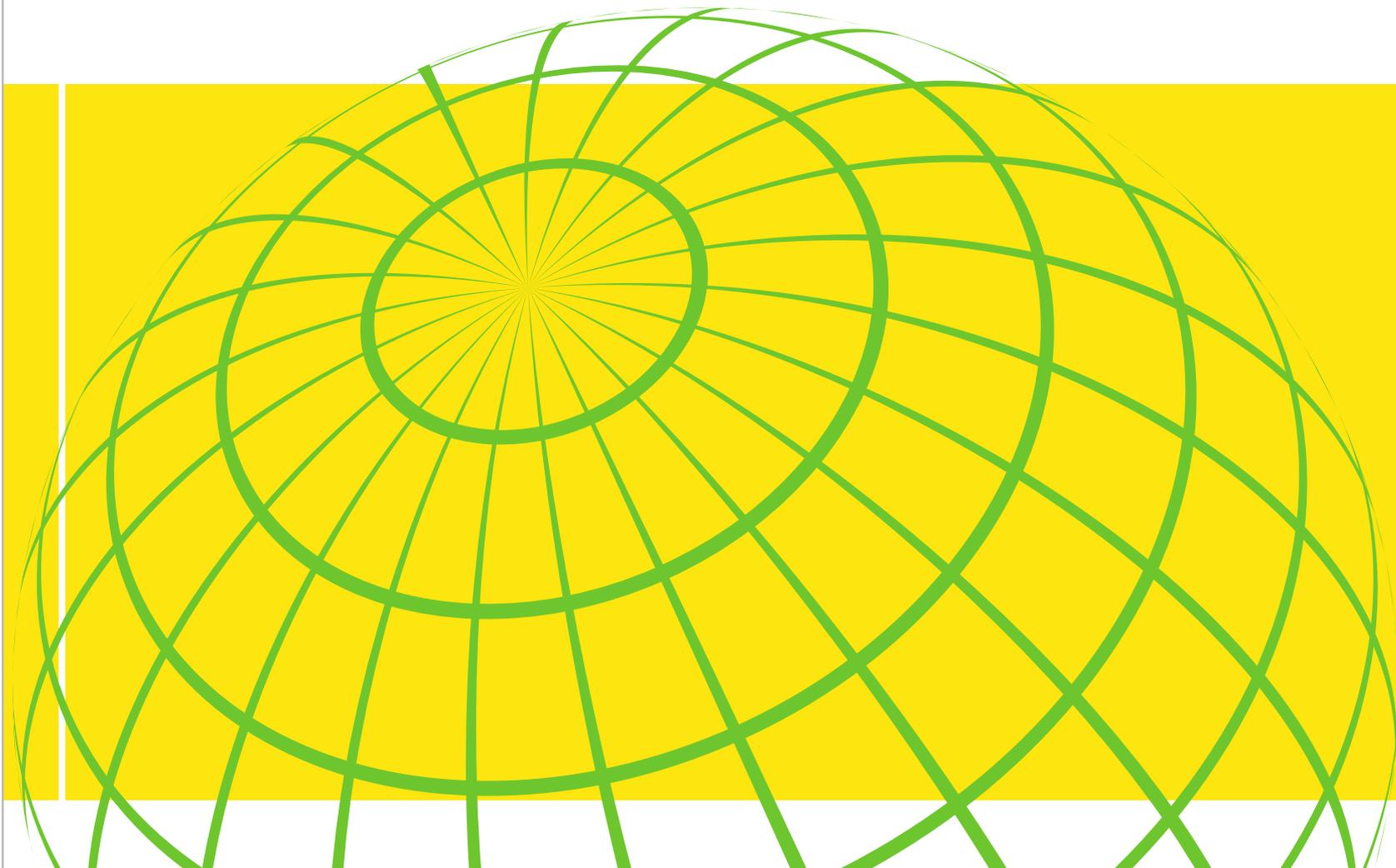


# BP Energy Outlook 2030

January 2013



# Disclaimer

---



This presentation contains forward-looking statements, particularly those regarding global economic growth, population growth, energy consumption, policy support for renewable energies and sources of energy supply. 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; 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.



# Contents

---

	Page
Introduction	4
Global energy trends	7
Outlook 2030: Fuel by fuel	27
Implications	69
Appendix	81

Welcome to the 2013 edition of *BP's Energy Outlook 2030*.



BP's annual Energy Outlook contains our projections of future energy trends and factors that could affect them, based on our views of likely economic and population growth and developments in policy and technology. Together with the annual Statistical Review of World Energy, it has become a respected contribution to the global discussion on energy and I am pleased with the feedback we are receiving.

Last year's edition led the way in showing how North America is likely to become self-sufficient in energy. This year's edition follows up by examining more closely the phenomenon which is driving America's energy revival, the revolution in shale gas and tight oil, including its global prospects.

The Outlook describes a future that is different in several respects from what many expected just a short while ago. We still expect global energy demand to grow – by 36% between 2011 and 2030 - driven by the emerging economies. Without continuous improvements in energy efficiency, demand would have to grow much more rapidly simply to sustain economic growth.

Supply patterns are shifting. The Outlook demonstrates how unconventional oil and gas are playing a major role in meeting global demand. Over the period to 2030, the US becomes nearly self-sufficient in energy, while China and India become increasingly import-dependent. This report illuminates some of the consequences. The implications are far-reaching. Indeed, I believe they will stretch far beyond the boundaries of our industry.

As always, the numbers that make up this Outlook reveal long-term trends and highlight potential “fault lines” in the system; in short, their job is to convey the underlying challenges and opportunities we all face in producing and consuming energy.

What messages do we draw from this Outlook? It underlines the power of competition and market forces in driving efficiency and innovation – importantly not only in unlocking new supplies such as unconventional oil and gas but also in improving energy efficiency and consequently limiting the growth of carbon emissions.

A second message is the importance of technology and innovation, which underpin the key trends that are highlighted in the Outlook, from the development of shale resources to the efficiency of power generation and improved vehicle fuel economy.

Third, the Outlook highlights the way energy resources are opening up. The energy industry is highly competitive and investment will flow to the places that possess the right resources below ground and the right conditions above it. Highlighting the “above ground” factors that have made the US and Canada engines for energy innovation can be instructive for other nations seeking to develop their domestic energy resources.

The overall conclusion is that increased demand can be met as long as competition is present to drive innovation, unlock resources and encourage efficiency. This is why we remain optimistic the world will produce the energy it needs to fuel continued economic growth. We hope you find the 2013 edition of the *BP Energy Outlook 2030* a useful addition to the global energy discussion.

Bob Dudley

Group Chief Executive

## Note on method and assumptions

---

- This edition updates our view of the likely path of global energy markets to 2030, taking account of developments over the past year. The underlying methodology remains unchanged – we make assumptions on changes in policy, technology and the economy, based on extensive internal and external consultations, and use a range of analytical tools to build a “to the best of our knowledge” view.
- We focus on the “most likely” base case numbers, to provide a basis for discussion. Of course the future is uncertain, and in the process of building the Outlook we explore the impact of alternative assumptions. While we do touch on some of the key uncertainties, the treatment of energy market risks here is by no means exhaustive.
- Unless noted otherwise, data definitions are based on the *BP Statistical Review of World Energy*, and historical energy data through 2011 is consistent with the 2012 edition of the *Review*. Gross Domestic Product (GDP) is expressed in real Purchasing Power Parity (PPP) terms. All data sources are listed on page 86.

---

	Page
Introduction	4
<b>Global energy trends</b>	<b>7</b>
Outlook 2030: Fuel by fuel	27
Implications	69
Appendix	81



# Population and income growth...

### Population

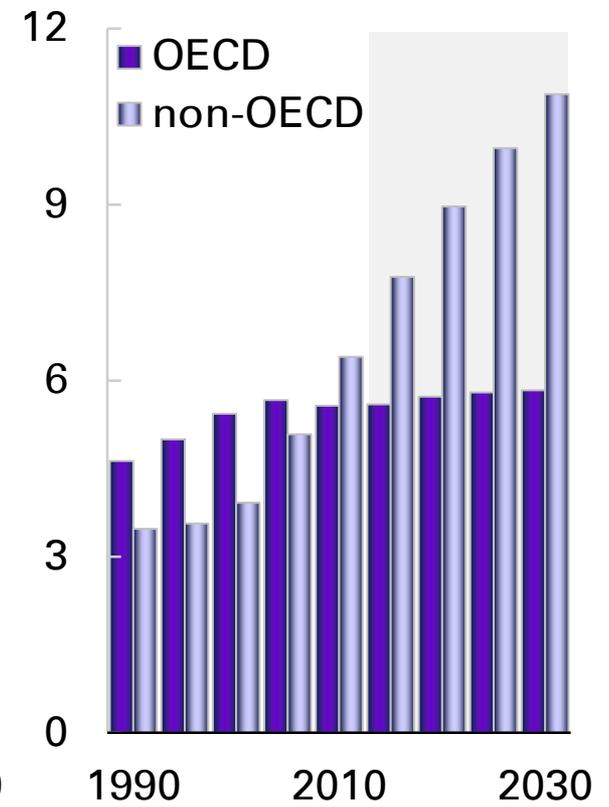
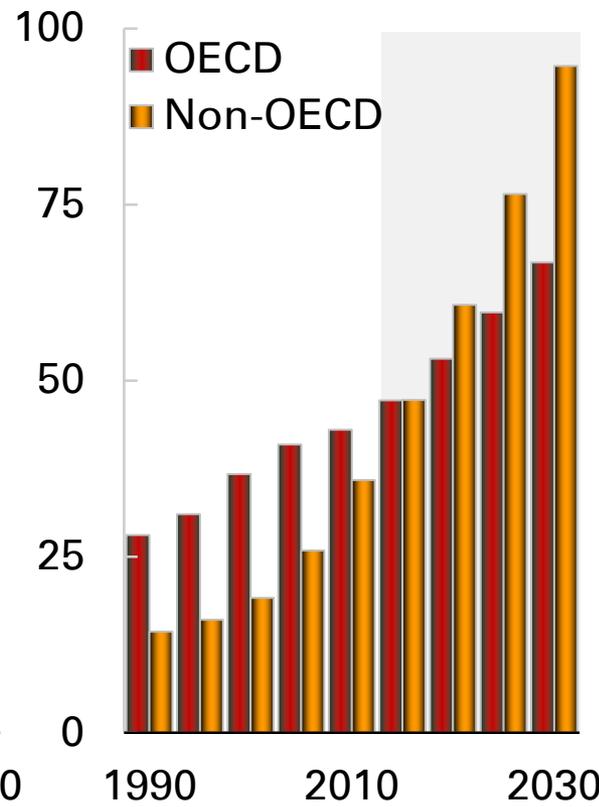
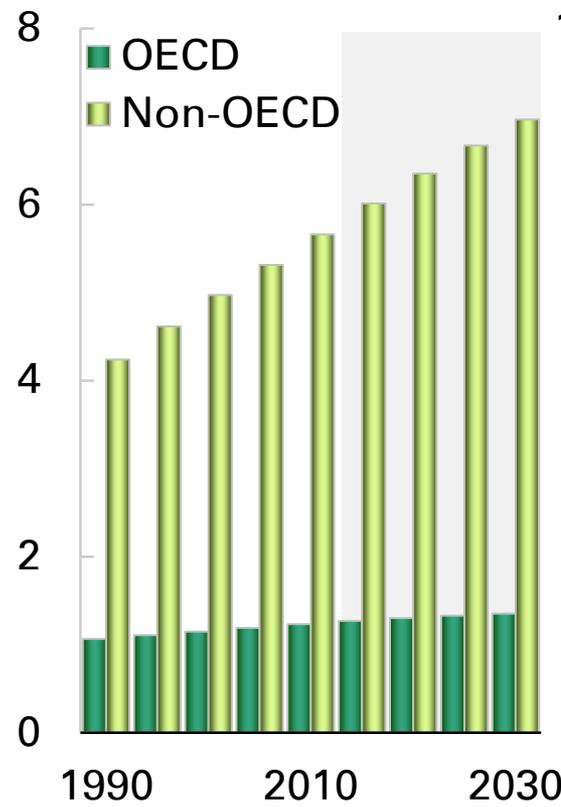
### GDP

### Primary energy

Billion

Trillion \$2011

Billion toe





## ...underpin growing energy consumption

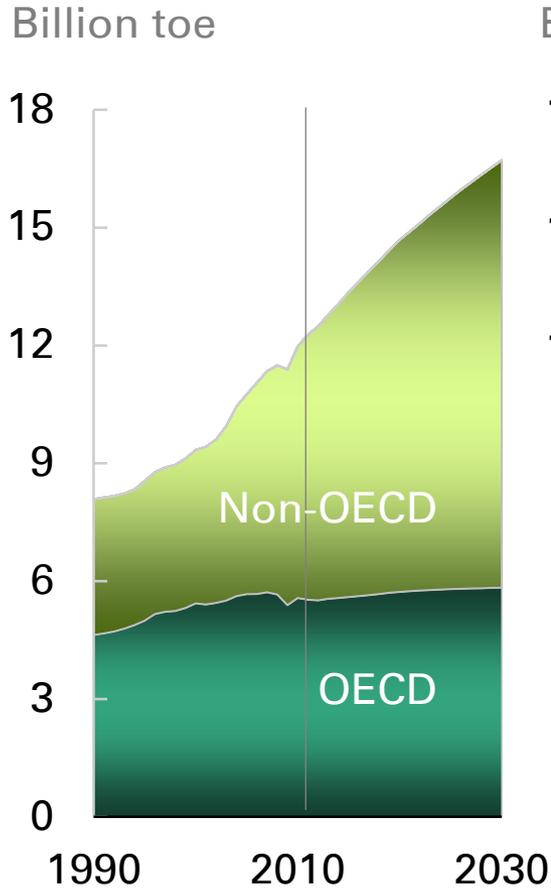
---

- Population and income growth are the key drivers behind growing demand for energy. By 2030 world population is projected to reach 8.3 billion, which means an additional 1.3 billion people will need energy; and world income in 2030 is expected to be roughly double the 2011 level in real terms.
- World primary energy consumption is projected to grow by 1.6% p.a. from 2011 to 2030, adding 36% to global consumption by 2030. The growth rate declines, from 2.5% p.a. for 2000-10, to 2.1% p.a. for 2010-20, and 1.3% p.a. from 2020 to 2030.
- Low and medium income economies outside the OECD account for over 90% of population growth to 2030. Due to their rapid industrialisation, urbanisation and motorisation, they also contribute 70% of the global GDP growth and over 90% of the global energy demand growth.

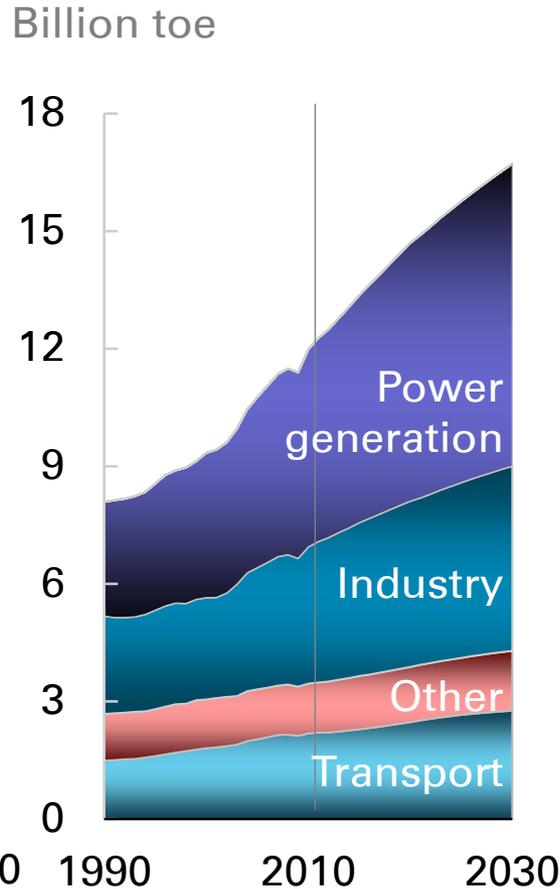


# Industrialisation and growing power demand...

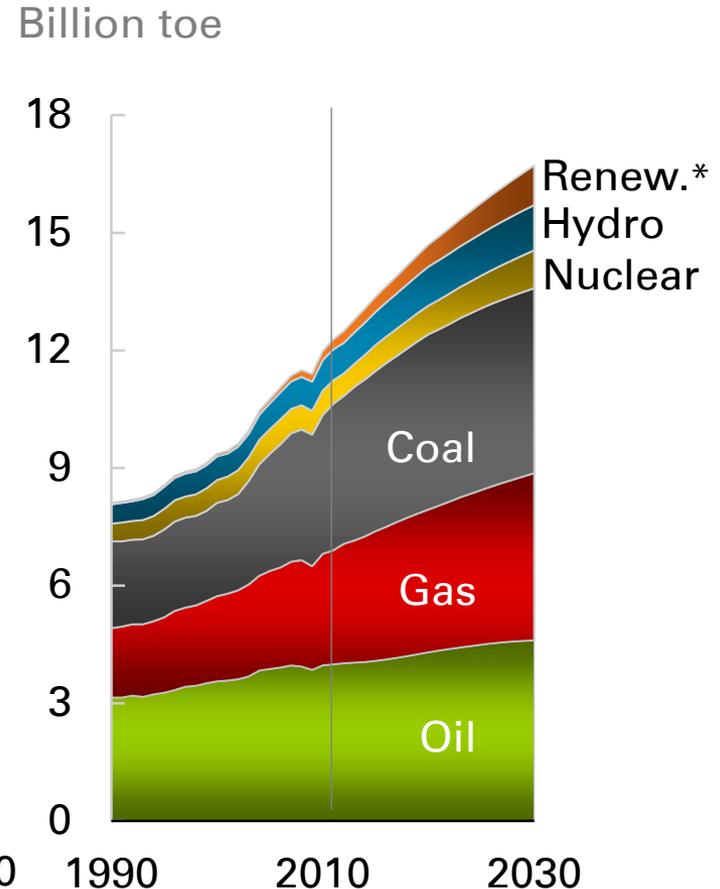
### By region



### By primary use



### By fuel



\*Includes biofuels



## ...increase the world's appetite for primary energy

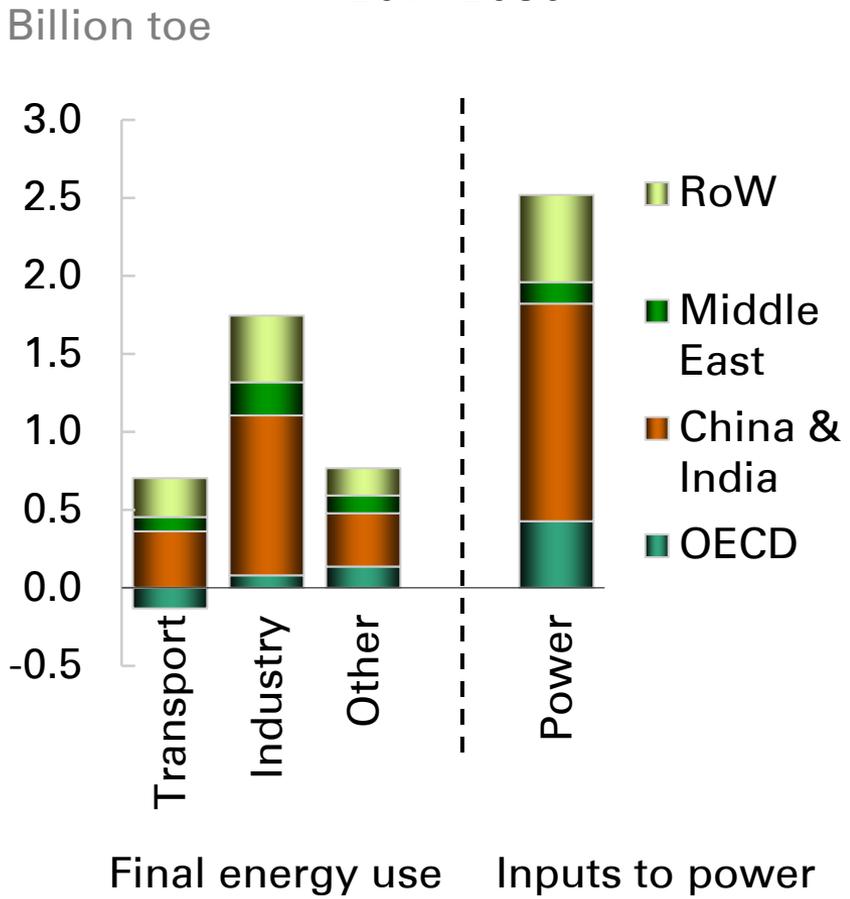
---

- Almost all (93%) of the energy consumption growth is in non-OECD countries. Non-OECD energy consumption in 2030 is 61% above the 2011 level, with growth averaging 2.5% p.a. (or 1.5% p.a. per capita), accounting for 65% of world consumption (compared to 53% in 2011).
- OECD energy consumption in 2030 is just 6% higher than in 2011 (0.3% p.a.), and will decline in per capita terms (-0.2% p.a. 2011-30).
- Energy used for power generation grows by 49% (2.1% p.a.) 2011-30, and accounts for 57% of global primary energy growth. Primary energy used directly in industry grows by 31% (1.4% p.a.), accounting for 25% of the growth of primary energy consumption.
- The fastest growing fuels are renewables (including biofuels) with growth averaging 7.6% p.a. 2011-30. Nuclear (2.6% p.a.) and hydro (2.0% p.a.) both grow faster than total energy. Among fossil fuels, gas grows the fastest (2.0% p.a.), followed by coal (1.2% p.a.), and oil (0.8% p.a.).

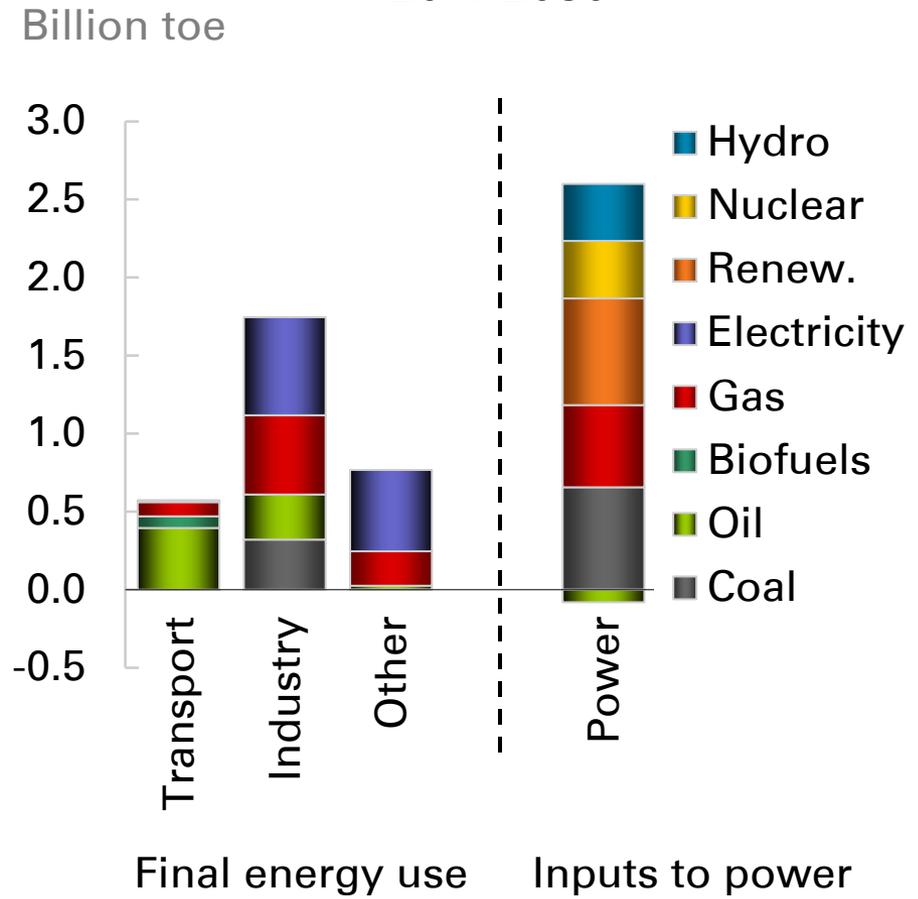


# The power sector leads primary energy growth...

Growth by sector and region, 2011-2030



Growth by sector and fuel, 2011-2030





## ...while industry leads the growth of final energy demand

---

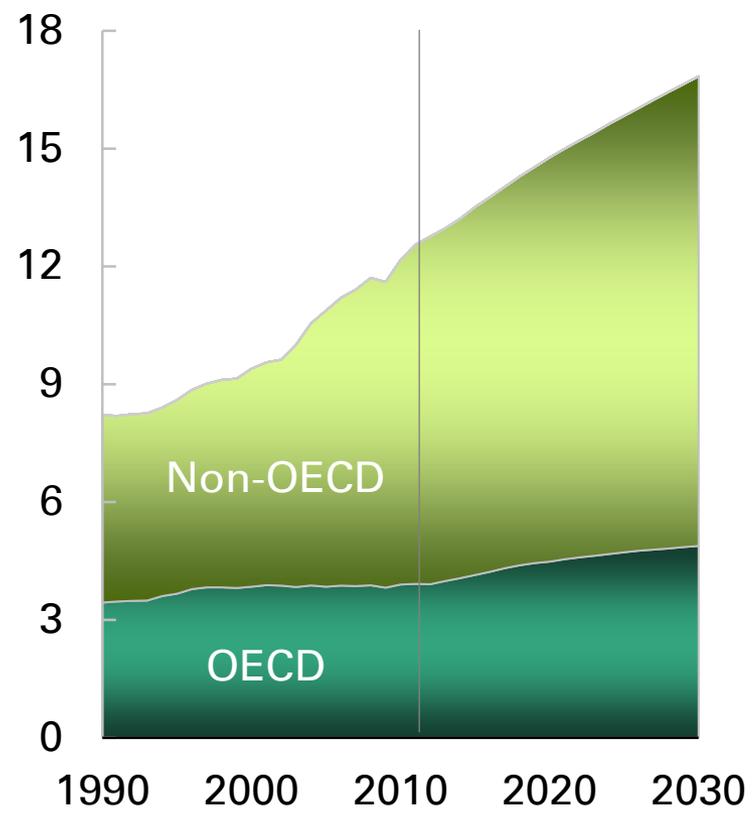
- The power sector diversifies its fuel mix, with more than half the growth coming from non-fossil fuels. Renewables contribute 27% of the growth, just ahead of coal (26%) and gas (21%).
- Industry leads the growth of final energy consumption, particularly in rapidly developing economies. The industrial sector accounts for 57% of the projected growth of final energy demand to 2030.
- The transport sector shows the weakest growth, with OECD transport demand projected to decline. The sector starts to show some diversification away from oil; gas accounts for 16% of transport energy demand growth, with another 13% coming from biofuels, and 2% from electricity.
- The growth of “other” sector energy consumption (primarily residential and commercial) is heavily weighted towards electricity, with gas making up virtually all the non-electricity energy use.



# Emerging economies dominate energy production growth...

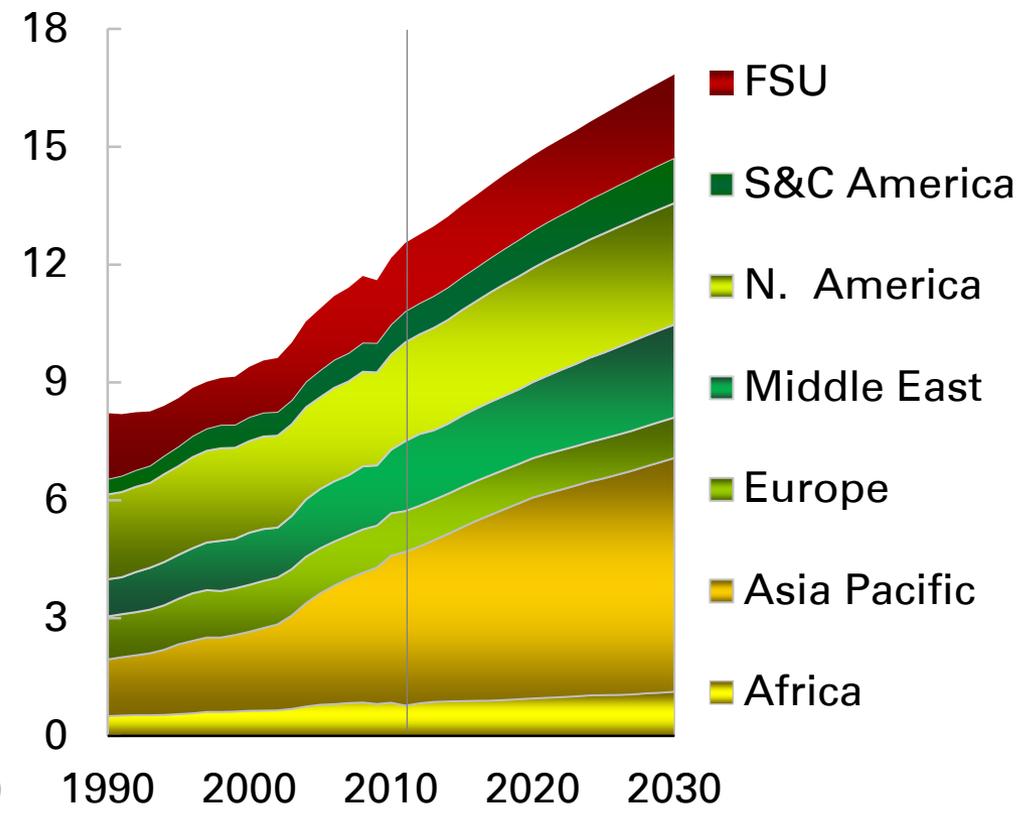
## Primary energy production

Billion toe



## Primary energy production

Billion toe





## ...with Asia Pacific accounting for nearly half of global growth

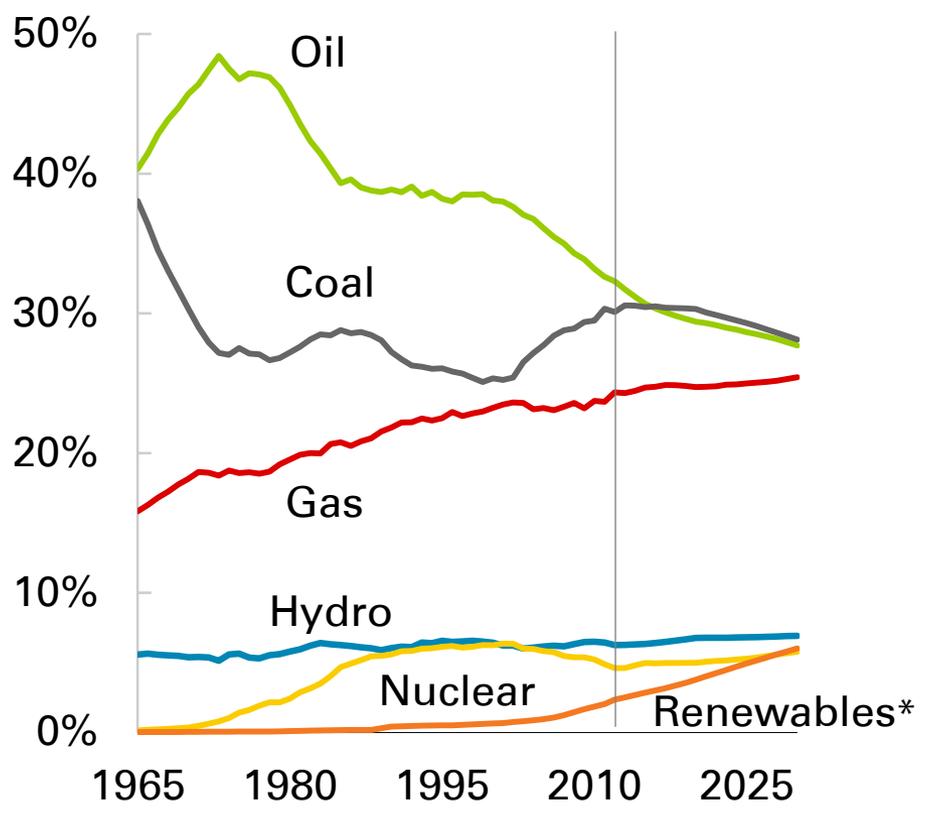
---

- World primary energy production growth matches consumption, growing by 1.6% p.a. from 2011 to 2030.
- As is the case for energy consumption, growth in production will be dominated by the non-OECD countries, which will account for 78% of the world's increase. These countries will supply 71% of global energy production in 2030, up from 69% in 2011 and 58% in 1990.
- The Asia Pacific region, the largest regional energy producer, shows the most rapid growth rate (2.2% p.a.), due to large indigenous coal production, and accounts for 48% of global energy production growth. The region provides 35% of global energy production by 2030. The Middle East and North America contribute the next largest increments for supply growth; and North America remains the second largest regional energy producer.
- Energy production will grow in all regions but Europe.



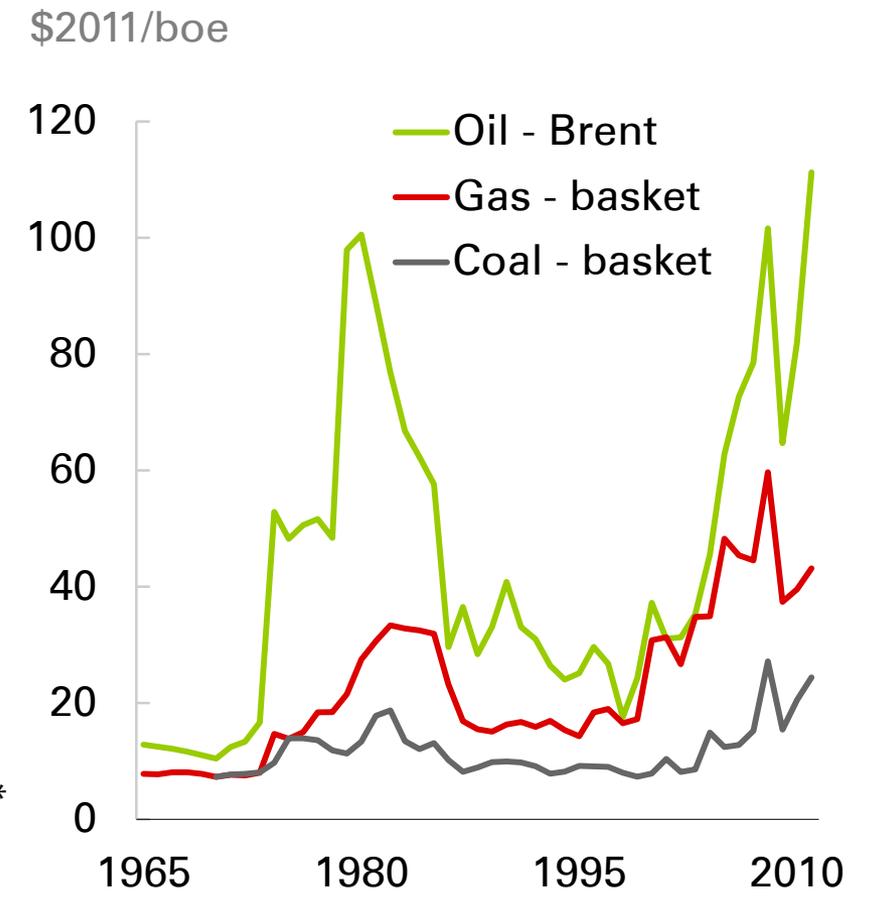
# Energy prices play a key role...

## Shares of world primary energy



\*Includes biofuels

## Energy prices





## ...in shaping the response of the global energy system

---

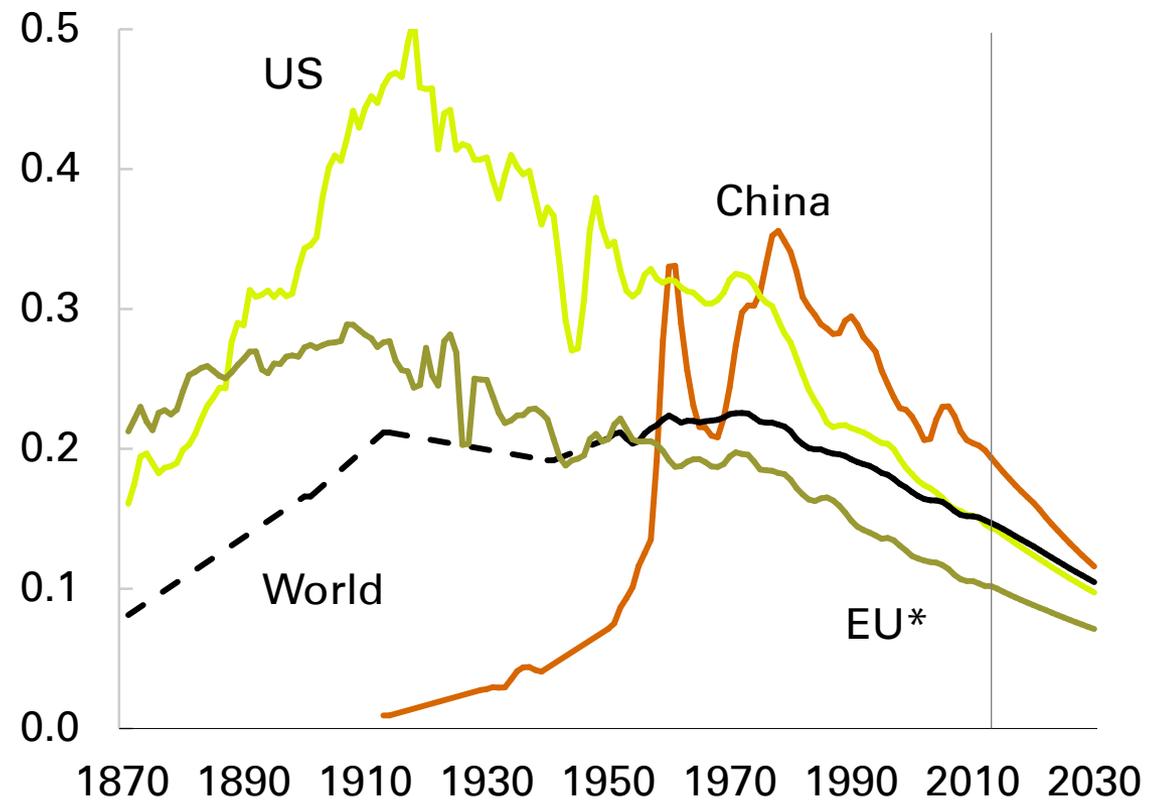
- Prices, technology and policy drive changes in the fuel mix. Fossil fuels are converging on a market share of 26-28% each and non-fossil fuels groups on a market share of 6-7% each. Gas and non-fossil fuels gain share at the expense of coal and oil.
- Oil follows a long run trend of decline in its market share, with oil increasingly concentrated in the sectors where it commands the highest value. Gas remains on a trend of modest but steady gains in share. Coal's recent rapid gain in share will start to reverse soon, with a trend decline evident by 2020. The rate at which renewables are projected to gain market share resembles the experience of nuclear power in the 1970s and 1980s.
- Fossil fuel prices have risen to record levels in real terms over the past decade. Average annual real oil prices over the five years 2007-11 were 220% above the average for 1997-2001; for coal the increase was 141% and for gas 95%. These long run price movements inevitably lead to demand and supply responses.



# Energy efficiency improvements are critical...

## Energy intensity by region

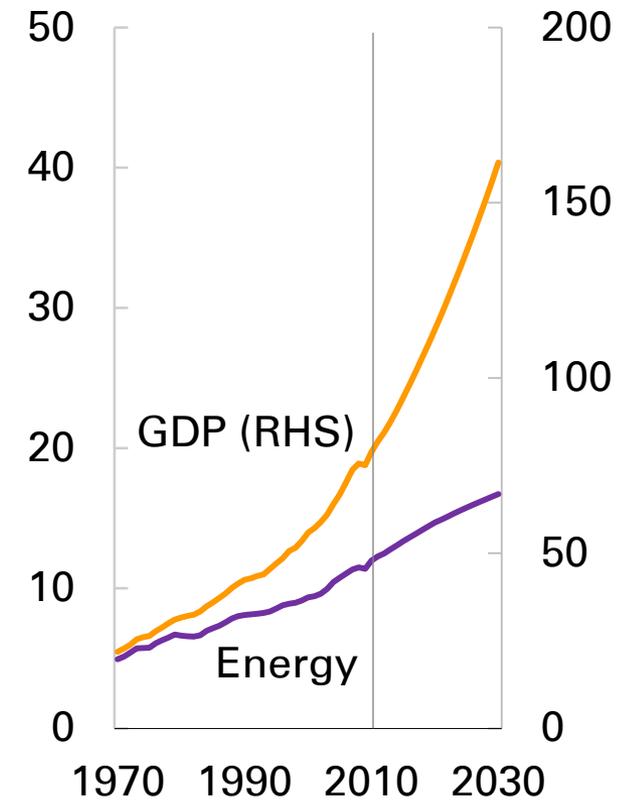
Toe per thousand \$2011 GDP



\*Euro4 (France, Italy, Germany, UK) pre-1970

## Energy and GDP

Billion toe      Trillion \$2011



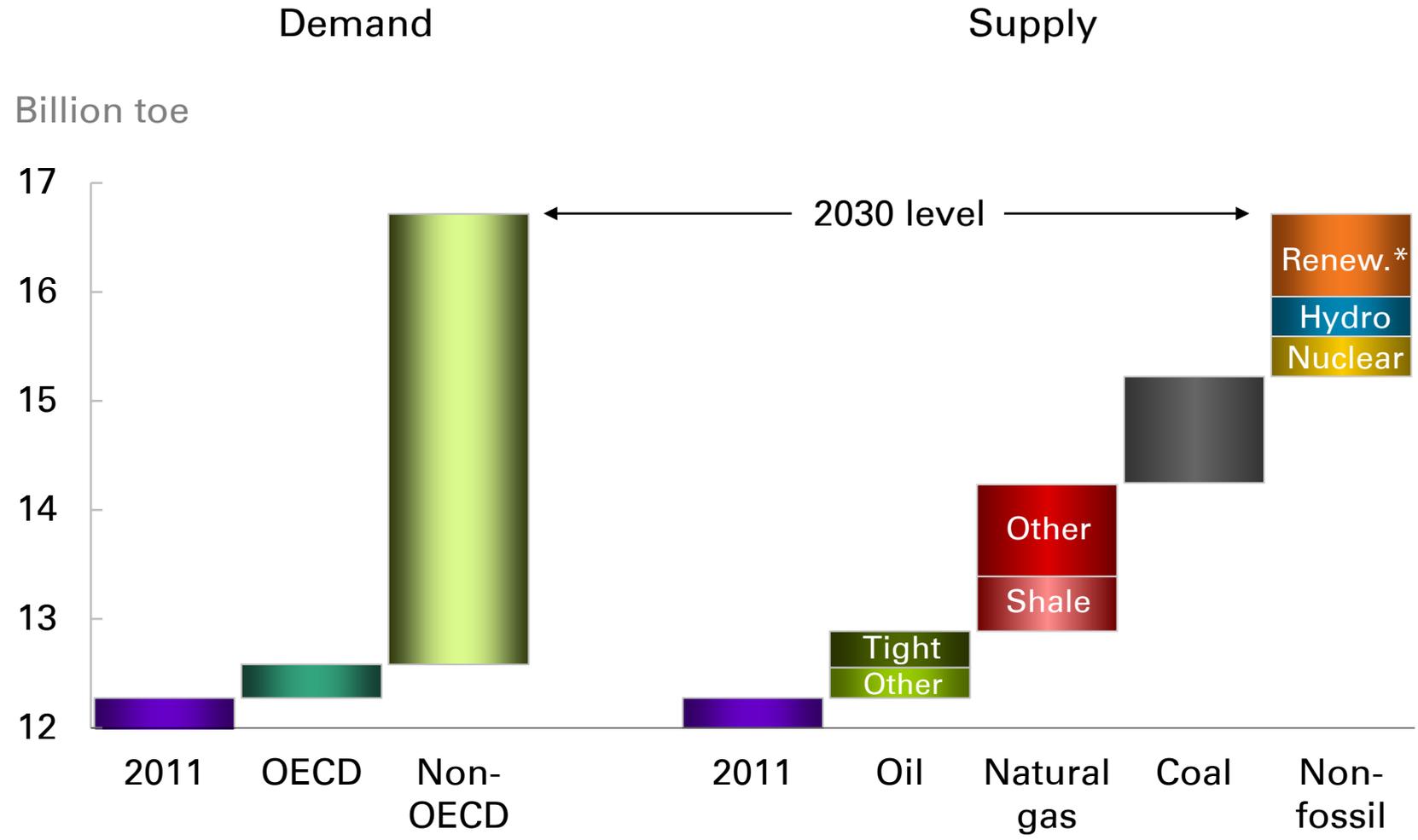
## ...to meeting the energy challenge

---

- We have previously noted the long run trend of declining and converging energy intensity (the amount of energy consumed per unit of GDP). Current high prices for energy and global integration reinforce this trend.
- Global energy intensity in 2030 is 31% lower than in 2011, declining at 1.9% p.a. compared to a decline rate of 1.0% p.a. for 2000-10. The rate of decline accelerates post 2020, averaging 2.2% p.a. for 2020-30, in large part the result of China moving onto a less energy-intensive development path. Energy intensity declines in all regions.
- The impact of declining energy intensity can be seen clearly in the gap between GDP and energy consumption. Without the projected intensity decline, the world would need to almost double energy supply by 2030 to sustain economic growth, rather than the 36% increase required in our Outlook.



# Energy demand growth is matched by supply...



\*Includes biofuels



## ...from all sources, conventional and unconventional

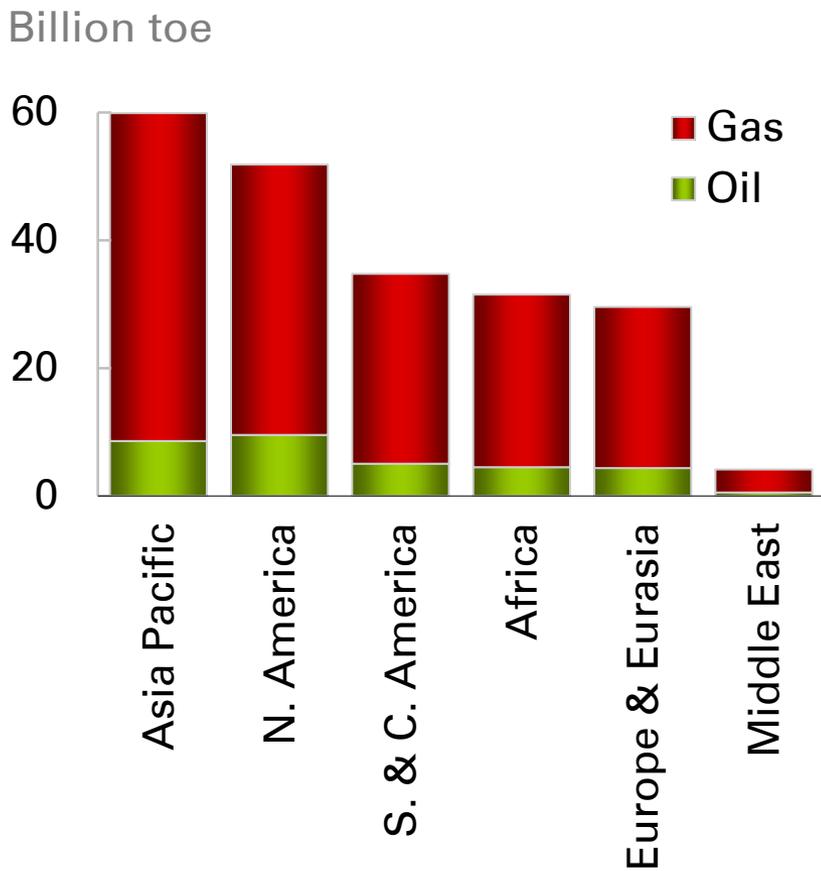
---

- High prices are also supporting the expansion of supply, and not just from conventional sources – the development and deployment of new technologies across a range of energy sources is opening up new supply opportunities at scale.
- The “shale revolution”, first for gas and then for oil, is an example of this. From 2011 to 2030 shale gas more than trebles and tight oil grows more than six-fold. Together they will account for almost a fifth of the increase in global energy supply to 2030.
- High prices for fossil fuels also support the expansion of non-fossil energy. Renewable energy supply more than trebles from 2011 to 2030, accounting for 17% of the increase in global energy supply. Hydro and nuclear together account for another 17% of the growth.
- Despite all the growth from shale, renewables and other sources, conventional fossil fuel supplies are still required to expand, providing almost half the growth in energy supply.

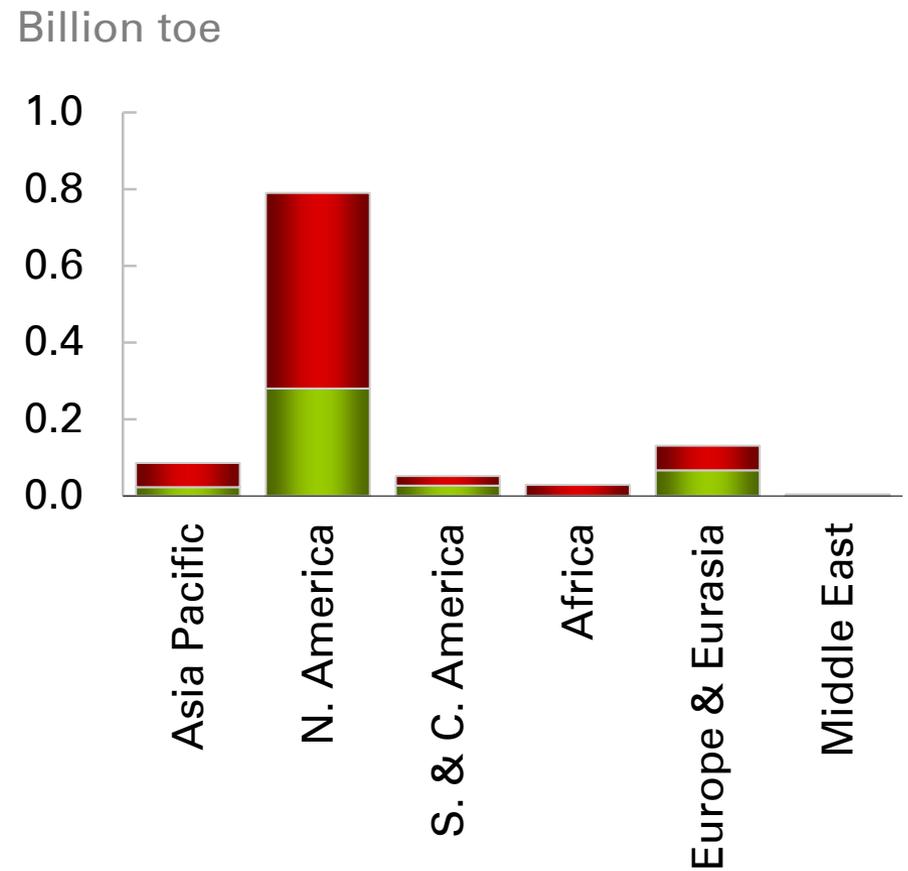


# Shale gas and tight oil resources and production...

### Current resources



### Production in 2030



Resources data © OECD/IEA 2012



## ...highlight the importance of above-ground factors

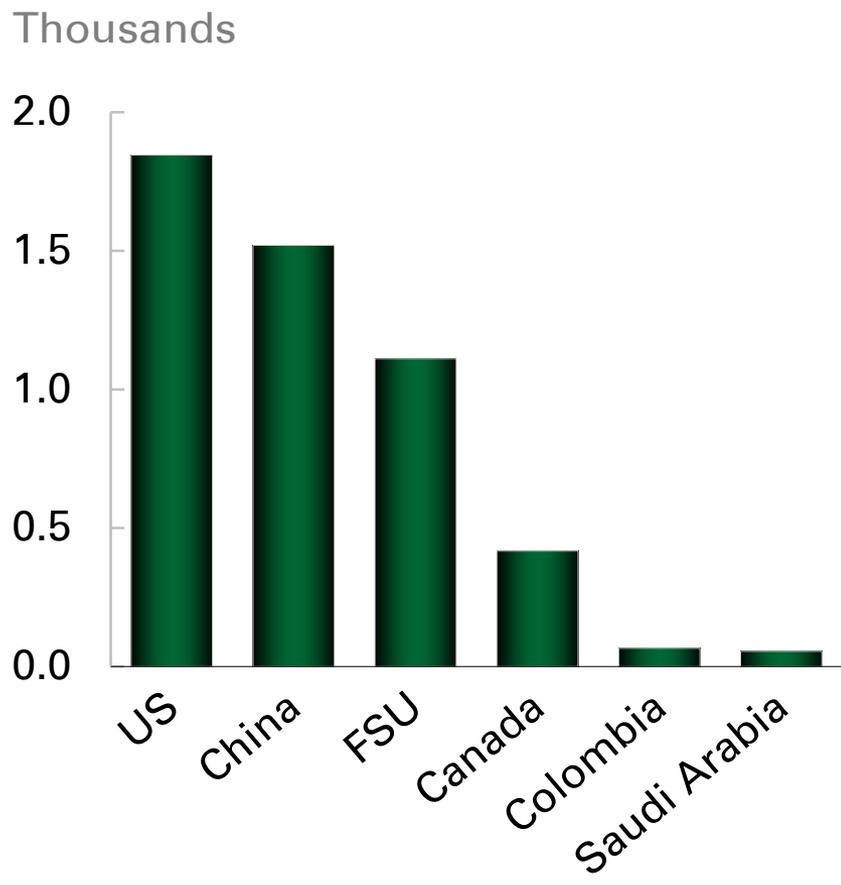
---

- High prices and technological innovation have unlocked vast unconventional resources in the US, reversing the trend of falling output and altering global energy balances.
- Globally there are estimated technically recoverable resources of 240 billion barrels (Bbbls) for tight oil and 200 trillion cubic meters (Tcm) for shale gas. Asia has an estimated 57 Tcm of shale gas and 50 Bbbls of tight oil, versus 47 Tcm and 70 Bbbls respectively for North America.
- In 2012, 2.1 Mb/d (24%) of US oil production was from tight oil and 24 Bcf/d (37%) of natural gas from shale. These resources have boosted gas output by nearly 20% and oil by 30% in the past five years.
- Assessing both global resources and “above ground” factors, North America will continue to dominate production by 2030, even as other regions gradually adapt to develop their resources.

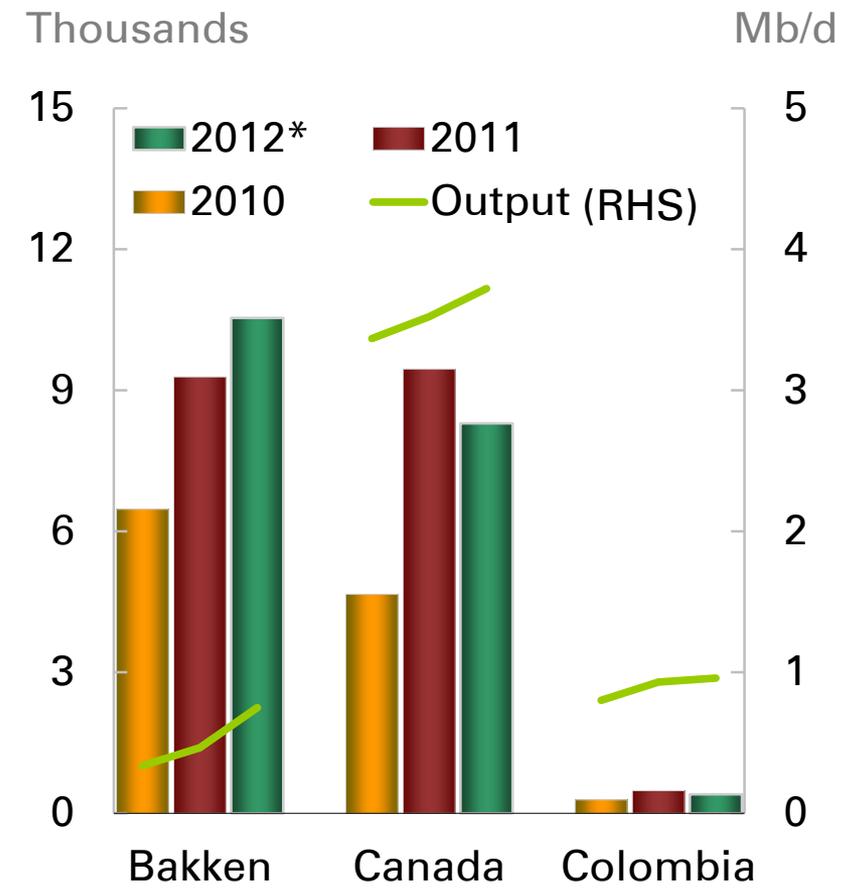


# US tight oil and shale gas output is supported by...

## Onshore oil & gas rigs 2011



## Oil wells drilled and output



\*Annualised from 1Q-3Q data



## ...a competitive environment including a strong service sector

---

- “Above ground” factors have enabled US success: a robust service sector with the world’s largest rig fleet (over 1,800 rigs in operation, a majority of which can drill horizontally), a competitive industry that spurs continued technological innovation, land access facilitated by private ownership, deep financial markets, and favourable fiscal and regulatory terms.
- As an example, output in the Bakken has increased from 0.1 Mb/d just five years ago to over 1 Mb/d currently, roughly matching that of Colombia, as operators are drilling more oil wells than in all of Canada.
- So far, only the US and Canada have combined these variables to support rapid production growth. The pace of development elsewhere is likely to be measured, given the lengthy checklist of factors required for development of shale gas and tight oil resources.



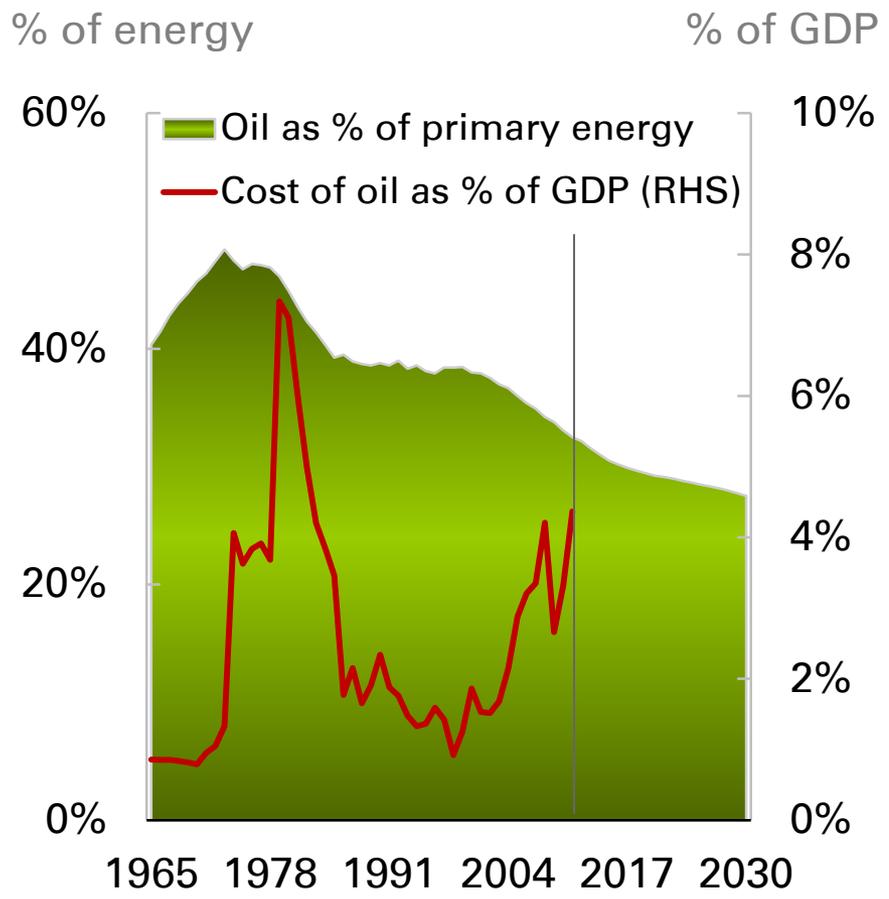
---

	Page
Introduction	4
Global energy trends	7
<b>Outlook 2030: Fuel by fuel</b>	<b>27</b>
Implications	69
Appendix	81

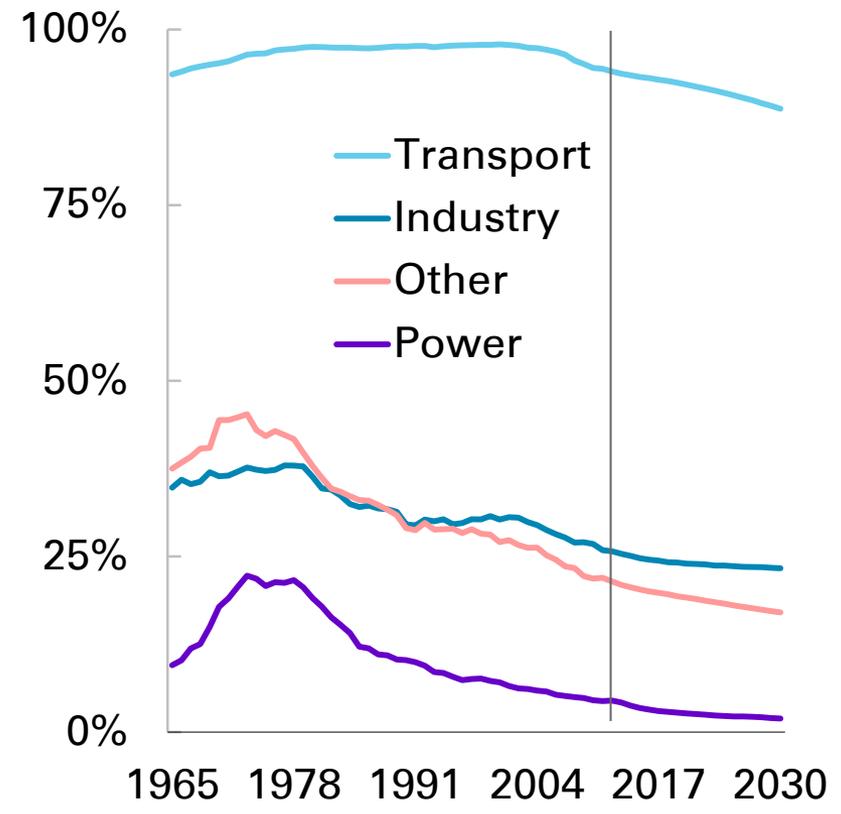


# High oil prices are reducing oil's share of primary energy...

## Oil share of energy and GDP



## Oil share in sector





## ...via substitution and efficiency gains in transport

---

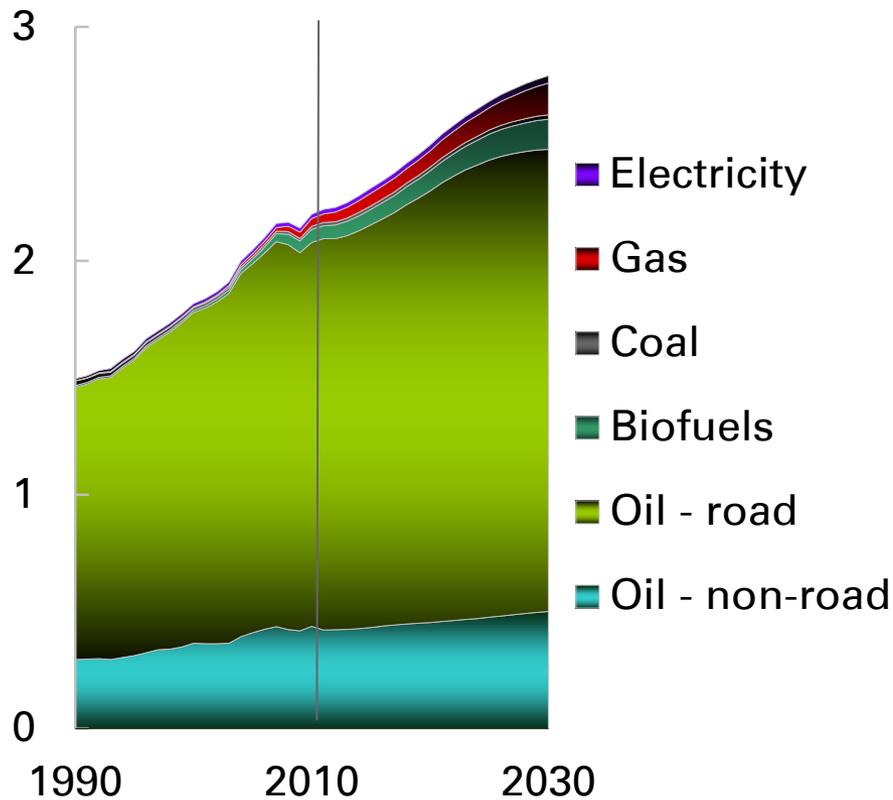
- After the oil price shocks of the 1970s, oil's share in primary energy consumption fell from a peak of 48% in 1973 to 39% in 1985. Rising oil prices have again increased the burden of oil on the economy in recent years and oil has lost market share again – falling to 33% in 2011. We project this to fall further to 28% by 2030.
- High relative prices have led to the substitution of oil by other fuels outside the transport sector where cheaper alternatives are available. Oil's share in power generation, for example, fell from 22% in 1973 to 4% in 2011 and is forecast to decline to just 2% by 2030.
- Oil's share in industry and other sectors (including residential and commercial) has also declined substantially, although the decline in industry has been (and will be) slower because of limits to substitution in petrochemicals and other non-energy uses.
- In transport, the market response to high prices has been primarily via efficiency gains. Oil will remain the dominant fuel in transport, although its share falls from 94% in 2011 to 89% in 2030.



# Global transport demand growth slows...

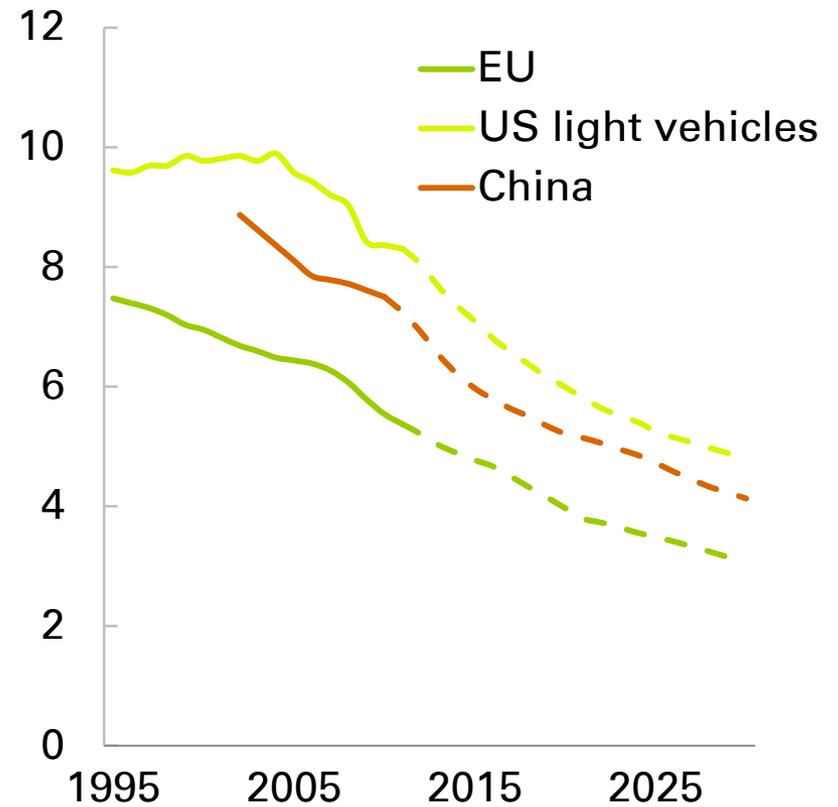
## Transport demand by fuel

Billion toe



## Fuel economy of new cars

Litres per 100 km





## ...as prices and policy boost vehicle fuel economy

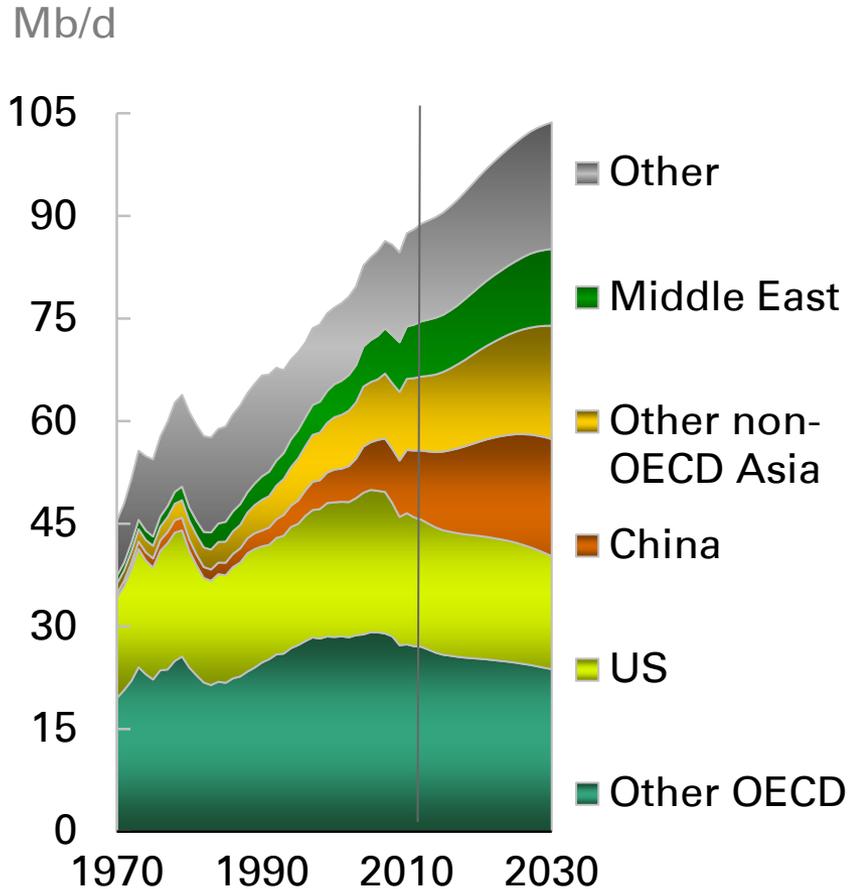
---

- Energy consumption growth in transport slows to 1.2% p.a. (from 1.9% p.a. 1990-2010) primarily due to accelerating gains in fuel economy. Other factors include the impact of high oil prices on driving behaviour, vehicle saturation in the OECD, and non-OECD subsidy reduction.
- Fuel economy improvements have accelerated in recent years, driven by consumer reaction to rising prices and tightening policy (e.g. CO<sub>2</sub> emissions limits in Europe and CAFE standards in the US) and enabled by technology improvements. Enhancements to the internal combustion engine and gradual hybridisation of the vehicle fleet are expected to further accelerate efficiency gains, with fuel economy in the US, EU and China improving by 2.9% p.a. in each region over the outlook period.
- Transport demand will remain dominated by oil, since alternatives are likely to remain uneconomic in most markets without policy support. Nevertheless, biofuels and natural gas both reach 5% share of transport by 2030 with electricity at 1%. Gas (including gas-to-liquids) is the fastest growing alternative and likely to overtake biofuels in transport by 2030.

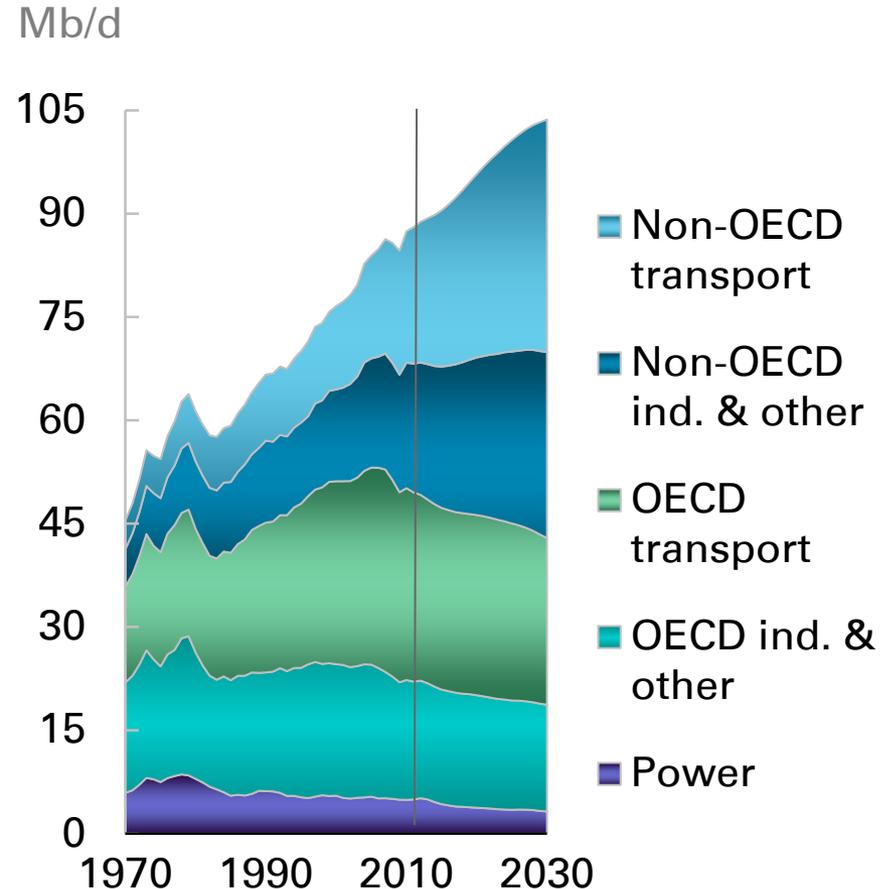


# Liquids demand growth by region and sector...

## Demand by region



## Demand by sector





## ...is dominated by non-OECD transport demand

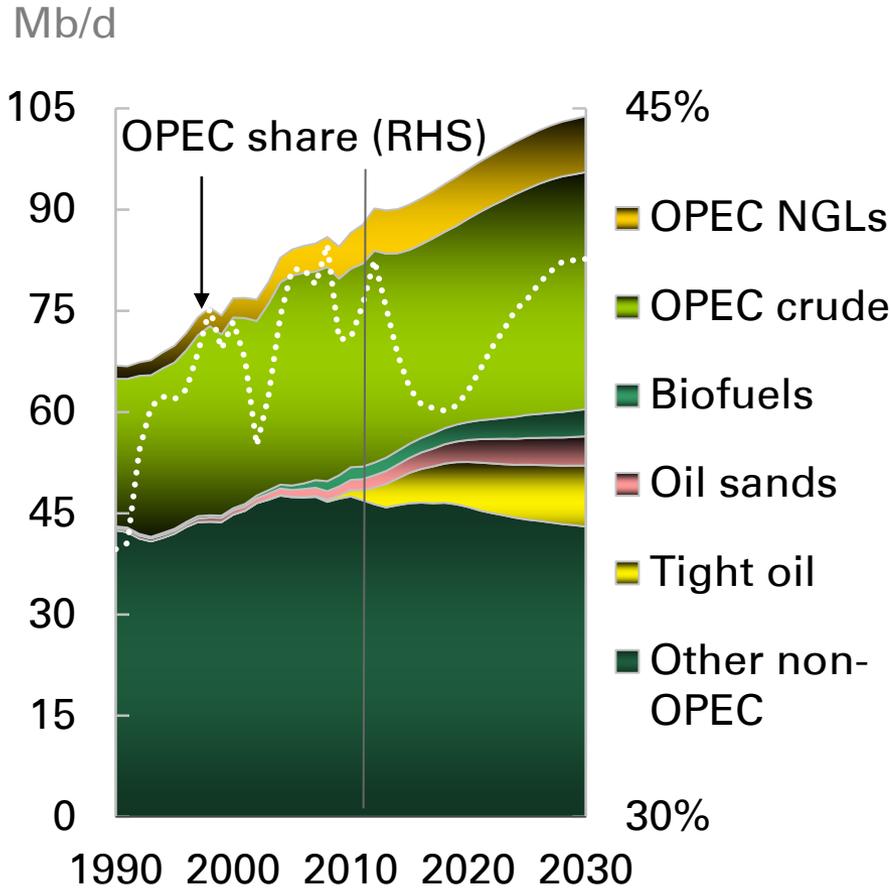
---

- Global liquids consumption is projected to reach 104 Mb/d by 2030 but growth slows to 0.8% p.a. (from 1.4% p.a. in 1990-2010 and 1.9% p.a. in 1970-90). OECD consumption will fall to 40.5 Mb/d, 1 Mb/d below the 1990 level. Non-OECD consumption is likely to overtake the OECD by 2014, and reach 63 Mb/d by 2030 – 2½ times the 1990 level.
- By sector, liquids demand growth to 2030 comes from non-OECD transport (nearly 14 Mb/d) due to a rapid increase in vehicle ownership, with non-OECD industry also rising (by 6.5 Mb/d, largely for petrochemicals). OECD demand declines across all sectors as vehicle efficiency improvements outweigh (slow) growth in the vehicle fleet, and oil is displaced by other fuels outside of transport.
- Demand in China grows by 7 Mb/d to 17 Mb/d in 2030, surpassing the US in 2029 (US demand falls by 2 Mb/d to 16.5 Mb/d over the outlook period). Other non-OECD Asia also shows strong growth of 6 Mb/d (of which almost two-thirds are in India). The Middle East is the next largest contributor to growth over the outlook period at 3.5 Mb/d.

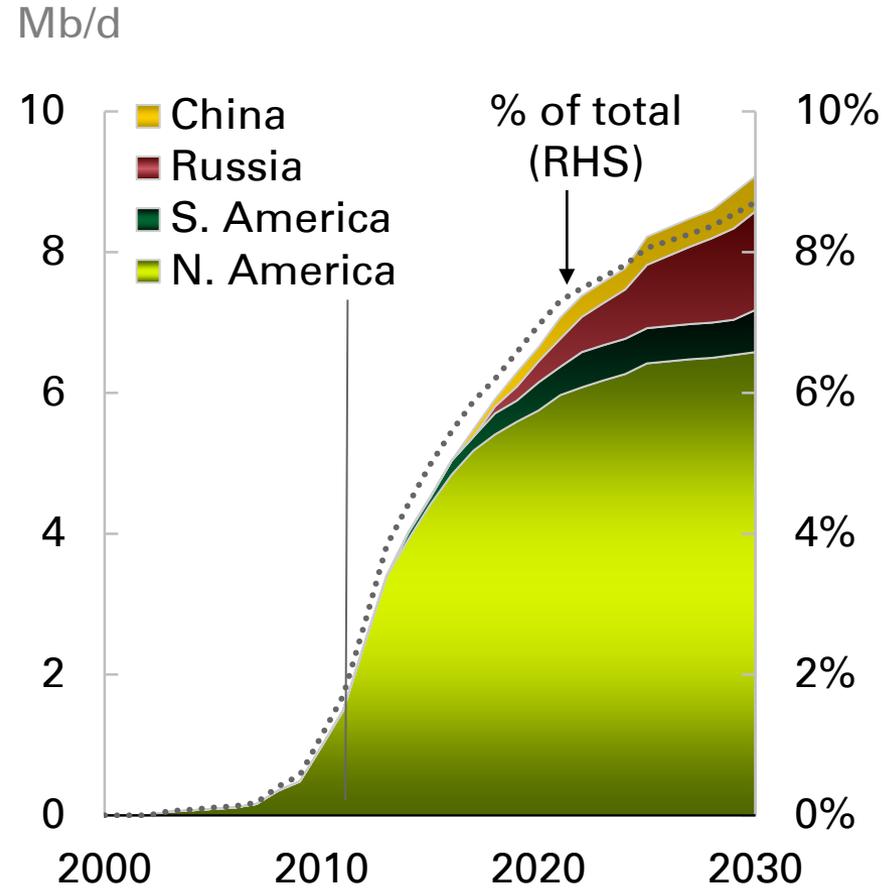


# Tight oil will drive global supply growth...

### Liquids supply by type



### Tight oil output





## ...as high prices and technology have unlocked vast resources

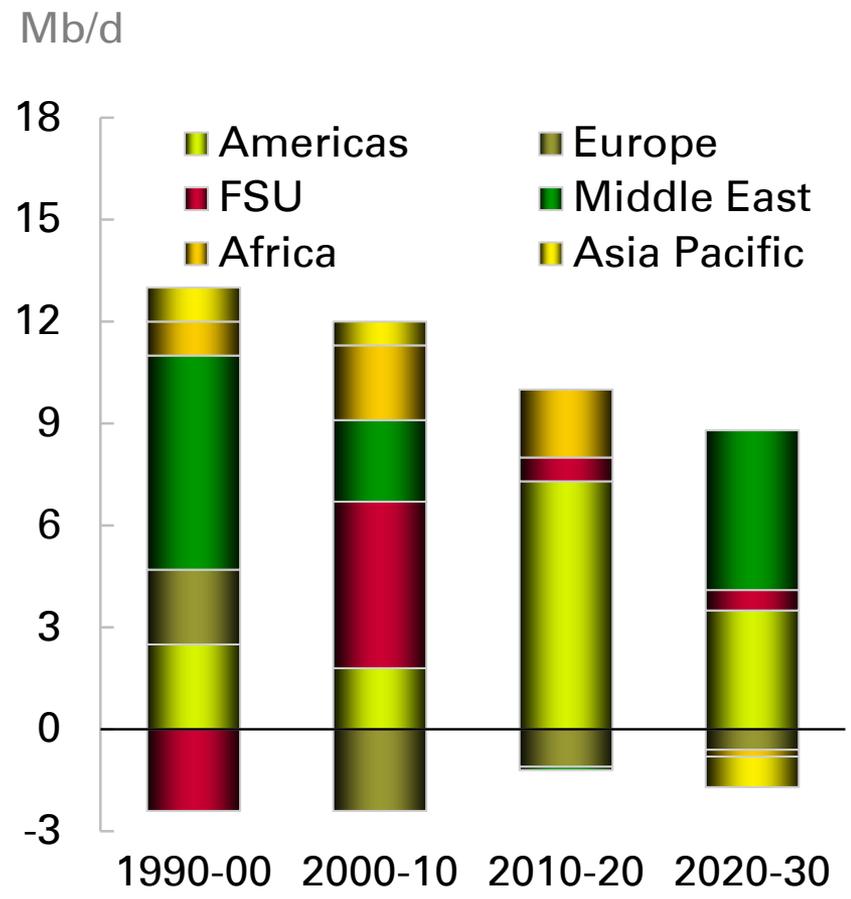
---

- Tight oil will likely expand by 7.5 Mb/d by 2030 and account for nearly half of the 16.1 Mb/d of global supply growth. Non-OPEC supplies will expand by 8.5 Mb/d versus 7.6 Mb/d for OPEC as the group will likely see its market share drop until 2018 due to the surge in tight oil supplies before recovering to 42% by the forecasting period.
- By 2030, tight oil should reach 9% of global supplies. North America will continue to dominate output with limited growth elsewhere.
- Both Russia and China – with robust service sectors and expected additional fiscal incentives – are expected to develop their tight oil resources reaching 1.4 Mb/d and 0.5 Mb/d by 2030, respectively. South America will also increase output due to investment in countries like Colombia and Argentina.
- North America's tight oil growth is expected to slow post-2020 due to today's view of the resource base and the costs and drilling activity required to sustain output.

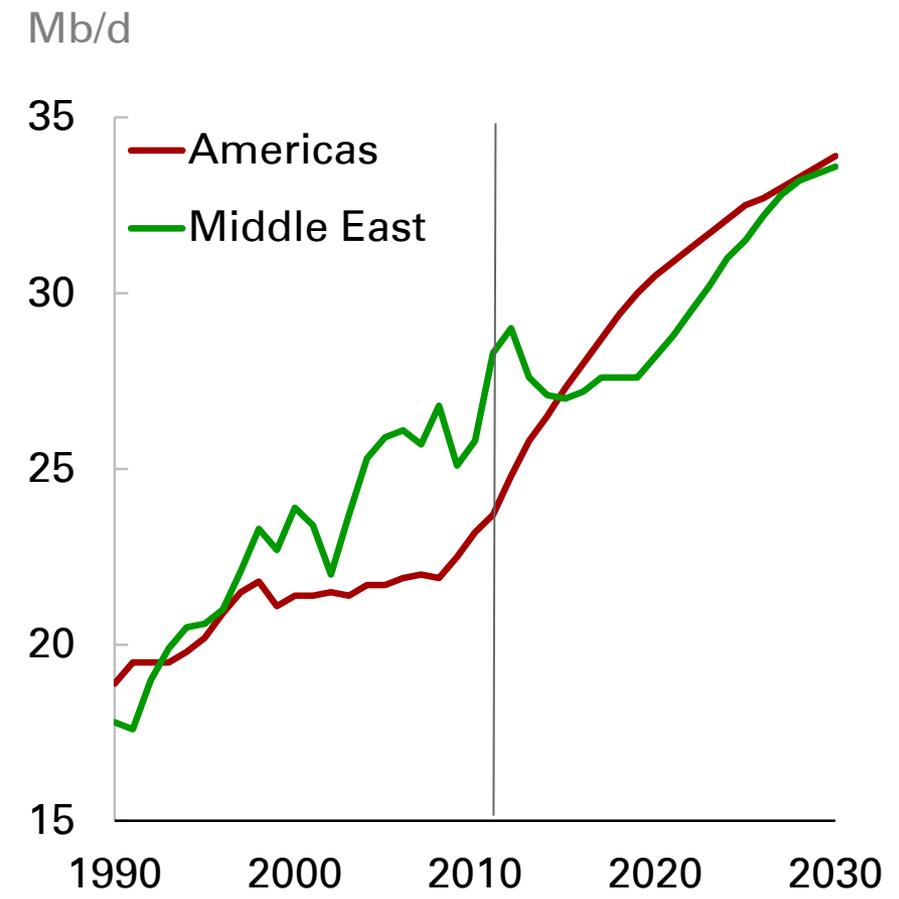


# With the Americas dominating global supply growth...

## Supply growth by decade



## Americas surpass Middle East





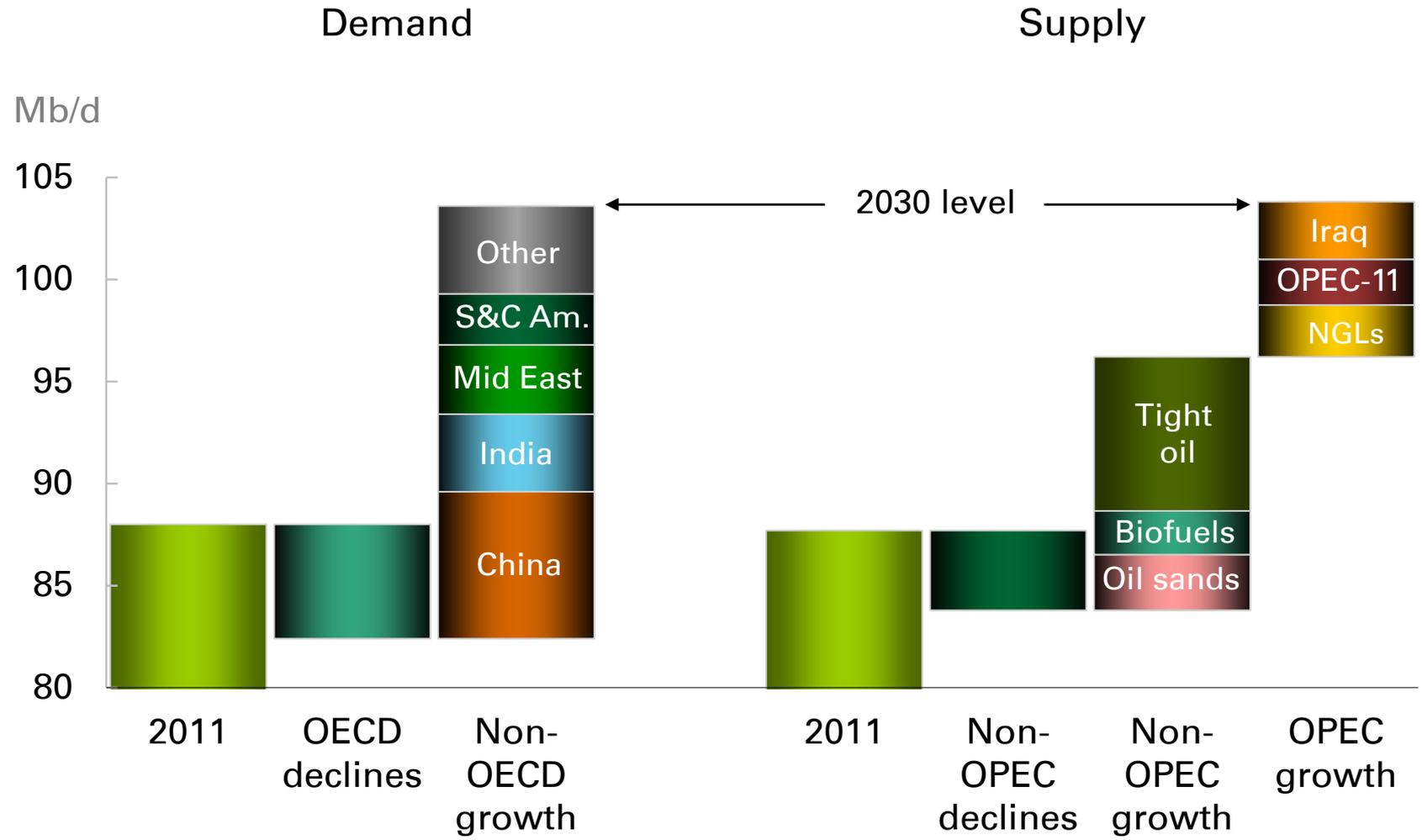
## ...unconventionals will constrain OPEC output

---

- The Americas will account for 65% of incremental supply growth to 2030 as tight oil (5.7 Mb/d), oil sands (2.7 Mb/d), and biofuels (1.8 Mb/d) drive growth. The US (4.5 Mb/d) leads regional increases and will surpass its previous record output reached in 1970.
- OPEC crude oil output will not return to the expected 2013 level of about 30 Mb/d until 2020 as non-OPEC supplies dominate global growth. From 2020-30, however, supplies will likely expand by 5.1 Mb/d as non-OPEC output growth fades.
- The US will likely surpass Russia and Saudi Arabia in 2013 as the largest liquids producer in the world (crude and biofuels) due to tight oil and biofuels growth, but also due to expected OPEC production cuts. Russia will likely pass Saudi Arabia for the second slot in 2013 and hold that until 2023. Saudi Arabia regains the top oil producer slot by 2027.
- The US, Saudi Arabia, and Russia will supply over a third of global liquids in our outlook.



# The global liquids balance reflects the shifts...





## ...in non-OECD demand and non-OPEC supply growth

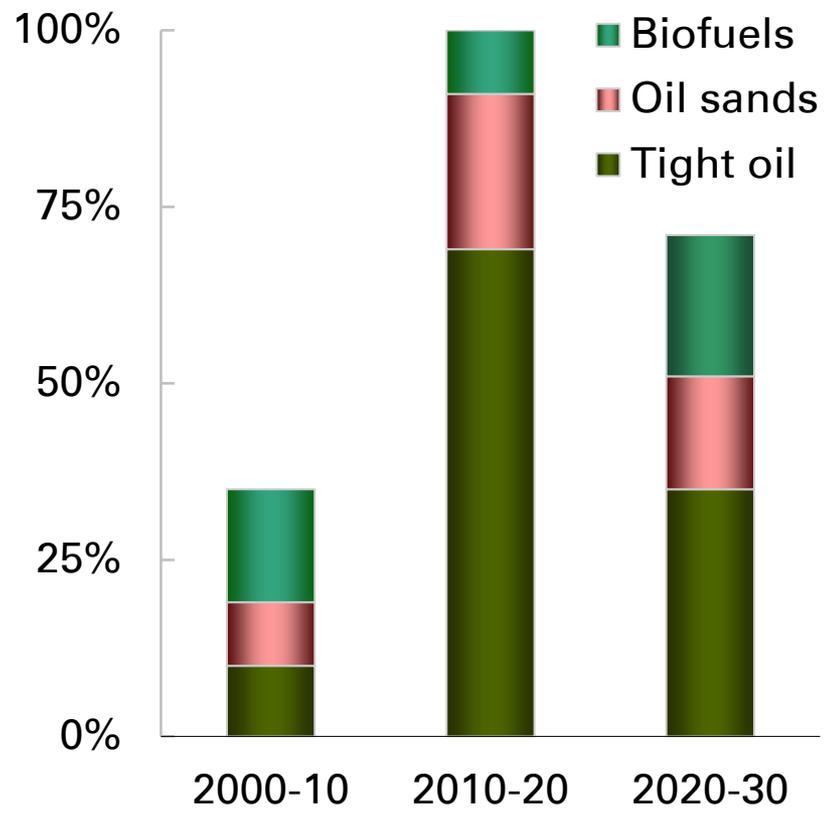
---

- Oil is expected to be the slowest growing fuel over the next 20 years. Global liquids demand (oil, biofuels, and other liquids) nonetheless is likely to rise by 16 Mb/d, to reach 104 Mb/d by 2030.
- Demand growth comes exclusively from rapidly growing non-OECD economies. China, India and the Middle East together account for nearly all of the net global increase. OECD demand has peaked and consumption is expected to decline by 5.6 Mb/d.
- Rising supply to meet expected demand growth will come primarily from non-OPEC unconventional sources and, later in the outlook, from OPEC. By 2030, non-OPEC supply is expected to increase by 8.5 Mb/d while OPEC production will expand by 7.6 Mb/d.
- The largest increments of non-OPEC supply will come from the US (4.5 Mb/d), Canada (2.9 Mb/d), and Brazil (2.7 Mb/d), which offset declines in mature provinces such as Mexico and the North Sea. The largest increments of new OPEC supply will come from NGLs (2.5 Mb/d) and crude oil in Iraq (2.8 Mb/d).

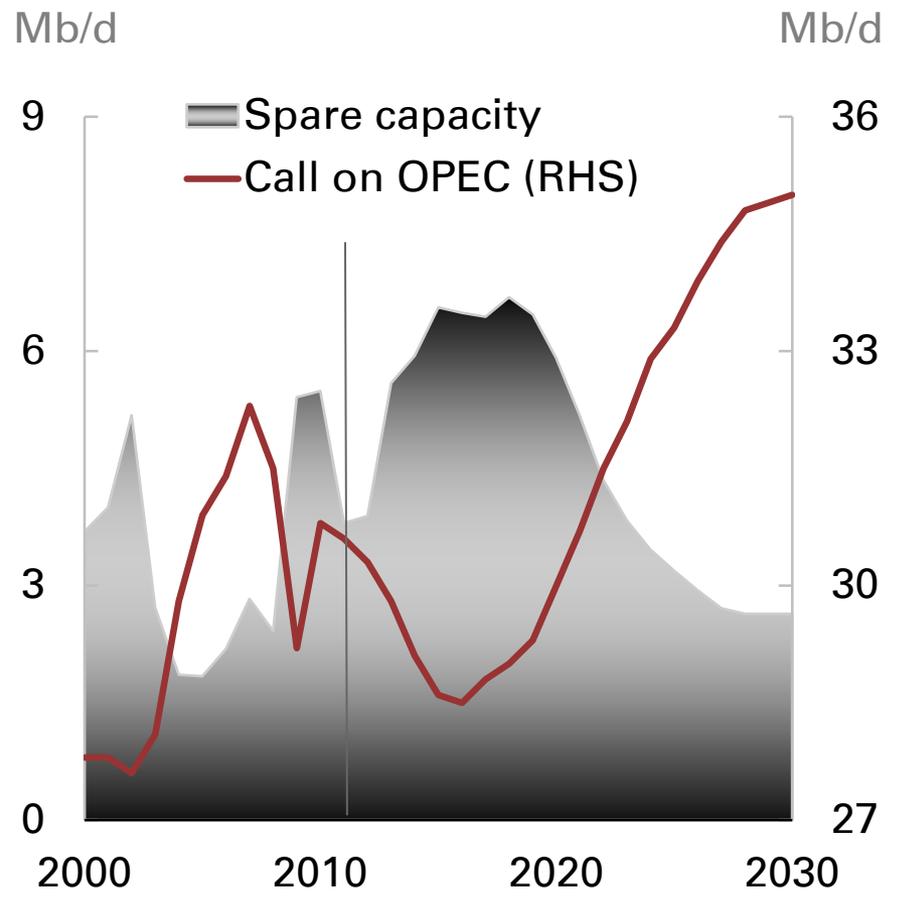


# Slow demand growth and unconventional supplies...

### Unconventionals share of net global supply growth



### Call on OPEC & spare capacity





## ...create a more challenging future for OPEC

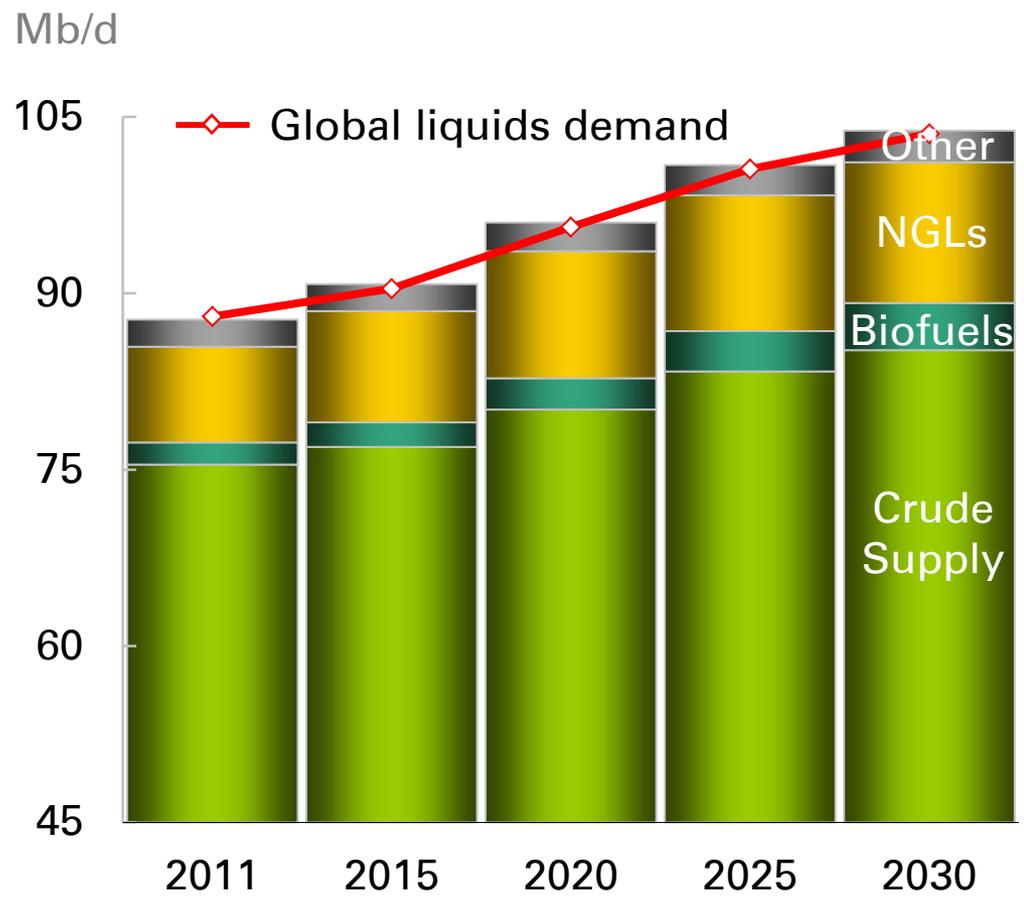
---

- In our outlook, demand growth slows and non-OPEC supplies rise – both as a result of high prices. Unconventional non-OPEC supply will account for all the net growth in global production over this decade, and over 70% of the growth from 2020-30.
- We assume that, in response, OPEC members will cut production over the current decade; spare capacity exceeds 6 Mb/d by 2015, the highest since the late 1980s. If OPEC were to maintain current production, the market would experience unsustainably large inventory increases.
- The market requirement for OPEC crude in our outlook is not expected to reach 2011 levels for another decade. Thereafter, OPEC production rebounds – and spare capacity shrinks – as the market requirement for OPEC crude recovers.
- While we believe that OPEC members will be able to maintain production discipline despite high levels of spare capacity, OPEC cohesion is a key oil market uncertainty, especially in the current decade.



# Refinery throughputs are limited by NGL and biofuels growth...

Global liquids supply and demand



Growth 2011-2030

*Supply:*

Total liquids	<u>16</u> Mb/d
Other liquids <sup>1</sup>	0.5
Non-refined NGLs	4
Biofuels	2

Crude + Condensates 9.5

*Crude runs:*

China <sup>2</sup>	7
World outside China	2.5 Mb/d

<sup>1</sup> includes processing gains  
<sup>2</sup> if no change in net product trade



## ...with the lion's share of crude run growth in China

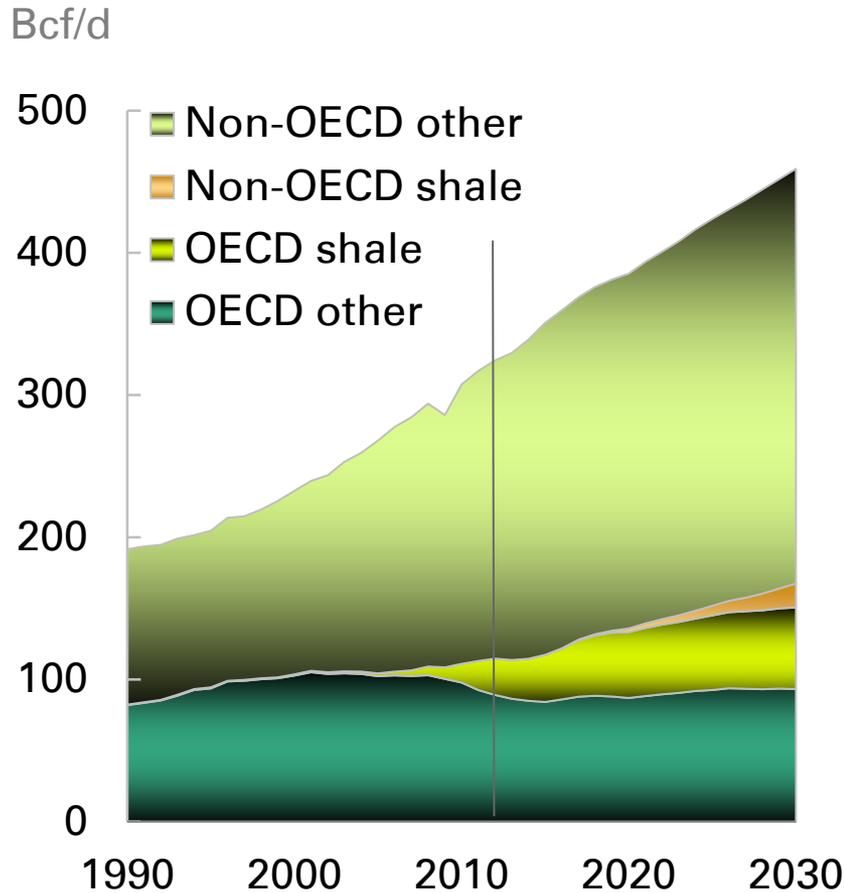
---

- Growth in the call on refinery throughput will be constrained by new supplies of biofuels (2 Mb/d) and NGLs (4 Mb/d) that do not need refining. Increases in processing gains and supplies of liquids derived from gas and coal are likely to add another 0.5 Mb/d to product supplies.
- These supply sources will compete directly with refineries to meet total liquids demand growth of 16 Mb/d between 2011 and 2030, limiting the increase in refinery crude runs to only 9.5 Mb/d over the next 19 years.
- Existing spare capacity can accommodate some of the future growth in refinery throughputs. In addition, new capacity continues to be added at a fast pace with a net 5 Mb/d due to be added globally by 2015.
- Around half of global liquids demand growth is in China and that country's refinery expansion plans will affect product balances globally. A continuation of its stated strategy to be self-sufficient in refined products would severely curtail crude run increases for refiners outside of China.

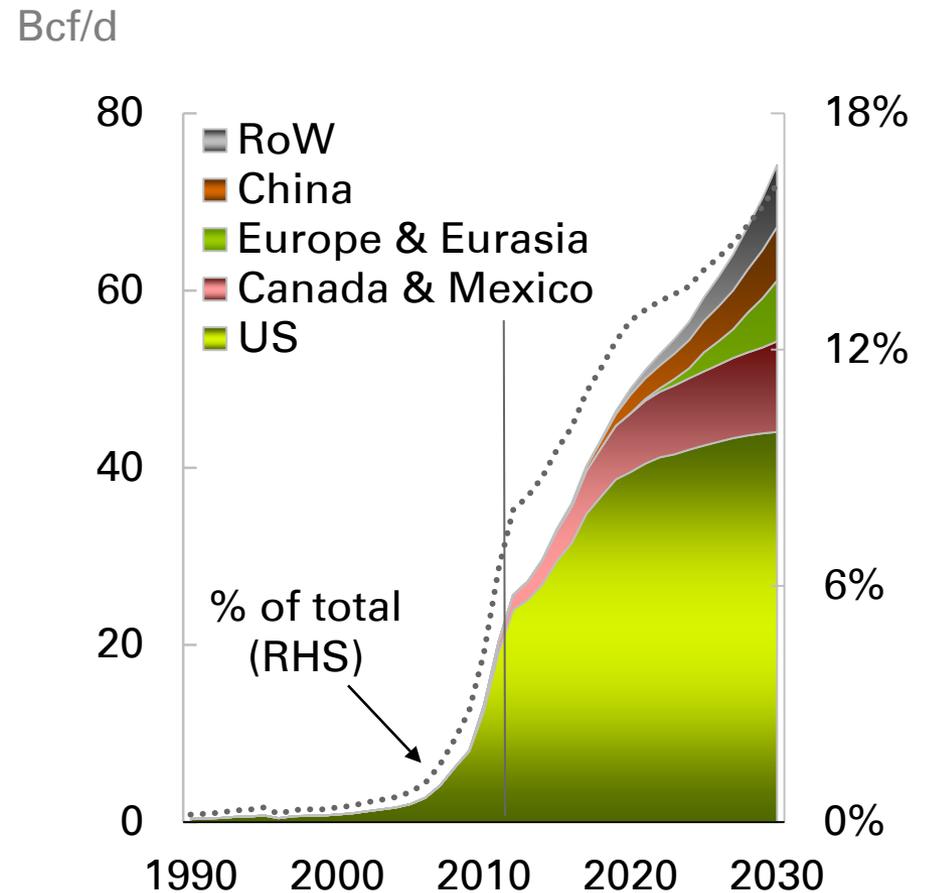


# Shale gas growth will gradually spread beyond the US...

## Gas production by type and region



## Shale gas production





## ...making a significant contribution to global gas growth

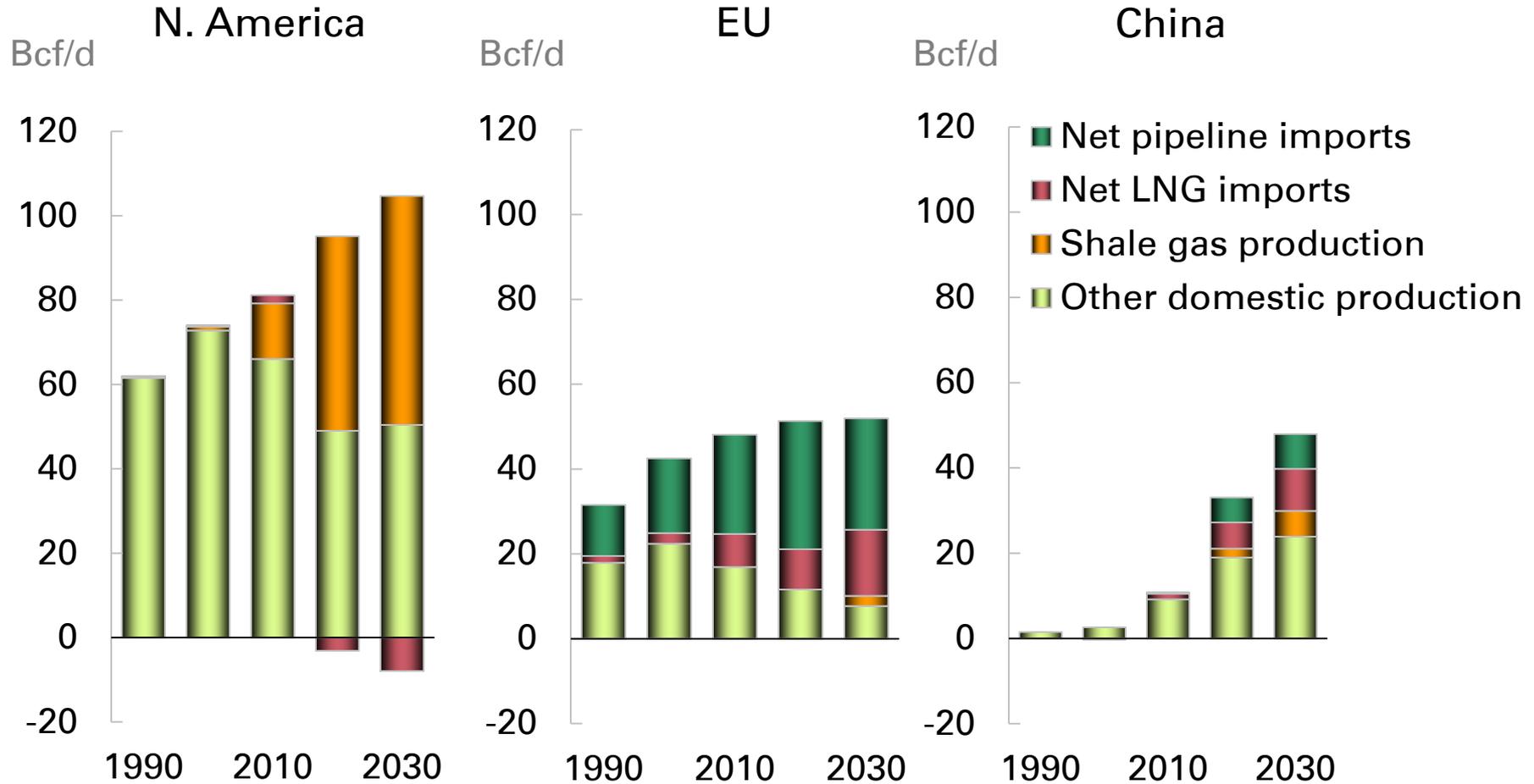
---

- Shale gas is expected to grow by 7% p.a. (or 54 Bcf/d) to reach 74 Bcf/d by 2030, accounting for 37% of the growth of natural gas supply. Shale growth is initially concentrated in North America, where growth is projected to slow after 2020, based on current resource assessments.
- From a global perspective, the momentum of shale gas growth is maintained after 2020 as developments spread to other regions, notably China.
- Total natural gas production is projected to grow by 2% p.a., reaching 459 Bcf/d by 2030. Most of the growth originates from non-OECD countries (2.2% p.a.), accounting for 73% of world gas production growth. The OECD also shows growth (1.5% p.a.), as declines in Europe are more than offset by strong growth in North America and Australia.
- By 2030 Non-OECD will account for 67% of total supply, up from 64% in 2011. Meanwhile, OECD shale gas is set to account for 12.5%, up from just 6% in 2011.



# Shale gas brings self-sufficiency to North America...

## Sources of gas supply, by region





## ...while EU and China will grow imports

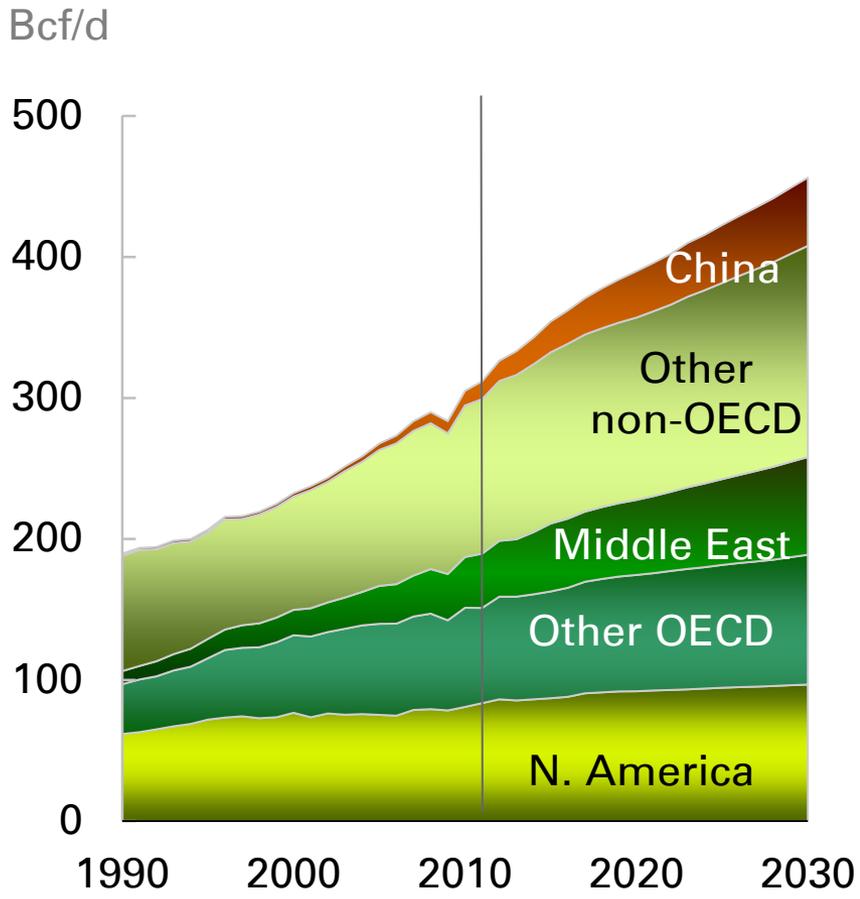
---

- North American shale gas production grows by 5.3% p.a. reaching 54 Bcf/d by 2030, more than offsetting the decline of conventional gas production. Supported by shale gas, North America will become a net exporter in 2017, with net exports approaching 8 Bcf/d by 2030.
- Shale gas development faces a number of challenges in Europe, so we are unlikely to see shale growth at scale before 2030. For the EU, shale gas production of 2.4 Bcf/d in 2030 is not enough to offset the rapid decline of conventional gas production, leading to a 48% increase in net imports.
- China is expected to be most successful in developing shale gas outside North America. Shale gas is projected to grow to 6 Bcf/d by 2030, accounting for 20% of total Chinese gas production. Nonetheless, given the fast growth of Chinese consumption, which by 2030 will be larger than the current EU gas market, China still requires rapid import growth (11% p.a.).

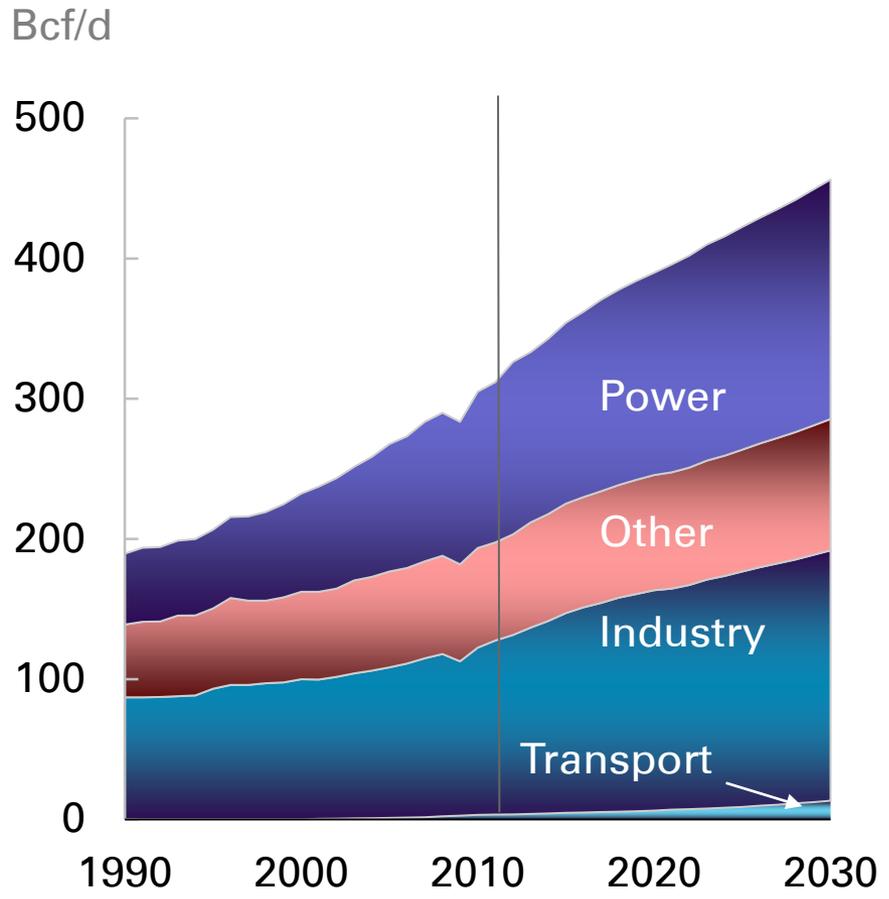


# Gas demand growth is driven by non-OECD needs...

### Demand by region



### Demand by sector





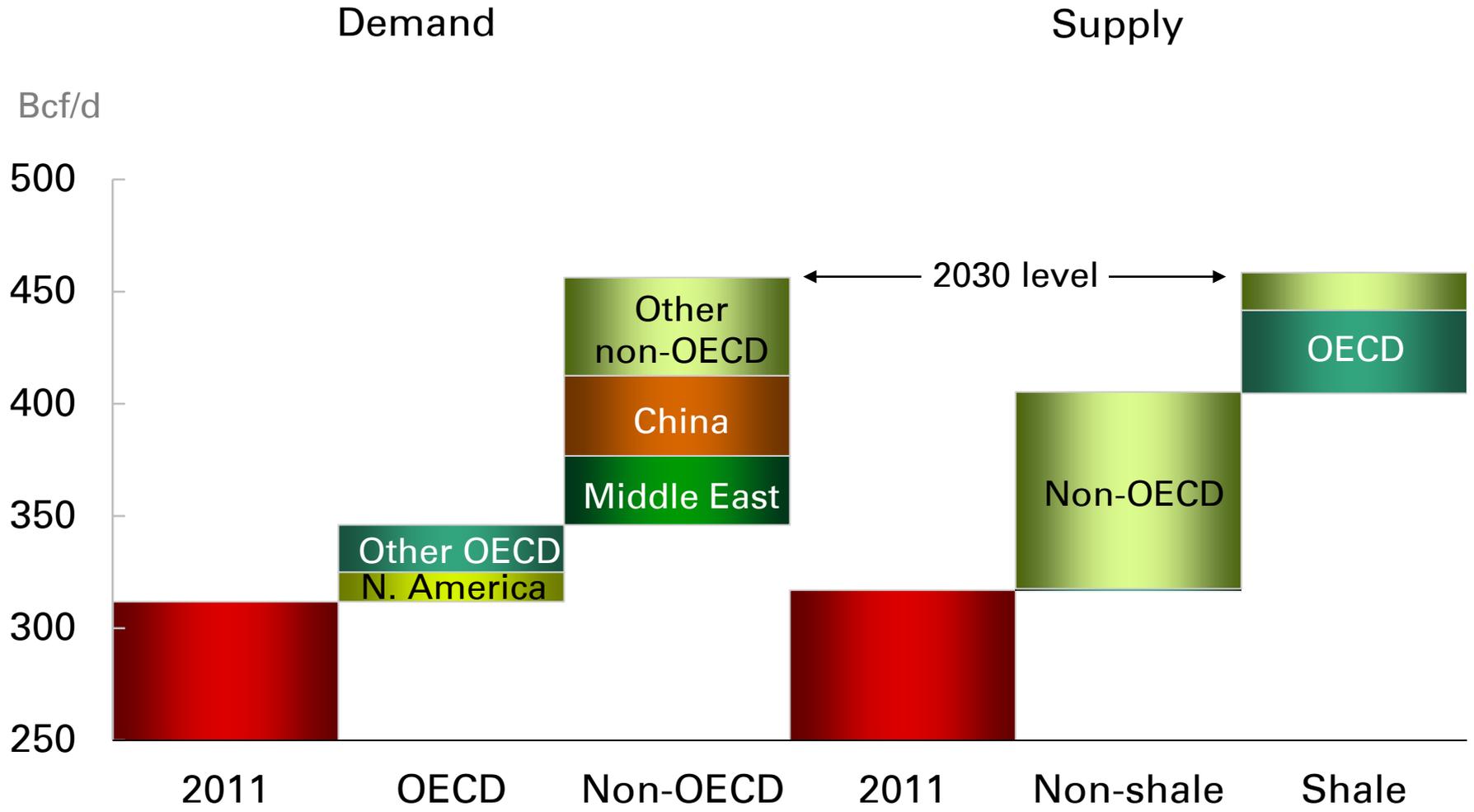
## ...for power generation and industry

---

- Non-OECD gas demand grows faster than in the OECD (2.8% p.a. vs 1.0% p.a.), increasing the non-OECD share of global gas consumption from 52% in 2011 to 59% by 2030. Non-OECD markets account for 76% of global gas demand growth to 2030. China alone accounts for 25% of the growth, and the Middle East for 23%.
- By sector, transport shows the fastest growth, but from a very small base. The bulk of growth comes from power (2.1% p.a.) and industry (1.9% p.a.), with the industrial sector remaining, just, the largest global destination for gas use in 2030. Power accounts for 39% of gas demand growth to 2030 and industry for 38%.
- Gas replaces coal in the OECD in power generation and industry, while non-OECD demand is strong enough to accommodate growth of gas and coal in both sectors.



# Shale gas is the big growth story in the OECD...





## ...but conventional growth in the non-OECD is even larger

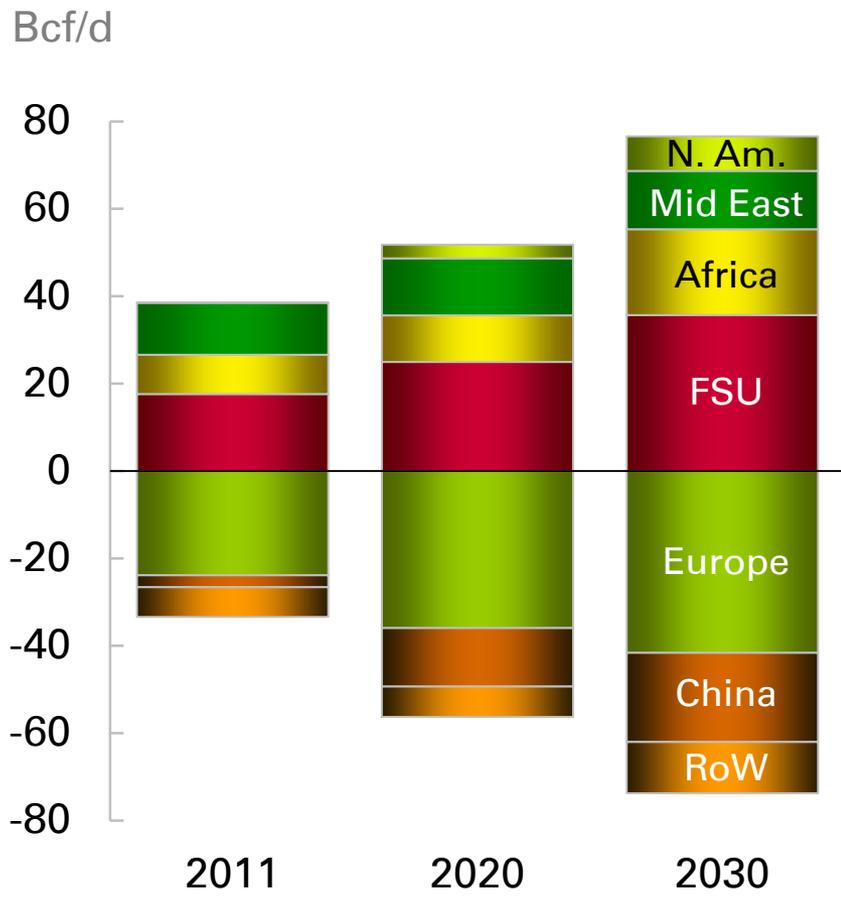
---

- The expansion of shale gas supply in the OECD (37 Bcf/d) is more than enough to cover the increase in OECD gas demand (34 Bcf/d). And shale gas contributes a further 17 Bcf/d to non-OECD gas production growth.
- However, despite all the attention surrounding the shale gas revolution, in volume terms the bigger story is the expansion of mostly conventional production in the non-OECD (84 Bcf/d). The Middle East is the largest contributor with 31 Bcf/d, followed by Africa (15 Bcf/d) and Russia (11 Bcf/d).
- Overall, the growth of non-OECD gas production (104 Bcf/d) almost matches the growth of non-OECD consumption (110 Bcf/d). However, this match on the aggregate level masks growing regional imbalances which will support the expansion of gas trade.

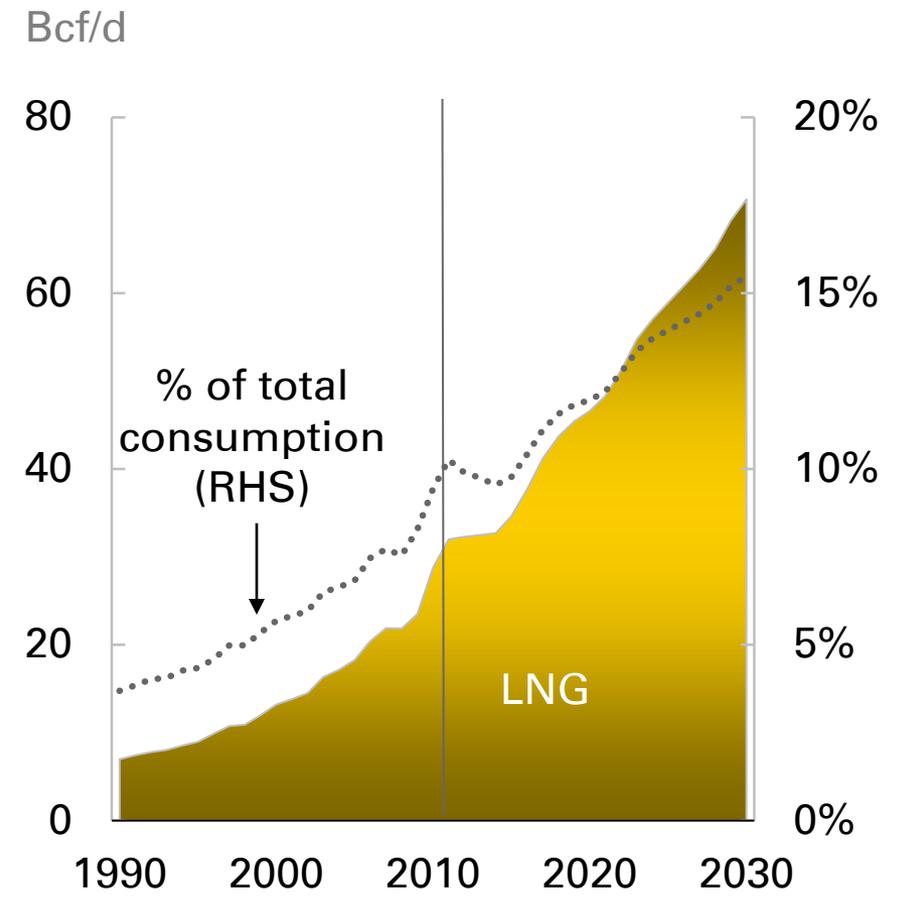


# Gas trade continues to grow faster than consumption...

## Regional gas imbalances



## LNG exports





## ...with LNG playing an ever larger role

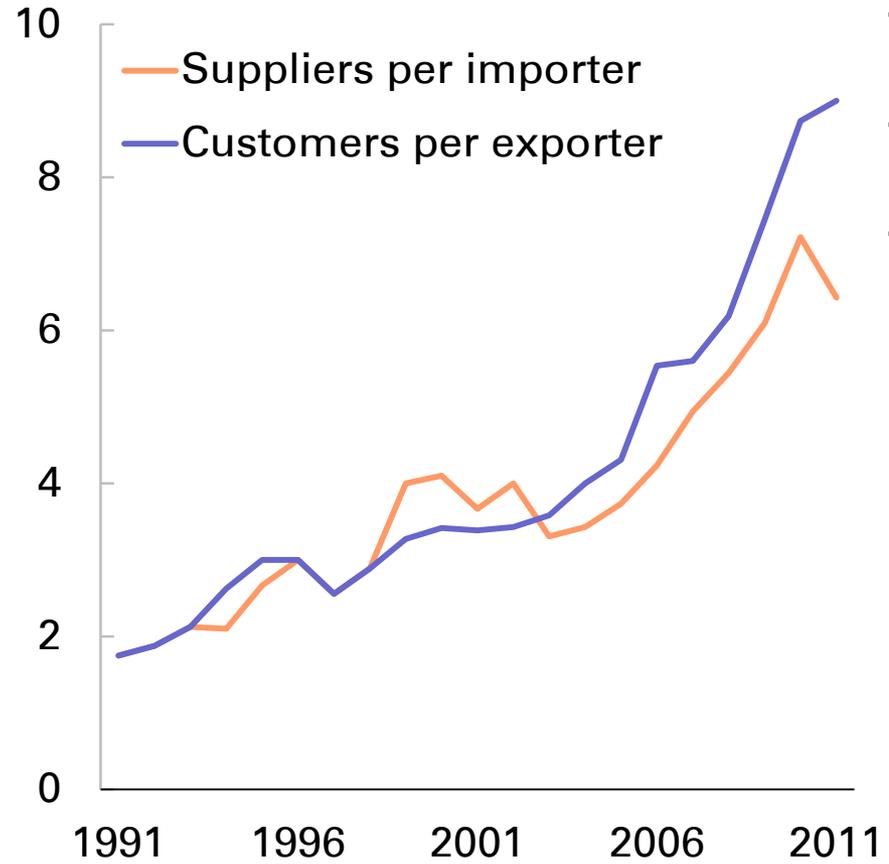
---

- Gas trade between regions continues to grow (3.7% p.a. from 2011). Europe remains the largest net importer, and accounts for the largest increment in net imports (18 Bcf/d). Russia remains the largest net exporter – predominantly to Europe.
- LNG contributes an increasing share of trade. LNG production grows by 4.3% p.a., accounting for 15.5% of global gas consumption by 2030. On a regional level, Africa is set to overtake the Middle East to become the largest net LNG exporter in 2028.
- Australia, with a wave of large projects coming on stream from 2014, expands LNG supply by 15 Bcf/d, overtaking Qatar as the largest LNG supplier by 2018 and accounting for 25% of global LNG production by 2030.
- Inter-regional pipeline trade grows by 3.0% p.a. to 2030, and like LNG trade, sees its share of consumption rising.

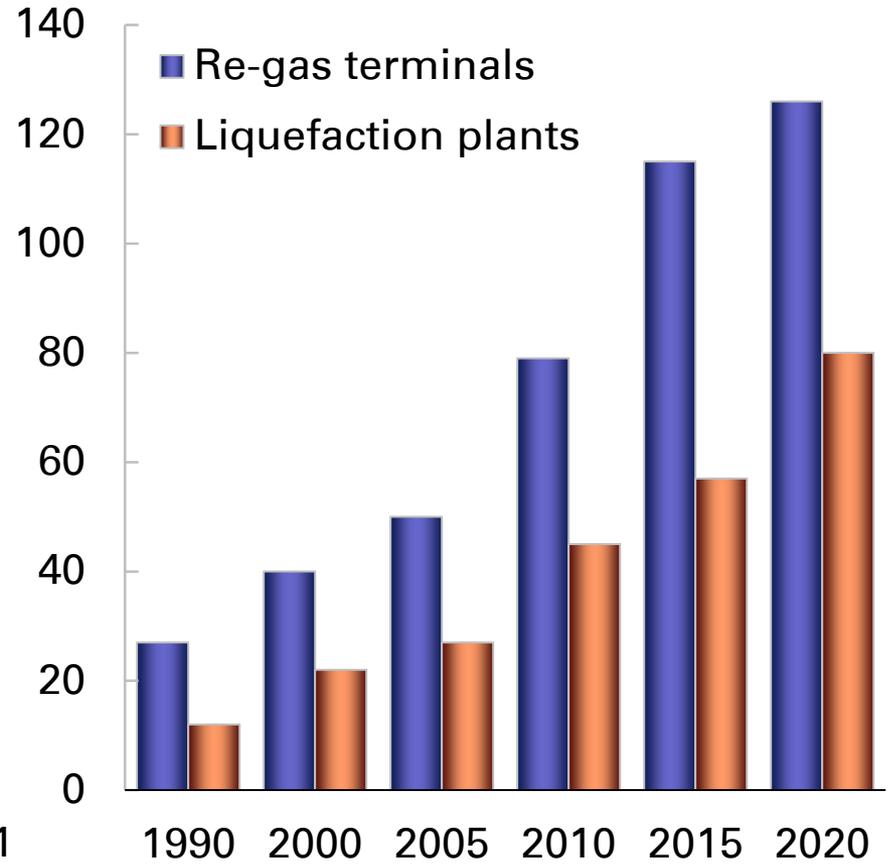


# LNG trade is accompanied by deeper market integration...

### LNG diversification



### LNG infrastructure





## ...improving optionality for importers and exporters

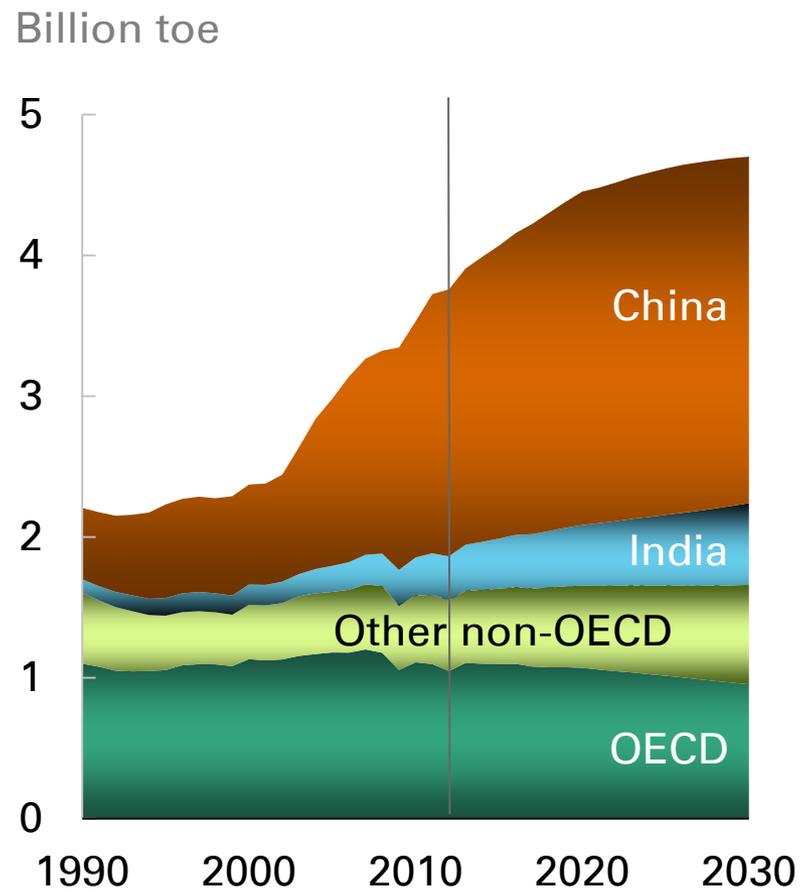
---

- Alongside the growth of LNG volumes, we have seen a diversification of trading partners for both exporters and importers. In 1990 each exporter or importer had an average of 2 partners – by 2011 that had risen to 9 and 6 respectively. Nigeria, Qatar and Trinidad & Tobago are leading export diversification, with an average of 20 trading partners in 2011.
- Another indicator of increased diversification is the decline in the share of LNG accounted for by the largest importer and largest exporter - from 68% and 39% respectively in 1990 to 23% and 31% respectively in 2011.
- The trend towards diversification is expected to continue as new exporters and importers join the LNG trade. Increased market flexibility and integration is also supported by the expansion of the physical infrastructure, creating an ever-expanding network of trading nodes.

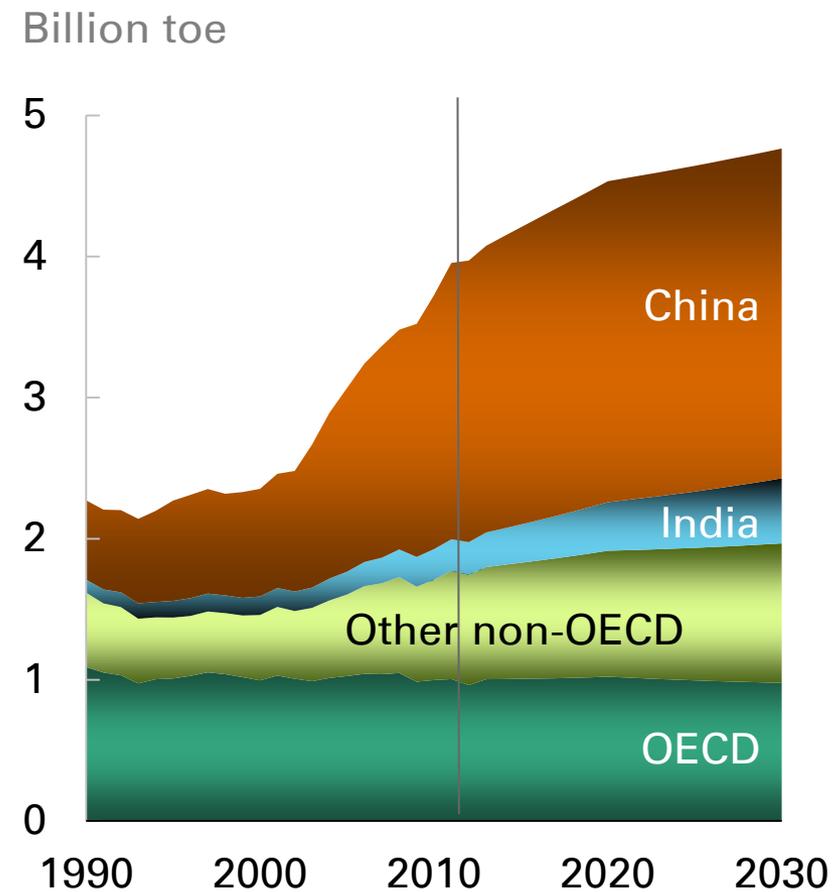


# Coal consumption and production will level off after 2020...

## Coal demand by region



## Coal supply by region





## ...as the OECD and China reduce their reliance on coal

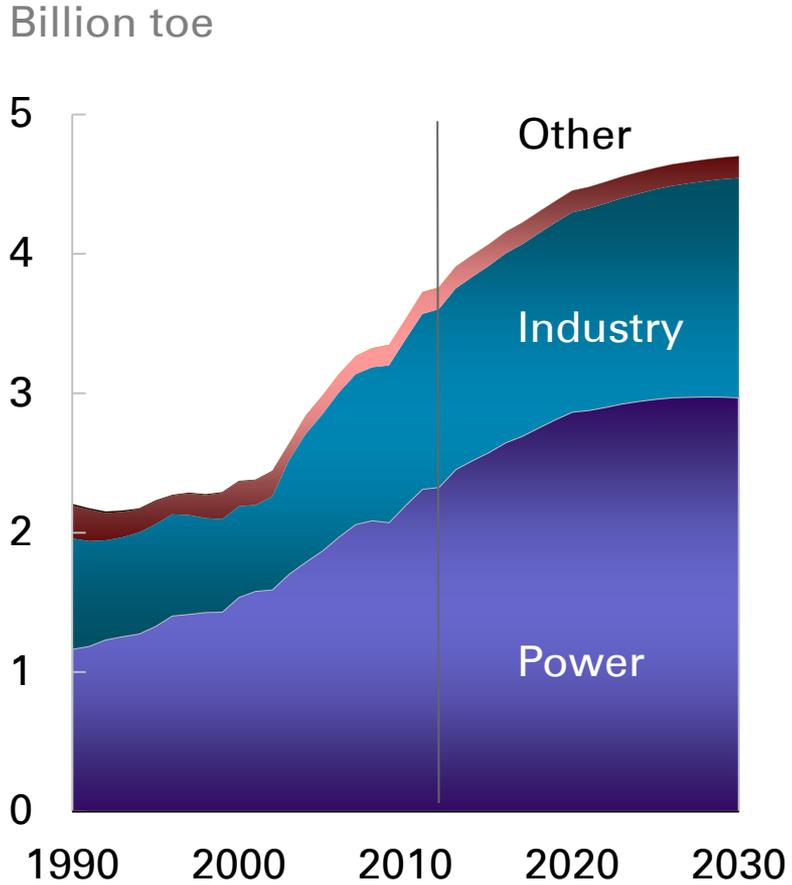
---

- Coal consumption declines in the OECD (by 0.8% p.a. 2011-2030), but continues growing in the non-OECD (1.9% p.a.). China remains the largest coal consumer (52% of global consumption), while India (12%) overtakes the US to become the second largest in 2024. China and India account for 63% and 29% respectively of global coal growth to 2030.
- China's coal demand growth decelerates rapidly from 9% p.a. in 2000-10 to 3.5% p.a. this decade and 0.4% p.a. in 2020-2030, driven by a shift to less coal-intensive economic activities and by efficiency improvements.
- India's coal demand growth slows down more gradually from 6.5% p.a. in 2000-10 to 3.6% p.a. in 2011-2030, as energy efficiency gains partially offset rising energy demand for industrial and infrastructure expansion.
- Global coal supply is set to grow 1.0% p.a. in 2011-2030, with increases in non-OECD countries offsetting declines in the OECD. Production in China and India rises 0.9% p.a. and 3.9% p.a. respectively. Growing imports drive further expansion and integration of global coal markets.

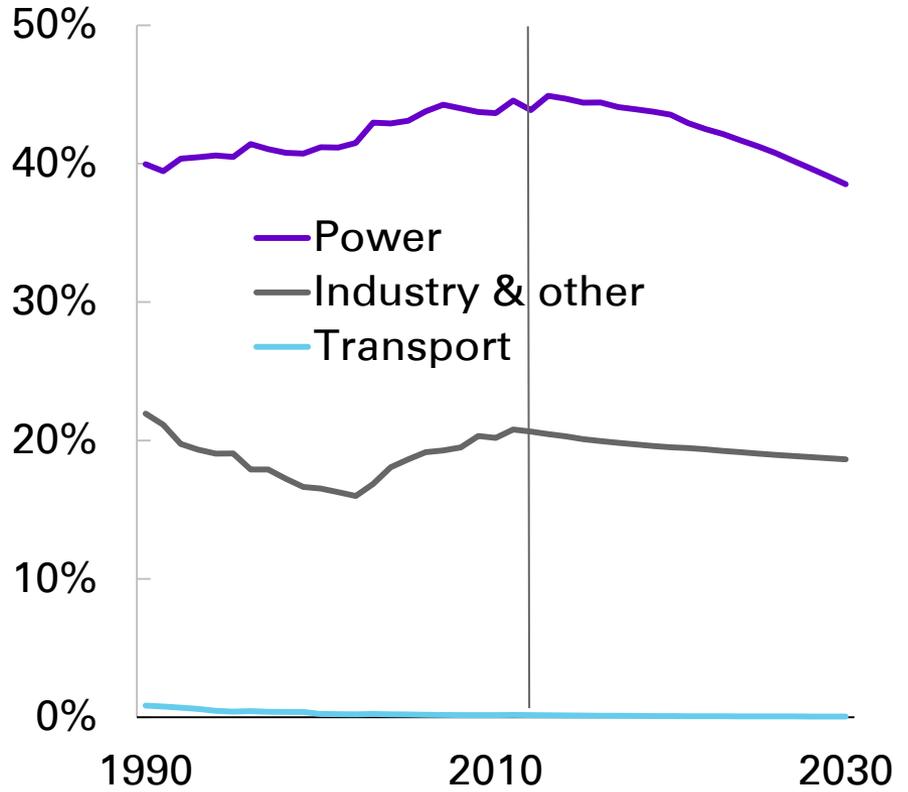


# The share of coal declines in all sectors...

### Coal demand by sector



### Coal share in sector





## ...driven by structural change and fuel diversification

---

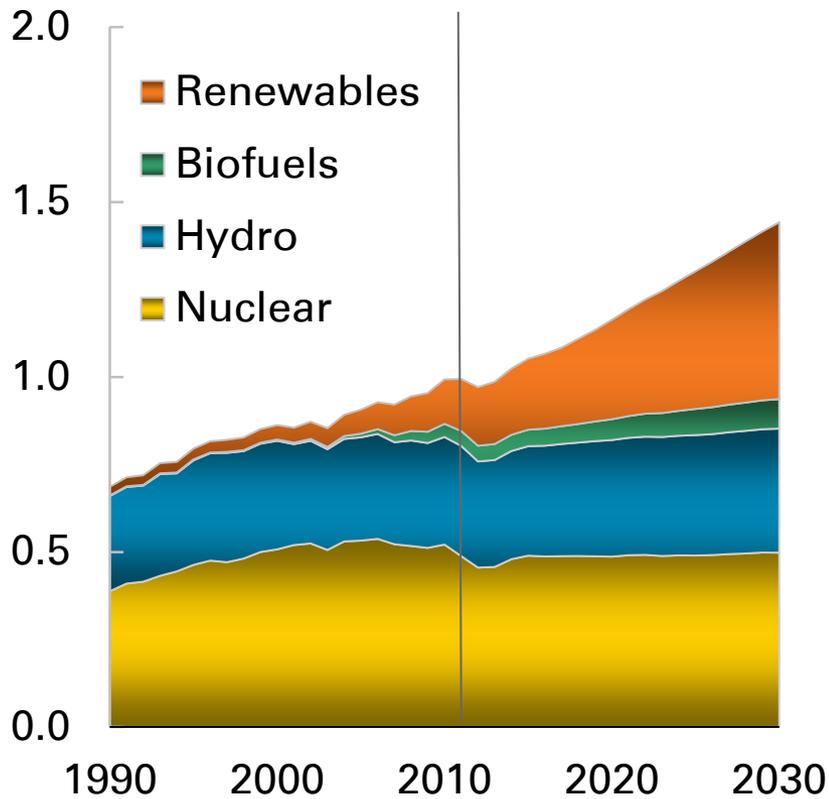
- The growth of global coal consumption in power generation slows from 3.6% p.a. in 2000-10 to 2.4% p.a. in 2011-20 and 0.4% p.a. after 2020. In the OECD coal use in power is already in decline (-0.2% p.a. 2000-10); this decline accelerates to -1.2% p.a. in 2020-30. In the non-OECD, the growth of coal use in power slows, from 7.7% p.a. 2000-10 to 1.0% p.a. after 2020.
- As a result, coal's share in fuels used for power generation declines from 44% in 2020 to 39% in 2030; gas, nuclear and renewables all gain share.
- Coal consumption in the industrial sector also levels off. While consumption continues to decline in the OECD (-1.1% p.a.), growth in the non-OECD decelerates from 7.8% p.a. in 2000-10, to 1.9% p.a. 2011-20 and 1.2% p.a. in 2020-30. As the focus of China's economic development shifts from rapid industrialisation and infrastructure building to growth based on services and light manufacturing, its industrial consumption of coal decelerates from 9.6% p.a. in 2000-10 to 0.9% after 2020.



# Non-fossil fuels growth is led by renewables in the OECD...

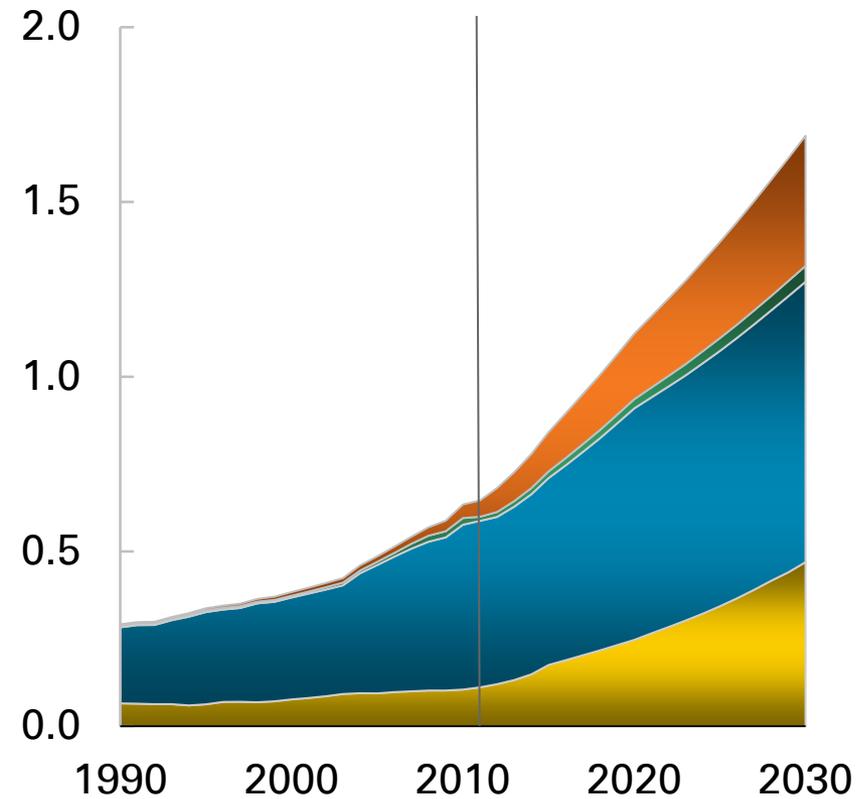
## OECD

Billion toe



## Non-OECD

Billion toe





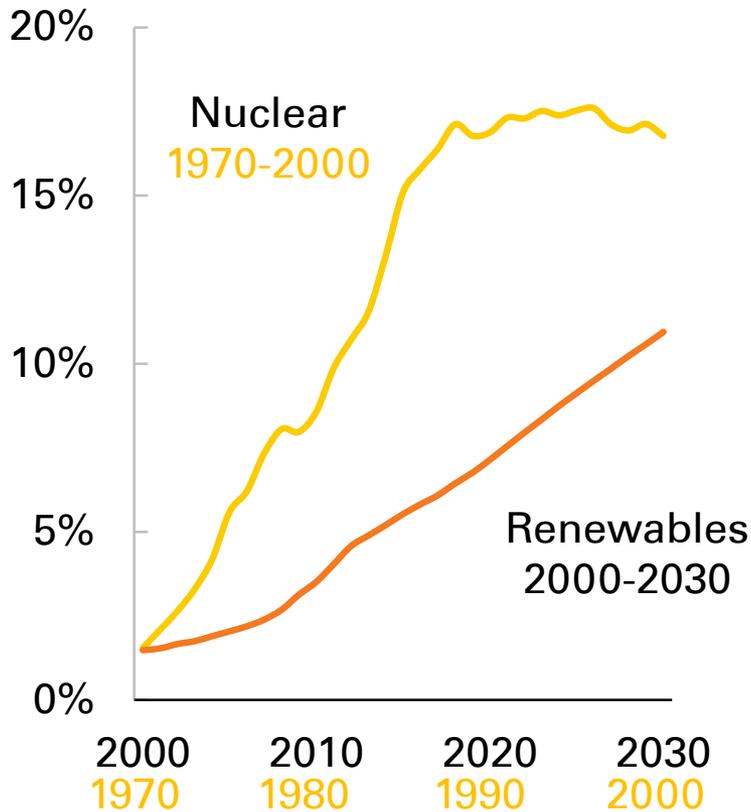
## ...while nuclear leads in the non-OECD

---

- Non-fossil fuels grow strongly in both the OECD (2.0% p.a.) and non-OECD (5.2% p.a.). OECD growth is concentrated in renewable power (6.7% p.a.), while nuclear output remains below pre-Fukushima levels, and hydro continues to grow slowly.
- In the non-OECD, growth is more evenly split between renewables, nuclear and hydro. Nuclear contributes the most to growth, with output increasing rapidly (7.9% p.a.) as China, India and Russia pursue ambitious expansion programmes.
- Including biofuels, renewables reach a 6% share of global primary energy by 2030, up from 2% in 2011. Renewables growth is initially led by the EU, but from 2020 the US and China are the largest sources of growth. The non-OECD shows a higher growth rate than the OECD (10.9% p.a. vs 6.1% p.a.), but in terms of volume growth the OECD remains just ahead of the non-OECD.

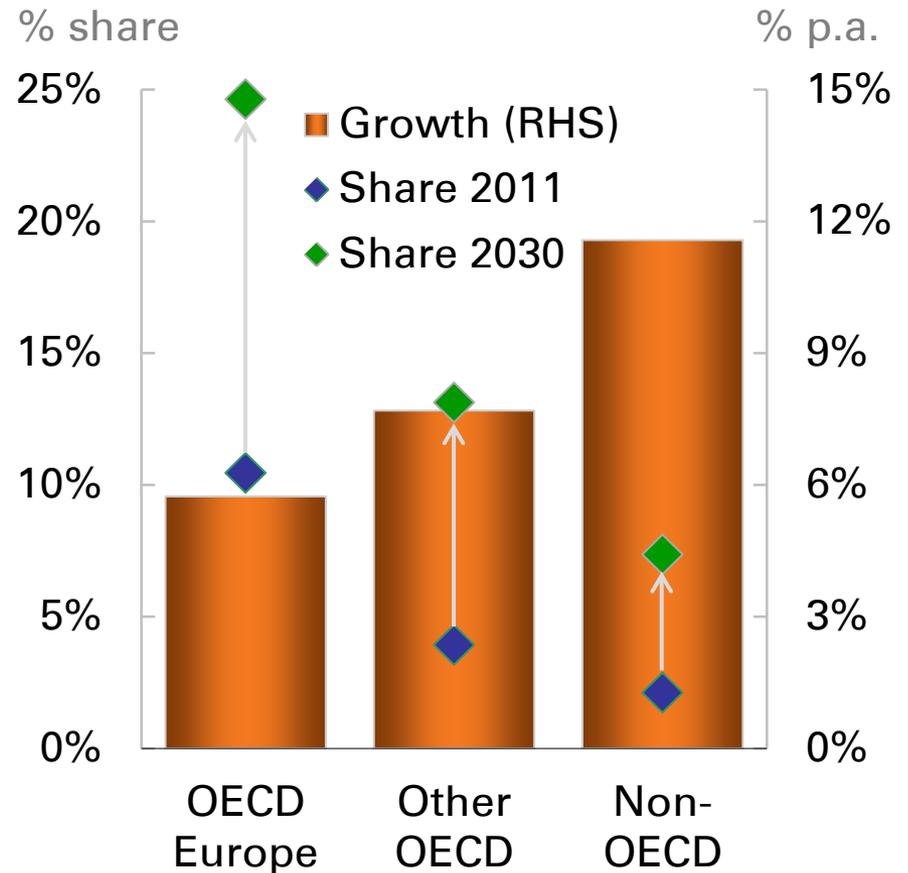
# Renewables continue to gain market share...

## Share of power generation



## Renewable power

Growth 2011-30, and share of power





## ...assuming cost declines can keep the subsidy burden in check

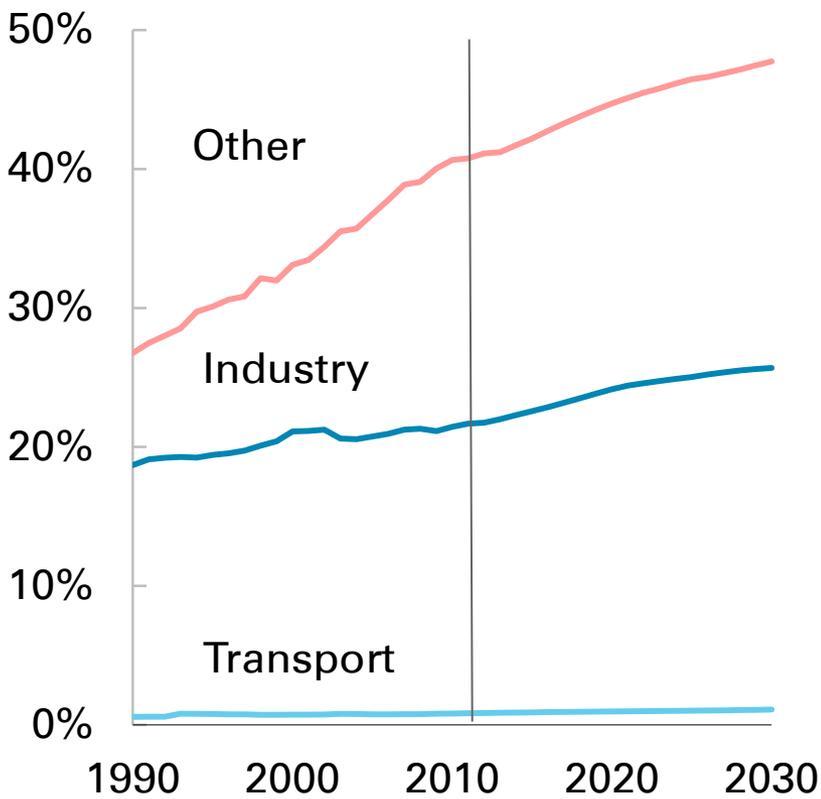
---

- Renewables are projected to gain market share in power, at a slower but perhaps more sustainable rate than nuclear in the 1970/80s. Nuclear power then gained share rapidly, but peaked in the 1990s as safety concerns, rising costs, and continued public opposition led to a loss of policy support.
- Renewables face a different set of challenges, the most pressing of which – and the key factor limiting growth – is the affordability of subsidies. Continued rapid cost reductions are required to keep the subsidy burden at an acceptable level as renewables scale up.
- Renewable power growth in the EU slows, as the share of renewables is now at a level where the subsidy burden has become an issue. Nevertheless renewables continue to gain market share in the EU, because overall power growth is low (0.8% p.a.). Less mature markets for renewables, with lower current shares, can sustain higher growth rates.



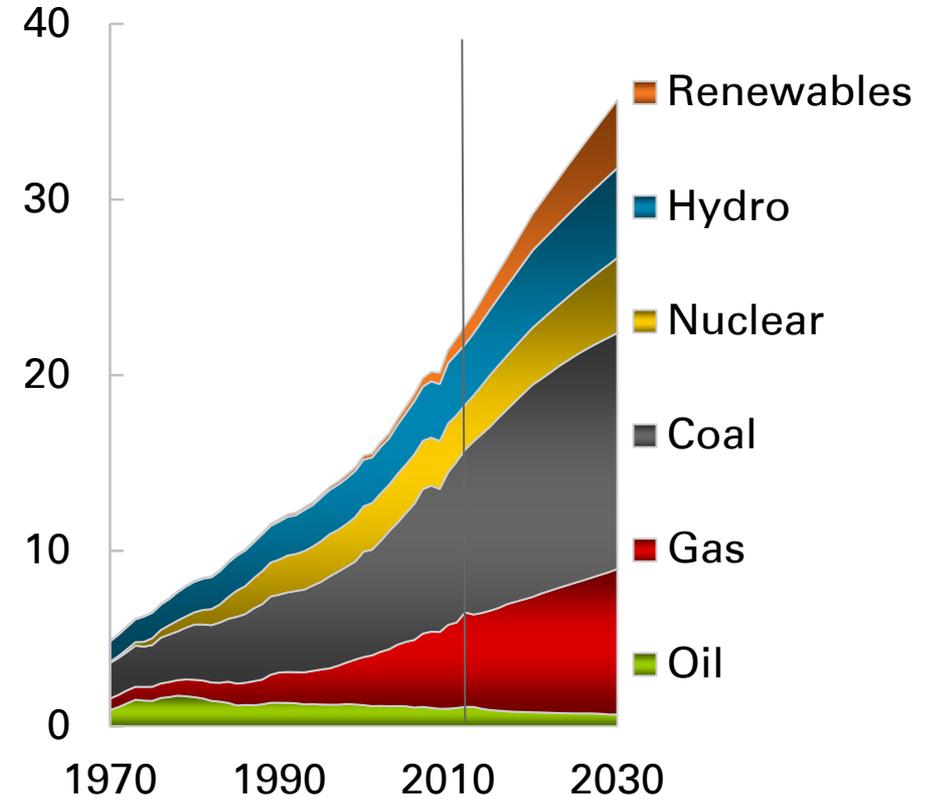
# Electricity gains in all sectors...

## Electricity share of final consumption



## World power generation

Thousand TWh



## ...but power growth slows as China restructures

---

- The power sector is a key driver of global energy growth, and the only sector where all the primary fuels compete. Total electricity consumption will be 61% higher in 2030 than in 2011, growing by 2.5% p.a. (versus 3.4% p.a. for 2000-10, and 2.7% for 1990-2000). Electricity continues to gain share in final energy use, meeting 33% of non-transport energy demand in 2030, up from 28% in 2011.
- Electricity is closely tied to economic growth and industrialisation. Global electricity demand growth accelerated as China started to industrialise at scale. Beyond 2020 global electricity growth slows as China shifts to less energy-intensive growth.
- Improving end-use efficiency everywhere adds to this “China effect”. The net result is a 1.1% p.a. decline in electricity per unit of GDP, compared to a 0.1% p.a. decline 1990-2010.
- Improving conversion efficiency in power generation means that the total fuel inputs to generate power grow less rapidly than electricity demand, averaging 2.1% p.a.

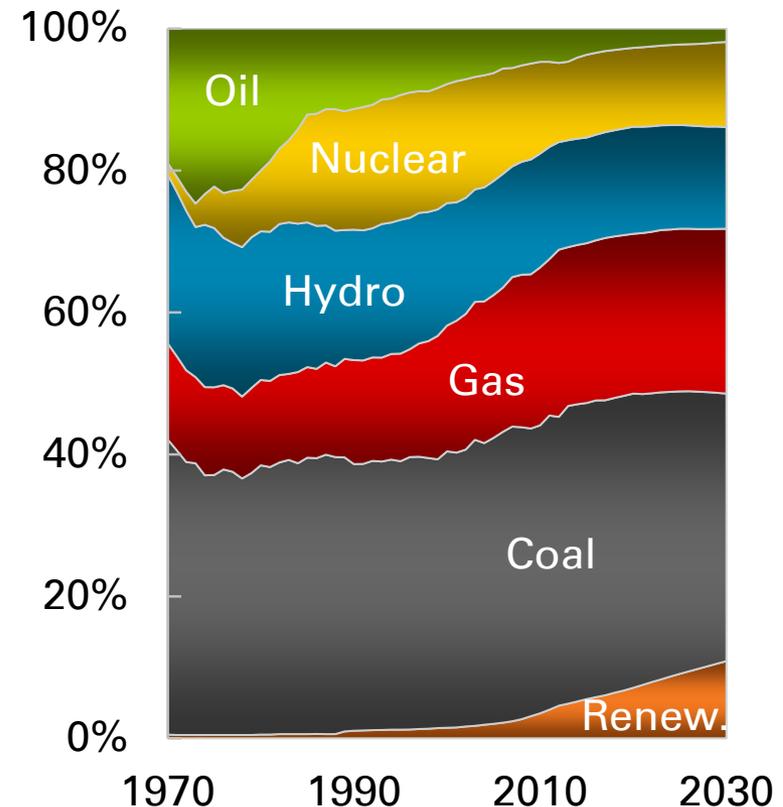
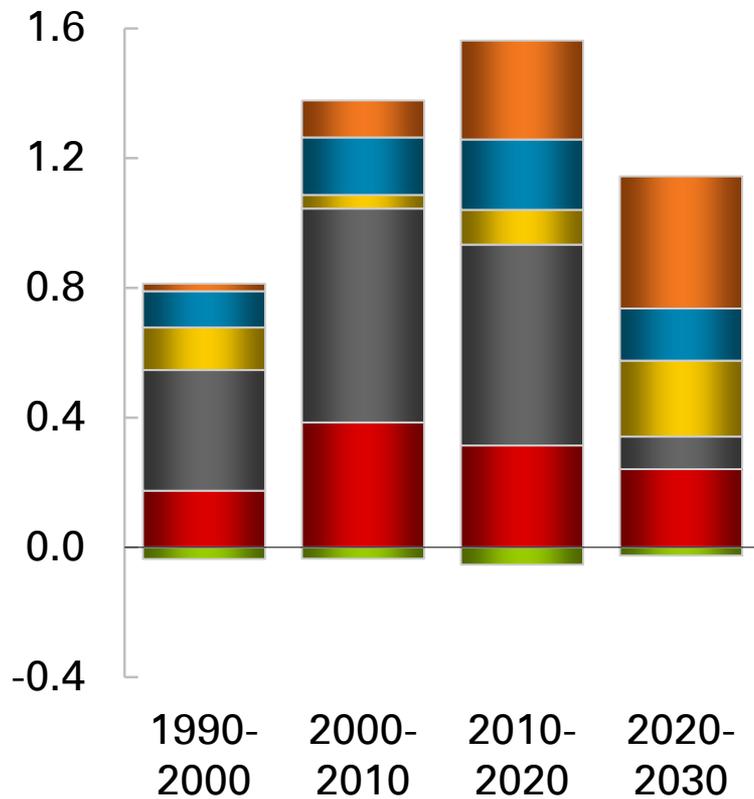


# The fuel mix for power generation diversifies...

### Growth of fuel inputs to power

### Shares of power output

Billion toe





## ...with coal's share declining rapidly post 2020

---

- Over time we see large shifts in the fuel mix for power generation, driven by relative prices, policy, and technology developments. In the 1970s and 1980s high priced oil was replaced by nuclear and to a lesser extent by coal. In the 1990s and 2000s gas gained share as CCGT technology was deployed, and coal's share also rose, reflecting the growing weight of Asia's coal-intensive power sector in global power generation.
- From 2011 to 2030 coal loses share and gas gains share only marginally, as renewables start to penetrate the market at scale.
- The impact on the growth of fuels for power, in volume terms, is particularly striking in the final decade of the outlook. After 2020 we see very little growth in coal used in power, in stark contrast to the previous two decades. This is the result of the slowdown in total power growth, and the increased role of both renewables and nuclear. Gas growth is also reduced, but to a much lesser extent than coal.

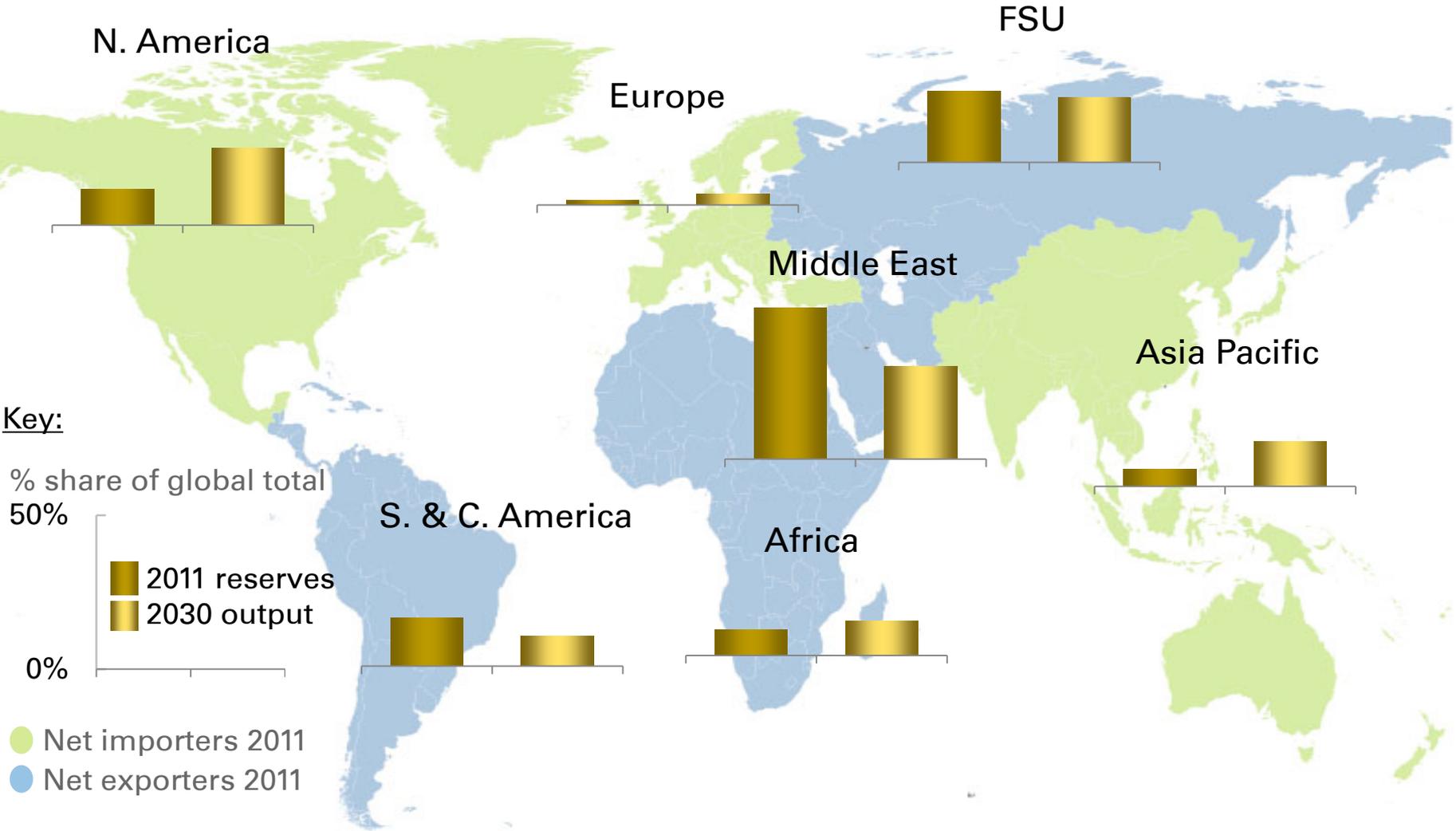


---

	Page
Introduction	4
Global energy trends	7
Outlook 2030: Fuel by fuel	27
<b>Implications</b>	<b>69</b>
Appendix	81



# Distribution of oil and gas reserves: importing regions...



## ...more likely to turn reserves into production

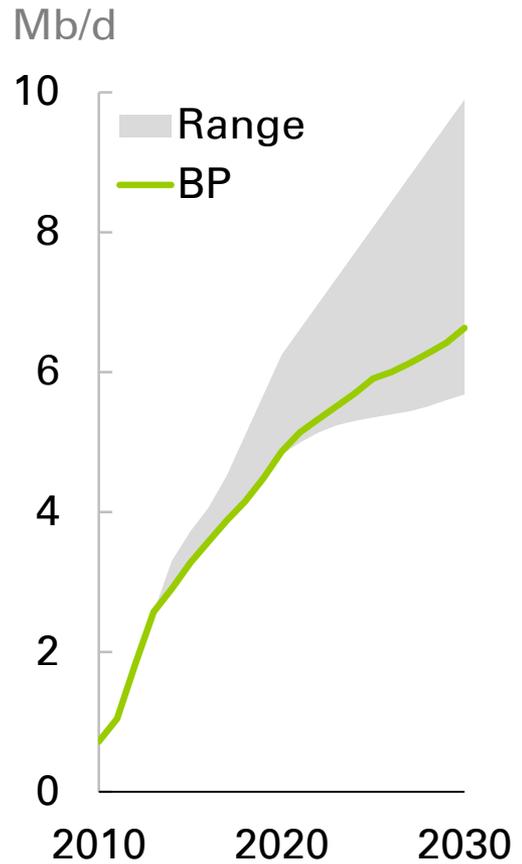
---

- The world has ample proved reserves of oil and natural gas to meet expected future demand growth. At the end of 2011, global proved reserves of oil were sufficient to meet 54 years of current (2011) production; for natural gas that figure is 64 years.
- The distribution of global proved reserves of oil and natural gas – while essential for energy production – is not a good predictor of the distribution of future production growth. Indeed, the world's oil and gas importing regions – Asia Pacific, North America, and Europe – are expected to contribute a disproportional share of the world's oil and natural gas production to 2030.
- These countries sit atop just 16% of global proved reserves of oil and natural gas, yet they will account for 38% of global production in 2030, and will deliver one-third of the growth in global production.

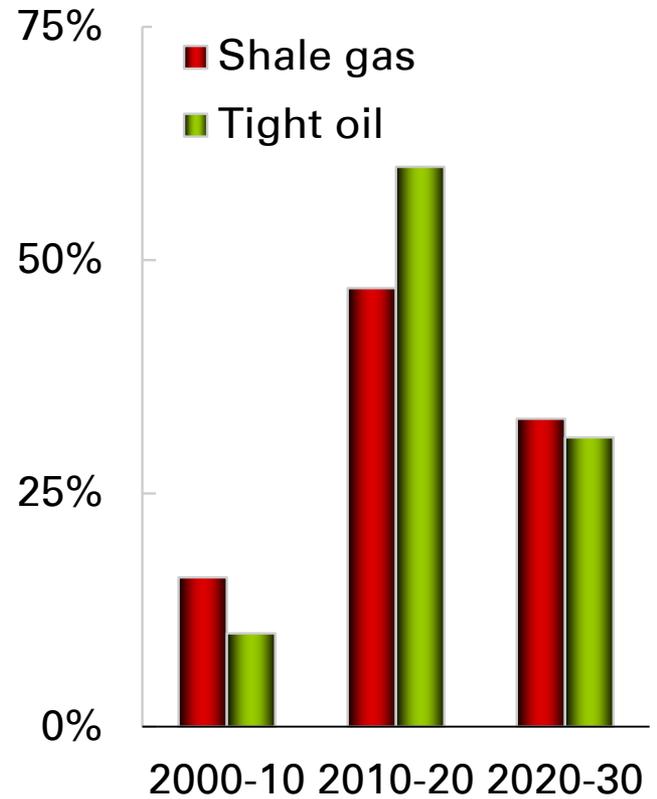


# The expected slowdown in tight oil and shale gas production...

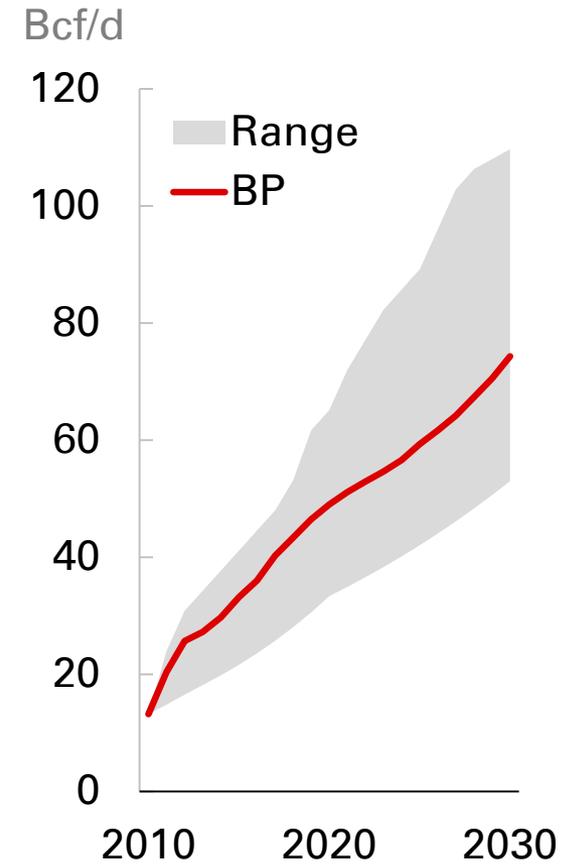
### Range of tight oil forecasts (excludes NGLs)



### Share of global supply growth



### Range of shale gas forecasts





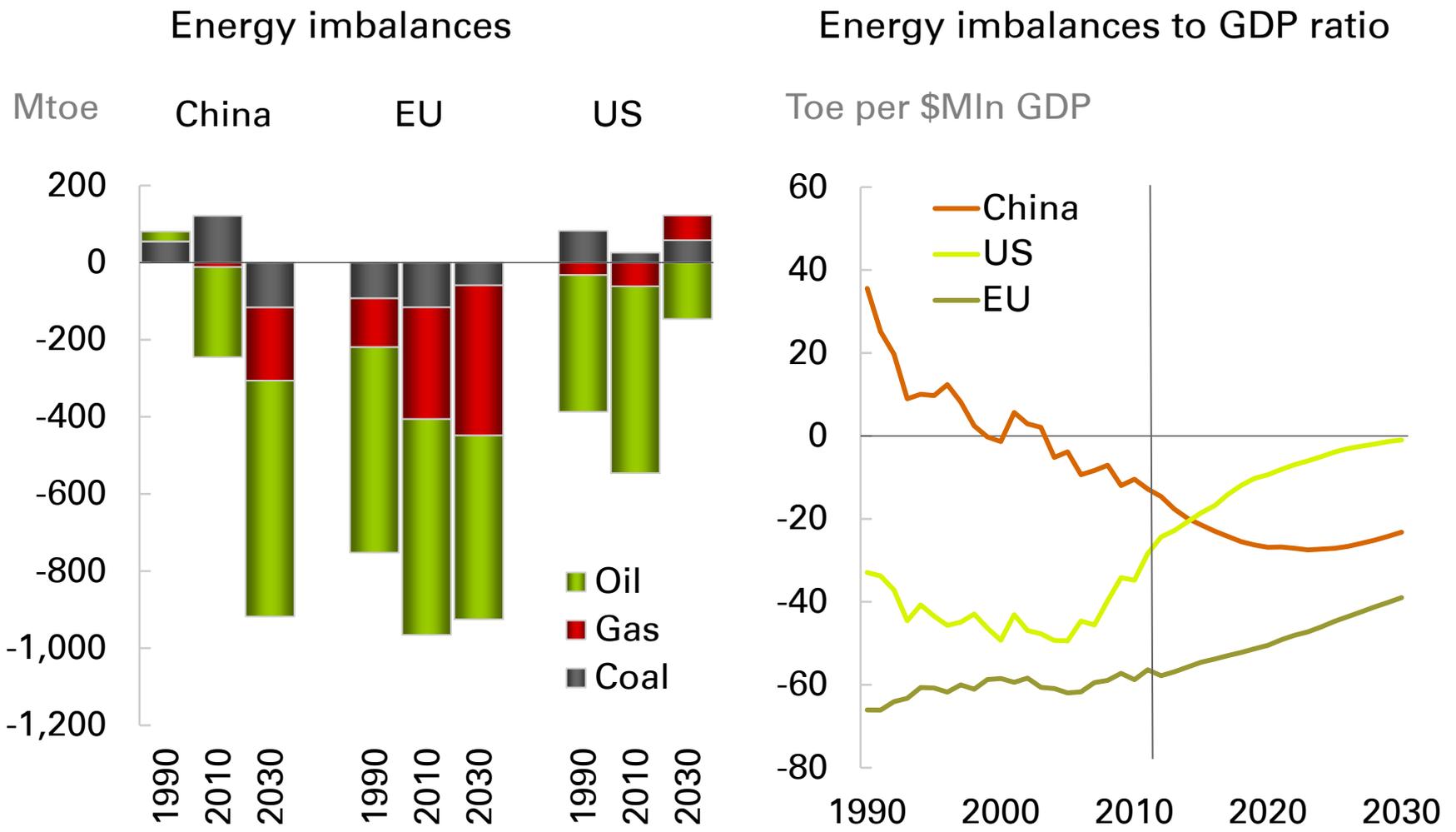
...may not materialise if more optimistic outlooks are realised

---

- We project that the current decade will experience the most rapid growth in global production of tight oil and shale gas. After 2020, North American growth is expected to moderate, in part due to current assessments of the resource base. Continued, but more modest, growth elsewhere results in slower global production growth in the next decade.
- The global understanding of tight oil and shale gas potential is still evolving, however, and the range of external forecasts reflects the uncertain landscape. Different views on the North American resource base – in particular, whether to expect further growth – are the key factor behind the range of external forecasts. Elsewhere, varying assessments of above ground issues are another driver of divergent forecasts.
- These uncertainties could result in a significantly higher path for tight oil and shale gas production – as much as 5 Mb/d and 35 Bcf/d, respectively, by 2030. Additional supplies would have follow-on implications for the broader outlook: in the case of oil, for example, by reducing the market requirement for OPEC crude and boosting spare capacity.



# Energy imbalances: significant changes in import profiles...





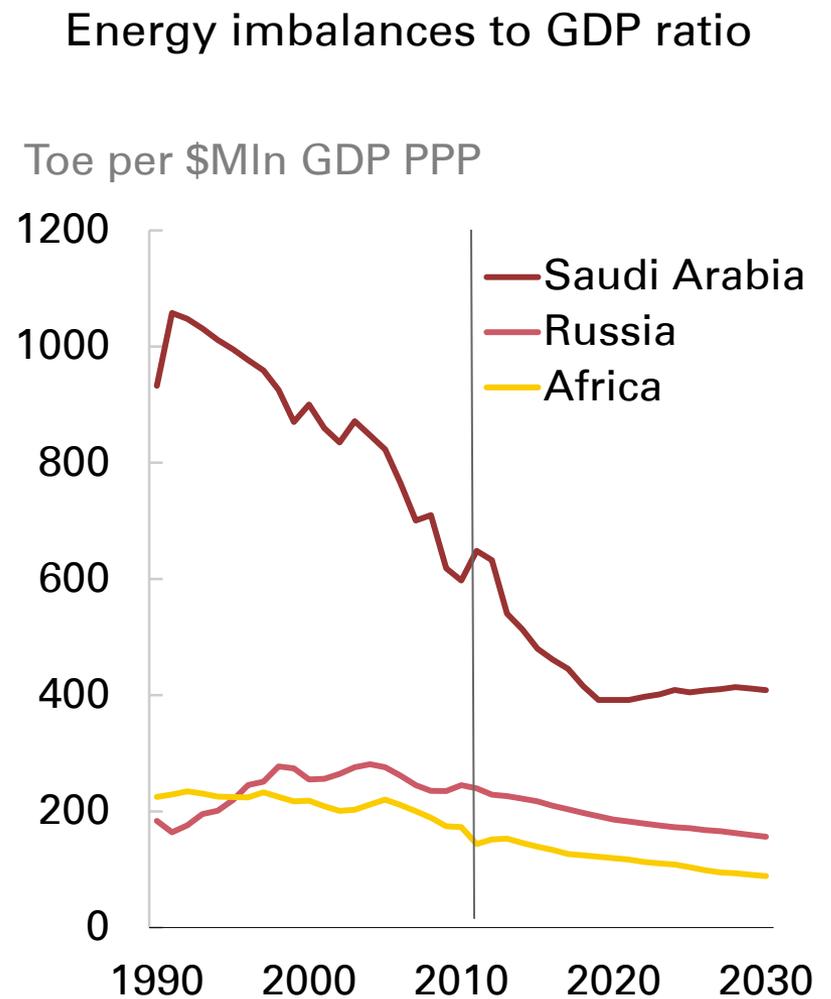
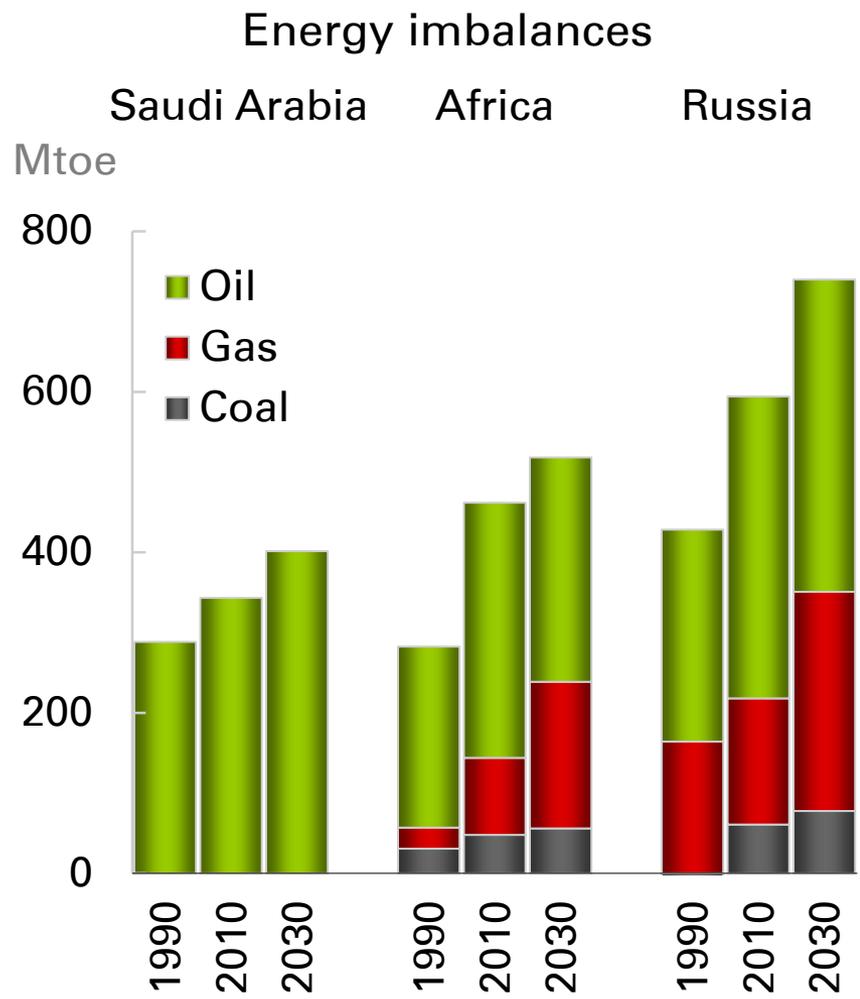
## ...put into perspective by economic growth

---

- Growing production and flat consumption will see the US become nearly self-sufficient in energy by 2030. The US will remain a small net importer of oil, although net imports will decline by about 70%. With net exports of natural gas and coal, US energy production will reach 99% of domestic consumption, up from a low of 70% in 2005.
- China is on pace to match Europe as the world's leading energy importer by 2030, and will replace the US as the world's largest oil importing nation by 2017.
- However, the growth in Chinese energy imports will be taking place in a context of robust economic growth. Adjusting the volume of energy imports for expected economic growth will leave China relatively less dependent (per unit of GDP) than EU on imported energy.
- Other things equal, the development of energy imbalances point toward a reduction of global trade imbalances.



# Energy imbalances: growing energy exports...



## ...and their relative importance

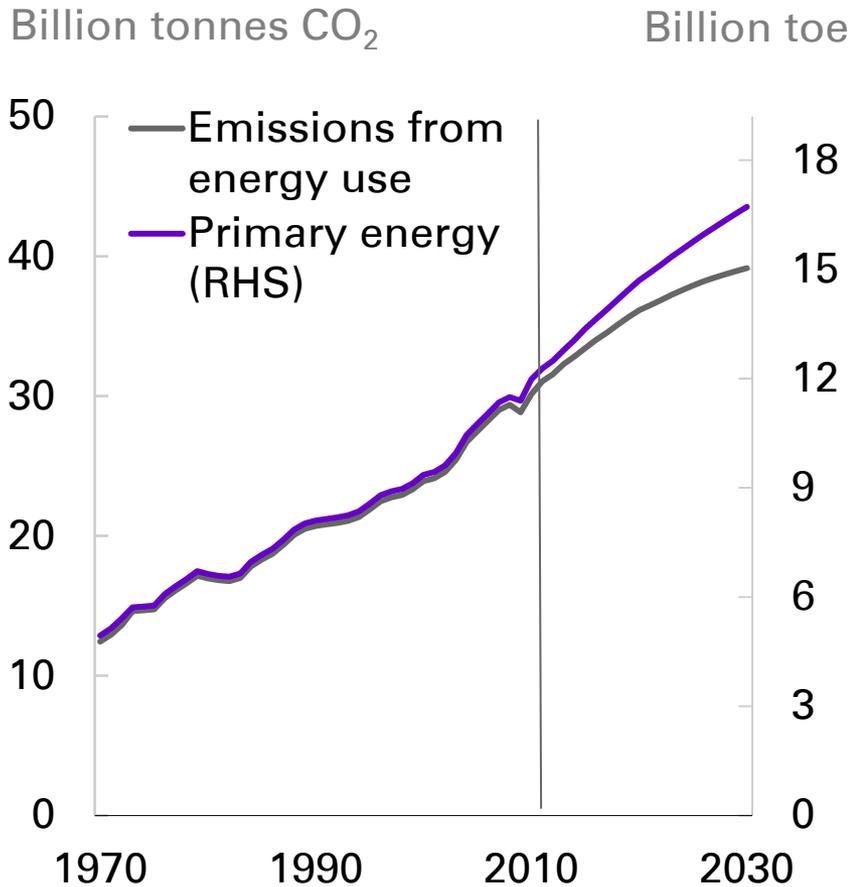
---

- Russia will remain the world's largest energy exporter, with increases in exports of all fossil fuels. Net energy exports will rise by 25% in volume terms.
- By 2030, Saudi Arabia will be the world's largest oil exporter, although the trajectory over time will be impacted by the likelihood of OPEC production cuts discussed earlier. By 2030, oil exports in volume terms are likely to be 17% above the 2010 level.
- As a region, Africa will become an increasingly important source of fossil fuel exports as well.
- Once again adjusting for expected economic growth, Russia – and the African countries as a group – are likely to remain significantly less dependent on energy exports than Saudi Arabia.

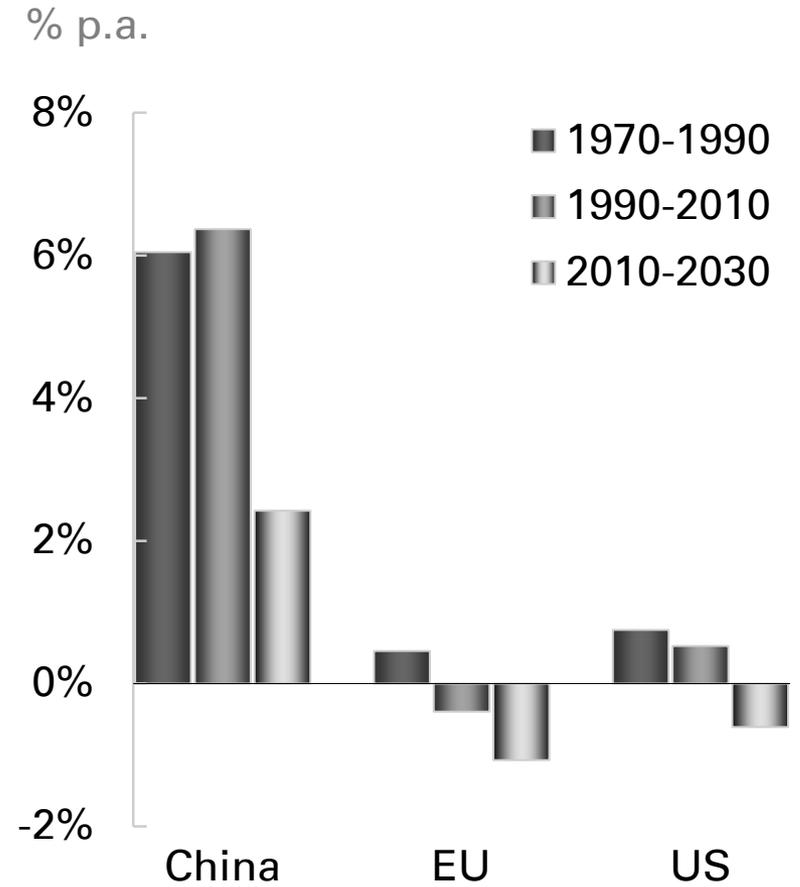


# Energy demand growth drives carbon emissions...

## CO<sub>2</sub> emissions and primary energy



## Growth of CO<sub>2</sub> emissions



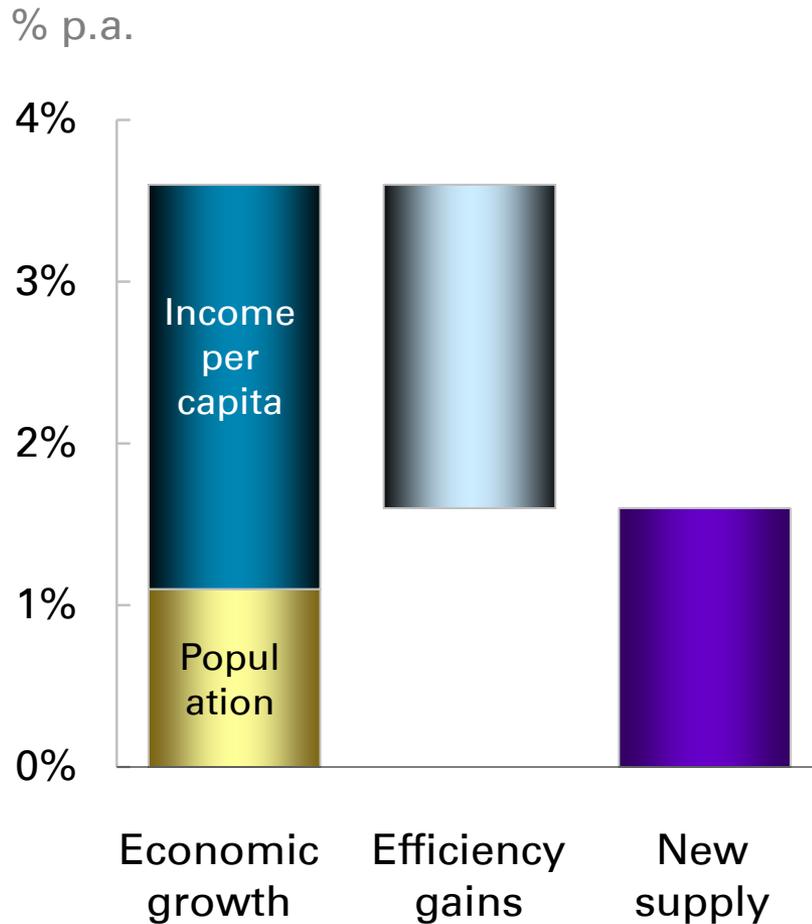


## ...but the link weakens as the energy mix decarbonises

---

- Carbon emissions from energy use continue to grow, increasing by 26% between 2011 and 2030 (1.2% p.a.). We assume continued tightening in policies to address climate change, yet emissions remain well above the required path to stabilise the concentration of greenhouse gases at the level recommended by scientists (450 ppm).
- There is some progress: the changing fuel mix, in particular the rising share of renewables and substitution of coal with gas, results in a gradual decoupling of emissions growth from primary energy growth.
- Carbon emissions continue to fall in the EU – on the back of carbon abatement policies, support for renewables and declining overall energy demand – and in the US – driven by falling oil demand (efficiency gains in the car fleet), renewables in power and the displacement of coal by gas.
- The structural transformation of China's economy slows its energy demand growth, especially after 2020 and especially for coal, causing a significant reduction in the growth of China's carbon emissions.

# Conclusion



- Economic growth needs energy
- Competition and innovation are the key to meeting this need
  - energy efficiency
  - new supplies
- Energy security and climate change remain challenges

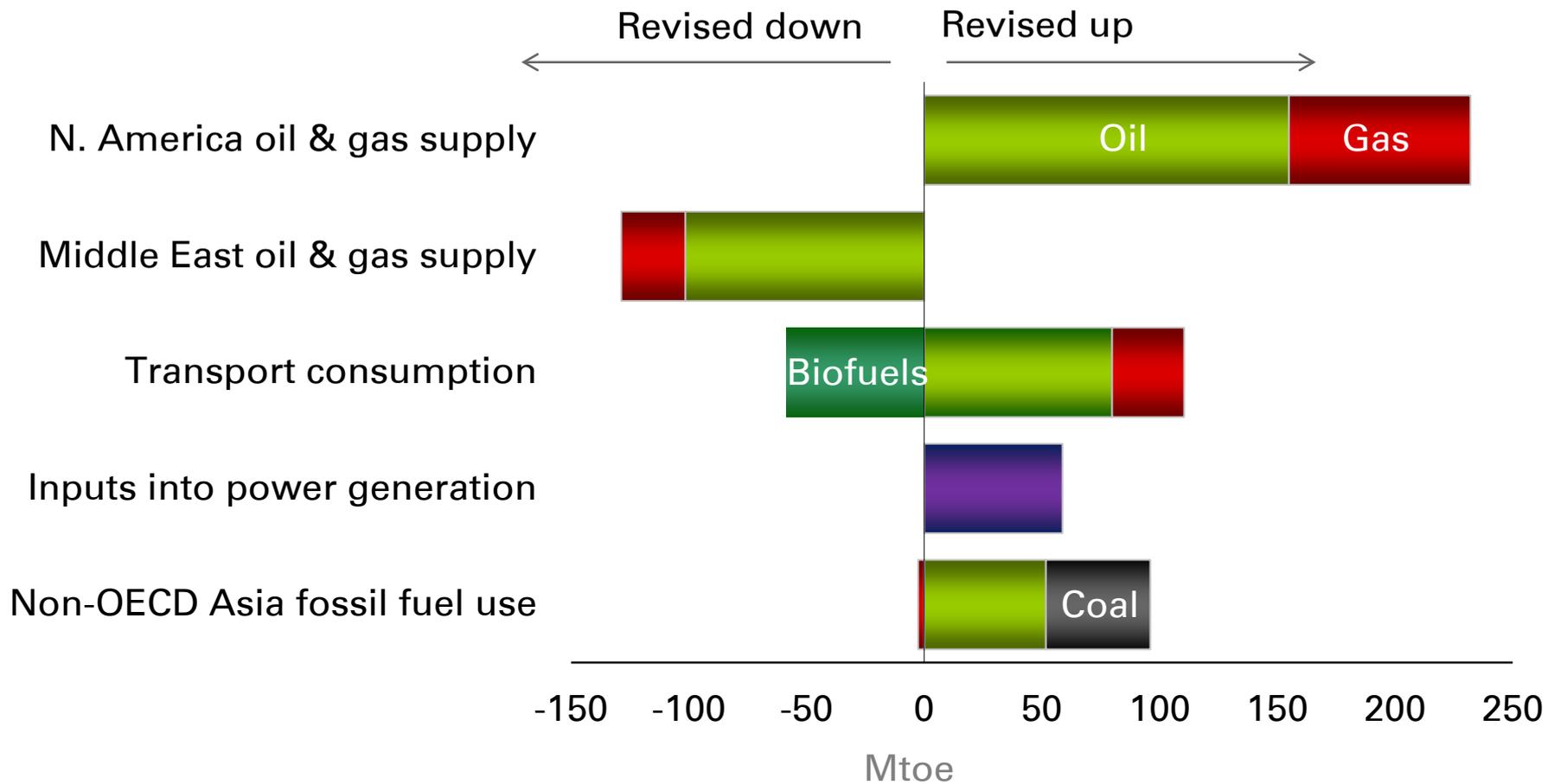
---

	Page
Introduction	4
Global energy trends	7
Outlook 2030: Fuel by fuel	27
Implications	69
<b>Appendix</b>	<b>81</b>



# Key changes versus last year's *Outlook*...

## Changes in 2030 levels versus the 2012 *Outlook*





## ...result in little net change in total energy

---

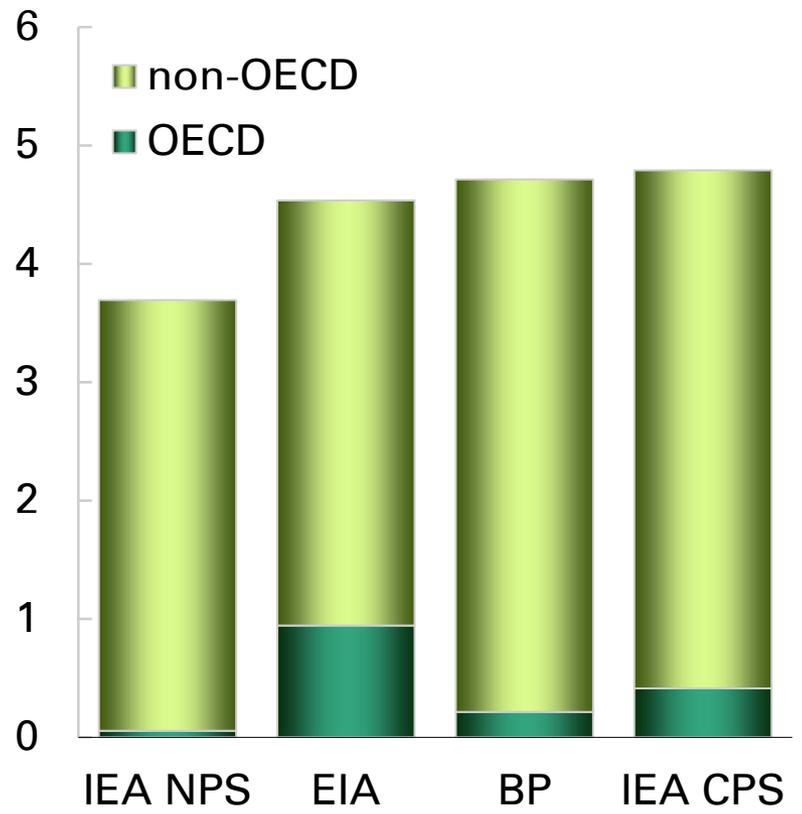
- Our aggregate projection for world energy demand and supply is little changed since our last Outlook – up about 0.5% by 2030.
- The North American oil and natural gas supply outlook has been revised higher (14%) due to evolving expectations for shale gas/tight oil plays.
- Higher tight oil output leaves the market requiring less OPEC production, with overall Middle East oil output revised lower with knock-on effects for associated natural gas production.
- Oil and gas useage in the transport sector has been revised up, largely reflecting the need to offset a drop in biofuel supplies resulting from more modest expectations of the penetration of next generation fuels.
- Demand for power generation has been revised higher due mainly to increased demand for electricity in non-OECD Asia Pacific, where fossil fuel useage is impacted by a reassessment of that region's potential for economic development.



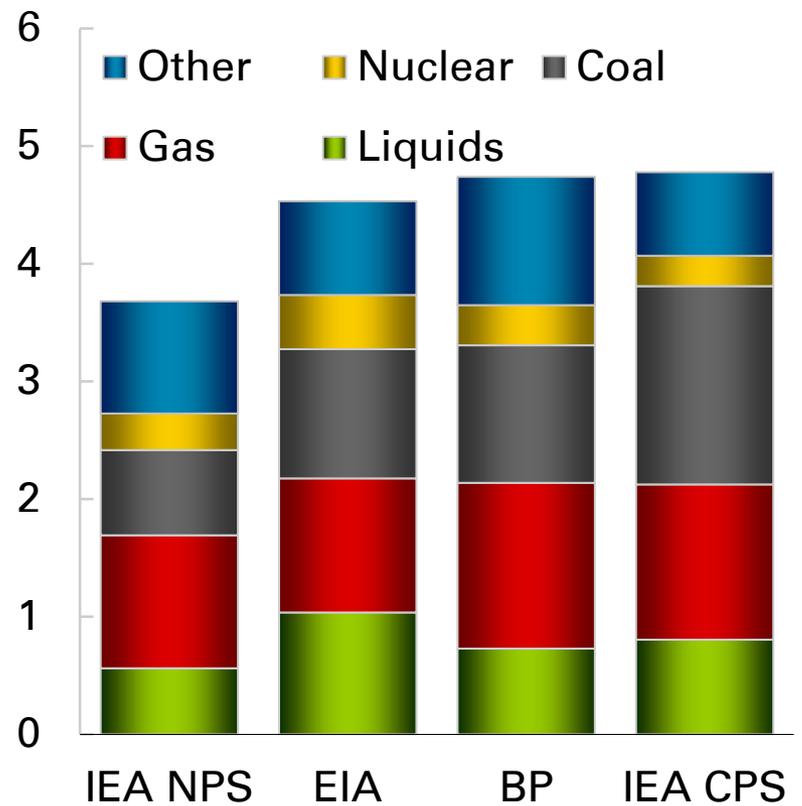
# Comparison with other outlooks: the key difference...

## Growth of energy consumption, 2010-2030

Billion toe



Billion toe





## ...lies in different views on non-OECD prospects

---

- Our Outlook is based on a “most likely” assessment of future policy trends. In that respect it differs from the energy projections published by the IEA and the EIA, which are based on specific policy scenarios and which make no judgements about the likelihood of those scenarios.
- Our policy assumptions are closest to those in the IEA’s “New Policies Scenario” (NPS), which assesses demand prospects on the assumption that announced national policy objectives are implemented. Yet our outcomes are closest to the IEA’s “Current Policies Scenario” and the EIA’s reference case, both of which assume no change in policy settings.
- Our Outlook shows more growth in non-OECD energy demand than the IEA NPS; it also shows more growth for fossil fuels, especially for coal. This probably reflects differing views on the outlook for rapidly industrialising economies, in particular on the speed with which they can move to a less energy-intensive growth path.



## Data sources

---

Baker Hughes, Houston, Texas

BP p.l.c., BP Statistical Review of World Energy, London, United Kingdom, June 2012

BP p.l.c., BP Energy Outlook 2030, London, United Kingdom, January 2012

Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, Heston, A., Summers, R., Aten, B., Penn World Table Version 7.1, Nov 2012.

Energy Information Administration, International Energy Outlook, Washington, D.C., United States, 2012

GIIGNL, Paris, France

International Council for Clean Transportation, Global passenger vehicle standards update. August 2012

International Energy Agency, CO<sub>2</sub> Emissions from Fuel Combustion, Paris, France, 2012

International Energy Agency, Energy Balances of Non-OECD Countries, Paris, France, 2012

International Energy Agency, Energy Balances of OECD Countries, Paris, France, 2012

International Energy Agency, World Energy Outlook 2012, Paris, France, 2012

Oxford Economics Ltd, Oxford, UK

PIRA Energy Group, New York, NY, United States

Rühl C., Appleby P., Fennema J., Naumov A., Schaffer ME. (2012). Economic development and the demand for energy: a historical perspective on the next 20 years. *Energy Policy*, vol 50, pp. 109-116.

Smith Bits S.T.A.T.S.

UN Population Division, World Population Prospects: The 2010 Revision, New York, United States, 2011

US Environmental Protection Agency, Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2011. March 2012

World Bank, World Bank Commodity Price Data (Pink Sheet), November 2012

Plus various official sources

---