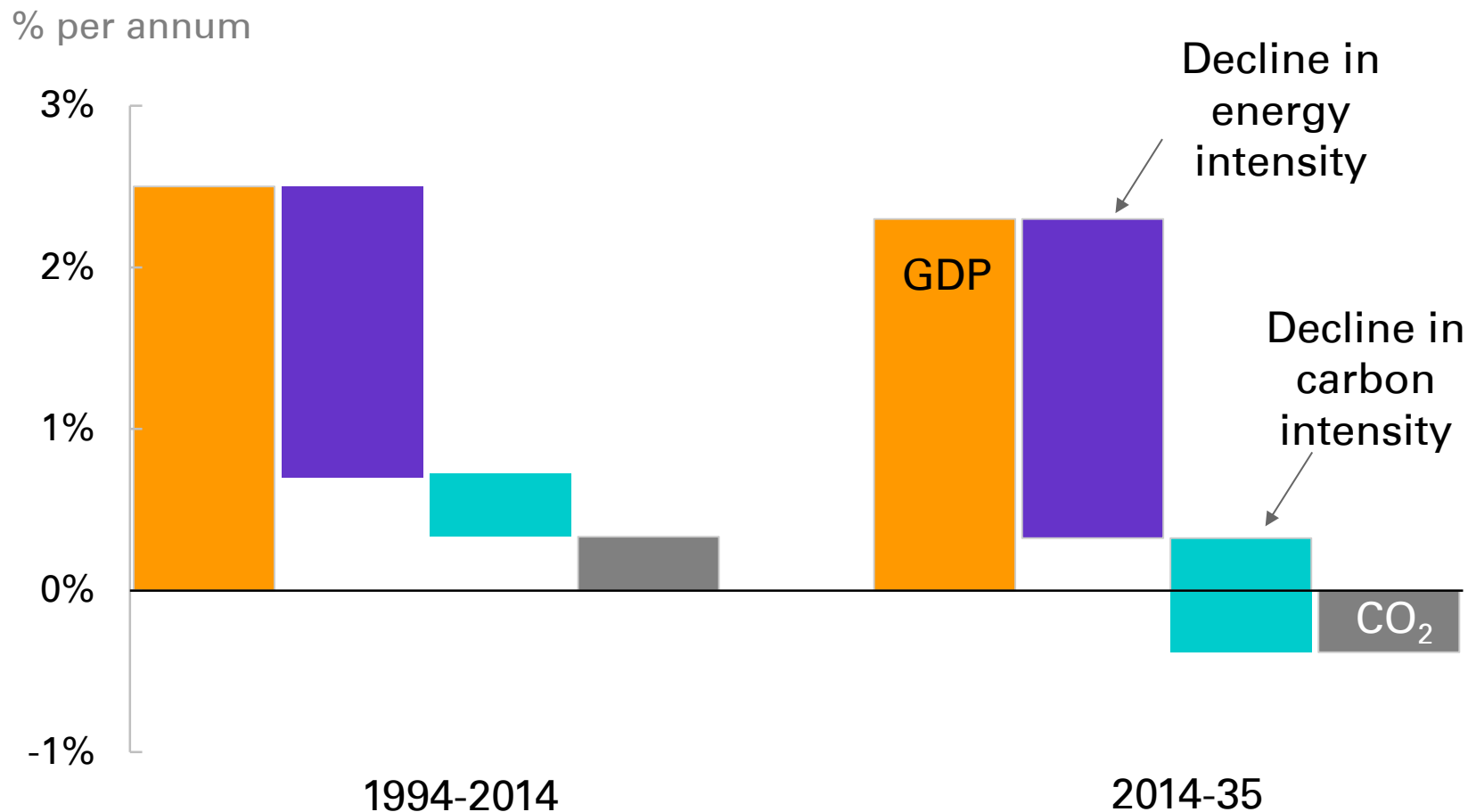
...offset by significant improvements in energy intensity

- As the economy grows, more energy is required to fuel the increased level of activity.
- However, rapid improvements in energy intensity – the amount of energy used per unit of GDP – mean that energy demand grows far less quickly than North American GDP: 6% versus 61%.
- North American energy intensity is projected to decline by 2% p.a. over the forecast period. This is faster than in any 20-year period in history since our data begins in 1965.



North American carbon emissions decline over the Outlook...

Decoupling emissions growth from GDP growth





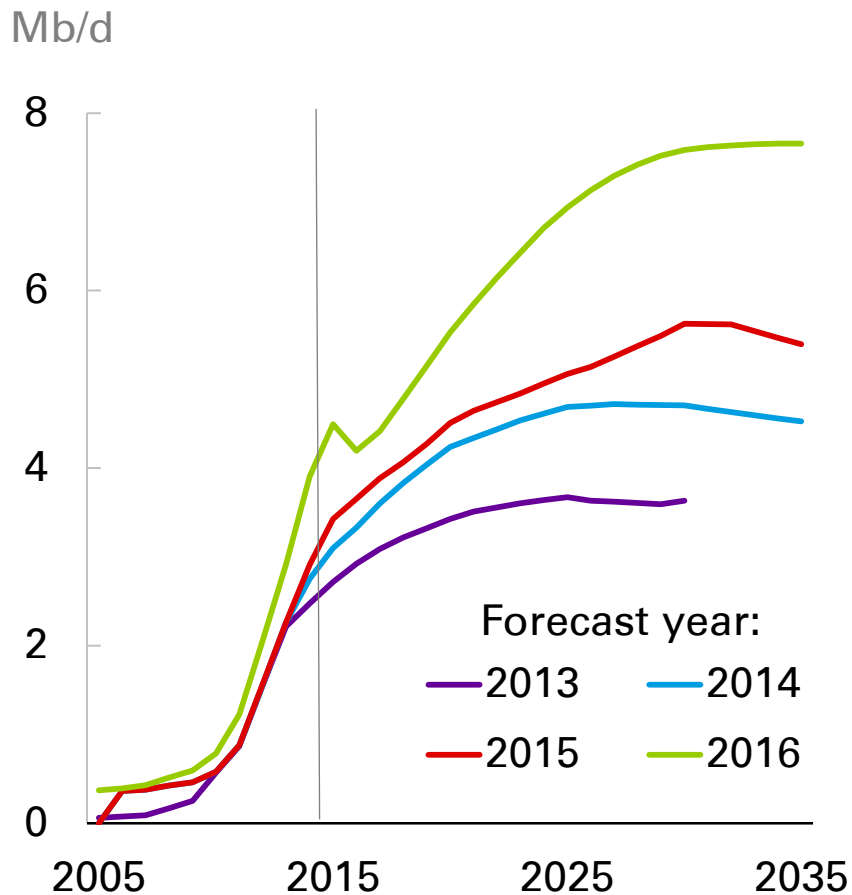
...driven by faster efficiency gains and the changing fuel mix

- North American carbon emissions are expected to decline by 0.4% p.a. over the Outlook compared to growth of 0.3% p.a. over the past 20 years.
- Given that GDP is projected to grow only slightly slower than the historical trend, this represents a significant degree of 'decoupling' of carbon emissions from GDP.
- This decoupling reflects significant increases in the expected pace of decline of both energy intensity (energy used per unit of GDP) and carbon intensity (carbon emissions per unit of energy consumption).
- The world is embarking on a transition to a lower-carbon energy system. The pledges made by participating countries in their Intended Nationally Determined Contributions (INDCs) ahead of the COP21 meeting in Paris, and the level of agreement reached in Paris, have increased our confidence that the world will achieve this break from past trends.
- The potential impact of an even sharper break with history, and a faster transition to a lower carbon world, is explored in the alternative case described later (pages 53-54).

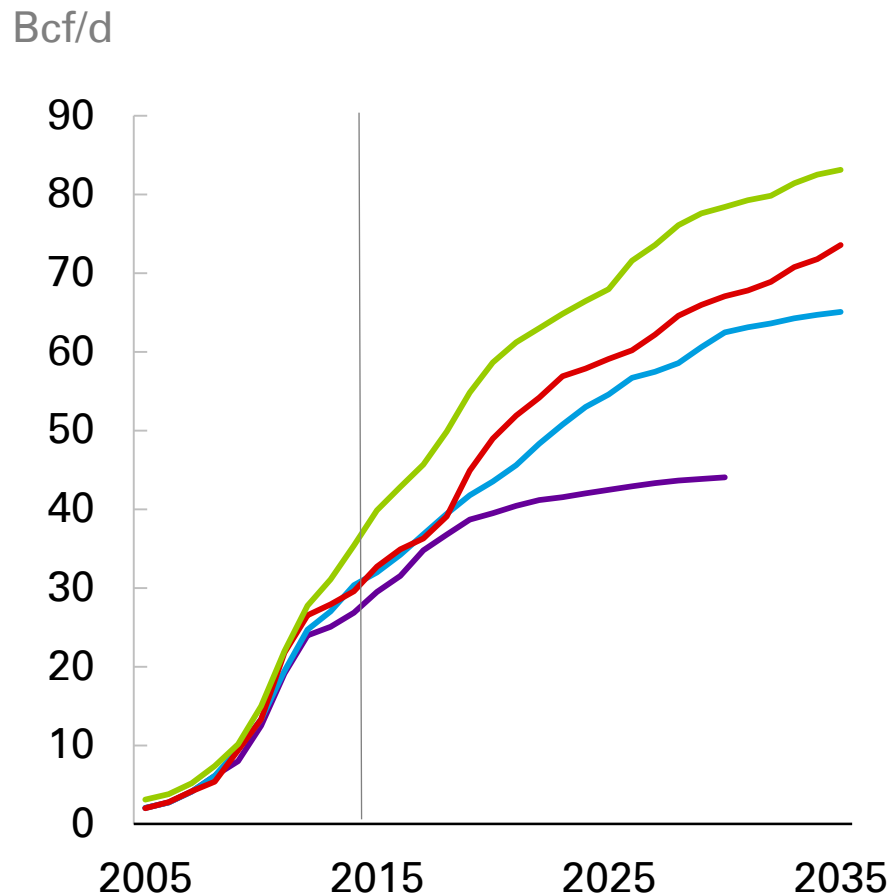


The outlook for US shale has been revised up repeatedly...

US tight oil forecasts



US shale gas forecasts





...as technology and productivity gains unlock new resources

- We have been repeatedly surprised by the strength of US tight oil and shale gas. Technological innovation and productivity gains have unlocked vast resources of tight oil and shale gas, causing us to revise the outlook for US production successively higher.
- In the 2013 Energy Outlook, US tight oil was projected to reach 3.6 Mb/d by 2030 – that level was surpassed in 2014. After a brief retrenchment due to low prices and falling investment, US tight oil production is now expected to plateau in the 2030s at nearly 8 Mb/d, accounting for almost 40% of total US oil production.
- US shale gas is expected to grow by around 4% p.a. over the Outlook. This causes US shale gas to account for around three-quarters of total US gas production in 2035 and almost 20% of global output.
- The past surprises in the strength of the shale revolution underline the considerable uncertainty concerning its future growth. This uncertainty is explored later in an alternative case (pages 55-58).

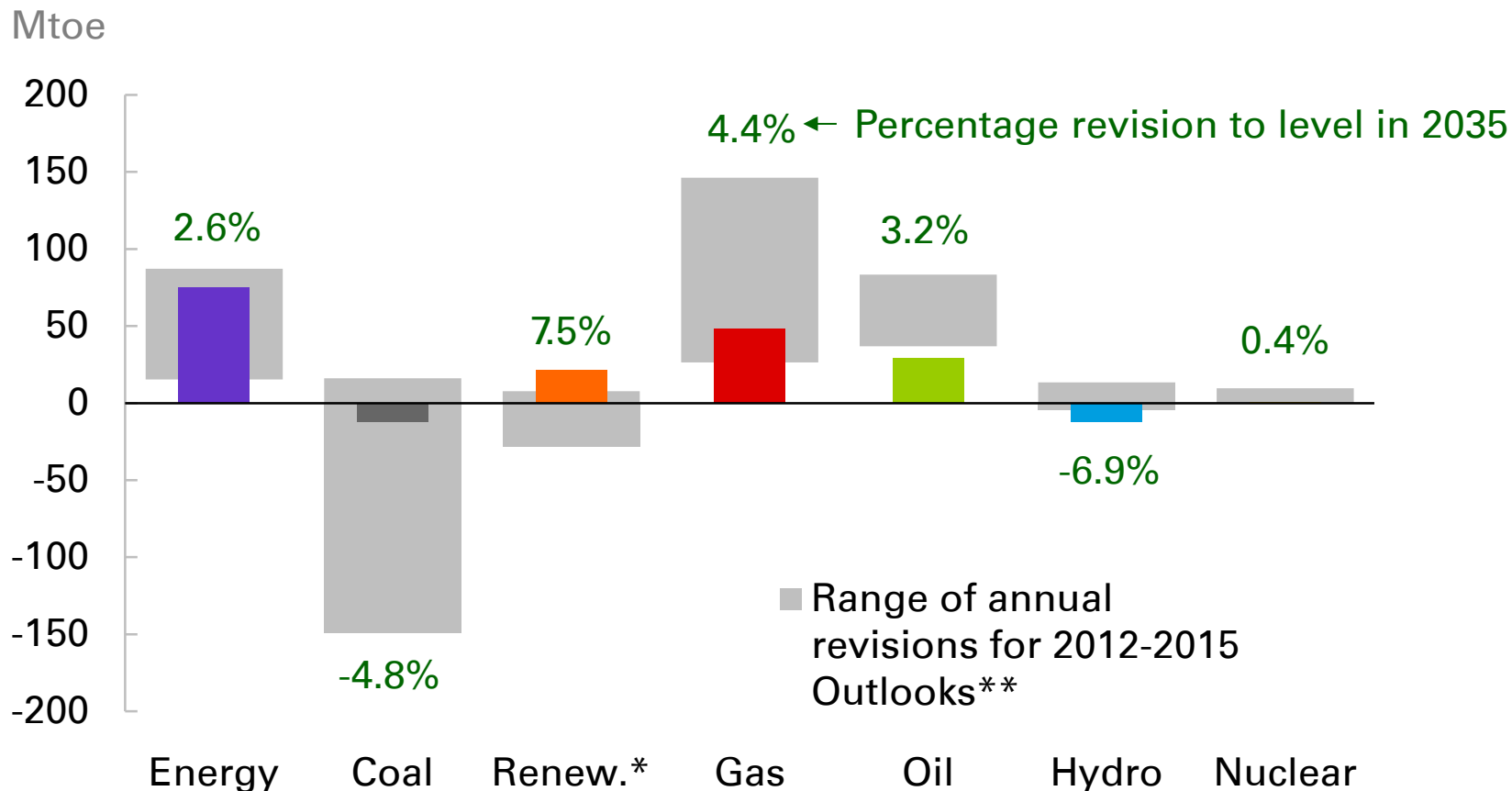
Base case

Main changes



North American energy demand in 2035 has been revised up...

Changes to level in 2035 relative to previous Outlook



* Renewables including biofuels

** Revision in final year of Outlook



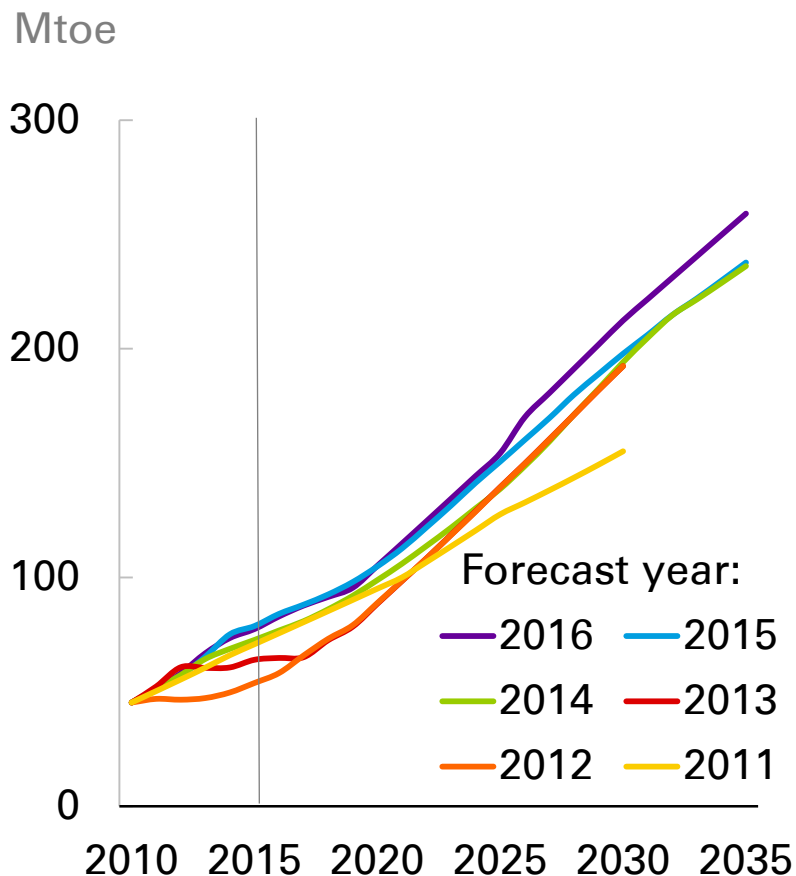
...with increases in renewables, gas, and oil

- North American energy demand in 2035 has been revised up by 2.6% (75 Mtoe) relative to the 2015 Outlook, while global demand has been revised down by nearly 1% (-150 Mtoe).
- Renewables have been revised up by 7.5% (21 Mtoe) – the largest revision in percentage terms – driven by faster-than-expected cost reductions, particularly for solar, and the anticipation of more supportive environmental policy.
- North American gas consumption has been revised up by around 4% by 2035 on the basis of an upward revision to our North American production forecast, in particular US shale gas.
- Oil demand is revised up by 3.2% (29 Mtoe) as lower oil prices drive higher consumption.
- The downward revision to coal demand by 2035 (-4.8%, -12 Mtoe) reflects competition from cheap natural gas and environmental and climate policies encouraging a faster switch to lower carbon fuels.



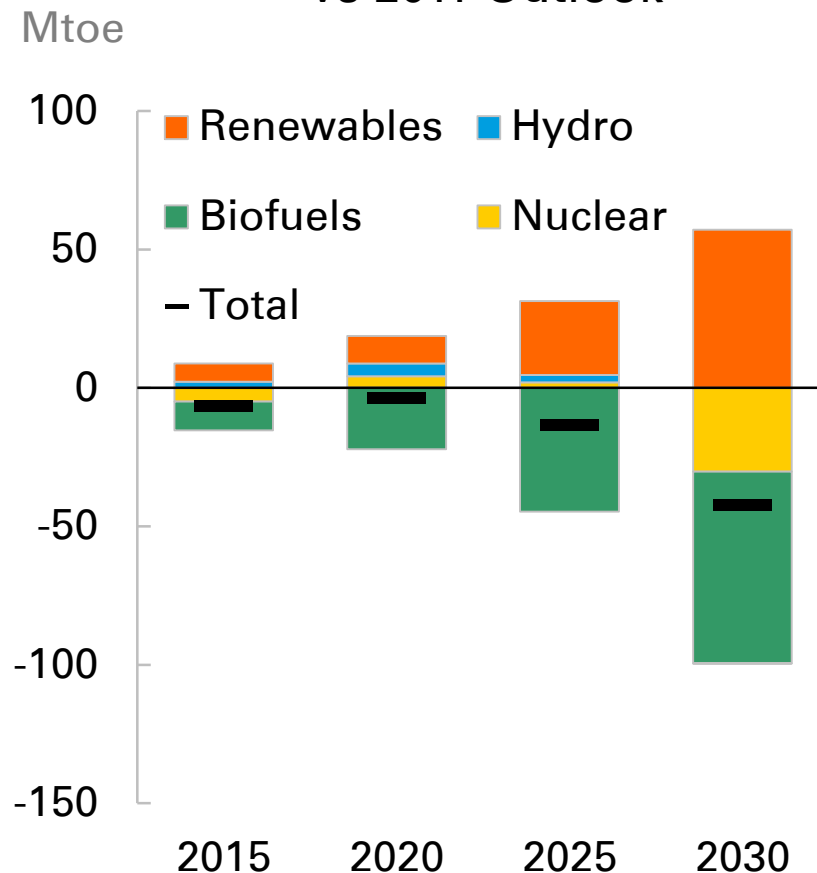
Renewables in power have been revised up repeatedly...

Renewable power forecasts



Note: Projected growth from each Outlook applied to latest 2010 data

Revisions to non-fossil fuels vs 2011 Outlook





...while other non-fossil fuels have been revised down

- Renewable power has been revised up every year for the past five years: renewables in 2030 are projected to be over 35% higher than expected in 2011.
- These upward revisions reflect both higher-than-forecast outturns in recent years, and our increasing confidence in future growth. Faster-than-expected cost reductions, more rapid deployment, and widening policy support have all contributed to the reassessment of future growth prospects.
- Despite these upward revisions to renewable power, the expected level of total non-fossil fuels in 2030 is actually lower than in the 2011 Outlook, reflecting weaker prospects for nuclear energy and biofuels.
- The downward revision to nuclear energy is due to changing views on the timing of expected plant retirements. The lower profile for biofuels reflects both slower-than-expected technological progress on advanced biofuels and weaker adoption in transport fuel.

Key uncertainties

Slower global GDP growth

Faster transition to a lower-carbon world

Shale oil and gas have even greater potential



Exploring the impact of alternative assumptions...

Case 1: Slower global GDP growth

Case 2: Faster transition to a lower-carbon world

Case 3: Shale oil and gas have even greater potential



...illustrates some of the uncertainties around the Outlook

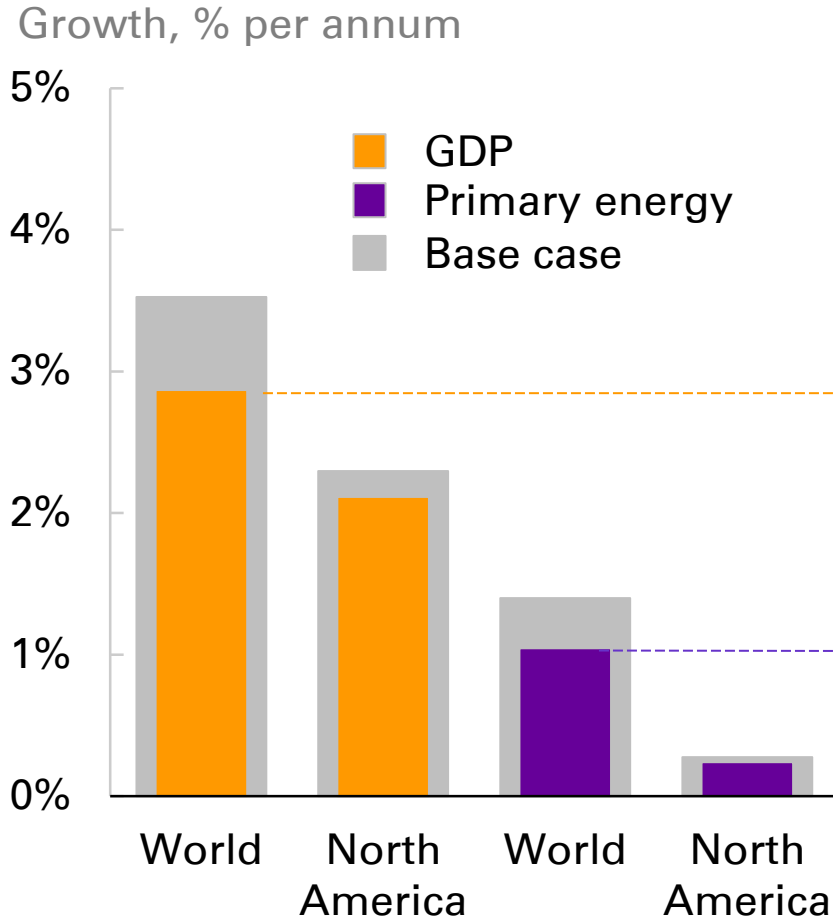
- The base case in the Outlook presents the single 'most likely' path for energy demand and the various fuels over the next 20 years. As such, it helps to highlight the main trends and forces that are likely to shape energy markets over the next two decades.
- But there are of course many risks and uncertainties surrounding the base case. It is possible to explore some of these uncertainties by varying a few of the key assumptions and judgements underpinning the base case and assessing their impact.
- We explore three key uncertainties, which are described in more detail in the following pages. This is not intended to be an exhaustive list, but these alternative cases provide useful insights into how varying some of the key assumptions might affect the projected trends.

Beyond our forecasting horizon, technological advances could radically alter the choices available to us. The role of technology in shaping the energy landscape over the next 30 to 40 years is explored in the BP Technology Outlook.

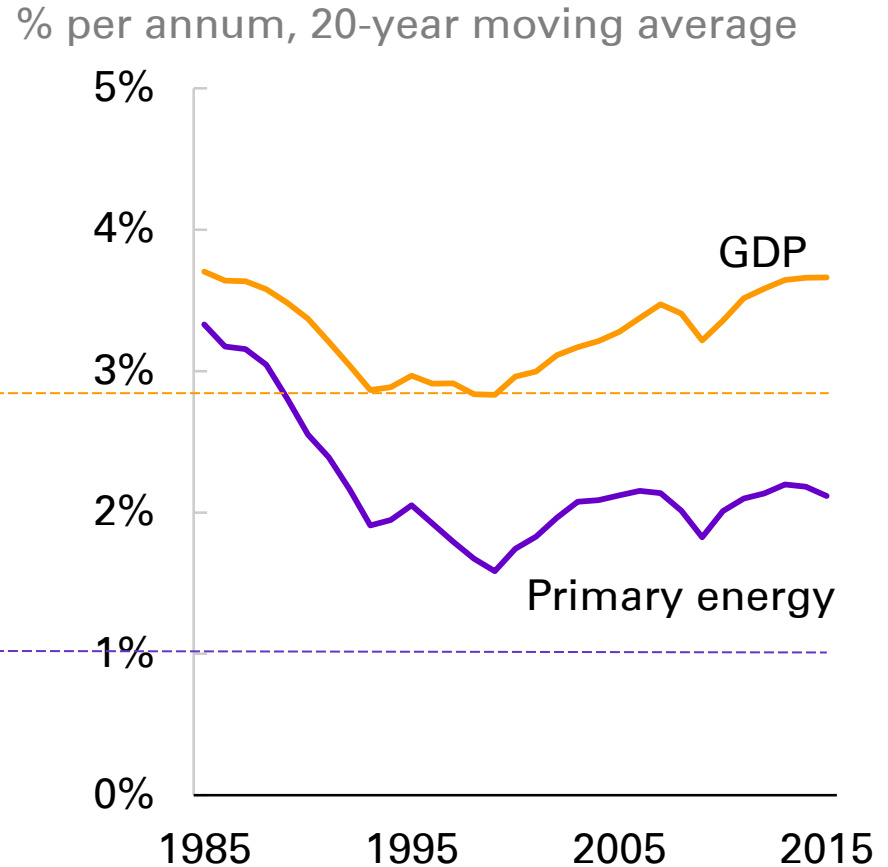


Case 1: Slower Chinese and global GDP growth...

Projected growth rates, 2014-35



Historical growth rates



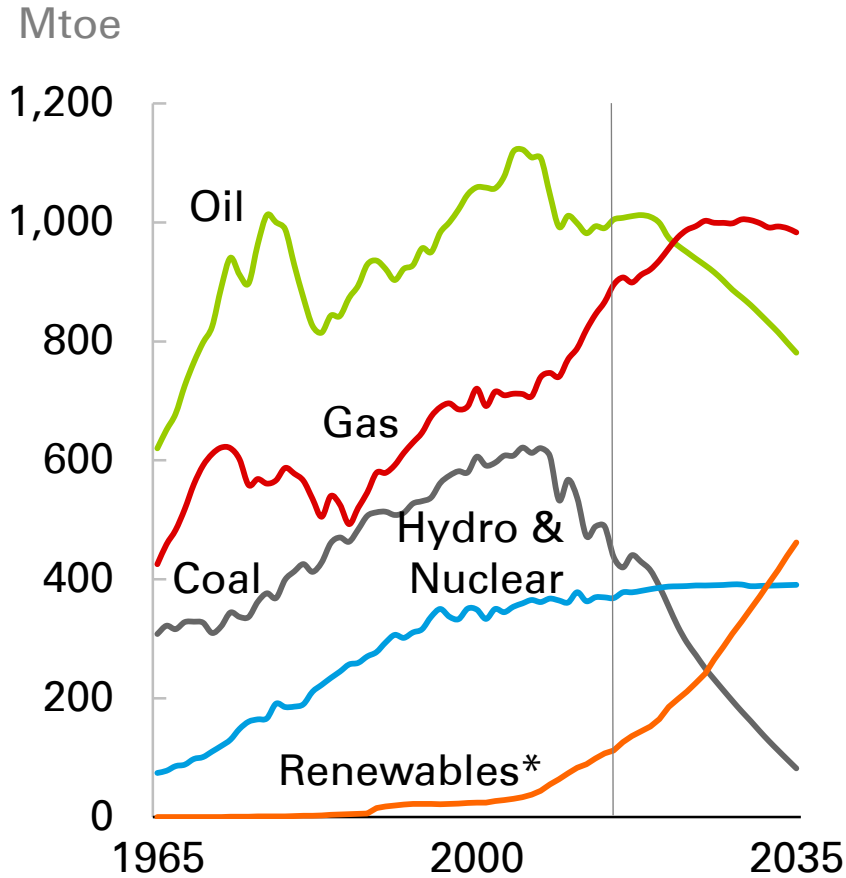


...has a significant impact on global energy demand

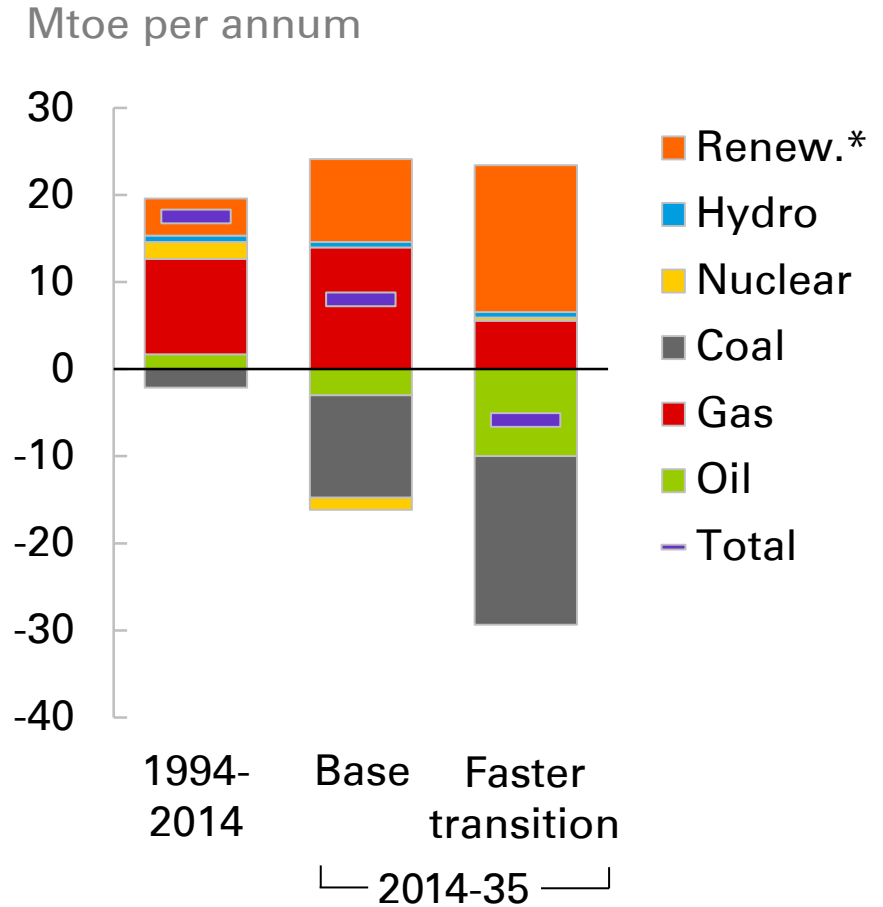
- The pace of growth in China and other emerging economies is a major source of uncertainty for global GDP growth and hence energy demand.
- The 'slower GDP growth' case assumes that China grows at 3.5% p.a. over the Outlook, compared with nearly 5% p.a. in the base case.
- Allowing for trade and other spill-over effects, this causes world GDP to grow at a little below 3% p.a., 0.5% p.a. below the base case and comparable to one of the weakest periods of economic growth seen in recent history. Since North America is not as strongly connected to China, growth slows slightly, from 2.3% p.a. in the base case to 2.1% p.a..
- The slower growth of global GDP reduces the overall increase in energy demand by around a third relative to the base case. North American energy demand grows at a slightly slower pace, 0.2% p.a. vs 0.3% p.a. in the base case.

A faster carbon transition has a significant impact...

Consumption by fuel



Annual demand growth by fuel



*Includes biofuels



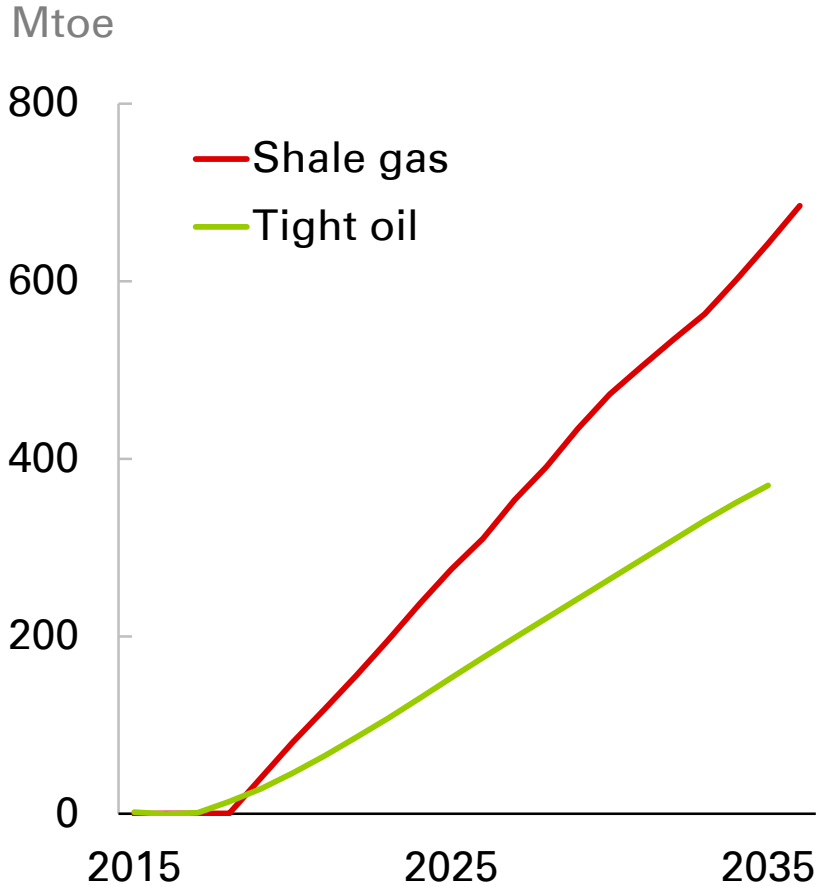
...on both overall energy demand and the fuel mix

- The speed of transition to a lower-carbon energy system is a key source of uncertainty affecting the Outlook. The 'faster transition' case is based on a rising carbon price, tougher vehicle standards and significant energy efficiency.
- Total North American energy demand declines in the 'faster transition' case, (-0.2% p.a. versus 0.3% p.a. in the base case). Fossil fuels decline by 21% over the Outlook and their share in total energy falls from 83% today to less than 70% by 2035.
- Natural gas still increases in the 'faster transition' case, accounting for a little over a third of total energy demand in 2035. The rate of decline in oil consumption speeds up (-1.1% p.a. versus -0.3% p.a. in the base case). Coal consumption suffers the most, falling by more than 80% to its lowest level in our dataset going back to 1965.
- The big winner in the 'faster transition' case is renewables, with over a four-fold increase in output (8% p.a.). Renewables' share in the energy mix grow from 4% today to 17% by 2035 in the 'faster transition' case.

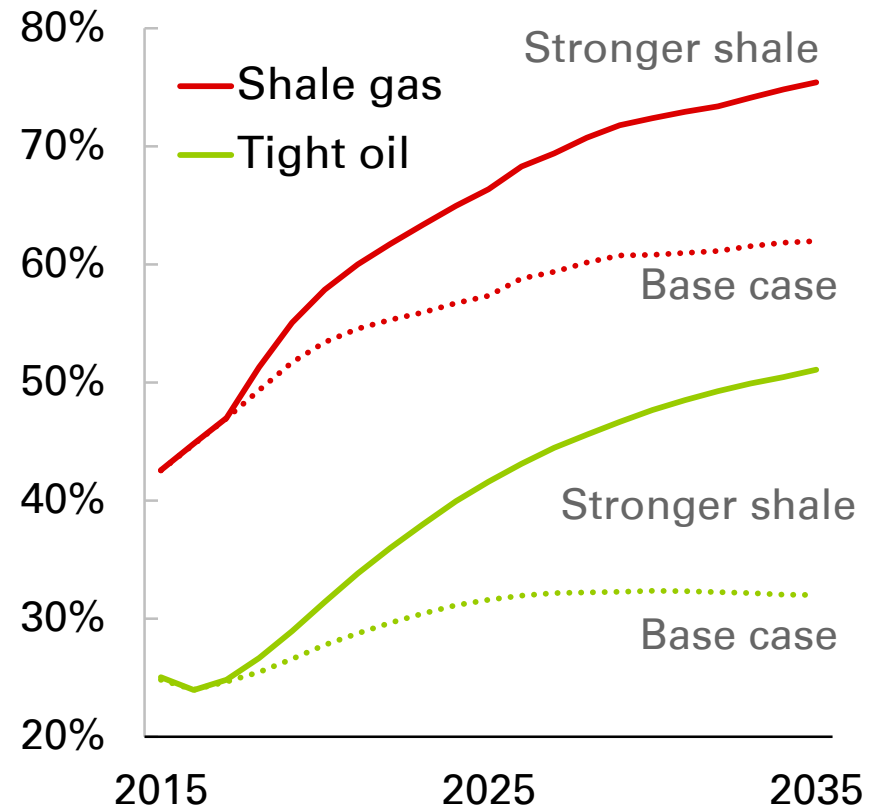


Case 3: Tight oil and shale gas having even greater potential...

Differences in supply from base case



Shares of total oil/gas production





...has significant implications for energy supplies

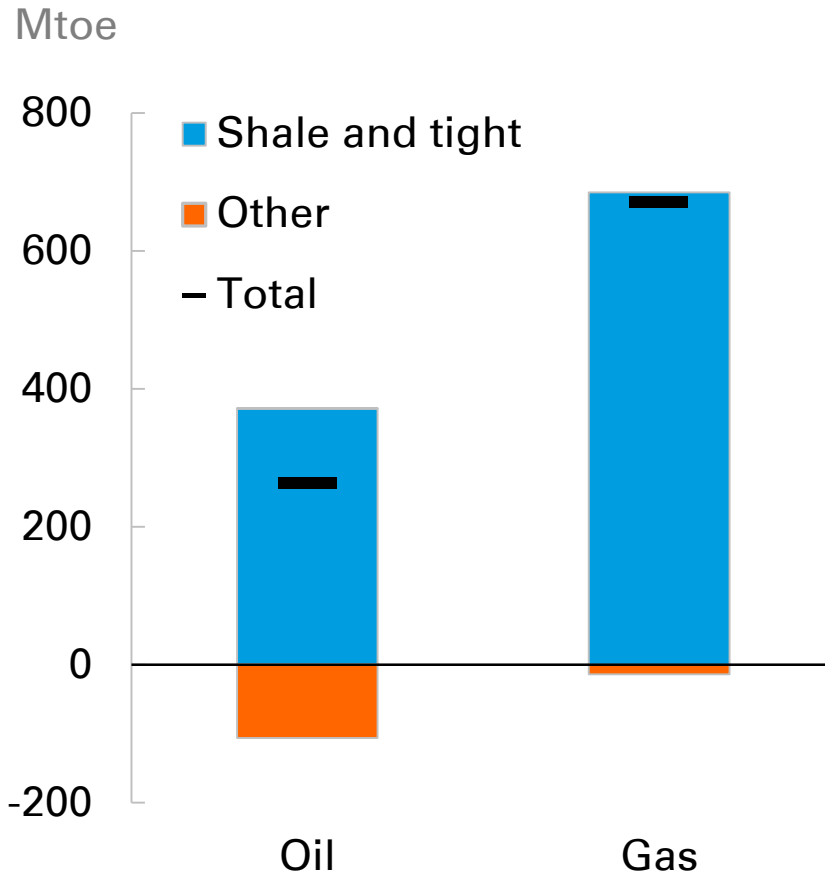
- The continued growth of tight oil and shale gas in the US, and the spread of shale outside North America, are key uncertainties in our Outlook.
- The 'stronger shale' case assumes global shale resources are significantly bigger than in the base case (in the US by 50% for oil and 30% for gas; elsewhere by 100% and 50%), and productivity is 20% higher by 2035.
- As a result, global supplies of tight oil and shale gas are much greater than in the base case. The higher weight of shale gas within gas supplies, and the greater ability of gas to substitute for other fuels, means the impact is more marked for shale gas than for tight oil.
- North American shale gas production is around 72 Bcf/d higher by 2035, with North American shale gas accounting for almost a third of global gas supplies in the 'stronger shale' case.
- North American tight oil output increases to 16 Mb/d by 2035, nearly twice its level in the base case, with its share of global liquids output reaching 14%.



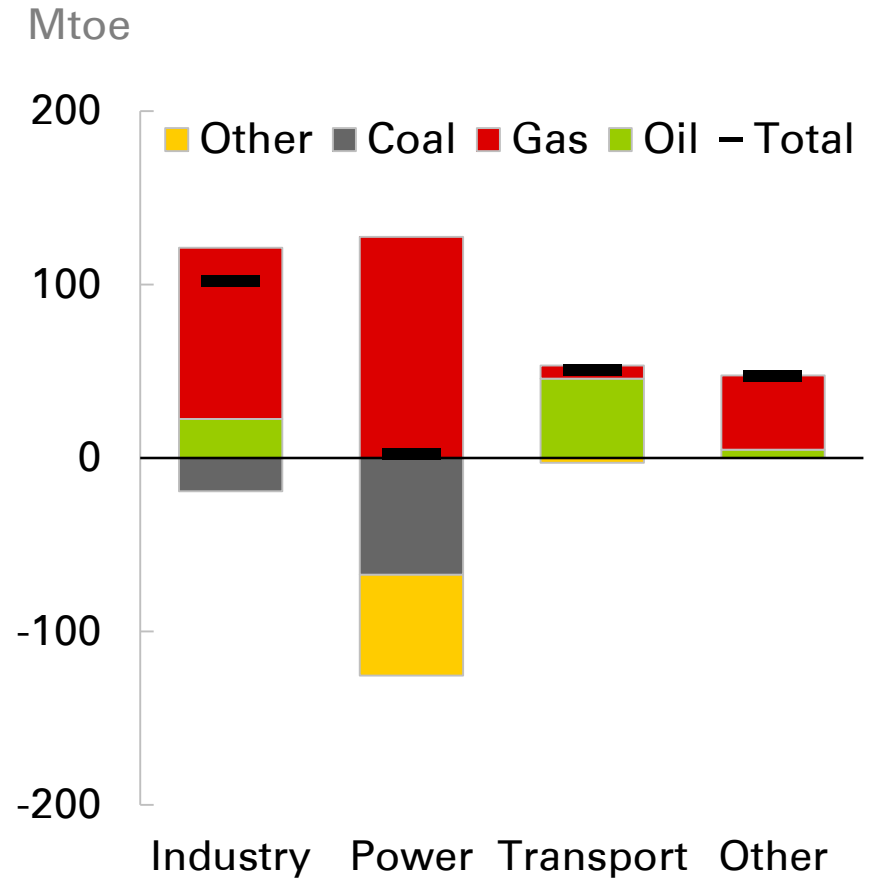
Higher shale output crowds out conventional production...

Differences from base case in 2035:

Oil and gas production



Consumption by fuel





...and demand for other fuels

- The stronger growth in shale oil and gas crowds out both conventional supplies of oil and gas as well as demand for other fuels.
- In the oil market, tight oil nearly doubles and is nearly 8 Mb/d higher by 2035 than in the base case, whereas total oil production is less than 6 Mb/d higher.
- In the gas market, shale and tight gas (included in the positive supply shock) are up by a combined 72 Bcf/d in 2035 versus the base case. Conventional gas and coal-bed methane supplies are down by 1.5 Bcf/d in aggregate, leaving total gas production 70 Bcf/d higher by 2035.
- On the demand side, fuel substitution is most pronounced in the power sector where gas competes with all other fuels. The main casualty is coal, which is 67 Mtoe lower by 2035 than in the base case; renewables are 58 Mtoe lower.

Conclusions

Conclusions

- North American demand for energy continues to rise slowly
 - with significant improvements in energy intensity
- Fuel mix changes significantly
 - coal and oil lose, renewables and gas gain
- North American carbon emissions decline
 - but global carbon emissions continue to increase without further policy changes



Annex

Key figures and fast facts



Key figures and fast facts

	Growth 2014-35 (p.a.)	Growth 2014-35 (cumulative)	2014 (share)	2035 (share)
Primary energy	0.3%	6%	100%	100%
Oil	-0.3%	-6%	35%	31%
Gas	1.4%	34%	31%	39%
Coal	-3.3%	-51%	17%	8%
Nuclear	-0.7%	-13%	8%	6%
Hydro	0.4%	8%	5%	6%
Renewables*	5.1%	186%	4%	10%
Population	0.8%	18%		
GDP (\$2010 PPP)	2.3%	61%		
Energy Intensity	-2.0%	-34%		
CO ₂ emissions	-0.4%	-8%		

* Includes biofuels



- Natural gas becomes the leading fuel in North American energy consumption around 2023 – increasing from 31% of total consumption in 2014 to 39% in 2035.
- Liquids consumption declines by 1 Mb/d to 22 Mb/d by 2035, the lowest level since 1996.
- Liquids production increases by 9 Mb/d to 30 Mb/d in 2035, to the highest level ever.
- The US achieves overall energy self-sufficiency by 2021 and oil self-sufficiency by 2030.
- North America accounts for 77% of global shale gas output in 2035 and 84% of global tight oil output.
- China surpasses the US as the world's leading oil consumer by 2035, but per capita oil consumption remains just 27% of the US.
- Renewables consumption (including biofuels) grows by 5.1% p.a. from 2014 to 2035 and their share in the fuel mix increases from 4% in 2014 to 10% by 2035.