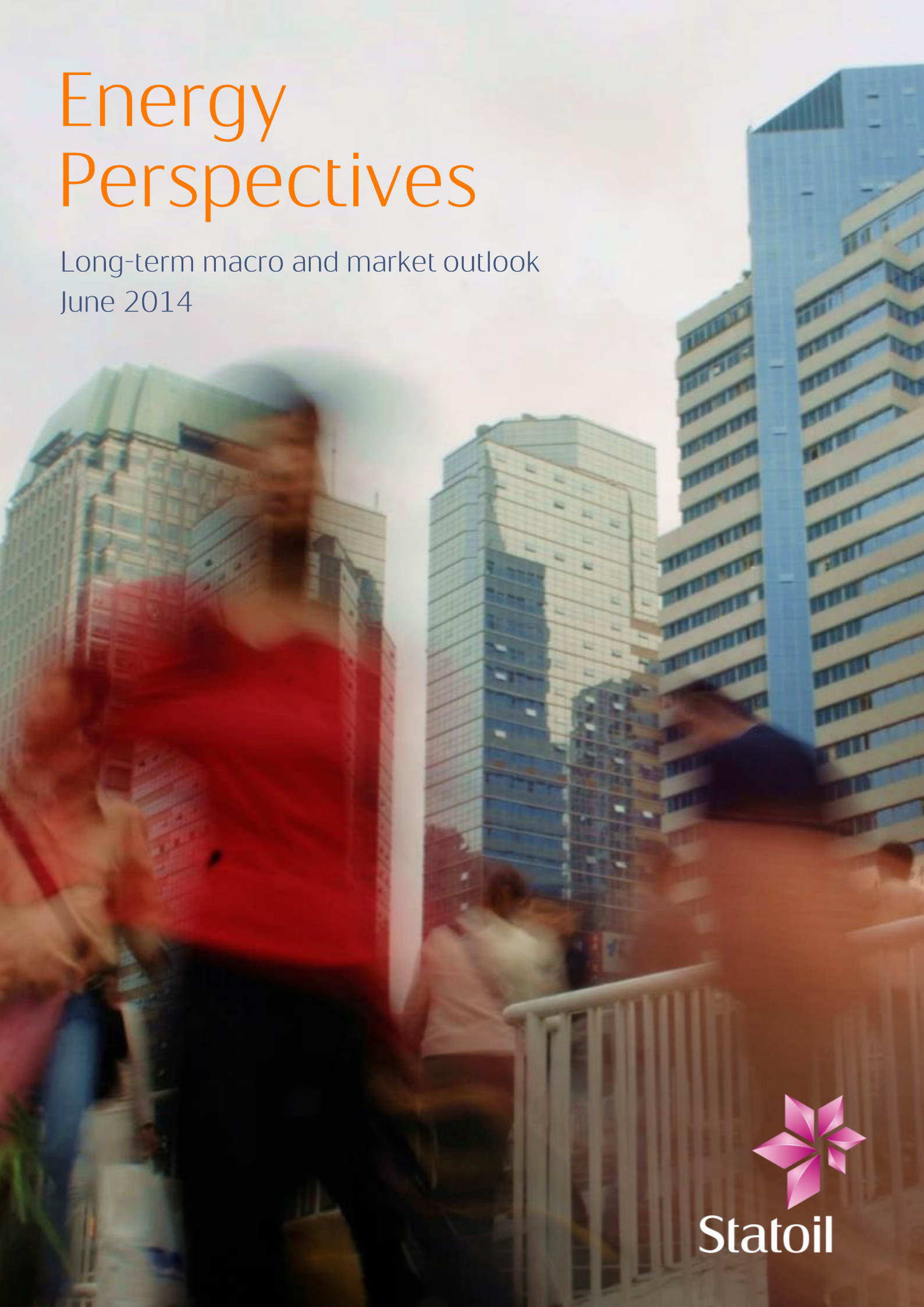
Energy Perspectives

Long-term macro and market outlook
June 2014



Statoil

Acknowledgements

The analytical basis for this outlook is long-term research on macroeconomics and energy markets undertaken throughout the Statoil organisation during the winter and spring 2013/2014.

The research process has been coordinated by MPR MT Macroeconomics and Market Analysis in Statoil, with crucial analytical input, support and comments from various parts of the company, including but not limited to market and policy analysts in various business areas and staffs.

Joint efforts and close cooperation between the above units and other resources in the company have been critical for the preparation of an integrated and consistent outlook for total energy demand and for the projections of future energy mix.

We hereby extend our gratitude to everybody involved.

Editorial process concluded 6 June 2014.

Front page photo: The city Shenzhen in China. Photographer: Øyvind Hagen, Statoil.

Energy Perspectives 2014

Global energy issues are again at the crosshairs of geopolitics and international cooperation. Recent developments have demonstrated the immediate and acute worry if energy deliveries are perceived to be threatened, as well as the increasing worry that humanity is on an unsustainable path with unpredictable long-term consequences.

The latest reports from UN's International Panel on Climate Change reinforce the message that climate risks are increasing, that consequences can be dire, and that growth in greenhouse gas emissions must be curbed and turned to decline in the near future if we are to limit global temperature increases to sustainable levels. Simultaneously, local consequences of burning carbon are rapidly becoming untenable in large population centres in China and other emerging economies, clearly illustrating the increasing costs of increased use of coal. The visible local negative consequences of a still largely invisible global problem could bode for increased momentum in near-term climate policy making in key countries.

The crisis in Ukraine is a clear example of how geopolitical developments and energy issues interact, creating concerns about short-term consequences for gas deliveries to Europe and subsequent calls for increased diversification of Europe's energy supplies. One outcome could be stronger European energy diversification, combined with Russia diversifying its gas supply towards the East – as the recent agreement with China signals. In addition, a possible outcome is increased tension between one of the world's largest energy producers, Russia, and its neighbours, customers and the US. This may add on to geopolitical disturbances to global energy markets from lasting conflict and tension in countries like Libya, Syria, Iraq, Iran and Nigeria.

In energy forecasting, therefore, the interplay between short-term geopolitics, long-term sustainability and development of market balances seem to be a recurrent feature.

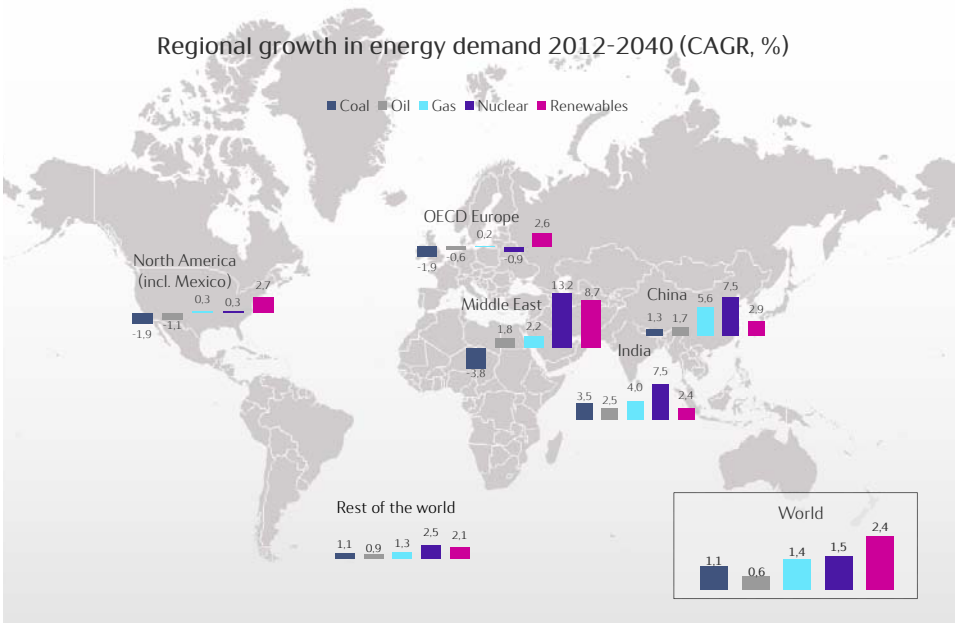
In this year's edition of Energy Perspectives, we have updated our Reference scenario on economic growth, energy demand development and energy mix. Compared to last year's forecasts, the changes are relatively small, confirming what we see as the most likely development trend, but with some adjustments. Global economic growth is assumed to average at 3% per year until 2040, with some large emerging economies, notably India, Russia and Brazil, growing moderately less than in last year's forecast. Energy demand is expected to grow by 1.3% on average, reflecting an expected and continued improvement in energy efficiencies. As in previous editions of Energy Perspectives, we foresee a gradual greening of the energy mix, with new renewables, gas and nuclear energy developing faster and gaining market share relative to coal and oil, but with demand for all fossil fuels continuing to grow. Consequently, global CO_2 emissions continue to grow until oil (and coal) demand is expected to peak somewhere around 2030.

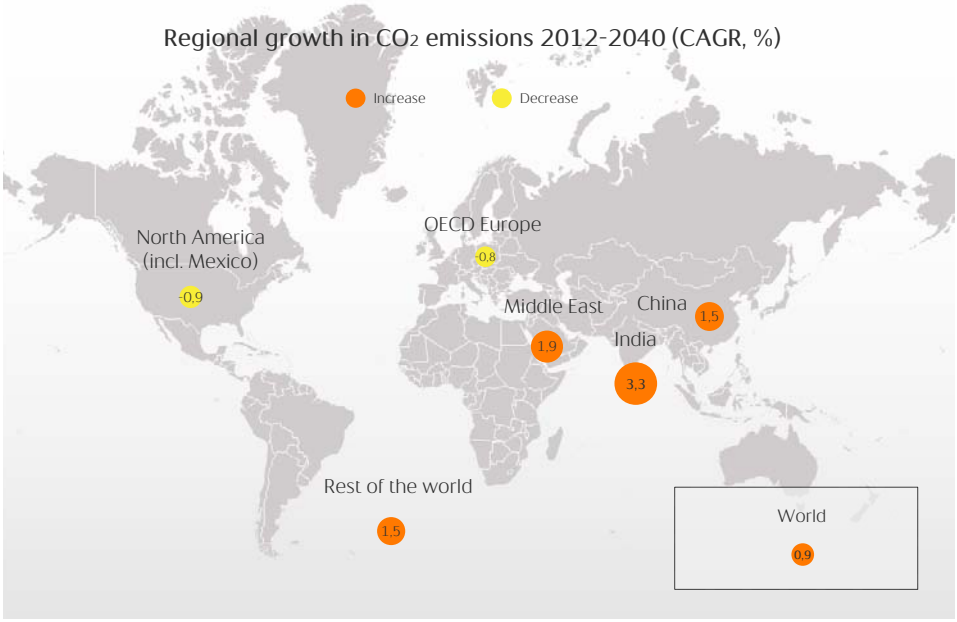
In the Reference scenario, coal, oil, and gas demand on average grow by 1.1, 0.6, and 1.4% per year, respectively, until 2040. In other words, gas is expected to grow its market share moderately, while coal and oil are losing market share to other fuels. New renewables (wind, solar, geothermal energy) are growing by 8% per year, entailing that energy from these sources are almost 6 times higher than today and constituting 6.5% of total energy demand in 2040.

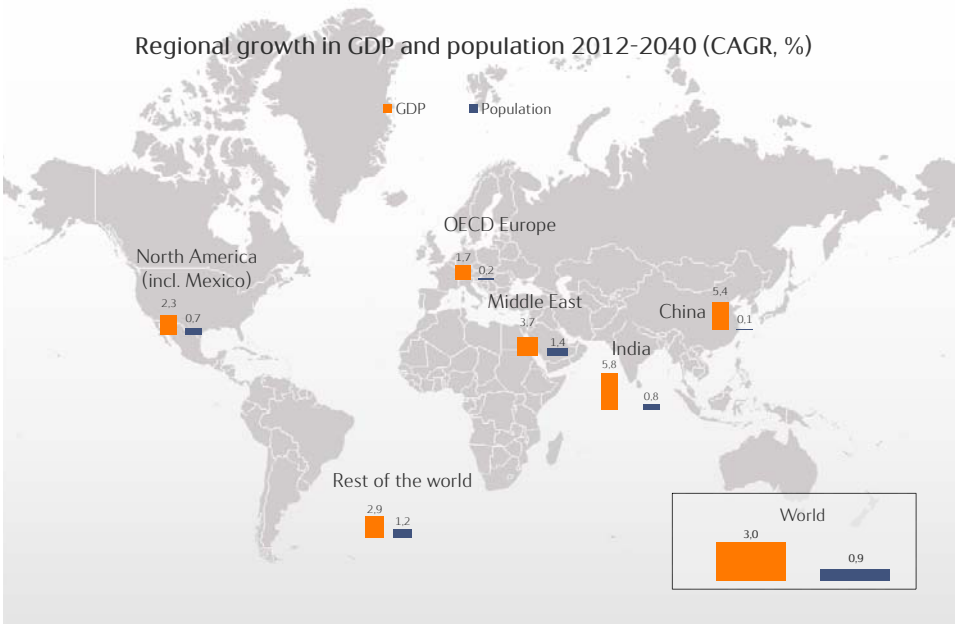
30-year forecasting is by nature risky business. In order to visualize that the world might go in different ways than that portrayed in our Reference scenario, we have in this year's Energy Perspectives also developed two alternative scenarios, or development paths. They represent possible futures that could materialize, even if we think such developments are less likely than the one displayed in the Reference scenario. One of the alternative scenarios represents a Low Carbon future, expanding on possibilities for policy changes and technological developments resulting in a significantly lower energy demand and greener energy mix than in the Reference scenario, but with roughly the same level of income (GDP) in 2040. In this scenario, total primary energy demand in 2040 is roughly the same as today (and 38% lower than in the Reference scenario), and energy related CO_2 emissions are 24% lower than today. Oil and gas demand are lower than in the Reference scenario, but still much higher than what can possibly be produced from existing oil and gas reserves. Even in a Low Carbon scenario, therefore, there is a substantial need for continued investments in new oil and gas production.

The other alternative scenario is a Policy Paralysis scenario, characterized by geopolitical conflict, less international economic integration, beggar-thy-neighbour economic policies, lack of progress on climate policies and focus on security of supply. This results in a future with significantly lower economic growth and energy demand more dominated by local sources of supply in key regions, including a larger coal share in the fuel mix. In this scenario, total primary energy demand in 2040 is 26% higher than today (and 12% lower than in the Reference scenario), with CO_2 emissions 5% lower than in the reference scenario, pulled down by the lower GDP growth.

Eirik Wærness
Chief economist


Regional growth in energy demand 2012-2040 (CAGR, %)
Coal
Oil
Gas
Nuclear
Renewables
North America (incl. Mexico)
-1.9
-1.1
0.3
0.3
2.7
OECD Europe
-1.9
-0.6
0.2
-0.9
2.6
Middle East
1.8
2.2
13.2
8.7
-3.8
China
1.3
1.7
5.6
7.5
2.9
India
3.5
2.5
4.0
7.5
2.4
Rest of the world
1.1
0.9
1.3
2.5
2.1
World
1.1
0.6
1.4
1.5
2.4


Regional growth in CO2 emissions 2012-2040 (CAGR, %)
Increase
Decrease
North America (incl. Mexico)
-0.9
OECD Europe
-0.8
Middle East
1.9
China
1.5
India
3.3
Rest of the world
1.5
World
0.9


Regional growth in GDP and population 2012-2040 (CAGR, %)
GDP
Population
North America (incl. Mexico)
2.3
0.7
OECD Europe
1.7
0.2
Middle East
3.7
1.4
China
5.4
0.1
India
5.8
0.8
Rest of the world
2.9
1.2
World
3.0
0.9

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Context and uncertainties

Introduction

The forecasts in this publication build on assumptions for economic development, energy intensity and energy mix over a period of almost 30 years. Obviously, no one can predict exactly what the world will look like in 2030 or 2040. But acknowledging the uncertainties, it is still important to describe what the future can look like and to understand possible consequences and risks. The energy business is by nature long-term, and industry decisions will have impact for many decades to come – on shareholder values and revenues for the companies, on production, and on stakeholder welfare. Hence, it is a prerequisite for economic and social responsibility to try to understand and describe the most important underlying factors for development in energy markets, e.g.:

- *Political decisions and development*: Are the big countries and regions moving towards military rivalry or collaboration? Will policy paralysis prevail in a multipolar world?
- *Sustainability,* with climate change at the centre of our attention: In the long term climate change will impact the operating environment for all businesses, and in the short and medium term it is uncertain whether decision makers are able to agree on sustainable climate policies.
- *Technological progress* can impact long-run marginal costs of fossil energy, costs for Carbon Capture and Storage, transportation patterns and various other supply and demand factors.

These uncertainties are described in more detail in the following sections. They are closely linked to global economic and social development. Continued GDP growth along the historic average from the previous decades will be the single most important driver for energy demand. Economic stability and progress may increase willingness to accept decisions that balance short-term welfare with sustainability over generations. Unemployment, extreme income inequality and poverty may threaten political stability and certainly limit willingness to have a long-term perspective on investments in energy and other welfare improving input factors.

In the short and medium term the business cycle is impacted by monetary transition policies following the years after the financial crisis in 2007/08, and thereafter the Eurozone crisis, and now the transformation of China's economy from a credit and investment driven economy towards a more consumption driven economy. Fear of deflation in the Eurozone, possibly worsened by the Russia-Ukraine crisis, and headwinds in some emerging markets will also matter.

In the long run, demography, structural policies to improve economic efficiency and markets, or impact from climate change will determine the global growth potential. Productivity growth, globalization and infrastructure investments are other examples of key drivers.

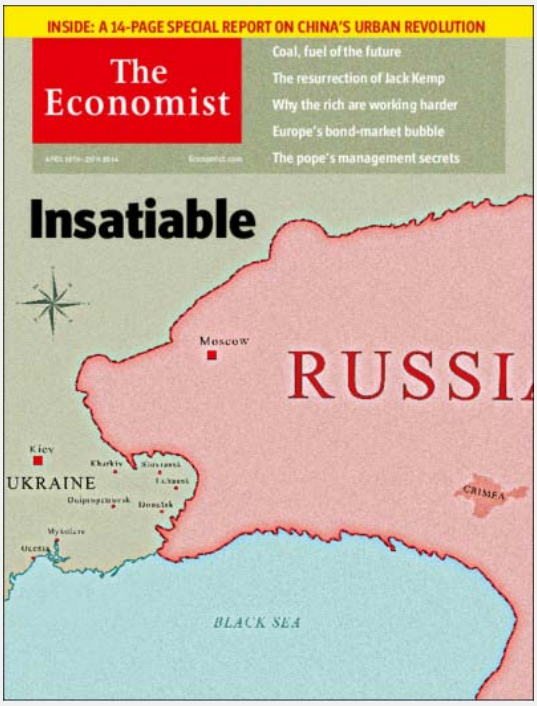
The global centre of population

Source: Reddit

Sustainability, political development and technological progress are important and uncertain drivers for development

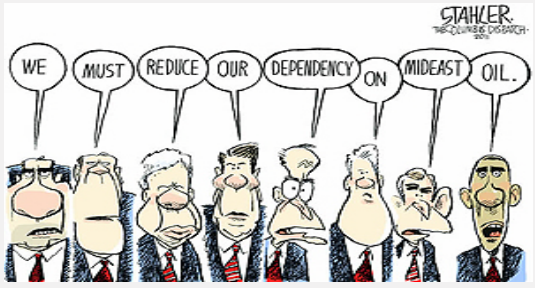
Source: The Economist

Unemployment and inequality can threaten political stability and ability for long-term thinking



Source: The Economist

Energy security and access are key sources of power in the international system



The international system seems to be changing, but into what?

The geopolitics of energy

Geopolitics and energy mutually impact each other. A cooperative and benign geopolitical environment is conducive to global economic growth, increased energy demand and efficient development of energy supply. On the other hand, a geopolitical setting characterised by inter-state rivalry, tension and conflict will have a negative impact on global GDP growth and operating environments. It can also lead to more frequent supply disruptions, as a result of war or sanctions, in addition to disruptions caused by domestic developments in producer countries.

Similarly, energy can be an amplifier of geopolitical opportunities and tensions. Energy security and access are key sources of power in the international system. Russia's role in world affairs, for example, is also tied to its position as an energy producer. Equally, the revolution in unconventional oil and gas in the United States may impact Washington's international role.

The backside of the medallion is obviously that energy scarcity can be a source of geopolitical vulnerability and risk. Ensuring stable energy supplies through diversification of sources and routes is a key national security priority for most import dependent countries. It has been a preoccupation of the U.S. since the early 1970s and China since the early 1990s. It is rapidly becoming India's main concern, and this could intensify the global competition for energy resources. Recently, energy supply security has also gained importance in the European debate.

Recognising this importance of geopolitics for energy markets, forward-looking energy perspectives cannot afford to discount the evolution of geopolitical events. More importantly one cannot ignore the potential impacts of an international system that is in flux.

The changing nature of the international system

Since the end of the Cold War, the geopolitical environment has been relatively cooperative. After the collapse of the Soviet Union, cooperation in trade and economics through an established international system took hold over widespread military tension and conflict. However, this system seems to be changing, and there are large uncertainties around what can be the fall-out of this reconfiguration of global collaboration and power.

Asia is growing to become the main economic powerhouse of the world. The US becomes less dependent on energy import. Russia is demonstrating power in the Crimea and did recently agree on a major gas sales agreement with China. These are examples of developments that can add to the geopolitical ambiguity.

Similarly, many ask what role China will play towards security related issues, as well as in international and economic collaboration. To this adds the major uncertainty over the coming decades of whether China can manage a transition from being a predominantly export-led economy to one more reliant on domestic consumption without precipitating mass political upheaval at home. Domestic challenges associated with pollution, water scarcity, demographic changes and corruption will be important for China's development and sustainability model.

Outcome from nuclear negotiations with Iran will impact Middle East stability

Will the rise of China be peaceful, with maintained high levels of economic growth and political stability?

Photo: Øyvind Hagen, Statoil

Climate change is already ongoing

One key barometer of near- and long-term stability in the Middle East will be a potential global accord over Iran's sensitive nuclear programme. The future will no less be shaped by Saudi Arabia and Iran, which are undergoing major social and economic changes of their own. Given the Middle East's importance, any energy supply disruptions here will have severe adverse effects on the global economy.

There are, thus, many questions, and few answers. One safe conclusion is that the degree of geopolitical uncertainty is significant: Is the US in decline or is this only perceptions not based on facts? Will the rise of China be peaceful and will the new economic giant manage to maintain high levels of economic growth as well as political stability? How large and sustainable are Russia's geopolitical ambitions? What will India's role on the world stage look like and which reactions will it trigger? Will a nuclear deal with Iran materialise and what will be the consequences for regional development in the Middle East? How will important alliances shape and take form based on the developments in both geopolitics and in the energy sector?

While attempting to paint a future geopolitical landscape, we are also cognisant that forecasting the future towards 2040 is challenging. We will therefore explore more in detail the potential implications of different geopolitical developments on the future of energy. In the Reference scenario in the coming chapters we base our forecasts on assumptions about a relatively benign scenario where cooperation outweighs conflict and contributes to economic growth and development roughly in line with the development the last twenty years. Towards the end of the report we will use different geopolitical assumptions as backdrop for a scenario driven by rivalry and more conflict, leading to a significant slow-down in economic growth, decreased energy demand and different development of the energy mix.

Sustainability and climate concerns as drivers for energy markets

Climate change is already ongoing and contributing to droughts, increased water stress, more frequent extreme weather events, increased pressure on biodiversity, melting glaciers and rising sea levels. The capacity of the natural environment to deliver the services and resources needed by a continuously growing and increasingly wealthy population is under threat in almost every region of the world. In addition, deteriorating air quality and traffic congestion affect the living conditions for hundreds of millions of people in big cities. How politicians, companies and consumers handle issues of long-term sustainability represents the biggest uncertainty for energy markets towards 2040 and beyond.

First of all, a development that can compromise future generations' ability to meet their fundamental needs and consumption preferences will also have negative impact on communities and companies. How much will it hurt global and regional economic development? What are the extra costs involved? What can be the consequences for energy supply and demand?

Source: France Diplomatie

What climate policies will emerge, and will governments across the world manage to agree on a framework?

Source: The Economist

Technology breakthroughs represent uncertainties for global energy markets

Secondly, there is a need for globally coordinated political action. But what kind of energy and climate policies will emerge, and will governments across the world manage to agree on a framework that is both effective *and* efficient?

Two important developments on the supply side of global energy has stimulated a change in the mind-set as far as taking specific action to confront carbon pollution: On the one hand, a significant reduction in the cost of deploying renewable energy sources such as solar photovoltaic and wind power. And on the other hand a massive increase in the potential availability of low carbon natural gas from shale deposits in many regions worldwide.

On the political arena, the 2015 UN Climate negotiations in Paris will be another milestone. Will it provide necessary steps towards a more predictable and sustainable energy development? Taking into account that the Paris conference may not deliver all the answers, what kind of development can be expected in the following years towards 2020 and 2030? What will be the role of China, the US, India and EU, on their respective domestic arenas and in their approach towards the international negotiations? Their choices, along with the outcome for other climate related uncertainties, will affect long-term technology development, transportation patterns, urban development and the energy mix.

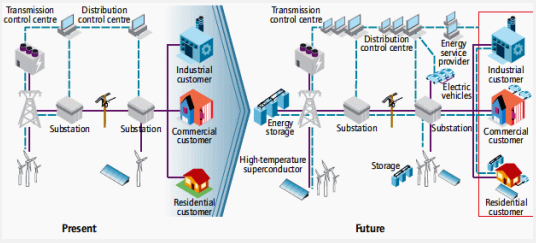
Key technological uncertainties in a 30-year perspective

Future energy supply, demand and energy mix, will also depend on technological developments. Possible breakthroughs represent key uncertainties for global energy use and energy markets. For the supply side, we may ask:

- How will technological development affect the cost/energy quotient for renewable energy in large energy systems?
- How will technology affect long-run marginal costs of new sources of fossil energy?
- Can technology make carbon capture and storage a viable solution within our forecast period?
- Will technology contribute to increasing the role of nuclear energy in the future energy mix?

Answers to these questions form important frames of reference for long-term forecasts of energy supply and energy mix. This is so, even if we do not take into account fundamental changes with large impact and low probability, the black swans of energy supply, such as cold fusion.

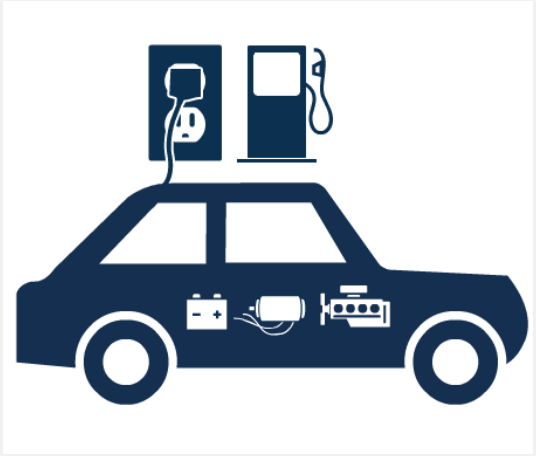
Smarter electricity systems



Source: IEA

It takes time to change existing energy systems, city structures, building composition and transport fleets

Key components of a plug-in hybrid electric vehicle



Source: IEA

Parts of the energy savings disappear, or rather, are used to increase our individual wellbeing and comfort

On the demand side, we may ask:

- How can technology contribute to accelerating the long-term trend of reduced energy use per unit of GDP?
- Will technology improvement facilitate large scale energy efficiency improvements in buildings and transportation?
- How will technology improve possibilities for and efficiency of storing energy, and in particular electricity, in transportation and energy systems?

Even if the time horizon for our forecasts is 2040 and relatively long compared to many economic forecasts, it is in many respects short when the purpose is to consider the impact on energy markets of the technology issues listed above. This is because of capital stock inflexibility: It takes time to change existing energy systems, city structures, building composition and transport fleets. New cars, aircraft, trains and ships have a life of decades, power plants run for 30-40 years, buildings can last for hundreds of years, and most cities are already built. Consequently, even if large technological changes take place and have considerable effect on new sources of energy supply or on demand patterns of new energy users, global energy markets could be only marginally affected year-on-year. Thus, also large technological changes take time to work.

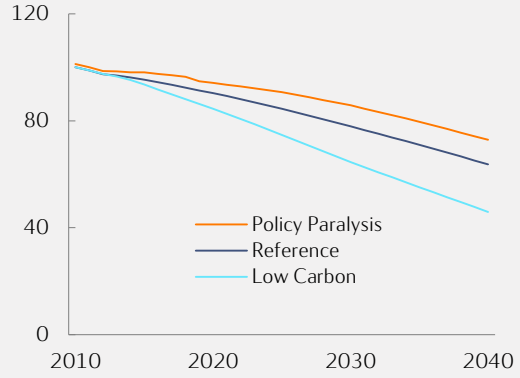
Other factors that affect the impact of technological changes on energy demand are the combined effect of different improvements and possibilities and compensating effects. If technology results in energy becoming cheaper for the user, there is a tendency that energy use will increase, since the goods that require energy are both price and income elastic. If fuel efficiency of cars improves, there is a tendency that we will drive more, or that we will allow ourselves to change to a larger, heavier, safer, and more comfortable car. Then, parts of the energy savings disappear, or rather, are used to increase our individual wellbeing and comfort. Some of the technology improvements that lead to less energy use, e.g. development of electronic and digital communication systems, also lead to possibilities for increasing energy use through new types of equipment requiring energy, in our cars and houses.

In our Reference scenario, we have implicitly taken into account technological change in a number of ways:

- Energy intensity is assumed to continue to gradually decline, autonomously as well as incentivised by prices and policies.
- Electrification is assumed to increase in different regions and sectors, partly driven by technology improvements.
- Technologies for carbon capture and storage are assumed to be developed and lead to results, however, with only very limited impact on CO_2 emissions before 2040.
- Continuous technological improvements are assumed to fight decline and increasing costs in the supply of fossil fuels, limiting the increase in long-run marginal costs and facilitating supply growth to satisfy demand increases.

Energy intensity development in different scenarios

Index, 2010=100

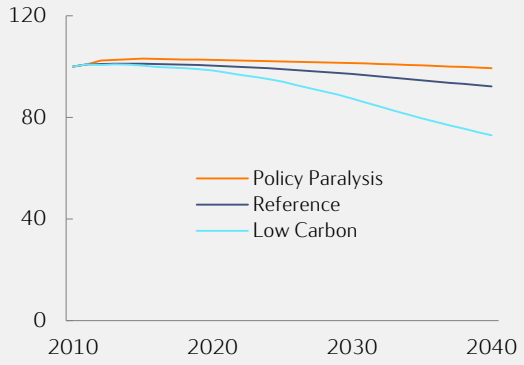


Source: Statoil

Different routes of development can impact economic development, energy markets and carbon emissions

CO_2 emissions/TPED

Index, 2010=100



Source: Statoil

The Reference scenario is only one possible future

Energy Perspectives contains forecasts on the most likely development in economic growth and energy demand for different energy carriers in 12 regions until 2040. As shown in the previous paragraphs, the future is uncertain due to factors like climate change, geopolitics and technology.

The following chapters outline the Reference scenario with an expected, average global GDP growth at 3.0% and a total primary energy demand growth at 1.3% towards 2040. In the long run, upsides and downsides for economic growth are relatively well balanced around uncertainties of productivity development, labour availability and capital efficiency.

Similarly, a continued lower energy intensity, at about the same speed as in previous decades, is a critical assumption behind these numbers. It requires continued policy measures to increase energy efficiency, in power production, transport, manufacturing industries and in households.

The Reference scenario rests, not only on already decided policies, but also on policy ambitions and targets presented by the different governments, as well as our forecasts on a likely development in different policy measures.

To further illustrate the big uncertainties related to our long-term forecast, this report also presents two alternative scenarios. The alternative scenarios build on different assumptions for key drivers and consequently outline different paths for global economic development, energy demand, energy mix and CO_2 emissions towards 2040.

The purpose is to highlight how different routes of development can impact economic development, energy markets and carbon emissions.

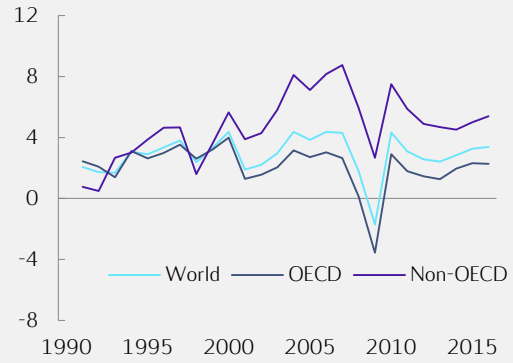
The Low Carbon scenario builds on the assumption that decision makers agree on more ambitious climate policies compared with the current agreements. These policies interact with a more rapid technological development to facilitate a different development in energy markets towards 2040. The more rapid technological improvement is driven by growth and policy, and also by a higher "self-sustaining" technology development over time.

The Political Paralysis scenario on the other hand, builds on the assumption that rivalry, protectionism and distrust among world powers limit the ability and willingness to solve global challenges and to collaborate. This yields a very different development path for the global economy than in the reference scenario. In this scenario the general economic and political climate is less conducive to technology diffusion and technological improvements, reducing growth and energy efficiency compared to the development in the other two scenarios.

The global economy

GDP growth 1990-2016

Annual % change at market exchange rates

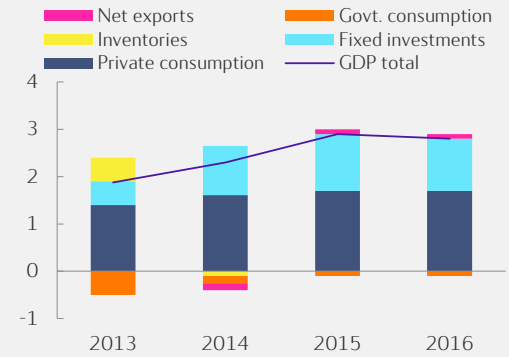


Source: IHS Global Insight (history), Statoil (projections)

Transition processes in both OECD and non-OECD economies will shape the global economy the coming years

Contribution to change in annual US GDP

%



Source: US Bureau of Economic Analysis (2013), Statoil (projections)

A favourable policy environment is expected to support private consumption and spur business activity

Medium-term outlook: transition and trust

The global economy is characterized by transition after years of crisis management into a more normal situation. In the OECD, governments have started loosening the belt and investors are less worried about debt sustainability. Banks are gradually becoming stronger. Since the start of the financial crisis, central banks of the largest OECD countries have injected massive amounts of liquidity into their economies, thereby reducing uncertainty and pushing interest rates to very low levels. The recovery taking place in the advanced economies can to a large extent be attributed to these actions. In the United States the recovery is perceived to be so solidly founded that the Federal Reserve has started unwinding its ultra-loose monetary policy. In the Eurozone and Japan the private sector is still reducing its debt, output gaps are still large and inflation very low, which require further policy efforts to restore trust and ensure robust growth.

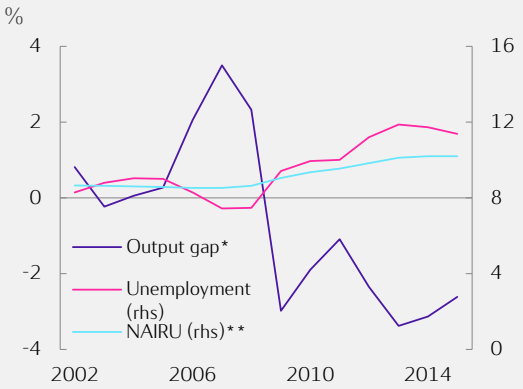
Credit-fueled OECD growth and high commodity prices were vital factors behind the strong growth seen in emerging market economies (EMEs) during the first ten years of this century. The financial crisis and the subsequent drop in demand for EMEs' exports accelerated the need to start reconfiguring these economies towards more domestic-driven growth. This however requires extensive market and political reforms, which face strong headwinds from groups with vested interest in status quo and supply-side bottlenecks. The loose external financial conditions have also led many EMEs with high current account deficits to finance it with cheap foreign capital instead of undertaking necessary structural adjustments. The US tapering is consequently weighing on growth in these countries. Escalating political tensions in some EMEs only accelerate the need to enhance economic buoyancy. The remainder of this decade, thus, will be shaped by profound transition processes in both OECD and non-OECD, naturally accompanied by large uncertainty.

US medium-term outlook: progress on its way

Underlying economic growth is solid in the US due to robust household consumption. This is helped by job creation, a wealth effect stemming from a rise in asset prices and by unleashed pent-up demand for cars and homes. Moreover, household debt has been reduced significantly since the financial crisis. The Federal Reserve has started to scale down its ultra-loose monetary policy, but is still expected to be accommodative for quite some time. In general, conditions for consumption to remain the key driver are in place. Agreements on the federal budget and debt ceiling relieve the constrained public finance situation and have reduced policy uncertainty, at least in the near term. Together with a solid cash flow, reduced uncertainty is expected to lift business investments.

Average annual growth over 2014-16 is forecasted at 2.7%, assuming that the slack in the US economy is further utilized. Downside risks are related to moving away from a historic era of monetary easing, with a protracted housing market and less business investments if expectations fade. Albeit near-term policy uncertainty is reduced fiscal challenges still remain owing to a future mismatch between spending and income. It is also a concern that there is still a sizeable slack in the labour market. Conversely, re-industrialisation lifted by lower energy prices and more consumption on the back of a stronger financial position could lift growth.

Eurozone output gap and unemployment



*Actual GDP in % of potential GDP

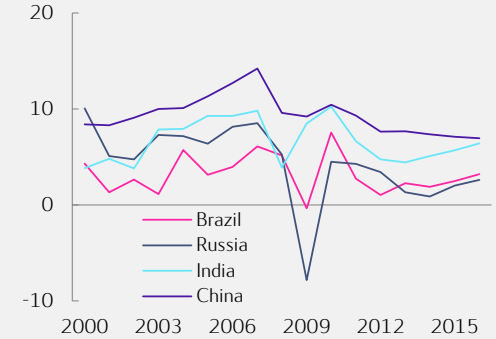
**Non-accelerating inflation rate of unemployment

Source: OECD Economic Outlook May 2014

Eurozone recovering, but further policy efforts required to avoid stagnation

BRICs GDP growth

Annual % change at market exchange rates



Source: IHS Global Insight (history), Statoil (projections)

Non-OECD economies seek to reconfigure toward domestic demand, but are held back by headwinds

Eurozone medium term: a lasting turnaround

After two years in recession the Eurozone is finally experiencing positive economic growth. Financial markets calmed by the massive liquidity injections, more budget flexibility and increased competitiveness in the South have helped the turnaround, as has the stabilization of domestic demand. Over the medium term further improvements should materialize, supported by the progress made on the policy front. Unemployment is still too high and overall, unutilized capacity is sizeable, which will require additional action to avoid stagnation and social unrest. The necessary debt reductions in the public and private sector will nevertheless continue to weigh on the pace of the economic recovery. All in all the Eurozone economy is expected to continue to expand, but at a slow pace; 1.4% on average over the next couple of years. Less commitment to reforms or failure to turn around disinflationary trends remain real risks to the turnaround and the monetary union's long-term growth potential.

Emerging economies medium term: reform to lower vulnerabilities

The EMEs' vulnerabilities to macroeconomic and political risks are varied and depend on the size of their current account deficits and their efforts to restructure their economy. The Federal Reserve tapering is felt in **Brazil** with its relatively high current account deficit, infrastructure bottlenecks and lack of reforms. In **Russia** an ever-increasing capital flight is exacerbated by the Ukraine crisis and following sanctions. **India** has managed to curb a ballooning trade deficit by imposing restrictions on imports. All three countries nonetheless suffer from high inflation and subsequent tight monetary policy, putting additional strains on their medium-term growth prospects.

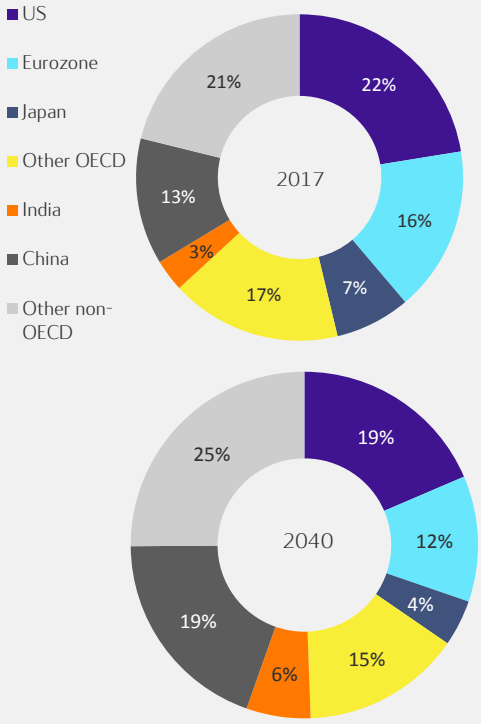
Despite current economic softness in **China**, reform momentum is maintained. Growth will remain moderate in 2014 as the property market cools, the reduction of debt and overcapacity continues and consumption softens due to anti-corruption efforts. Policy makers are refraining from full-blown stimulus and implement a series of structural reforms. The property sector embodies most risks with weak sales, rising inventories and a fall in prices especially in lower tier cities. A widening of the official currency trading band and cooling investment and credit growth helped deter speculative hot money while recent lower inflation gives the central bank room to ensure stable credit growth. Tighter credit and stricter regulations distress borrowers, but some industries still enjoy healthy profit margins, and export improves on higher orders from the EU and US. The Chinese economy is expected to continue to grow at a relatively modest pace of 7.1% on average over 2014-16.

Most of other emerging Asian countries are well placed to gradually recover as they maintain a loose monetary policy and demand from the advanced countries are expected to rebound. Some of their export growth could however be affected by the slowdown in China.

With the OECD recovery expected to bolster EMEs' export growth, BRICs expected to do more to stabilise macroeconomic and political risks and the US Fed policy remaining accommodative for quite some time, non-OECD GDP growth is likely to firm up in the near term. Delays in structural reforms and removal of bottlenecks are however limiting the upside and impact the long-term growth prospects negatively.

Composition of global GDP

2010 USD at market exchange rates

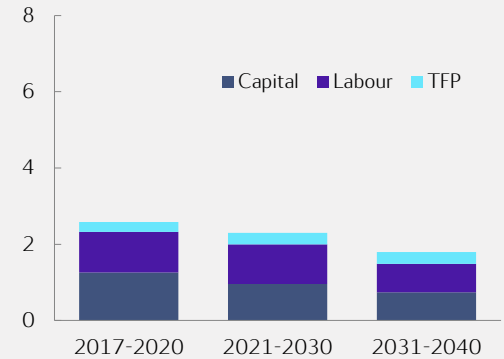


Source: Statoil

There will be major changes in the composition of world GDP

USA GDP growth by source

%



Source: Statoil

Long-term growth: 2017-2040

Approach

Compared to the demand-side focus of short- to medium-term forecasting of economic activity, the long-term approach shifts attention to the supply side; i.e. the production potential of individual economies. Our growth framework is based on a production function which splits economic output growth into components associated with changes in input factors such as labour and capital and a residual that reflects production efficiency, Total Factor Productivity (TFP). Population growth and the quality of the labour force are variables taken into account to calculate the impact from labour on GDP growth. The contribution from capital has been decomposed into capital accumulation and capital efficiency. While the former is a stock variable capturing changes to capital investments, the latter is an attribute that describes how effective capital markets will support channelling of savings to productive investments. Similarly, elements such as globalization, regulation and reforms, research and development (R&D) and technological progress are used to forecast contribution from TFP on economic growth prospects.

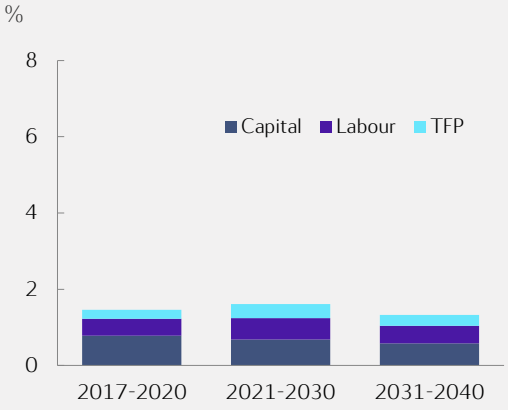
A key assumption behind our forecast is convergence between nations. The idea is that emerging countries will grow at faster rates than advanced countries because they can replicate technologies and production methods instead of generating them from scratch – resulting in convergence with the average OECD per capita income over a given time span. In this framework this so called catch-up effect is evident in higher TFP growth in non-OECD than in OECD countries. The pace of catch-up growth declines gradually over time, as the less advanced economies slowly move closer to the technological frontier.

Key trends in major regions and countries

Global economic growth is expected to moderate gradually from 3.4% in 2017-2020 to 3.1% in the 2020s. Slower population growth, diminishing catch-up potential in non-OECD economies, and slowing productivity growth are foreseen to further moderate global growth to 2.7% in the 2030s. OECD economies are foreseen to expand much less than global growth towards 2040. Growth here is foreseen at 2.2% over the 2017-20 period and to remain close to this rate also in the 2020s. Through the 2030s OECD growth is expected to moderate to 1.7%. This moderating pattern is also evident in the outlook for non-OECD economies, which are foreseen to grow at an average rate of 5.4% for the latter part of this decade before moderating to 4.6% in the 2020s and 3.9% in 2030s. Although both OECD and non-OECD economies experience moderating growth, higher growth in non-OECD will gradually add to their combined share of the world economy. Consequently, global growth the next 30 years is expected to be close to the average of the previous 30 years.

USA constitutes 25% of global economic output and is likely to remain among the world's largest economies over the forecasting period with an average annual growth rate of 2.2%. It has the fastest growing population among the large OECD economies and thus contributions from labour will be comparatively large. Capital investments are expected to contribute by approximately as much as labour, helped by the energy revolution. As the catch-up growth potential for the US economy is assumed to be exhausted, however, it will grow less than its historic

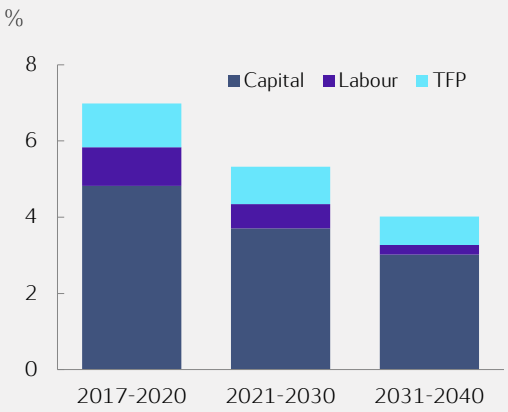
Eurozone GDP growth by source



Source: Statoil

Lack of policy response to medium-term trends are affecting long-term growth potential

China GDP growth by source



Source: Statoil

Energy demand growth in the long term will largely stem from emerging Asia

average of 2.5% per year from the 2020s. Increased inequalities, the coming post ultra-loose monetary policy era and unsustainable public finances also cause some concerns about the economic giant's long-term growth potential.

Eurozone economic activity is projected to expand by 1.5% on average between 2017 and 2040. The lingering debt issues and consolidation process are assumed to lead to subdued growth towards 2020. Thereafter policy adjustments such as structural reforms in the labour market as well as investments in R&D are expected to support growth and start to pay dividends from the 2020s. However, an aging population and slowing capital investments are foreseen to pull down growth to 1.3% in the 2030s. **Japan** will see growth decelerate even more sharply vis-à-vis 1990-2016, mainly due to an unsustainable and increasing debt to GDP ratio, shrinking population and falling productivity. "Abenomics" is so far not sufficiently addressing the structural issues to turn these trends around.

Lack of or delays of appropriate policies and reforms in response to medium-term trends are also affecting the long-term growth prospects for emerging economies. In **Brazil** prolonged infrastructure bottlenecks, lack of investments and reforms make the long-term outlook for Brazil uncertain, but still decent with 3.6% growth foreseen on average from 2017 to 2040. **Russia** faces mounting challenges such as negative population growth and slowing investment inflows. Combined with slow progress on reforms and an economy highly dependent on oil and gas revenues, this results in economic growth forecasted to a modest 2.7% on average. The Russia-Ukraine crisis could also lead to a prolonged loss of economic momentum. This is not a part of our long-term forecasts, but is an example of increased tensions and instability explored in the Political Paralysis scenario in this report.

India's declining growth trajectory for the past couple of years also reflects in part structural factors such as decreasing infrastructure investments and reform setbacks, leaving the long-term prospects less rosy than previously thought. The Indian economy is expected to grow at an average annual rate of 5.9% towards 2040, mainly driven by its large catch-up potential and huge demographic dividend. The population growth could nonetheless jeopardize output growth if sufficient jobs are not created.

A gradual and successful shift from an investment driven economy towards more consumption is assumed in **China** going forward. A loose and complex credit situation might cause some bumps in the road, though. Capital accumulation and technological advancement will be the key to growth, while an aging population carries some loss of economic momentum. China's GDP is expected to triple between 2017 and 2040, with a solid and more sustainable growth averaging 7% from 2017 to 2020, before moderating to 5.3% in the 2020s and 4% in the 2030s.

These trends imply that even though growth rates in emerging countries are slowing, they will still increase their economic weight relative to the OECD economies. This, combined with the economic structure of economies at such levels of development, imply that virtually all growth in energy demand will stem from emerging economies, and mostly so from Asia.

Energy demand and fuel mix outlook

Energy demand outlook

Energy demand growth no longer tracks economic growth one-to-one. Today a one per cent increase in industrial value added typically generates only a fraction of a per cent growth in the demand for oil products, gas and electricity. This is partly because of energy efficiency improvements. New technology is being introduced at breakneck speed, and market incentives and policy pressure in the form of e.g. efficiency standards are ensuring that technology developers are indeed prioritizing the target of lowering the amounts of energy commodities per unit of energy services provided. Mounting concerns about energy security, local air quality and global warming have accentuated this trend.

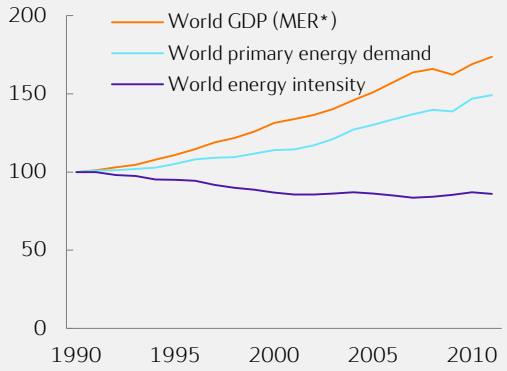
Energy efficiency improvements are not easily measured at aggregate levels. Instead we measure energy intensity changes, i.e., how the amount of energy required for the production of one unit of GDP has evolved. This is a proxy with weaknesses since it captures the impacts of more processes than genuine energy efficiency improvements, but it is needed for benchmarking purposes.

Between 1990 and 2011 world primary energy consumption increased by 49%, while world GDP (measured at exchange rates) increased by 74%. By implication the energy intensity of the world economy declined by an average of 0.7% per year. Most regions took part in this decline. Decline rates varied from -0.2% per year in OECD Pacific to -3.8% in China. Though regional energy intensity ratios have come together, those of the non-OECD regions remain on balance four times higher than those of the OECD regions. If we measure GDP at purchasing power parity rates the gap narrows, but is still significant.

The energy intensity decline rates realized in the past may sustain into the future, but we should not take for granted that they will. First, policy independent technology developments may not proceed at the same pace in the future as in the recent past. They could slow if developers run out of "low hanging fruits" and find themselves left with only costly options for making cars or buildings even more energy efficient. Or they could accelerate if developers manage to crack previously unsolved technology challenges. Secondly, policy attention to energy efficiency may fluctuate in the future as it has done in the past. And thirdly, even if we could forecast policy decisions, the impacts of given policies can never be predicted with full certainty.

There is however no reason to expect energy intensities to level out on a permanent basis any time soon. As the IEA and other institutions point out, there are large gaps between the energy efficiencies of the best technologies, and those of average technologies, in use in vehicles, buildings, heating and lightning systems, refrigerators, air conditioners, etc. Over time the average equipment in use will become more like today's most efficient equipment, at the same time as the most efficient equipment in use becomes even more efficient, reproducing the gap and keeping the wheels rolling.

World GDP, energy demand and energy intensity



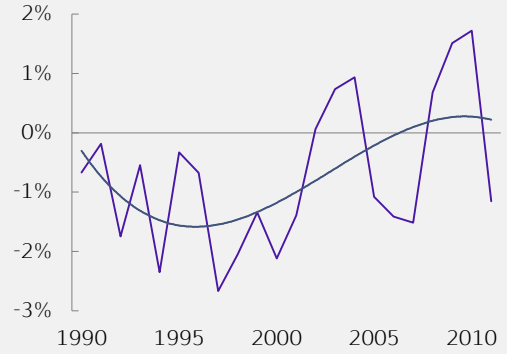
*Market Exchange Rates

Source: IEA

The energy intensity of the world economy levelled out in the 2000-10 period, but will continue declining

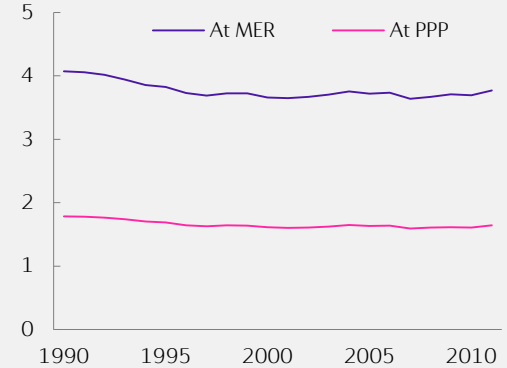
Energy intensity of the world economy

Annual changes



Source: IEA

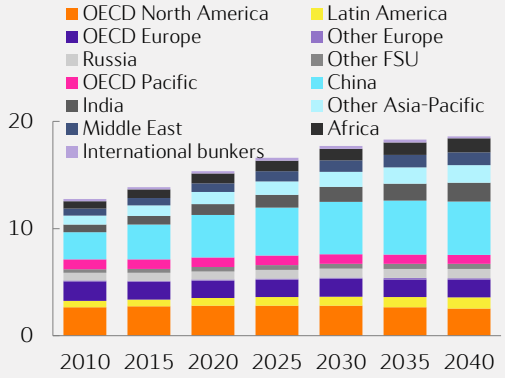
Energy intensity ratio of non-OECD vs OECD economies



Source: IEA

World primary energy demand by region

Bn toe

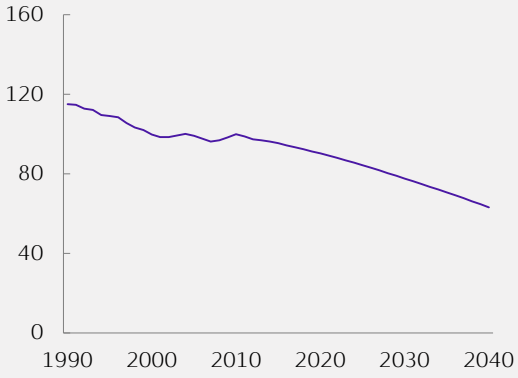


Source: IEA (2010), Statoil (projections)

Tighter policies will ensure continued energy efficiency improvements

Energy intensity of the world economy

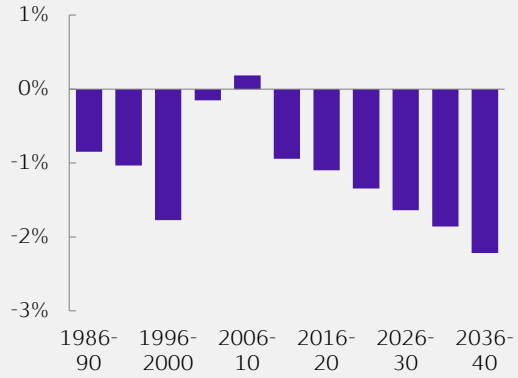
Index, 2010=100



Source: IEA (1990-2011), Statoil (projections)

Energy intensity of the world economy

CAGR, 5-year periods



Source: IEA (1990-2011), Statoil (projections)

In our Reference scenario, the energy intensity of the world economy declines by an average of 1.5% per year between 2010 and 2040. We thus assume higher decline rates for the coming 30 year period than the world experienced between 1990 and 2011. Our assumption is more in line with the record for the 1990s alone (-1.4% per year). At the regional level average annual decline rates vary from -1.4% for the Middle East to -3.2% for China. The OECD regions' annual decline rates also vary, from -1.5% for OECD Asia Pacific via -1.9% for OECD Europe to -2.3% for OECD North America.

We base our assumptions on two core beliefs: i) that continued rapid technology development will make such decline rates physically possible; and ii) that tighter policy frameworks will ensure that the possibilities are indeed exploited. We also assume in our Reference and Low Carbon scenarios that the subsidisation of fossil fuel use going on in many non-OECD countries will be sharply reduced. In line with these beliefs we do not see the global energy intensity curve flattening before 2040; we rather see the pace of energy efficiency improvements building towards the end of the scenario period.

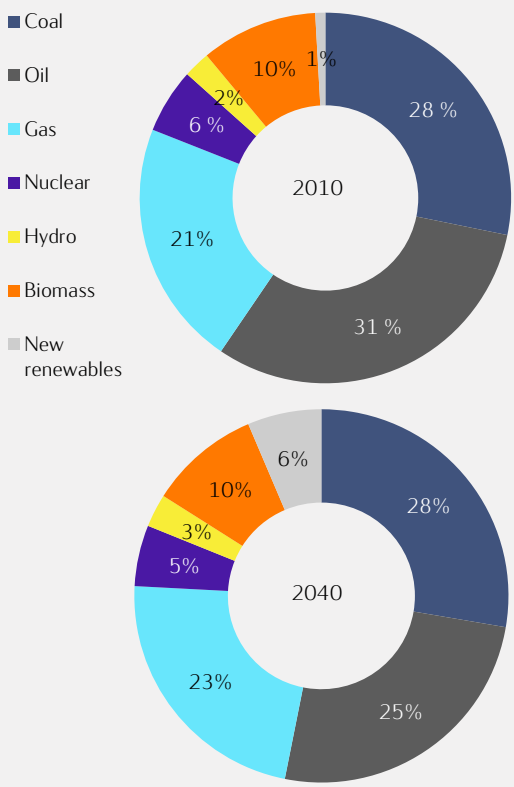
Evidently there is downside risk to our assumptions – the pace of energy efficiency improvements could get stuck on technological inertia or failures to agree and implement adequate policies. Also, we could underestimate the so-called "rebound" effect of energy efficiency improvements. Judging by other recent scenarios there is however also a significant upside. ExxonMobil suggests in its latest "Outlook for Energy: A View to 2040" an average annual global energy intensity decline rate of 1.7% per year. In BP's latest "Energy Outlook 2035" the energy intensity of the world economy declines by an average of 1.9% per year between 2012 and 2035. And the 2013 version of the IEA's New Policy scenario suggests a 2.3% yearly decline in the energy intensity of the world economy.

Our energy intensity assumptions result in a 1.3% yearly growth in world primary energy demand between 2010 and 2040, with the OECD area experiencing negative yearly growth rates in the -0.1 to -0.3% range and the non-OECD regions positive growth rates in the 0.7-3.0% range.

Fuel mix outlook

In 1990 oil consumption made up 36.1% of world primary energy consumption, with coal in second place (25.7%) and gas in third place (19.2%). The biofuels, nuclear and hydro shares were 10.4%, 6.1% and 2.1%, respectively. The so-called new renewables – mainly wind power, solar power and geothermal energy – contributed a miniscule 0.4% to global primary energy supply. By 2011 oil was still in first place, but its share had shrunk to 30.7%. In spite of many years of attention to global warming, the coal share had increased to 29.2%, reflecting a 69% increase in global coal use over the 21-year period. Gas use had also become more widespread, making in 2011 up 21.5% of total energy use. While the nuclear share had dropped to 5.2%, the new renewables share had more than doubled but was still, at 1.0%, tiny compared to the fossil fuel shares. In terms of final energy consumption, the main development between 1990 and 2011 was that the electricity share increased from 13.7% to 18.5%.

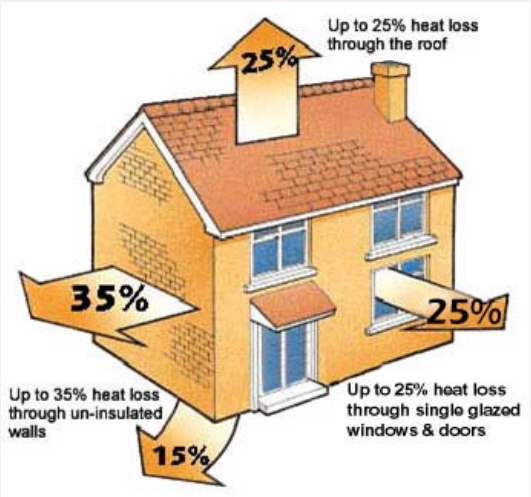
World fuel mix in the Reference scenario



Source: IEA (history), Statoil (projections)

The new renewables are set for rapid growth, but from a small base

Energy efficiency: No lack of potential



Source: Greenenergybricks.com

While the global fuel mix is indeed changing, the change is rather slow. As many have pointed out, it takes time to turn the Titanic. Looking ahead, some trends still seem pretty robust. Oil will become increasingly marginalized in all sectors except the transport sector, and is under pressure from substitutes in the road and maritime transport sub-sectors as well. Oil has however certain advantages in its remaining strongholds that will prevent a demise from the energy scene. Oil will likely do best under business-as-usual conditions. In a more carbon conscious world as well as in a politically fragmented world with international trade falling apart, the pressure from energy efficiency measures and from substitutes to gasoline and diesel will build.

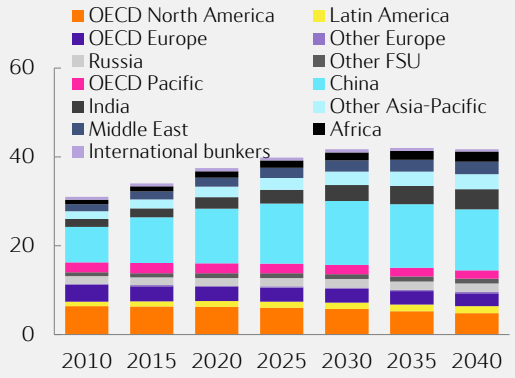
Gas looks set to gain further ground thanks to its effectiveness and relative cleanness as a power sector fuel, its potential as a transport sector fuel and its relative abundance – if, that is, the shale gas revolution sustains in North America and spreads to at least some other parts of the world. Gas is widely considered to have a bright future under carbon constrained as well as business-as-usual conditions. In a politically fragmented world gas resource rich countries would likely seek to step up gasification while the import dependent parts of the world would go in the opposite direction. As for regions, Europe could be the exception from the main rule with gas facing an uncertain future in all scenarios analysed in this report.

Coal looks set to lose market share due to its dirtiness – there is hardly a major coal burning country left that does not see its coal dependence as a problem – but probably not at a pace consistent with the IEA's and others' green scenarios. Nuclear energy, whose share of global power generation had plummeted from 17% in the mid-1990s to 11.7% by 2011 was dealt another blow by the Fukushima accident, but could still bounce back with China and select other non-OECD countries commissioning a series of new reactors. However, costs, safety and radioactive waste disposal issues make the extent and longevity of any revival open to question. The new renewables – wind, solar power and geothermal energy – seem assured of a bright future as they play up to all the concerns that are expected to drive the global fuel mix, and as the costs especially of solar power are coming down. See separate chapters for more detail on these energy carriers.

In our Reference scenario, the fuel substitution processes observed since 1990 continue, but at a moderate pace so that the global fuel mix does not look extremely different 26 years from now than it does today. The main development is that the new renewables increase their combined share of world primary energy supply and demand from 1% to 6.4%. The oil and coal shares decline to 24.5% and 27.7% respectively. The biomass share also declines, from 10.1% to 9.5%. The gas share increases to 23%, the hydro share edges up by half a percentage point to 2.9% and the nuclear share stays virtually unchanged.

World CO_2 emissions by region

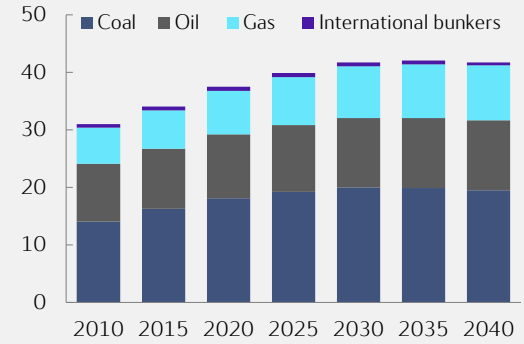
Bn tons



Source: IEA (2010), Statoil (projections)

World CO_2 emissions by fuel

Bn tons



Source: IEA (2010), Statoil (projections)

Emissions will be lower if CCS comes into widespread use – but the Reference scenario assumes no early breakthrough

Source: BBC

Greenhouse gas emission outlook

World CO_2 emissions related to fossil fuel consumption increased by 2% per year between 1990 and 2011. OECD area emissions were up by 0.5% per year and non-OECD emissions by 3.3% per year. Global emissions increased nearly three times faster in the 2000-2011 period – by 2.9% per year – than in the 1990s (1.0% per year). This acceleration was due to a formidable spurt in non-OECD emissions. After having increased by 0.8% per year in the 1990s, they were up by 5.7% per year in the 2000-11 period. The pace of OECD area emission growth dropped from 1.2% per year in the 1990s to minus 0.2% per year after the turn of the century.

The main drivers behind these opposite developments were on the one hand the Chinese economic boom based primarily on investments in infrastructure and heavy industry, and on the other hand the financial crisis which capped economic and energy demand growth in the West. While governments' energy efficiency and renewables policies also played roles, so did the relocation of energy intensive industry from Europe and North America to countries like China. Thus the OECD regions' success in reducing their CO_2 emissions has contributed in no small amount to the explosive growth in the non-OECD regions' emissions. A related observation is that the OECD regions' success in making their production less CO_2 intensive has not at all been replicated on the consumption side – they have merely switched from domestically produced CO_2 intensive goods to imported – e.g., Chinese – CO_2 intensive goods. This indicates that replicating the development in front-running OECD countries cannot easily be replicated on a global scale.

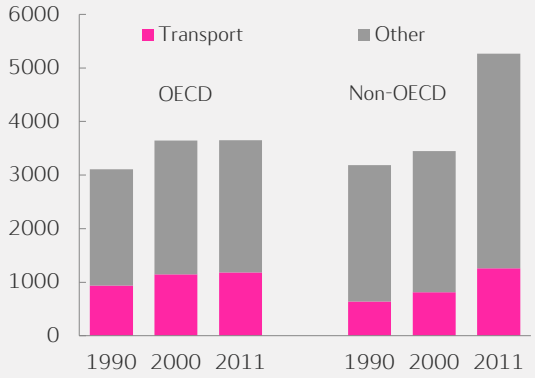
In IEA's so-called 450 scenario, world CO_2 emissions drop by 31%, or by an average of 1.5% per year, between 2011 and 2035. This is, IEA argues, what it will take to contain global warming at 2 degrees Celsius. It may be technically feasible to engineer the changes in fuel consumption patterns implied by such an emission curve. It may even be the economically optimal way forward – many observers from the Stern report and onwards have argued that it will be cheaper to prevent global warming than to allow it to happen and pay for its consequences.

The 450 scenario and similar scenarios would, however, need much stronger incentives than those in place to materialize. A back-cast, which is what the 450 scenario is, is free to assume that its preconditions fall into place in a timely manner without further explanation of how that is to happen. A descriptive reference scenario accounting for current and likely future constraints needs a different approach. Our Reference scenario fossil fuel demand assumptions therefore result in a global CO_2 emission curve rising to 41.7 billion tons per year by 2035 before going into gentle decline and ending at 41.2 billion tons per year by 2040.

A breakthrough for CCS could make our fossil fuel demand assumptions consistent with a lower, more sustainable CO_2 emission curve. Since limited progress has been made and the policy incentives remain weak, we are however less optimistic on CCS in this year's Reference scenario than in last year's. We assume that only around 1.5% of world CO_2 emissions related to fossil fuel consumption will be captured and stored by 2040.

Final energy consumption

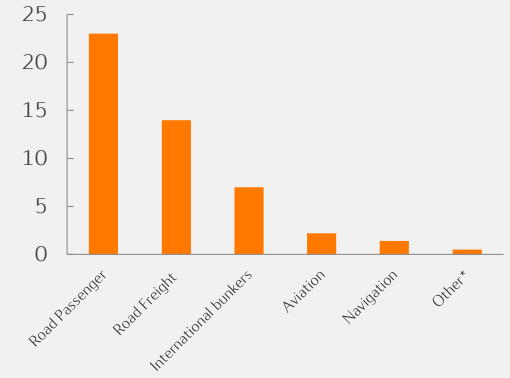
By sector, mtoe



Source: IEA

Oil demand in transport – by sub-sector

Mbd, 2012

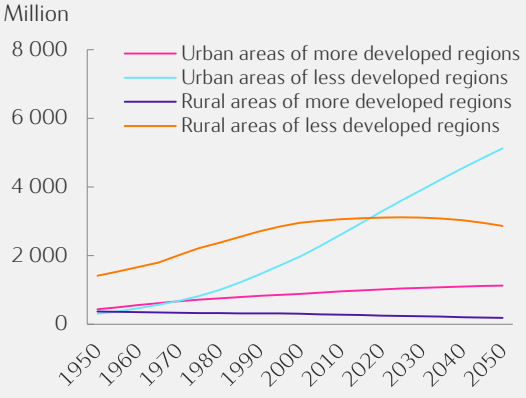


*Rail, pipeline and non-specific transport

Source: IEA

Population in urban and non-urban areas

Million



Source: United Nations, 2011

Energy use in transport – rising demand, with oil losing out

An increasing share of energy is consumed in the transport sector

Since 1990 global energy use in the transport sector has risen from almost 1.6 to more than 2.4 bn toe (2011), which represents an annual average rise of 2%. At the same time the sector's share of total final energy (TFE) demand has increased from 25% to nearly 28%. Demand for individual mobility and goods transport have increased in both advanced and emerging economies. However, after 2000 efficiency improvements and saturation effects in transport and other sectors in the OECD regions have led to stagnation in energy use. With more than 90% of the energy use consumed by cars, buses and two-wheelers, road transport is still the overriding transport mode. The use of light duty vehicles has been dominant in the advanced economies and is rising sharply in the emerging economies. Globally, oil has traditionally had a monopoly position in the road sector, in domestic and international aviation and in marine transport, while coal and electricity have had significant market shares in the rail sector.

The future megatrends – urbanization, local issues and policies

Continued economic growth with rising income levels in all regions suggests that the demand for mobility should continue to grow over the next decades. However, the overall demand growth and individuals' choices of transport modes will increasingly be affected by several offsetting forces, which have large implications for car ownership and car use:

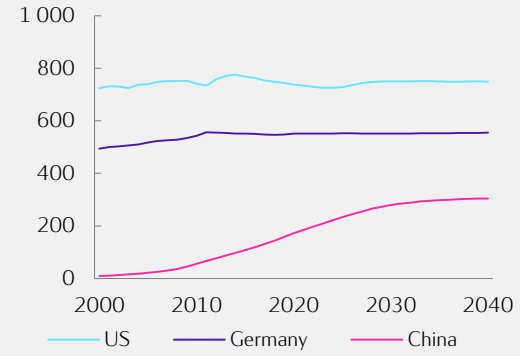
- *Strong trend towards further urbanization*
  Both in advanced and emerging economies a rising share of the population will live in cities and megacities, which suggest that individuals overall could find it more efficient to choose other modes than personal cars and trucks for their everyday transport needs.
- *Rising pressure on road capacity and air quality*
  As a result of increased populations, most cities have increasingly experienced sharply rising road traffic, severe congestions and worsened local air quality.
- *Restrictions motivated by local and national policy objectives*
  The harmful side-effects of urbanization – pressures on the transport system and air quality – are increasingly met by regulations by local and central governments. In several regions, e.g. in Europa and Asia, energy security and climate change are additional concerns that motivate tighter regulations.

Car ownership meets resistance and car licence rates are falling

In many cities the car still gives individuals freedom to choose. However, the car option increasingly fails to deliver on choice of route, arrival time and convenient parking. Furthermore, there is a growing list of acceptable alternatives, both virtual and physical. Rising awareness of individuals' health also suggests that walking and cycling gradually will be more common. While car ownership has continued to grow in several cities in emerging economies during 2002-2012 (driven by income and status effects), ownership rates fell in several cities in the OECD area. Furthermore, driving licence rates for the youngest age groups in the US have fallen markedly since 1997-1998. These are signposts that the traditional link between income and car ownership and car use (distance travelled) has weakened in several parts of the world.

Vehicle density

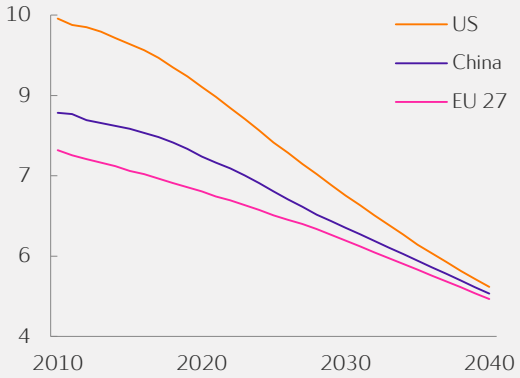
Passenger cars/1000 people



Source: IEA (history), Statoil (projections)

Fuel efficiency

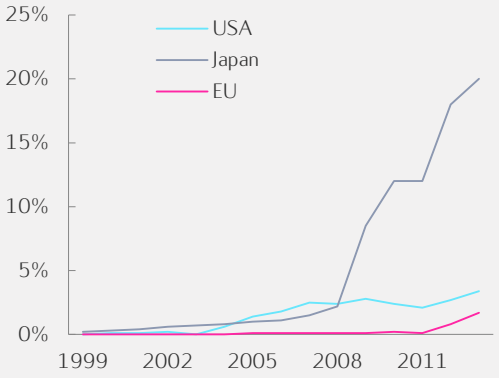
Light duty vehicles, l/100 km



Source: IEA (history), Statoil (projections)

Hybrid sales

Market share per region



Source: IHS

The future of cars in China – one of the wild cards

The trends towards rising traffic congestion and deterioration of local air quality have been particularly evident in China. In many large cities and regions, where smog levels have moved far above acceptable health standards, local governments have introduced licence plate restrictions to regulate car ownership and car use. Looking ahead, private ownership and distances travelled per vehicle should potentially continue to drive energy demand in transport. While the US and Europe have private car ownership of 700 and 550 vehicles per 1000 inhabitants, respectively, it is more likely that China, on a national basis, will see ownership rates of 250-300 vehicles, dependent on the overall rural and urban structure, the type of transport network between cities as well as air quality trends and other wider policy objectives. The same variables will probably lead to lower distance travelled per vehicle over the next decades – from the current level of 12 000 kms per year to 7000-9000 kms.

The dual effects of standards – efficiency and alternative engines

Fuel efficiency and emissions standards of vehicles have emerged as the main policy instrument in the transport sector in all main regions. Corporate standards require that the average efficiency, and the corresponding CO_2 emission level of the models of an automaker, must comply with the adopted standards. Since the efficiency improvements of internal combustion engines (ICE) ultimately have limitations, passenger vehicles with alternative engine technologies have to be marketed and actually sold in order to comply with standards. Thus, tighter performance standards simultaneously give directions on the size of the penetration of alternative technologies, like hybrids, plug-in hybrids (PIHs) and full electric vehicles (FEVs).

Steady tightening of the efficiency standards in all markets

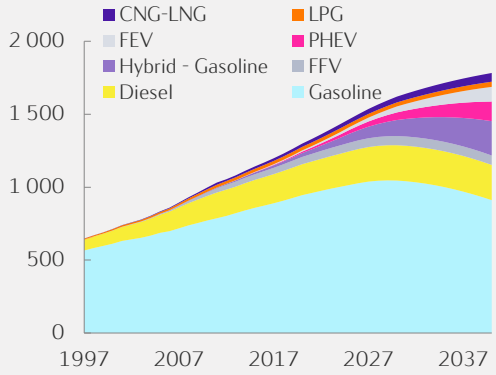
The EU emission standards require that new passenger cars on average emit a maximum of 130 gram of CO_2 per km (5.3 l/100 km) in 2015 and 95 g/km by 2021 (3.8 l/km). Over the next decades the standards will most likely be tightened further, most likely to 60-75 g/km by 2030. In the US the joint efficiency and emissions standard for new cars and trucks for model year 2015 is currently 160 g/km. The Obama administration has made agreements with thirteen large automakers to increase fuel economy to 54.5 miles per gallon for cars and light-duty trucks by model year 2025, which corresponds to 125 g/km, equivalent to 5.6 l/100 km for gasoline cars. In 2013 the US Environmental Protection Agency also established emission standards for heavy duty vehicles, which will reduce the CO_2 emissions for diesel and gasoline trucks by 17% and 12%, respectively. Driven by broader energy and climate concerns it is assumed that the mandated performance standards will be steadily raised over the next decades. A parallel development is assumed in China and gradually also in the other, larger emerging economies.

Hybrid sales have made inroads in the Japanese market

Since the introduction and marketing in the mid-2000s, sales of hybrids have been rather different between the three main OECD markets. In the five million Japanese vehicle market, where Toyota pioneered the development of the hybrid engine technology in gasoline cars, hybrid sales increased sharply in the aftermath of the 2008-2009 economic recession, mainly driven by eco-car tax breaks and subsidies. In 2013 the

Passenger vehicles by type

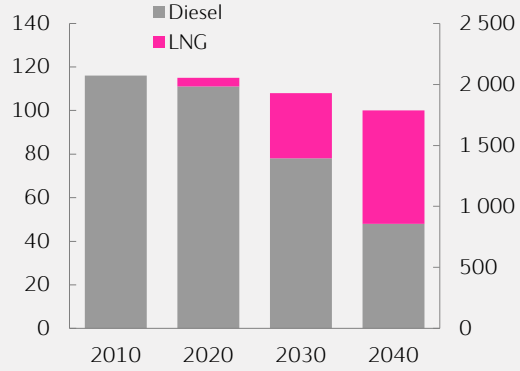
Million cars



Source: IEA (history), Statoil (projections)

US fuel demand

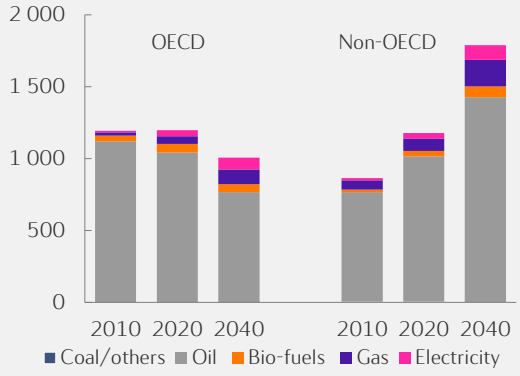
Heavy trucks, bcm (lhs), kbd (rhs)



Source: IEA (history), Statoil (projections)

Energy use in the transport sector*

Mtoe



*Excluding international bunkers

Source: IEA (history), Statoil (projections)

sales of hybrids reached 770 000 or a market share of 15%. In the diesel-dominated European market, with generally high fuel prices, tax incentives on diesel and marketing of smaller, fuel efficient conventional gasoline engines, hybrid sales have been more modest. However, hybrid sales more than doubled in an overall declining market. Offering both improving fuel efficiency and range the hybrid technology has been seen as well suited for the US vehicle market. With higher gasoline prices since 2011 sales have doubled to about 0.5 million, but market shares are still modest and have not met expectations. In the Chinese market where annual sales have reached 21 million vehicles, conventional engines totally dominate the market with a share of 99%. Natural gas driven engines, hybrids and FEVs all have tiny shares.

Next decades - gradual penetration of hybrids and electric vehicles

Payback calculations for hybrids and electric vehicles show that most of these cars are still not fully cost competitive at current fuel prices. However, declining prices for batteries and electric engines are steadily reducing payback periods. Together with the assumed tightening of combined efficiency and emissions, the market shares of hybrids and PIHs are expected to rise gradually over the next decades. In North America hybrids will remain the most popular non-combustion engine, while the more densely populated European market, where range is less critical, will see a larger share of FEVs compared with the US market. By 2040 more than half of the world's LDV fleet will still be powered by gasoline and diesel cars, while the rest is expected to be hybrids and other alternative engine technologies.

LNG will make inroads in the heavy duty segments

The largest potential for gas penetration in the road sector is in the heavy duty truck segment (class 8 trucks) of the US market. Currently the 2.6 million long-haul trucks consume about 2 mbd of diesel or close to 60% of total US diesel demand. While the use of LNG is currently modest, gas penetration is expected to rise, driven by a continued wide price spread between diesel and LNG and the development of a retail network of LNG filling stations. The loss of diesel demand could reach around 1 mbd.

Given the persuasive economics of LNG-based engines, the pace of expansion of the infrastructure is the main uncertainty. In Europe, a network of EU supported filling stations is expected to be in place by 2020 and the economic benefits will lead to a rapid growth in the market share for LNG. In China, an extensive LNG network is already in place and the economics for both truck owner and suppliers are favourable.

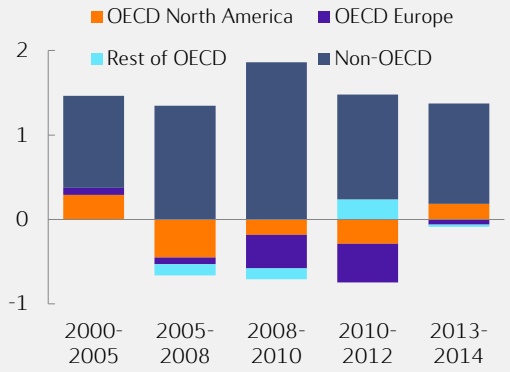
On balance - rising mobility compensates for higher efficiencies

Towards 2040 the net effect of all these forces and trends leads to a continued, although decelerating growth in the energy demand of the world's transport sector. China and generally the emerging markets will experience the strongest growth, driven by rising demand for mobility and continued preference for passenger vehicles. The more aggressive regional policies with comprehensive regulations and efforts to redirect travel from road to rail and to public means of transportation, and the enhanced efficiency are in aggregate not sufficient to arrest the underlying income-driven growth. However, due to the increasingly stronger penetration of alternative vehicle technologies oil demand in the world's transport sector is projected to reach a peak around 2030.

The global oil market

Global oil demand

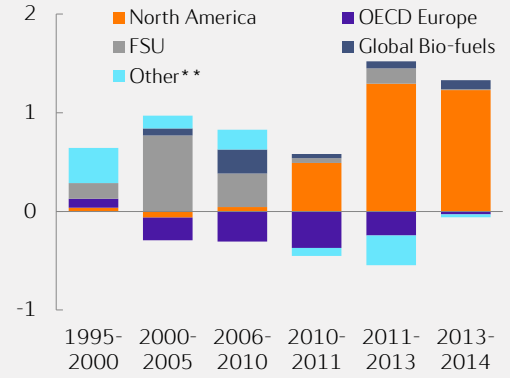
Average annual change, mbd



Source: IEA (history), Statoil (projections)

Non-Opec production*

Average annual change (mbd)



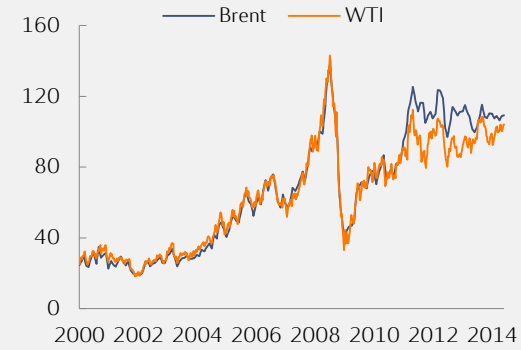
* Total liquids, incl. biofuels and processing gains

** Includes processing gains

Source: IEA (history), Statoil (projections)

Crude oil prices

Brent and WTI, USD/bbl



Source: Reuters EcoWin

Recent trends – the pendulum swings to the US market

Revival of US oil demand has lifted global demand growth

After a steady fall in US oil demand since 2005, only interrupted by an economic recovery-led growth in 2010, oil demand experienced a strong 0.4 mbd gain in 2013. The revival of US demand was led by solid growth in gasoline and gasoil demand, driven by stronger economic growth and a cold pre-winter. Continued cold weather during 1Q14 and prospects for healthy economic growth suggest that US oil demand will see a further rise of 0.15 mbd this year. OECD Europe oil demand has experienced similar trends. After annual declines of about 0.5 mbd in 2011-2012, demand only fell by 0.1 mbd in 2013 and could level out this year. Despite only moderate growth in emerging economies, revitalization of US and European demand contributed to the lifting of global demand growth to 1.3 mbd in both 2013 and 2014.

The momentum of the US shale revolution keeps up ....

US tight oil production, which started accelerating in 2009-2011 and continued with a massive growth of 0.9 mbd in 2012, pushed (shale) crude and condensate production to 2.0 mbd for the year. Most observers expected somewhat slower growth through 2013, but tight oil production actually powered ahead with an additional 0.7 mbd gain. All main plays, Bakken, Eagle Ford and the Permian, experienced strong production growth driven by continued productivity improvements and cost improvements. On top of these volumes, NGL production from shale gas plays added another 0.15 mbd to all US liquids production 2013. There are few signs that the expansion of US tight oil will slow significantly in 2014.

...and contributed to a 1.3 mbd gain in non-Opec production

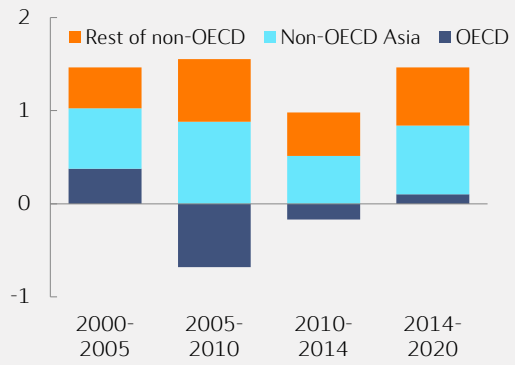
With a total growth of 1.1 mbd of US liquids production, an increase of 0.2 mbd of Canadian production and an unchanged level of supply disruptions, non-Opec production rose by 1.3 mbd in 2013, sharply up from 2011 and 2012 and the strongest performance since 2001. Outside North America, Russian production edged higher by 0.15 mbd, while North Sea production fell by close to 0.2 mbd in 2013, although significantly less than the average trend since the mid-2000s. Brazilian oil production experienced another year of decline, due to operational problems at existing fields and delays in bringing new fields on stream, affected by an overstretched supplier industry. Kazakhstan's huge Kashagan field, which initially started production in September 2013, had to seize operations after few weeks due to serious leakages.

More Libyan losses – a new year with oil prices around 110 USD/bbl

High levels of mainly MENA supply disruptions, initially driven by the Arab Spring, have since early 2011 generally contributed to a tight oil market. After a period of rising oil stocks in 2Q13 a new round of Libyan supply disruption from August 2013 triggered by local tribes' occupations of terminals, led to a renewed tightening of the market. To alleviate the tightness in the physical markets, Saudi Arabia has since then kept crude production around 10 mbd, which has pushed down Opec's total spare capacity to levels around 2 mbd. The combination of low spare capacity, record low commercial oil stocks and a continued elevated risk premium, fuelled by the fear of further supply disruptions as well as the crisis in Ukraine, have mainly kept oil prices between 105 and 115 USD/bbl over the last three and a half years.

Global oil demand

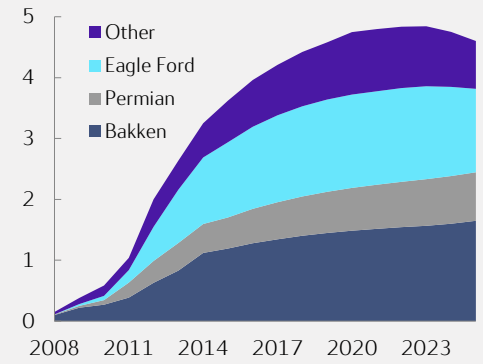
Average annual change, mbd



Source: IEA (history), Statoil (projections)

US tight oil production

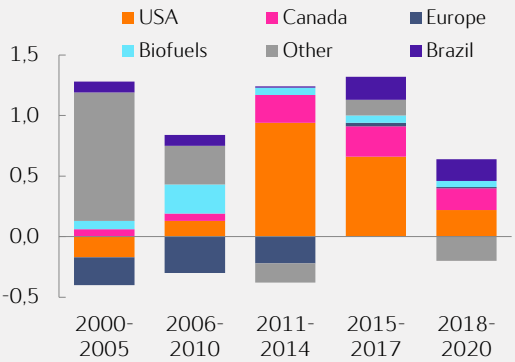
Mbd



Source: IEA (history), Statoil (projections)

Non-Opec production*

Average annual change, mbd



* Total liquids, including biofuels and processing gains

Source: IEA (history), Statoil (projections)

Outlook to 2020 - North America remains the key driver

Oil demand growth remains solid

The outlook for global oil demand to 2020 is based on the view that the world economy strengthens and grows along its long-term trend. However, existing and new policy-induced efficiency gains, particularly in the OECD, are restraining the growth in oil products demand. OECD oil demand continues to grow more slowly over the next few years, before demand stagnates and starts to fall beyond 2020. Compared with Energy Perspectives 2012 and 2013 the more positive economic outlook for the OECD has led to an upward revision of demand by about 1 mbd by 2020. Despite many challenges, the restructuring process of the Chinese economy is assumed to develop relatively smoothly. Together with tighter efficiency standards this leads to an annual growth in Chinese oil demand of 0.4 mbd. Oil demand in other emerging economies is also assumed to grow roughly in line with historical trends, which in aggregate leads to an average annual growth in global oil demand of 1.4 mbd. A more turbulent economic development in China and other emerging markets represents the largest risk to this projection.

US tight oil production is bound for the 5 mbd level

The tight oil revolution has exceeded most expectations. A high level of drilling activities and significant improvements in well and rig productivity, have been important drivers behind the surprisingly strong growth. Furthermore, limitations of the pipeline system, which potentially could have restrained the production growth, have been alleviated through a fast expansion of rail capacity. Looking forward, most underlying dynamics indicate that US tight oil production will continue to rise strongly up to 2020. Further growth in production from existing formations and from several "new" plays should bring US tight oil production towards 5 mbd by 2020. Downward pressure on oil prices – domestically or globally driven – could lead to a downward pressure on companies' cash flow and to a slower rise in production. The proposal to lift the crude oil export ban to alleviate the pressure in the domestic market is a controversial issue, and a decision is not expected in the near term.

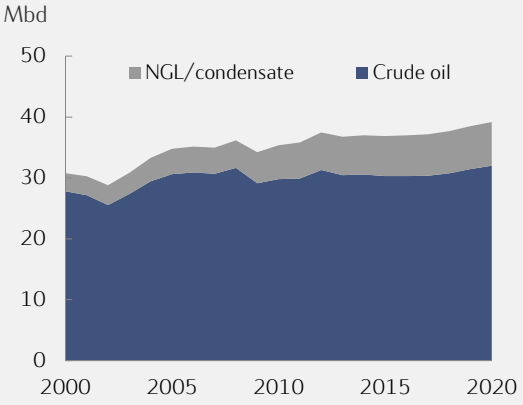
Only modest production effects of the IOCs' investment cuts

Driven by concern about rising costs and lower margins, several IOCs have over the last few quarters signalled higher priority to "value over volume" and have announced that upstream investments will be trimmed over the coming years. Since the tightness in supplier markets moderated significantly during 2013, the IOCs' concern is probably also a reflection of the gradual rising share of expensive projects in their portfolios. Statements suggest that many companies will try to make cuts that minimize the effects on new field development and oil production. Thus, the effects on non-Opec production between 2016 and 2020 will most likely be rather moderate. US tight oil production will hardly be affected, while oil sands and deep water projects are more vulnerable.

Non-Opec production grows strongly up to 2017-2018

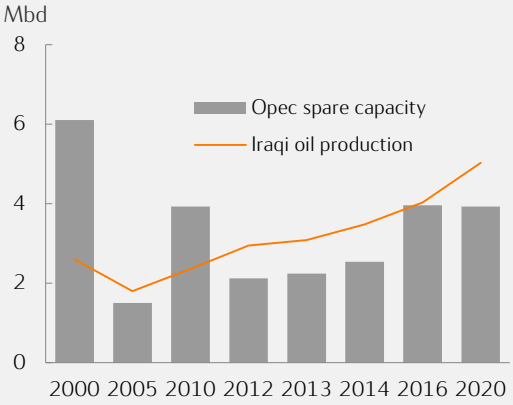
On top of the rising US tight oil output, production growth of other liquids – conventional crude, oil sands and NGL – is expected to give significant contributions to non-Opec oil production. Although the resource potential of Canadian oil sands is huge, the development of new projects may be slowed by uncertain project economics, driven by

Opec oil production



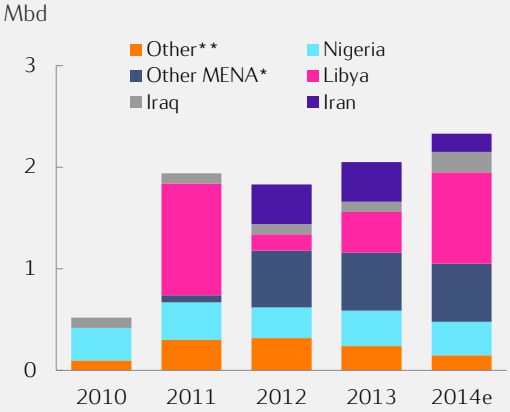
Source: IEA (history), Statoil (projections)

Opec spare capacity and Iraqi oil production



Source: IEA (history), Statoil (projections)

Supply disruptions



* Yemen, Syria, South Sudan

** Technical related outside the Middle East and Africa

Source: IEA (history), Statoil (projections)

potential downward pressure on prices and rising costs, as well as delayed start-up of new export pipelines. However, the fast development of railroad facilities has so far accommodated the rising production. In total, oil sands production is assumed to grow by almost 0.25 mbd annually up to 2020.

Outside North America, Brazil and Kazakhstan have the largest potential, but stagnations and delays in recent years, partly affected by local content requirement, capacity problems and protectionist policies suggest that production will only grow moderately. The outlook for the problematic Kashagan field is now highly uncertain. Recent reports indicate that renewed start-up could be delayed to 2016. In aggregate, non-Opec production is bound for record strong growth over the next four years, before production growth moderates in the last few years of the decade. USA and Canada will contribute with about two thirds of the overall growth. Positive effects on Mexican oil production of the proposed energy reforms will probably first be seen beyond 2020.

Stagnant demand for Opec crude up to 2018

After some years with strong expansion, growth in Opec NGL production has slowed. Towards 2020 the production continues to rise only moderately. Based on the outlook for oil demand, non-Opec and Opec NGL production, there is room for an Opec crude production of 30.4 mbd in 2014, the same level as last year. Over the next three to four years call-on-Opec crude remains stagnant. However, in the last part of the decade the pace of non-Opec production growth slows, again leaving room for higher Opec production.

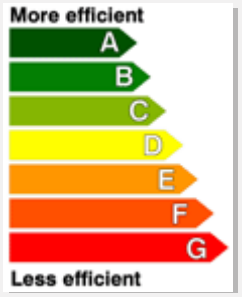
The outlook for Opec capacity has become more uncertain than ever

Libya, which struggles with a fragmented political structure and a weak central government, will probably come to see further decline in its nominal production capacity and a risk for sustained supply disruptions for several years. Iraq, which has experienced significant challenges, has so far been able to expand its production capacity. Our Reference scenario assumes that its capacity will continue to rise by 0.20-0.25 mbd annually – in line with recent trends. The capacity outlook for Iran, which is critically dependent on the involvement of IOCs, is clouded by the various sanctions. The current negotiations over the nuclear program may eventually lead to the lifting of some sanctions. However, it could take years before Iran's crude capacity starts to increase. In other member countries only small changes in the crude capacities are expected. Mainly driven by the assumed expansion in Iraq, total Opec effective capacity is expected to rise by about 2.0 mbd over the next four years.

Rising Opec spare capacity and higher internal tensions

The outlook for rising capacity and stagnant call-on-Opec crude implies that Opec's spare capacity will rise from around 2 mbd in 2013 to about 4 mbd in 2017, and that Saudi Arabia and other members must leave room for higher Iraqi volumes and potential recovery of Libyan oil. Saudi Arabia will most likely accept taking a significant share of the cuts, but other member countries must contribute to keep the market stable. Most likely, the production quotas regime has to be re-introduced, also suggesting that the internal tension in the organization could rise again. A more comfortable spare capacity situation will partially put downward pressure on oil prices, but continued concern about new supply disruptions will remain high and provide price support.

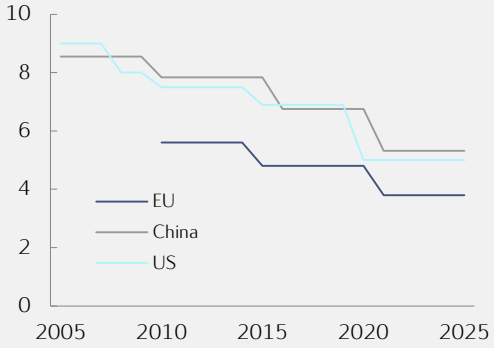
Energy efficiency labels



Source: EU

Fuel efficiency

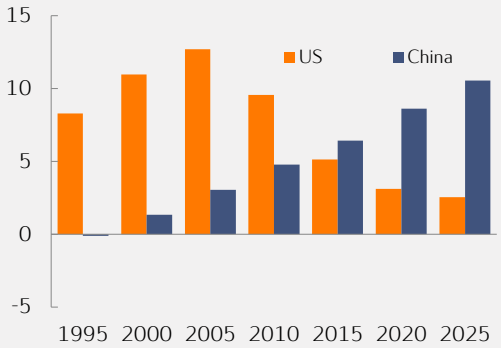
L/100 km



Source: IEA (history), Statoil (projections)

US and Chinese net oil imports

Mbd



Source: IEA (history), Statoil (projections)

The long-term outlook – towards peak in oil demand

Political response to address sustainability challenges

The long-term supply and demand trends in the oil market will continue to be strongly affected by various global forces, as well as regional and country specific forces. Local air quality, supply of clean water and other local and regional issues have been effectively dealt with in the most advanced economies, and the EU has played a leading role in addressing climate change. Especially China, but also several other emerging economies, have been successful in lifting income levels, but deteriorating air quality and generally rising pressure on local resources, exacerbated by continued urbanization, suggest that current trends are unsustainable. As stressed in previous chapters – as various sustainability issues are expected to move to the forefront of policies in all regions – it is assumed that more comprehensive energy and climate policies are adopted and implemented. Tightening of efficiency standards, especially in the transport sector, and specific regulation of mobility and transport activities, will have strong and dampening effects on oil demand.

Climate concerns will move to the forefront of US policy

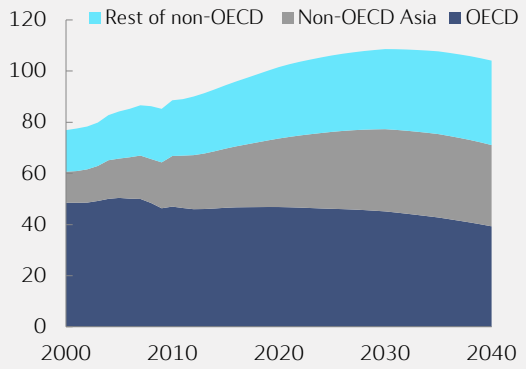
US energy policy has for decades been motivated by concerns about energy security, and specifically oil imports security. High oil prices and partly climate concerns have also played a role. These factors were imperative when the combined fuel efficiency and emissions standards were tightened in 2010-2011, and they have motivated further initiatives in recent years. It has been argued that the ongoing shale revolution, which potentially could contribute to almost completely eliminating US oil imports, will erode the support for new and aggressive policy initiatives on the demand side. However, as the US gradually moves out of the economic problems created by recession and stronger evidences of climate change occur, climate change policies will probably move upwards on the US policy agenda. Similar concerns and efforts in the EU and China will facilitate a common internal position and thereby create sufficient support in the US Congress for the introduction of new measures. Thus, a steady tightening of efficiency standards in all sectors of the US economy beyond 2020 is a key assumption behind our projection of US oil demand.

Chinese energy policies will also be steadily tightened

China's broader energy policies are inherently linked to the underlying economic development, which requires a lot of coal, oil and gas, provides desirable energy services, but with harmful side effects. Furthermore, with a steady rise in income levels and urbanization, China will increasingly face the fundamental dilemma of realizing ordinary people's aspirations about individual car ownership and mobility versus the broader social needs of a more sustainable development. More specifically, China's broader transport and energy policies will primarily be driven by three domestic factors; the concern about rising import dependence, the deterioration of air quality in the larger cities and the need to develop a sustainable transportation system. In 2014 China will be importing about 6 mbd of its 10.5 mbd of domestic oil demand. Despite the implementation of further efficiency measures in the years up to 2020, oil demand will probably reach 13 mbd in 2020 and take total oil imports to 9 mbd. With a strong preference for self-sufficiency, this trend is politically sensitive, and will most likely be addressed.

Global oil demand

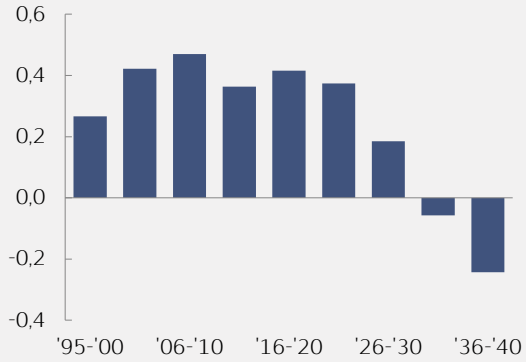
Mbd



Source: IEA (history), Statoil (projections)

Chinese oil demand

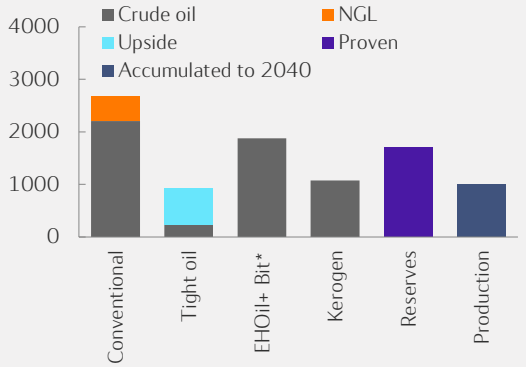
Average annual change, mbd



Source: IEA (history), Statoil (projections)

Remaining recoverable oil resources, proven oil reserves and accumulated production

Bn barrels



* Extra Heavy Oil and Bitumen

Sources: IEA (US Geological Survey), Statoil

The air quality of several Chinese cities has gradually deteriorated over recent years, but the level of smog and air pollution moved far above acceptable health levels for longer periods last winter. Much of the smog comes from transportation, but a large part also drifts in from the coal-powered plants and manufacturing activities surrounding the cities. Air pollution is currently becoming one of the key social stress factors, and the issue is increasingly addressed by local and central government. Based on the outlook for potentially strong rise in transport activities and power generation over the next decades, only very comprehensive and strong measures will help avoiding lasting, unacceptable air quality standards. In aggregate we expect that China will make strong and sustained efforts to raise energy efficiency in all sectors of the economy over the next decades. Stronger regulations of the transport sector and the use of alternative fuels will be part of the policy packages.

Oil demand growth decelerates through the 2020s - peak in 2030

Driven by gradually lower GDP growth, continued improvement of energy and oil efficiency and gradually rising substitution away from oil to gas and electricity, regional oil demand slows in all regions. After a period of economic recovery-led consolidation, OECD oil demand is expected to fall steadily through the 2020s. In China annual demand growth will slow from 0.3-0.4 mb/d in the early 2020s towards stagnation and decline in the 2030s. In other emerging economies oil demand will continue to rise modestly through the 2030s. The transport sector where oil products have held almost a monopoly position is a key part of this projection. As described in the chapter on transport, steady tightening of fuel efficiency standards and further progress in hybrid and battery technologies, which make alternative technologies competitive, give important contributions to the slowing of oil demand growth. Given these prospects for oil demand, two key questions should be raised; first, is the size of the remaining recoverable oil resources sufficient to cover the accumulated demand up to 2040 and beyond, and secondly, at which cost level can these resources be developed and produced?

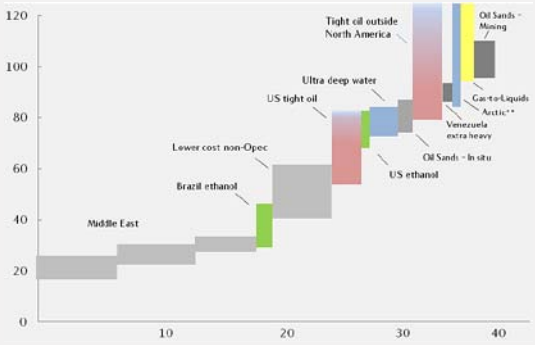
The recoverable resources are sufficient

The assessments of the US Geological Survey are the key source for several institutions' estimates of the remaining recoverable resources of various types of oil liquids. IEA estimates that the total remaining recoverable *conventional* resources of crude, condensate and NGLs are about 2670 billion barrels, and consist of the three main categories; proven reserves, reserve growth and undiscovered (yet to find) resources of 1700, 700 and 300 billion barrels, respectively. IEA believes that the remaining recoverable resources of *light tight oil* and *unconventional* resources are about 300 and 2880 billion barrels, respectively. Compared with other institutions, IEA's estimate of tight oil (shale oil) and NGL reserves from shale gas are conservative. In aggregate IEA's estimate of total remaining recoverable oil resources amounts to almost 6000 billion barrels, of which 1700 are proven reserves.

The estimates and perceptions of the size of the future reserve growth and yet to find resources, which are quite controversial, tend to fluctuate with upgrading and exploration performance. However, even if a lower, very cautious estimate (P95) is applied, the total remaining oil resources are sufficient to cover our projected accumulated oil supplies of approximately 1000 billion barrels up to 2040.

Marginal cost of new supplies - illustration

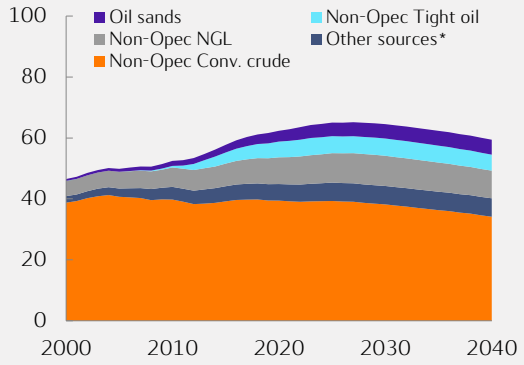
USD/bbl, WTI equivalents, mb/day



Sources: IEA, various research institutions

Non-Opec production

Mbd

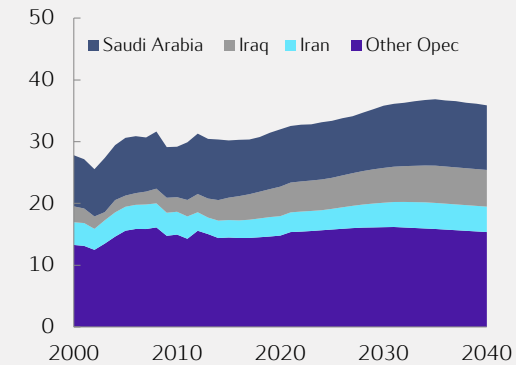


* Bio-fuels, GTL, processing gains

Source: IEA (history), Statoil (projections)

Opec crude oil production

Mbd



Source: IEA (history), Statoil (projections)

At which cost can new oil resources be developed and produced?

Full cycle cost (FCC) of current projects in various high cost areas like oil sands, ultra-deep waters and tight oil stretches over wide ranges. From the view of long-term price formation and market equilibrium the marginal projects (or the upper part of the range) are the most relevant, and the FCC of these projects are often assessed to be in the USD 80-90 USD/bbl range.

The cost level of next generations of projects – to be developed over the coming decades – will be driven by several forces, of which reservoir and project complexity, technology improvements and unit prices in the supplier markets are the most important. The continuation of the current trends toward development of smaller fields and more complex reservoirs will partially drive costs upwards, while learning and technological improvement could offset at least some of the cost increases. Unit prices of all input factors, which rose sharply in the mid-2000s due to tighter supplier markets, moderated in 2013. For the development of longer-term unit prices the main uncertainty is the supply of skilled and experienced people in engineering and some other segments. For the broader cost development, upstream policies of resource rich countries influencing upstream competition and local content requirements are important. The resource potential of tight oil resources outside North America is large, but in most countries there are multiple above ground barriers which suggest that the development will be gradual over the next decades. Due to the nature of these barriers, the cost level of future tight oil projects outside North America is highly uncertain, but generally believed to be above 100 USD/bbl.

Total liquid supplies are becoming more diversified

As the conventional crude oil production, excl. tight oil, at least outside the Middle East, is depleted, the share of non-Opec conventional crude production out of total liquids supply declines significantly; from 42% in 2014 to only about 33% in 2040. However, the technology-driven shale revolution and continuous improvements in oil sands technology mean that several "new" types of oil liquids; like tight oil, NGLs from shale gas and oil sands have become economic. Together with a moderate rise in bio-fuels production and smaller gains in gas-to-liquids output, these sources will replace the declining conventional non-Opec crude production over the next decades. Although Opec crude production will rise somewhat, total liquids supplies are becoming less dependent on crude and more diversified. Total non-Opec liquids supply is expected to peak in the late 2020, consistent with last year's projection.

Room for higher Opec crude in the 2020s

The decelerating growth in non-Opec production through the 2020s leaves room for a gradual increase in Opec crude output from about 32 mbd in 2020 to a level of 36-37 mbd around 2030, when global oil demand is expected to peak. Opec's total production of crude oil and NGL as a share of global liquid supplies will through the 2020s remain around the current level of 40%, but will gradually rise towards 45% in the 2030s. Given the large resource potential in Iraq, Iran and Saudi Arabia, the sharing of future production will remain an issue for negotiations. Dependent on the outlook for call-on-Opec crude, the scope for Iraqi and Iranian oil production could be about 6 and 4 mbd, respectively, in the 2030s. Saudi Arabia will remain the largest producer with a production level of almost 11 mbd.

The global gas market

Setting the gas scene – what are the issues?

Ample resources, but at what costs?

The prospects for natural gas as a global energy source are good. Demand is backed by large resources of conventional and unconventional gas. The shale revolution has contributed to a better geographical distribution with large resource additions in North America, China and Australia. But the costs of developing new gas reserves and transporting the gas to the market vary considerably. Shale gas production in the US is highly competitive, it is located close to large markets, but there is a need for exports of a building surplus of gas. This contrasts the cost of gas from other hydrocarbon provinces. Transportation from field to market, by pipeline or LNG, may add substantial costs to the upstream cost. Development of brownfield or expansion projects may significantly alleviate the cost challenge in these regions.

High gas prices, low coal prices and subsidies undermine the outlook for gas demand

The use of natural gas has many advantages compared to other fuels; it is flexible, convenient, clean and has a relatively low carbon footprint. In some markets prospects for gas demand growth are at risk due to high purchase costs. Affordable gas prices have become an issue in Europe, Japan and many emerging markets importing LNG. In Europe gas used for power generation requires support of carbon prices to compete with low-priced and abundant coal, and is also threatened by highly subsidized renewables. Energy-intensive industries face US competitors enjoying low gas prices. In Japan utilities are struggling, and there is an urgency to reduce the procurement costs for LNG post-Fukushima. The role of gas in the energy mix is thus at a turning point in some markets.

International gas price formation is in transition

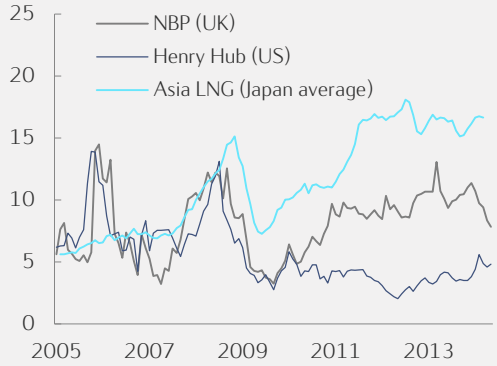
Gas price formation in Europe is in transition. More gas volumes are sold at liquid market places or at terms reflecting spot prices. More liquid hubs, new infrastructure and improved regulation now enable gas to move freely between local markets. Trading is exposing remaining price differentials, by geography or by season.

Globally, LNG importers in Japan and elsewhere have hopes that the advent of Henry Hub pricing of LNG exports from the US should have implications for the pricing of LNG from other locations. Buyers would like to offload exposure to contracts with traditional linkage to a crude oil index. The expectation is that alternative pricing principles should lower the procurement cost. Many emerging markets struggle to pay current high spot prices for imported LNG. The utilization of existing regasification plants is often well below technical capacity. LNG import demand is thus sensitive to price, and softening prices should boost demand.

Gas pricing does however not change the underlying cost picture of new supplies. Developers of complex projects far from main consuming markets will only invest if the project economics meet corporate hurdles. The long lead-time for the recently concluded Sino-Russian gas contract underlines this issue. There is also reason to believe that the number of LNG export projects in North America will grow significantly slower than the number of permit applications would indicate.

Key gas prices

USD/MMBtu

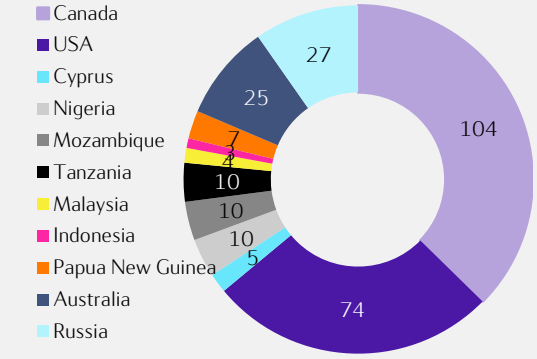


Source: EnergyScope

Regional gas prices remain regional

LNG capacity targeting FID in 2014 - 2017

Million tons per annum

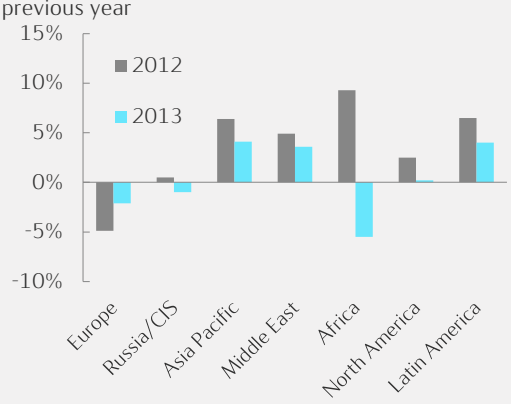


Source: Statoil, compiled from open sources

Ample gas resources available, but at what cost?

Change in gas consumption by region in 2012 and 2013

Percentage change in apparent consumption from previous year



Sources: Cedigaz

Marcellus is transforming US East Coast gas markets

Marcellus shale gas production meeting local demand

Year when Marcellus can replace all imports by state

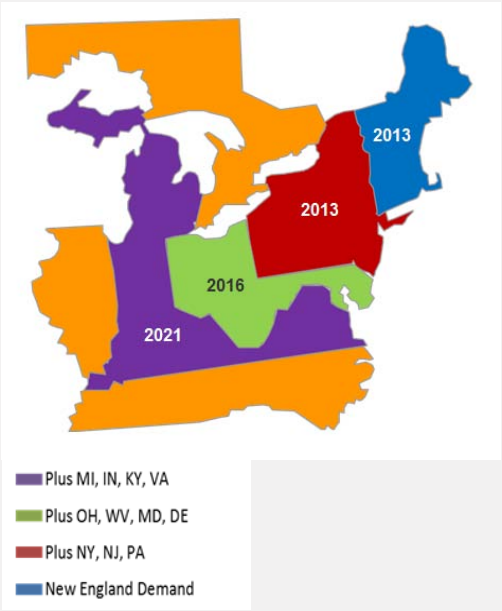


Illustration does not cater for exports to Ontario.

Source: Statoil

Outlook to 2020 – Rising capacity, strong demand

Continued high growth rates globally

The international association for natural gas (CEDIGAZ) estimates 2013 global gas consumption growth to have been 0.8%, rather modest compared to 2.3% growth in 2012. Most emerging markets continue to show strong growth in consumption (China 14.5%, Latin America 4.0% and the Middle East 3.6%), but India and some African countries reveal declines. European gas consumption continues its downward trend (-2.1%) and 2013 levels are 60 bcm or 10 per cent down from peaks in 2008 and 2010. OECD Asia Pacific gas consumption grew by 3.2%, while North American consumption was close to stable.

North American gas demand growth reflects favourable supply

US gas demand is on a long-term growth trajectory and 2013 consumption exceeded 2008 levels by almost 80 bcm (12%). The bulk of the growth has so far come from the power sector as stricter environmental regulations and competitive gas prices incentivize generators to turn to gas to satisfy underlying load growth and for coal replacement. Industrial gas demand should also grow, bolstered by oil sands development in Canada and increasing competitiveness of gas-intensive industries such as petrochemicals and fertilizers.

The shale revolution has transformed the supply side of the North American gas market. Analysis of hydrocarbon basins, acreage and reservoir flow characteristics suggest that the abundance of natural gas supply will continue for decades to come. The related low price of gas has focused attention on cost cutting, including more efficient drilling programs. There has also been a shift of drilling activity to liquid prone basins. Improved operational efficiency and technological progress are increasing the pace at which unconventional resources can be made available. Some shale plays are located in traditionally gas importing states such as Pennsylvania. Shale production in Marcellus may reach some 240 bcm by 2020, sufficient to cover eastern US gas demand and still export gas to Canada. Texas and Gulf of Mexico are awash with gas, and most potential US export projects are thus located at the Gulf of Mexico. Overall, we expect North American demand to grow by more than 50 bcm, or 6-7%, to 2020.

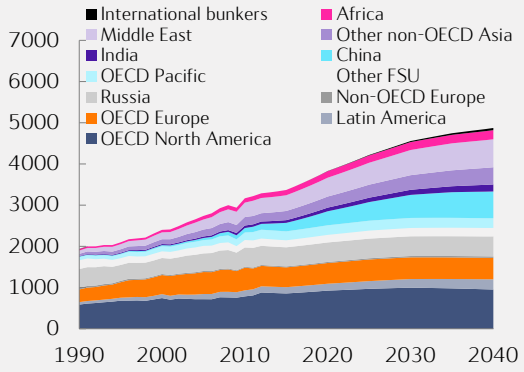
European gas demand outlook muted, supplies are available

European gas consumption is down 60 bcm from 2008 pre-crisis level. Manufacturing energy and gas consumption has been depressed by the Eurozone crisis and relatively high energy prices. The use of gas for power generation is competing with renewables and coal-fired generation. We expect European gas demand to level out and some modest recovery may take place towards 2020. The Eurozone is finally experiencing positive economic growth, and more stringent environmental legislation (Large Combustion Plant Directive, the Industrial Emissions Directive) will gradually be biting. The future EU ETS price is uncertain, and so is its impact on a European gas revival.

Since 2008 indigenous gas production in the EU has fallen by some 50 bcm/yr or by 25%, most notably in the UK. UK production is expected to level out as new fields come on stream. Norwegian production is expected to stay around 100 bcm per year for the rest of the decade. North African pipeline supplies have been slipping in recent years, but

Reference scenario gas demand development

Bcm

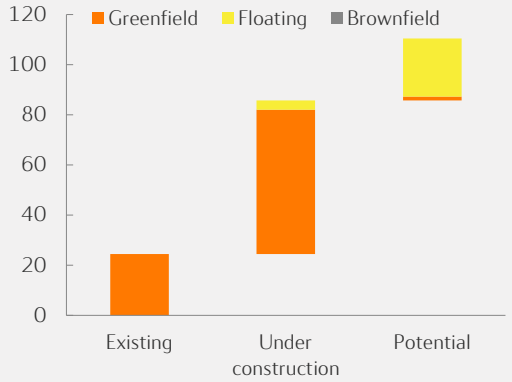


Sources: IEA (history), Statoil (projections)

Half of global gas demand takes place in Asia

Australian nameplate liquefaction capacity

Million tons per annum



Potential = projects seeking FID in the 2014 - 2017 period

Source: FACTS, Statoil (potential)

The number of LNG importers is increasing

should level out. LNG imports to Europe are down 40 bcm in two years; cargoes are directed to or re-exported from Europe to better paying markets in Asia and Latin America.

Russian gas production and export capacities are increasing. In 2012 Gazprom launched the giant Bovanenkovo field on the Yamal Peninsula, but growth in output has been slower than announced due to weak demand and other Russian producers vigorously building gas positions. Gas exports to Europe have remained fairly constant over the last decade. Russian gas use is also fairly stable and it contracted by 0.5% in 2013. Ukraine also consumes less gas. Implications are a well-supplied gas balance suggesting that Russia has production and transportation capacities to meet any conceivable demand requirements from Europe. However, due to the Ukraine crisis, many EU leaders would instead limit their dependence on Russian gas, to the extent possible.

Asia will continue to be the global growth engine

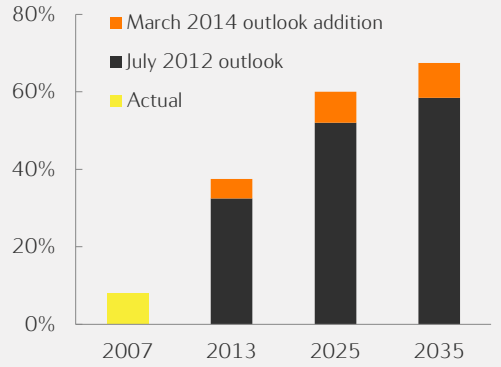
Gas demand in OECD Asia will stay at current high levels even though some nuclear plants are likely to restart operations in Japan and South Korea. Gas demand in China is expected to grow by around 10% p.a. constrained by available supplies. A tight LNG market and high procurement costs negatively impact demand growth in emerging markets. Underlying demand growth is strong, reflecting the strength of emerging Asian economies, penetration into new areas and rising concerns for local pollution in the region's mega-cities due to extensive coal burning. Conventional gas will meet most of China's incremental gas requirements until 2020, followed by a build-up of pipeline imports from Central Asia. By 2020 Asia's gas supply mix could be in the order of magnitudes two thirds domestic production (conventional and unconventional) and one third pipeline and LNG imports.

We see global gas demand increasing by around 2.1% a year in the period 2013 - 2020. Further to China, India and other emerging Asia, both Africa and the Middle East will deliver demand growth rates above the global average. Russia and most OECD markets will see growth below these rates. The gas supply situation is comfortable in North America and Russia.

The global LNG market is up for change

2014 will see the beginning of the so-called "Australian wave of liquefaction capacity"; one train in Papua New Guinea and one in Australia. New supplies will gradually ease the tightness in the global LNG market, but ramp-up of production will lag growth in capacity. Some existing LNG producers face feed-gas issues, thus some trains will run below capacity due to lack of gas. This is notably the case for Indonesia and Egypt, but also Algeria has to balance rising domestic requirements and export ambitions in a challenging upstream environment with gas output from Hassi R'Mel in decline. The first US Gulf of Mexico LNG train will commence operation in 2016, but North American LNG export capacity is not expected to exceed 50 bcm by 2020 (see discussion below). New LNG volumes are either contracted long term to buyers or to so-called portfolio players. The proportion of spot or short-term sales is steadily rising.

Shale share of North American productive capacity



Source: IHS CERA

Canada has many large and competing LNG export projects

Canadian LNG export projects in British Columbia

Source: IHS CERA

The long-term outlook

Abundant North American supplies boost demand and exports

North American gas demand is on a growth trajectory due to the US economic recovery, growing and competitive gas supplies and more stringent regulatory restrictions on thermal power generation. Coal's share of the US power generation mix is steadily declining as it is replaced by natural gas and renewables. Internationally competitive gas prices underpin growth in manufacturing gas demand. As gas prices remain competitive with oil prices, we believe that gas will be playing an increasingly important role in road transportation. Growth rates are however declining over time and are expected to turn negative in the 2030s.

The North American shale gas revolution has not run its course, and resource updates show that even more gas seems to be producible at moderate prices. This has triggered a large number of liquefaction projects, most of them along the US Gulf of Mexico and in British Columbia in Canada. The US projects typically enjoy favourable cost conditions: a vibrant and competitive contractor industry, gas to be sourced from a well-functioning market and available infrastructure. This contrasts the Canadian projects which are greenfield projects with resources located far from the coast and several obstacles to building pipelines. As of June 2014, only Cheniere Energy has made Final Investment Decision for four trains at their Sabine Pass project. The future scale of US and Canadian LNG exports remains subject to speculation. US industrial gas buyers remain concerned about losing the competitive edge that cheap gas provides, and keep lobbying the government to hold back. Still a significant growth in export capacity during the 2020s is expected.

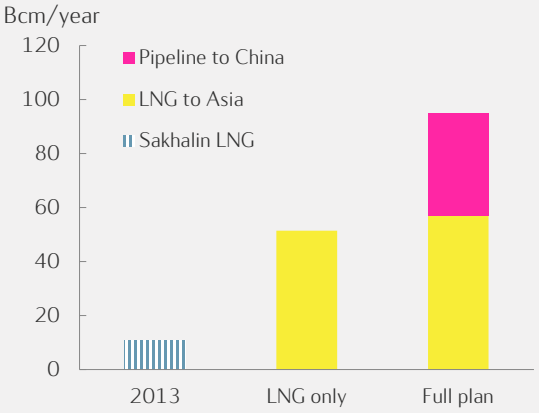
European gas demand not backed by EU energy policies

The European Commission has published a "2030 Communication" framework proposing a 40% carbon emission reduction target and a 27% EU-wide renewables target. The new 2030 framework is underpinned by an extensive analysis of the composition of energy prices and their impact on European competitiveness. Energy efficiency targets have not been included due to lack of data on the current energy efficiency policies. The Commission has also presented a legislative proposal to reform the EU carbon market.

The EU discussion has been polarised around the renewables target, rejected by most of the industry due to concerns over market distortions. Although the Commission proposes a target binding only at the EU level without specific national targets, new renewables will remain a competitor to gas. The industry has advocated that reforms of the EU ETS carbon market should improve the competitive position of gas versus coal in power generation. Furthermore, it is argued that a level playing field, without excessive and detailed regulation and authorities opting to pick winners, will result in higher gas demand and cheaper energy. We forecast European gas demand to reach 2008 levels around 2030 and then peak. Despite some shale gas, the decline in indigenous gas production will accelerate in the 2020s, resulting in a broadening 'supply gap' and a need for new gas supplies to Europe.

Russia is expanding in LNG and Asia

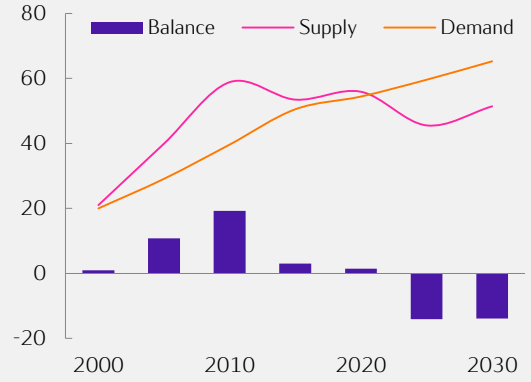
Potential Russian gas export scenarios to Asia by 2025



Source: Oxford Institute of Energy Studies (2014)

Some existing LNG producers are struggling

Egyptian gas balance and trade scenario 2000-30



Source: BP and WoodMac (history), Statoil (projections)

Russia is a potential gas power house for Europe and Asia

Russia possesses the resources to cover domestic demand, step up gas exports to Europe and establish its Eastern regions as a key supplier to North East Asia. Natural gas covers more than 50% of Russian energy needs, one of the highest in the world. Large scope for energy efficiency improvements suggests that Russia's gas demand will grow by 0.2% p.a. long term. Russian gas exports to Europe will also increase in the period. Supplies will both come from fields on the Yamal Peninsula and from West Siberia. The latter hosts large resources in deeper layers of existing fields or in new fields often located further north into the Ob and Taz bays.

Russia launched its Eastern Gas Program in 2007 to promote gasification of East Siberia and the Russian Far East, but also to prepare for gas exports to Asia. Despite the commercial logic of linking Russia's enormous gas resources with expanding demand centres in China, Korea and Japan, progress has been slow. Today gas exports are limited to Sakhalin LNG, but the 38 bcm/yr pipeline gas contract between Gazprom and CNPC will be a catalyst for the entire region. The contract is perceived not only to trigger the development of the Chayanda and Kovykta fields and a 4.000 km pipeline to Vladivostok on the Pacific Coast, but it will also make some of the new Russian LNG projects economically more robust. Russian LNG exports may more than triple by 2025.

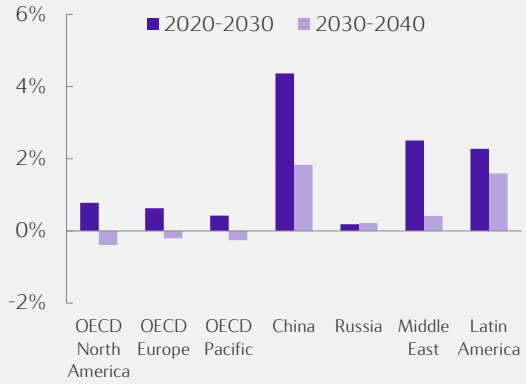
Caspian gas to Europe and Central Asian gas to China

Gas producers in the Caspian Region and Central Asia contest Russia's hegemony. The Shah Deniz consortium has decided to go ahead with Stage 2 of the Caspian Sea field and realize a Southern Corridor through Turkey to SE Europe and Italy by the end of this decade. Iraqi Kurdistan has gas resources located close to Turkey. Both Cyprus and Israel have made large gas discoveries on their respective shelves, and gas from the Aphrodite and Leviathan fields can be exported as pipeline gas or as LNG. A complicated political setting may however defer developments.

Central Asian producers, once an integral part of the Soviet gas system, exported 27 bcm to China in 2013. Chinese companies have a pivotal role in upstream developments, such as the Galkynysh field in Turkmenistan, and construction of pipelines. China is expected to import around 65 bcm of gas through the Central Asia – China pipeline from the early 2020s. Turkmen gas may reach Europe through the Southern Corridor, but face high transit costs and unresolved legal disputes over Caspian Sea territorial boundaries. The TAPI pipeline could link Turkmen resources to markets in Pakistan and India, but the political situation constitutes a major hurdle. Eventually, political risks could abate, allowing for new trade routes and accelerated gasification of the entire region. This may also be the case for Iran, holder of the world's second largest gas reserves, but future export levels from the region is uncertain as soaring domestic demand, boosted by population growth and low retail prices, lowers exportable volumes, as we also observe in North Africa.

Gas demand growth rates 2020 - 2040

Annual growth rates in % (CAGR)

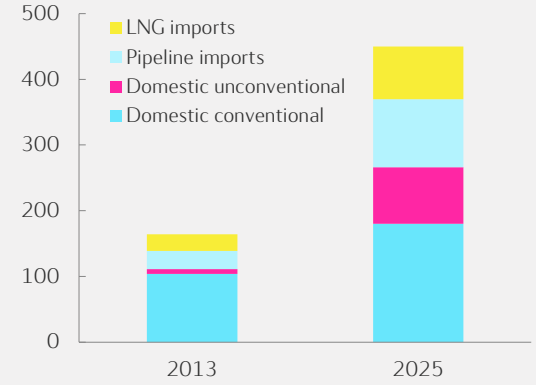


Source: Statoil

China and other emerging markets drive gas demand growth

Chinese gas supply

Bcm



Source: Statoil

Asian gas demand drives global gas markets; scope for shale?

Future gas demand in Asia will reflect the pace of economic growth in China, India and other emerging markets, but also the availability of gas imports to a region with scarce indigenous resources and the eagerness of the respective governments to support gasification. We observe a rising concern for deteriorating air quality in large cities in China, and replacing coal and oil with gas will be important to improve local air quality. Gas demand in the mature OECD markets in Asia and in the Pacific will show more modest growth. In general, we expect that gas volumes will be at hand to sustain high growth rates.

China has a large shale gas potential, even if there is uncertainty about the quality of the resources. Other obstacles are well-known and include limited water resources, gas market rigidities, and a supply industry with limited shale gas experience. Recently, oil companies have reported drilling results from shale gas projects in the Sichuan Basin that sparked renewed optimism. We factor in supply of significant shale volumes, but only after 2020. Test production of gas hydrates attracts attention too. Gas hydrates are molecules trapped in ice and held in place on the seabed or under permafrost conditions. Japan, Korea and China have strong incentives to tap these resources in order to reduce dependence on gas imports. Progress seems to have been made in China and Japan recently, but this is a long-term supply source at best.

List of new LNG projects far exceeds the needs

World LNG demand will grow faster than global gas demand and reach 600 bcm by 2030, a market share of 13%. Asia will capture most of the growth, but more LNG will flow to Latin America as well. The share of LNG in Europe's supply mix should rebound once the current tightness in global LNG markets recedes. There are more than enough liquefaction projects up and running, under construction or on the drawing board of oil companies to fulfil any supply requirement. Further to the seven LNG projects under construction, Australia has a number of both greenfield and expansion projects. In East Africa, Mozambique and Tanzania are eager to monetize large reserves, and so are Nigeria and other West African producers.

Far from all proposed LNG projects will be developed. Some resource holding countries provide strong political backing and attractive fiscal terms, as Russia, whereas Qatar may extend - or abolish - the moratorium on additional LNG trains. US authorities need to balance the interests of the upstream industry with those of domestic gas consumers. The construction boom in Australia has strained contractor capacity and local labour resources, resulting in cost overruns; thus there are limits on how many liquefaction trains that can be built in parallel in a region. Taking investment decisions requires binding offtake agreements and pricing terms justifying large investments. Security concerns may be critical for projects located in politically unstable regions. Finally, IOCs often mature 'competing' LNG projects at different locations, but will at some stage need to pick the winners, also to restrain escalating investment commitments and capital outlays.

Other energy carriers

The coal market – status and outlook

Coal is a challenging fuel from a local pollution as well as from a global warming point of view, but is indispensable for the world's most populous countries. Coal consumption makes up some 29% of world total primary energy consumption, with shares varying from close to zero in the Middle East and 4% in Latin America, to 42% in India and 68% in China. Most regions aim to wean themselves off coal, but it will to take a long time.

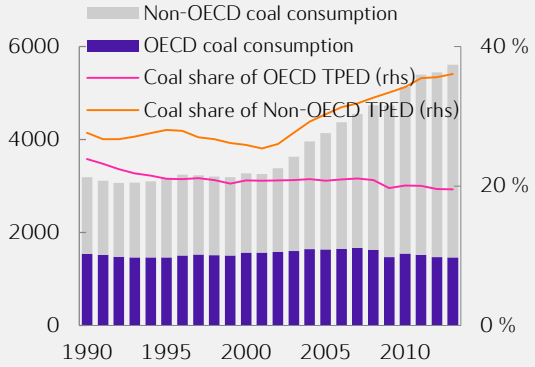
A striking feature of coal market developments since 2000 is the sharp increase in non-OECD consumption in both absolute and relative terms. This increase has been driven mainly by the uptick in Chinese economic growth based on energy intensive industrialization, and China's energy resource endowments which make the use of coal a comparatively simple and cheap proposition. China's share of world coal demand – currently some 51% and rising – will make the Chinese government's efforts to contain and eventually reduce coal use while sustaining economic growth crucial for global coal burning and CO_2 emission growth rates. Other factors that will influence the coal share of world primary energy demand, include traded coal price developments and developed country policies on emission standards and on carbon pricing or taxation.

The internationally traded coal market – which supplies less than one fifth of global coal consumption; most solid fuels are marketed domestically – has recently been depressed. The price of steam coal imported into Northwest Europe declined by 40% between 3rd quarter 2011 and 1st quarter 2014. The reasons were stagnant Chinese demand, declining US demand as coal lost ground to gas in the power sector, and robust growth in supply with producers trying to counter the impact of falling prices on their bottom lines by boosting output. Textbook economics would suggest that lower prices will reignite coal demand growth, but observers do not see that happening. US gas prices are likely to remain subdued for some time, sustaining the attractiveness of gas relative to coal. Moreover, the US electricity industry faces increasingly tight emission standards, with the decommissioning of a significant share of US coal power plants as a likely result. Meanwhile Chinese authorities have declared a war on air pollution and hope to force an acceleration of the phasing in of cleaner fuels. In Europe coal consumption has rebounded in response to a favourable coal-gas price ratio, but that situation is not expected to last for very long.

In our Reference scenario global coal consumption increases by 36% between 2010 and 2040. This total masks big interregional differences with OECD coal use dropping by more than 40% and non-OECD consumption increasing by almost 70%. Indian and other non-OECD Asian (apart from Chinese) coal demand is seen to more than double over the scenario period. Chinese coal use is assumed to grow by less than 60% in response to lower economic growth and tough energy efficiency and fuel diversification policies. Chinese coal use levels out around 2030 and goes into decline in the mid-2030s. The Chinese share of world coal consumption still increases to around 55%. India's coal demand grows faster than any other region's coal demand, boosting the Indian share of world coal use from 9 to 14%.

World coal consumption 1990-2011

Mtce, %

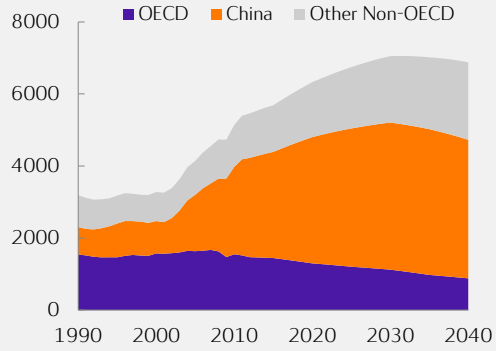


Source: IEA

Coal consumption makes up 29% of world total primary energy consumption with varying regional shares

World coal consumption

Mtce

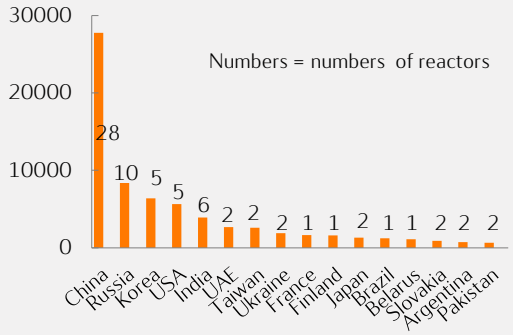


Source: IEA (history), Statoil (projections)

Global coal consumption increases by 36% between 2010 and 2040 with the strongest growth taking place in India

Nuclear capacity under construction

MW

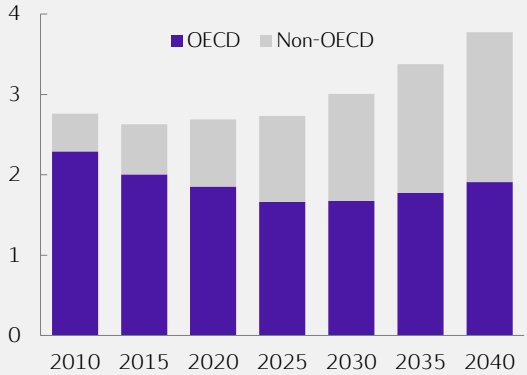


Source: World Nuclear Association

For the OECD another lost decade is expected, but China and other non-OECD countries will ensure growth

Nuclear power generation

GWh, thousands



Source: IEA (history), Statoil (projections)

Nuclear energy – status and outlook

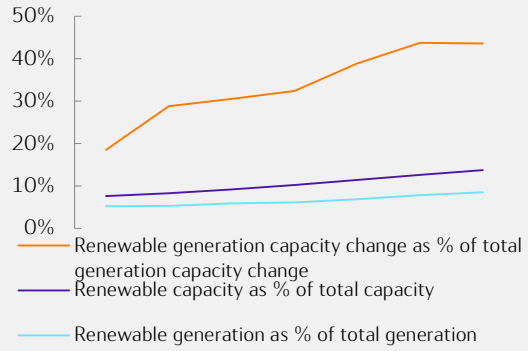
With developed country electricity demand stagnant, the Fukushima accident still fresh in people's minds and the nuclear industry struggling to stay competitive, the outlook for atomic energy is mixed. 72 new reactors are under construction or awaiting construction start-up, but one country – China – accounts for almost 40% of them. And many of the 44 reactors under development outside China have suffered significant delays and face an uncertain future.

World nuclear electricity generation dropped by almost 7% in 2012 due mainly to the shutting down of Japanese plants. Generation fell elsewhere too, however, confirming a trend observable since around 2005. As for 2013, OECD area generation levelled out, and some non-OECD countries experienced robust growth. The nuclear industry continues to face multiple challenges, however. The first, which affects the entire power sector, is the outlook for stagnant or declining electricity demand in most developed economies. The second is that, in spite of assurances that new "passive" designs have solved the safety problems of nuclear power generation, NIMBY – "not in my backyard" – attitudes to nuclear power plants prevail. In Japan it remains an open question how many of the shutdown plants that will ever be restarted. In Germany the decision to shut down the last of the country's nuclear power plants by 2022 enjoys continued support. The concerns about safety that increased to new levels in 2011 have also complicated permitting, delayed projects and boosted capital costs. Recent levelized cost of energy (LCOE) comparisons show nuclear in a less favourable light than pre-Fukushima comparisons.

For the OECD area we expect energy and electricity efficiency improvements, safety concerns and cost challenges to result in another lost decade for nuclear. In North America the outlook is clouded also by the impact of the shale revolution on gas and electricity prices. Five new reactors are under construction in the US, but these are all in states with regulated electricity markets. Announcements in 2012-13 of the retirement of a similar number of reactors in states with competitive electricity markets could be more important signposts for the future. We do however not foresee a demise of nuclear power generation, and from around 2030 we project a modest recovery. Unless the global warming threat recedes by itself, which seems unlikely to happen, it is difficult to see the developed world turning its back to the largest of today's zero carbon power generation technologies on a permanent basis.

Outside the OECD area where electricity demand is booming, interest in nuclear remains strong. With local pollution problems escalating, fuel supply constraints limiting the scope for gasification, investment constraints limiting the pace of growth in renewables and energy efficiency improvements a long-term fix at best, many governments have not much choice. Besides China, India, Russia and some Middle Eastern and Latin American countries continue to pursue ambitious nuclear targets. If however another Fukushima type accident occurs, which cannot be ruled out, all bets will be off for nuclear – in the OECD countries and likely also in many developing countries.

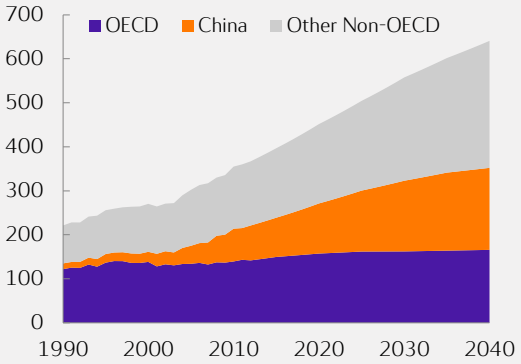
Renewable electricity shares of global electricity



Source: Bloomberg New Energy Finance

World hydropower generation to 2040

GWh

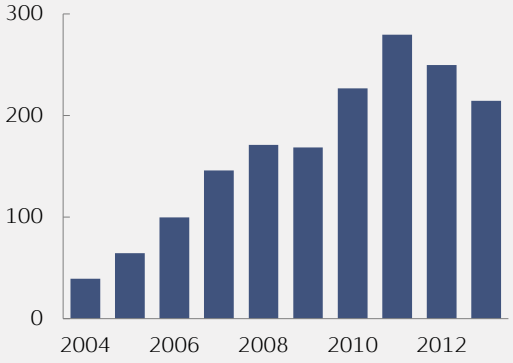


Source: IEA (history), Statoil (projections)

The financial support arrangements that have underpinned renewables in Europe and the US show signs of strain

New investment in renewable energy globally

Bn USD



Source: Bloomberg New Energy Finance

Renewables power generation

Renewables based power generation is booming in a number of countries, and the outlook is for further rapid growth. However, some of the countries which led the way are struggling to sustain the momentum.

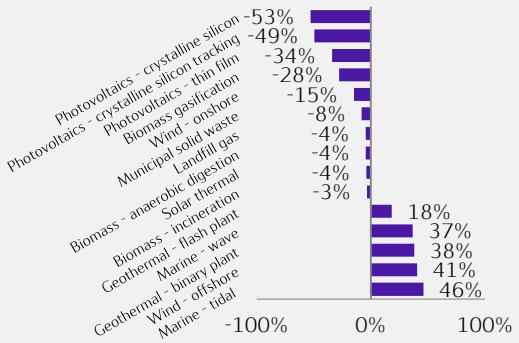
Other renewable resources may hold more promise for the future, but the world's rivers and waterfalls remain the biggest renewable source of electricity generation by a wide margin. Hydropower generation makes up around 15% of world total power generation – a bit more in years with above average rainfall in the regions relying most heavily on this option, a bit less in dry years. In the OECD area the scope for growth in hydropower generation is limited – the bulk of resources has already been developed. Outside the OECD area the situation is different. The World Energy Council estimates that only 33% of the potential in Latin America, 22% of the potential in Asia and 7% of the potential in Africa is being exploited. In China actual hydropower generation in 2011 corresponded to a mere 12% of estimated gross theoretical capacity. Big hydropower schemes have always been controversial, for aesthetic and increasingly for social and environmental reasons. Recent projects in China and Latin America have drawn much criticism. The apparently powerful combination of undeveloped hydropower resources and a worldwide craving for electricity not based on fossil fuels is therefore no guarantee for a mushrooming of big projects. Smaller schemes attuned to their surroundings are however enjoying increasing popularity.

This outlook sees world hydropower generation increasing by an average of 2% per year between 2010 and 2040. OECD generation is assumed to grow by 0.6% per year, Chinese and other non-OECD generation by averages of 3.1% and 2.4% per year, respectively.

The renewables attracting most attention are wind power and solar power. Both are growing fast, although not as fast as a couple of years ago. Global investments in wind power declined by 6% in 2012 and by another 1% in 2013. Investments in solar power dropped by almost 10% in 2012 and plummeted by more than 20% in 2013. However, the relative importance of renewable electricity (excluding big hydro) has continued to increase. According to Bloomberg, renewable generation capacity in 2013 made up 13.7% of world generation capacity, up from 12.6% in 2012, and accounted for 8.5% of world generation, up from 7.8% in 2012. Investments in new renewable generation assets made up more than 40% of worldwide investments in all generation assets in 2013 as in 2012. Both developed and developing countries saw less investment in renewable power in 2013, with Japan, the Americas apart from the US and Brazil, and the UK as notable exceptions.

Investments in wind and solar power have dropped for two reasons. One is positive – the prices of key components, in particular solar photovoltaic system, have come down, giving investors more bang for their bucks. The other is more disturbing from the point of view of the renewables industries – the financial support arrangements that have underpinned the ascension of renewables in Europe and the US show signs of crumbling. Governments struggling to make ends meet, and concerned about the impact of high electricity prices on their global competitiveness, have signalled cuts in subsidies and in some cases implemented retroactive adjustments. The result has been uncertainty about the future and investment delays.

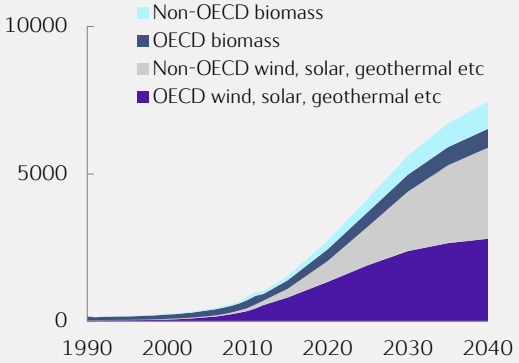
Changes in levelized costs of renewable power
3Q 2009 - 1Q 2014



Source: IEA

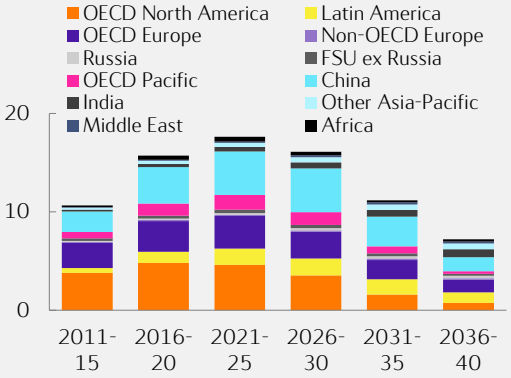
Renewables based power generation is still booming in a number of countries, and the outlook is further rapid growth

Non-hydro renewable power generation
GWh, thousands



Source: IEA (history), Statoil (projections)

Need for additional windmills per year*
Thousands



* Assuming 7.5 MW turbines and 30% efficiency

Source: Statoil

Though the bulk of renewable power still needs feed-in tariffs, green certificates, contracts for difference or other types of support, and will continue to do so, the onshore wind power industry claims that well-located wind farms are competitive with combined cycle gas turbines (CCGTs). Sceptics wonder whether such comparisons take grid connection and backup costs fully into account. The US DOE EIA's most recent levelized cost estimates for the US show gas power to be on balance 17-18% cheaper than onshore wind power inclusive of system costs, but confirm that cost ranges overlap. The renewables side adds to this that levelized cost comparisons are skewed from the start since the negative externalities of fossil fuel based power generation are not adequately priced - not in Europe with the EU ETS price at Euro 5-6/ton CO_2 and certainly not outside Europe where emissions have no costs at all.

The generation technologies which have made the fastest progress in cost terms are the solar photovoltaic technologies, but according to the EIA, the low end of the cost range for unsubsidized utility scale solar PV generation in the US remains one third above the high end of the range for CCGT generation.

In our Reference scenario, global renewable power generation apart from hydro generation increases by an average of 9% per year between 2010 and 2040. The growth rate goes from 14% per year in the first half of the period to 4.1% per year in the second, when slower economic expansion, structural and demographic changes and energy efficiency improvements result in declines in final energy use in the OECD regions and more or less subdued growth everywhere else. Renewable power generation net of hydro generation is seen to make up some 18% of world electricity generation by 2040, up from 4.5% in 2011. Of these 18%, wind power makes up 36%, solar power 32%, biomass based power an estimated 21% and geothermal power, wave power and other smaller technologies a combined 11%.

Projections like these are of course highly uncertain. In addition to the usual unknowns like how fast the world economy and its constituent regional economies will expand, how quickly energy intensities will decline, etc., there could be constraints on the pace of growth in intermittent power generation that we do not see clearly today. The requirements for interconnectivity and backup are well known in principle, but the required scale and optimal design of these conditions are open to question, and ensuring that they are there when needed will present developers with planning, financing and execution challenges. There could also be challenges related to the provision and location of wind and solar parks. The number of installations implied by our and others' Reference scenario assumptions scenarios is stunning. For illustrative purposes we have assumed that the windmills to be constructed between today and 2040 will have an average capacity of 7.5 MW (in line with today's biggest mills) and deliver 30% of their theoretically possible output (above today's average of 24%). Then, between 16000 and 18000 such units must be planned and built per year, for 15 years between 2015 and 2030. Where will they be? How will costs be affected as the best sites are filled up and developers have to take their business to less windy and/or more remote locations? Time will tell.

Alternative scenarios

The Low Carbon scenario – a possible future

The Reference scenario described in the previous parts of the report represents our view on the most likely development in the global energy markets. Given the large uncertainties and long time horizon, it is obvious that other developments can take place, with significantly different results. In this and the following section we explore two such alternative scenarios. In this section we explore what it will take to put the world on a trajectory significantly increasing the likelihood of limiting emissions of greenhouse gases to more sustainable levels. We have called it the Low Carbon scenario.

Climate policies incentivize green technology

The effects of global warming are becoming more and more visible and serious. In addition, urbanization, industrialization, improved income levels and increased consumption lead to more air pollution and traffic congestion in big cities. People all over the world ask their leaders to take concrete action on climate change. In the Low Carbon scenario we assume that governments respond to these demands, on both national and global levels.

In this scenario climate policies are strengthened swiftly and forcefully through global agreements, bilateral deals between major emitters such as China, the US, the EU and India, and ambitious regional and national initiatives. Tougher – and better coordinated – energy and climate policies are introduced in key sectors. Efficient cooperation on infrastructure investments and green technology development and deployment takes place. As a result, large reductions of greenhouse gas emissions are achieved.

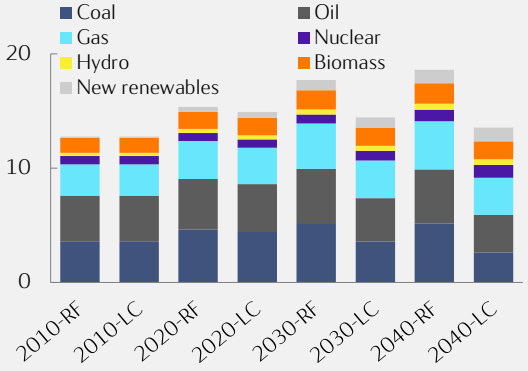
In the Low Carbon scenario a reinforced emission trading scheme in Europe results in a major increase in the carbon price (the cost of emission allowances). This positive investment signal significantly increases the shares of gas and renewables in the power sector. China introduces a national emission trading scheme, which contributes to improved energy efficiency and fuel switching in both the power and industry sectors. China also exploits a variety of other policy tools to make its economy less reliant on coal. A similar development takes place in India – though at a slower pace. The US tightens the emission performance standards in place for its power plants, resulting in a near phasing out of coal. The US and China collaboratively engage in support for development and global deployment of CCS.

Urban areas affected by local pollution introduce and reinforce regulations to avoid the use of coal in power generation. Specific local regulations are also introduced to reduce local pollution from diesel trucks and cars in cities. Emission standards on CO_2 for new vehicles are tightened.

Low growth, high unemployment and economic and social crisis can reduce decision makers' preparedness to adopt more long-term sustainable climate policies. Thus, one underlying assumption for this scenario, increasing the likelihood of coordinated energy and climate policies being swiftly implemented, is that the global economy improves moderately faster over the short and medium term than in the Reference scenario.

World TPED by fuel in the Reference and Low Carbon scenarios

Bn toe



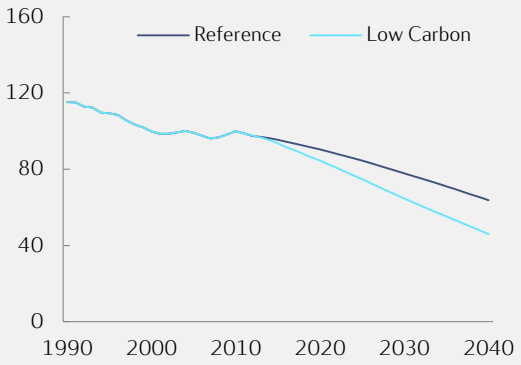
Note: RF = Reference scenario, LC = Low Carbon scenario

Source: IEA (2010), Statoil (projections)

International movement towards tightening policies ...

World energy intensity developments

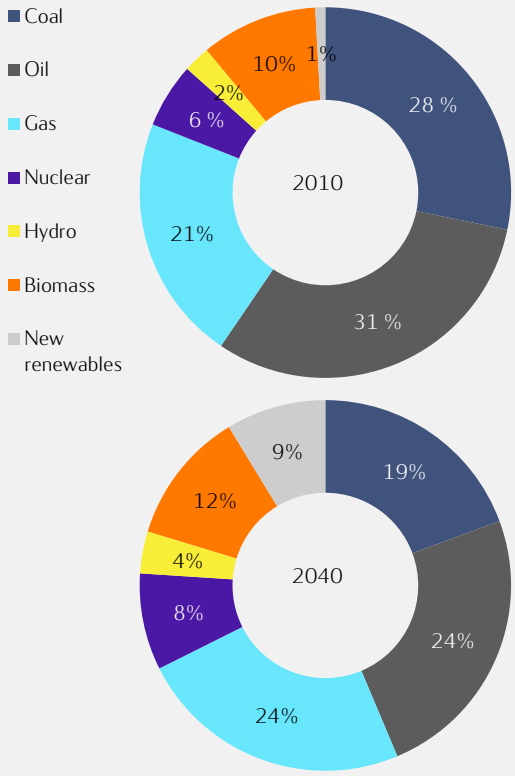
Index, 2010=100



Source: IEA (history), Statoil (projections)

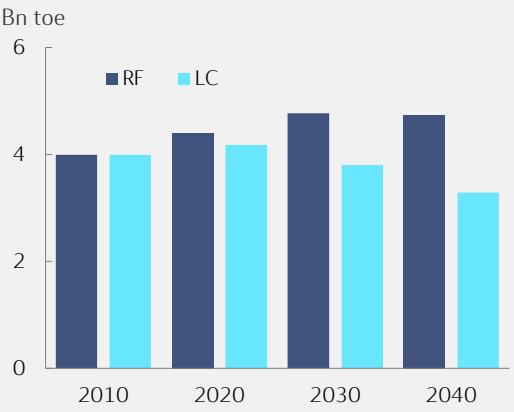
...partly driven by higher short-term economic growth

Global fuel mix in the Low Carbon scenario



Source: IEA, Statoil (projections)

World oil demand in the Reference and Low Carbon scenarios



Source: IEA (2010), Statoil (projections)

Generally, economic development in this scenario is characterized by international cooperation, integration and diffusion of good solutions, including technology. In the Low Carbon scenario economic growth is somewhat reduced compared to the Reference scenario during the 2020s, while restored and accelerated after 2030.

Urbanization drives energy efficiency

Continued global urbanization gradually increases energy efficiency and reduces overall energy consumption compared to the Reference scenario. Urban dwellers have less living space per citizen, and energy use for heating and electricity is more efficient. Energy savings on the final consumer side evolve, and "energy on demand" solutions via smart metering systems contribute to reduced electricity demand. Decentralized production of heat and electricity by the use of solar energy is common, and small fuel cells and small gas-fired power plants are used in combination with solar panels.

More people living in cities drive a strong shift in the development of public transport. Urbanization effectively limits the number of cars, due to limited parking opportunities and road capacity, and light vehicles that are easy to park become the new city standard.

Vehicles are electrified

By 2030 hybrid vehicles with both an electric and an efficient combustion engine dominate the markets for new vehicles, and contribute to lower total fossil fuel consumption. Battery costs for plug-in hybrids are lower than for electric cars, and plug-in hybrids can easily be recharged at home or when parked. The massive introduction of plug-in hybrids and electric cars result in a significantly higher share of electricity in the transport sector.

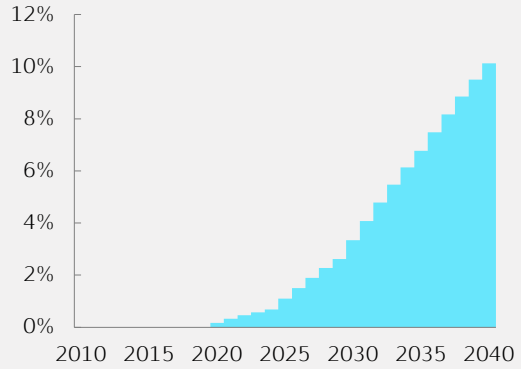
Fuel efficiencies of conventional cars also improve rapidly, as introduction of lightweight materials reduces the vehicle weight and engines are downsized.

Grids and storage allow for more intermittent renewable energy

Due to new stringent regulations, coal consumption for power generation is to a large extent phased out in the OECD regions and severely reduced in the rest of the world. Large scale and cost efficient energy storage and electricity transmission technologies, smarter grids and system integration allow for a significantly larger share of intermittent renewable electricity in the energy mix. Energy efficiency is improved and the need for back-up capacity is reduced. New renewable energy is being produced at significantly lower costs than today, with solar power seeing the greatest cost reduction. Investments in hydropower take place in countries with unexploited resources.

Grid capacities are significantly increased and grids are flexible enough to handle a substantially larger share of renewable energy and distributed power generation. Sub-optimization of national power transmission and power regulation belong to the past and is replaced by cross-border incentives and infrastructure.

Share of energy related CO_2 emissions captured and stored in the Low Carbon scenario

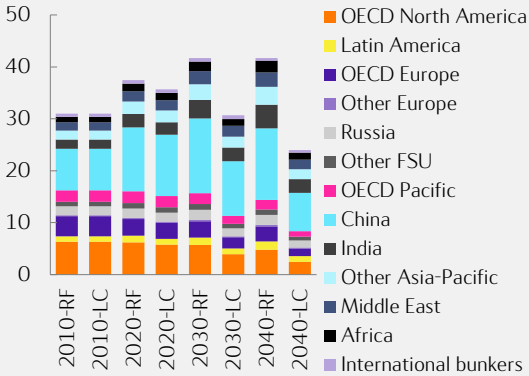


Source: Statoil (projections)

Energy efficiency, changes in fuel mix ...

World CO_2 emissions by region in the Reference and Low Carbon scenarios

Bn tons



Note: RF = Reference scenario, LC = Low Carbon scenario

Source: IEA (2010), Statoil (projections)

... and CCS drive reductions in energy related CO_2 emissions

Storage of energy will help overcome existing obstacles. Driven by technology development and investment subsidies, solutions for storage of energy will be available in the power sector. Energy produced from sun and wind are stored and used when it is calm and no sun.

Natural gas is another important enabler for renewables, with its flexibility to produce power when it is needed.

Nuclear growth

As better solutions for radioactive waste are found, nuclear energy comes to be seen as a realistic supplement to renewable energy. There will be a significant development of nuclear energy in China and India, but also other countries will increase their nuclear energy production.

Storage of CO_2

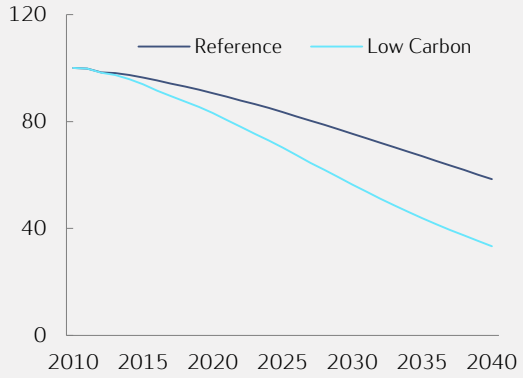
As climate policies get tougher and technology is matured, the necessary infrastructure is developed for CCS to become an integral part of power production, and high shares of remaining coal power plants in the OECD regions and select other regions are fitted with CCS. As CO_2 emission costs increase CO_2 storage is also becoming an increasingly important part of petroleum activities, both in connection with enhanced oil recovery and as a solution for CO_2 rich natural gas fields.

The Low Carbon scenario outcome

- The energy intensity of the world economy declines by an average of 2.6% per year between 2011 and 2040, against 1.5% per year in our Reference scenario. All regions go through structural changes making their economies less energy intensive and all are forced by circumstances to prioritize energy efficiency policies. The non-OECD world catches up with the OECD area in energy intensity terms only to a limited extent, since both areas experience rapid declines, but non-OECD energy intensity in 2040 is fairly close to the OECD intensity in 2011.
- World primary energy demand increases by a mere 4.6% between 2011 and 2040, against a total growth of 43% in the Reference scenario. The non-OECD regions' demand increases by almost one third, but this is almost compensated for by the reduced demand in the OECD regions. China's incremental energy demand over the 2011-40 period matches OECD North America's savings over this period pretty closely, and India's incremental demand matches OECD Europe's savings.
- The global fuel mix evolves in a greener and cleaner direction in the Low Carbon scenario than in the Reference scenario. The coal share of world primary energy consumption declines from 29.2% by 2011 to 19.4% by 2040. The oil share drops from 30.7% to 24.3%. All other energy carriers increase their shares of the only moderately growing total primary energy demand. In OECD Europe and OECD North America coal is marginalized as a power sector fuel and only makes up 3-4% of total primary energy demand by 2040.
- Global gas use by 2040 is 23% lower in the Low Carbon scenario than in our Reference scenario - there is coal-to-gas switching, but this effect pales next to the combined impact of energy efficiency improvements and growth in renewables. Global gas use still increases by 16% between 2011 and 2040.

World CO_2 emissions/GDP

Index, 2010=100

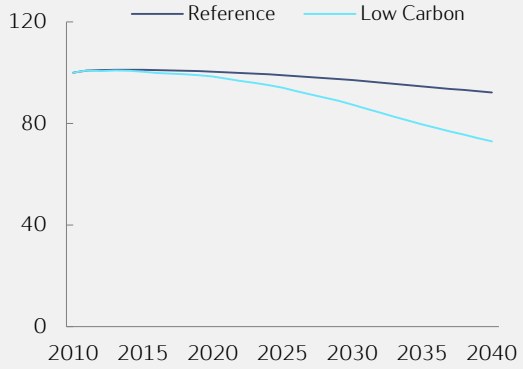


Source: IEA (2010-11), Statoil (projections)

Significant reductions in global CO_2 emissions from 2020 onwards

World CO_2 emissions/TPED

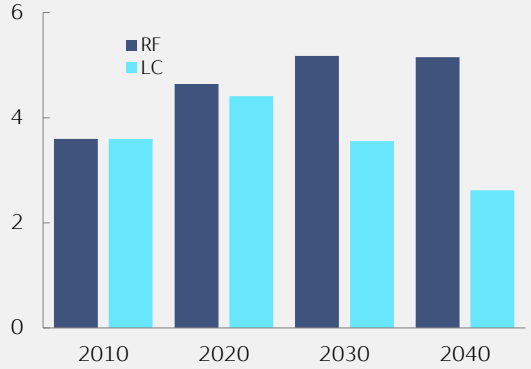
Index, 2010=100



Source: IEA (2010-11), Statoil (projections)

World coal demand in the Reference and Low Carbon scenarios

Bn toe



Source: IEA (2010), Statoil (projections)

- While wind, solar and geothermal energy and biomass and waste accounted for 4.5% of world electricity generation in 2011, and account for 18% by 2040 in our Reference scenario, their combined share is 24% by 2040 in the Low Carbon scenario. These totals mask big interregional differences. In the Low Carbon scenario new renewables provide 44% of OECD European electricity supply, 27% of OECD North American supply and 21% of Chinese supply by 2040.

In the Low Carbon scenario world CO_2 emissions peak at 35.7 billion tons in 2020 and fall to 30.7 billion tons by 2030 and 24.0 billion tons by 2040. At the end of the scenario period, emissions are 40% lower in the Low Carbon scenario than in the Reference scenario and 23% lower than they were in 2010. This is achieved with a combination of energy efficiency, coal phase-out and build-out of CCS facilities. By 2040 10% of all fossil fuel consumption related CO_2 emissions are captured and stored in the Low Carbon scenario, against 1.5% in the Reference scenario. In the OECD regions up to 50% of remaining coal power generation, and up to 30% of gas power generation, is fitted out with CCS. In China 30% of CO_2 emissions from coal power generation is captured and stored by the end of the forecast period.

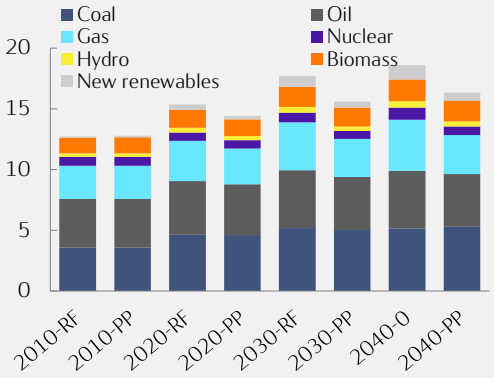
Comparatively low CO_2 emission levels could have been reached through many different sets of assumptions on energy efficiency, fuel switching, the phasing in of renewables and CCS. Moreover, completely different sets of assumptions about the future can be constructed, note for example our Policy Paralysis scenario below.

Our forecast period ends in 2040. It is not clear if this trajectory would be sufficient to contain global warming at 2 degrees over the course of the century. Still, the assumptions underlying our Low Carbon scenario go significantly beyond what we have seen in the past. As noted, the energy intensity of the world economy has declined by less than 1% per year since 1990. In the Low Carbon scenario we assume a 2.6% yearly decline rate between 2011 and 2040. Also as noted, CCS has progressed at a disappointingly slow pace in recent years. Only a small fraction of the number of pilot projects set for development some years ago are being implemented. In the Low Carbon scenario we nevertheless assume CCS to begin its take off already in the 2020s. Such step changes would require a number of very ambitious policies and regulations.

We realize that assumptions can be challenged – and they should be, because the purpose with this exercise is not to be categorical on how the energy markets *will* develop towards a low carbon world, but to show how they possibly *could* develop. It illustrates the uncertainties, opportunities, and a possible future context for long-term oriented companies and policy makers. Hopefully it can also generate debate and create more clarity on what decisions may be needed to reach a more sustainable energy system.

World TPED by fuel in the Reference and Policy Paralysis scenarios

Bn toe



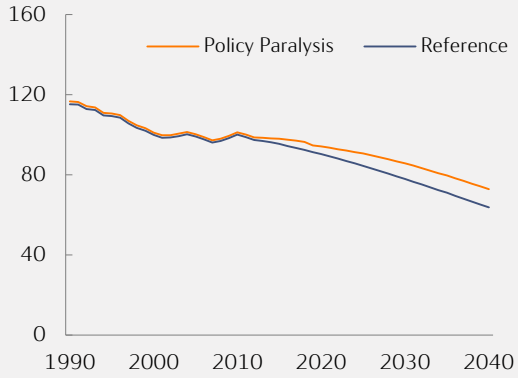
Note: RF = Reference scenario, LC = Low Carbon scenario

Source: IEA (2010), Statoil (projections)

Conflicts, rivalry, protectionism ...

World energy intensity developments

Index, 2010=100



Source: IEA (history), Statoil (projections)

... lead to lower growth, lower energy demand and less climate policy

The Policy Paralysis scenario – another possible future

In this section we explore the impacts of a more sombre geopolitical scenario on energy markets, global trade and carbon emissions. This scenario is characterised by more competition, conflict and nationalism. This leads to lower growth and a lack of ability to forge political solutions to common transnational threats. This future is named Policy Paralysis.

Geopolitical rivalry and conflict in a multipolar world

In the current international system we see not only examples of cooperation. There are also signs of rivalry, distrust and views of a zero-sum game, where any gain is perceived to be realizable only at the expense of others. Such negative trends may be reinforced in a scenario where geopolitics trumps collaboration in a quest for power and wealth.

A zero-sum game

In this scenario the perception of the US as less willing to lead, or to police the world's trouble spots, be that a result of military operational fatigue or more energy independence, actually manifests itself, temporarily or for a longer period. This leaves a leadership vacuum on the global stage which other major powers competes to fill, with higher levels of rivalry as a result. The growing assertiveness of rising powers is not only a reaction against a world order dominated by the West. It also reflects the vulnerabilities and insecurities of countries that have yet to overcome the looming middle-income trap. In a scenario where world powers look at prosperity and influence as a zero-sum game, the rivalry evolves instead into protectionism and conflicts, where nationalism trumps globalization. This new order would be less stable and more conflictive amid greater concerns globally about the unrivalled rise of emerging powers such as China in the wake of US retrenchment.

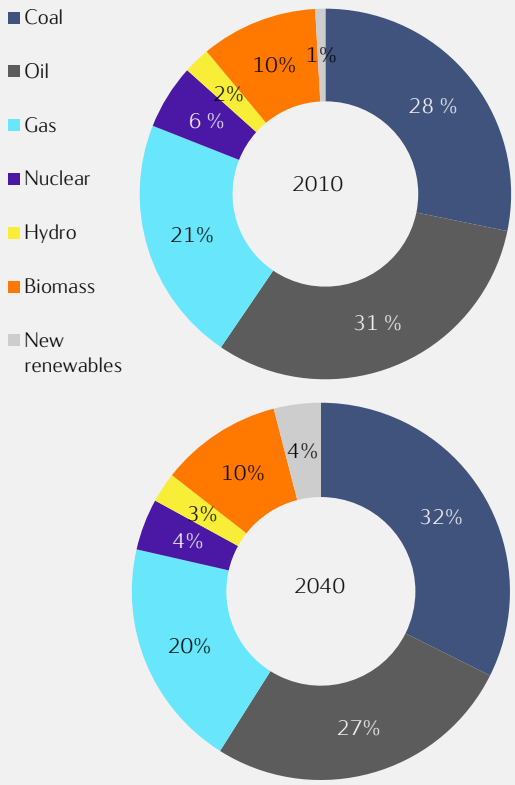
Nationalism and competition take the best of globalization in Asia

In this more conflict oriented scenario, the momentum towards regional economic integration is overshadowed by the latent climate of mistrust that persists across the region, rooted in historical grievances, growing nationalism and greater competition by Asia's major powers. The maritime territorial disputes in the East and South China Seas, the tension on the Korean peninsula, and disputed land border between China and India are possible venues for these tensions to manifest. In this context, the region becomes more security-oriented and less inclusive. In doing so, frictions between major powers that have so far been confined to the political domain, spill over into the economic domain as a result of increasing defence spending and more protectionist economic policies. Greater risks to maritime security in turn increase the cost of trade and undermine regional growth with a lasting impact on Asia's energy mix and demand.

Supply risks magnify as political instability increases

Just as demand patterns in Asia are shifting, supply risks from the Middle East magnify as the region undergoes increased political instability. A failure to agree a nuclear deal invites significantly greater sanctions on the Islamic Republic of Iran with concomitant repercussions for regional stability, for Iraq, Syria, Lebanon, the Gulf states, not to mention for North Africa. Also in this region we see more conflict. Principally among these is the rivalry between Saudi Arabia and Iran, which triggers a prolonged region-wide sectarian conflict.

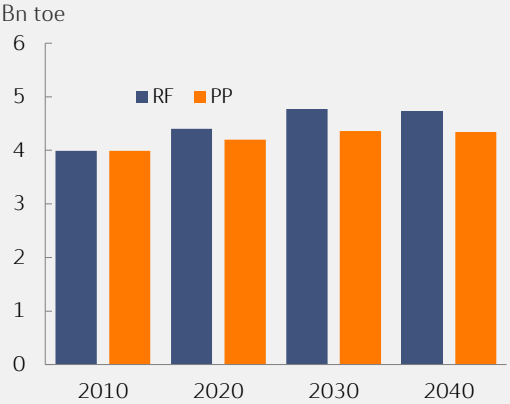
Global fuel mix in Policy Paralysis scenario



Source: IEA (history), Statoil (projections)

Domestic sources of energy are favoured

World oil demand in the Reference and Policy Paralysis scenarios



Source: IEA (2010), Statoil (projections)

No willingness to implement CCS or other technologies with significant development costs

An emboldened Iran counterbalances this through its own proxies and direct alliances across the region. In a zero-sum game where conflict actually manifests itself, supply disruptions in the straits of Hormuz or the Suez canal add to the cost of energy and impede energy flows to Asia and elsewhere. This causes a severe global economic crisis.

Russia is still an oil and gas behemoth with all the geopolitical and economic benefits that such a status carries. Increased tensions with Europe and the West over Ukraine forces demand pattern changes as Europe seeks to reduce its dependency on Russian gas, and Russia, by extension, gets pulled further into the Eastern energy orbit to help satiate demand in Asia. However, a reordering of the international system on account of direct Russian action is likely to have as much impact on Russia itself as on its European neighbours, leaving the country vulnerable to oil and gas prices and on fluctuations in foreign direct investments.

As tactical considerations puts strategy in the corner, miscalculation and improvisation lead the world into a period of increased conflict, power politics and economic disengagement affecting global economic growth negatively.

Power politics hinder progress on transnational issues

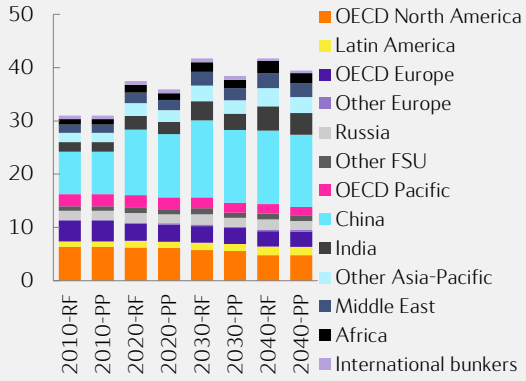
In this environment protectionism crowds out cross-border trade. Priority of security of supply favours domestic sources of energy. Distrust and less cooperation on transnational issues reduce ability to agree on global climate change policies. The impact of lower economic growth shifts focus away from climate challenges to domestic concerns. Less attention to the world's forgotten conflict zones breeds ungoverned space for malicious and non-state actors. Power politics hinder progress on key transnational issues and regional rivalries, spanning from regional conflicts and crises to global health challenges, terrorism and climate. The inaction towards the latter acts as a multiplier for more instability in the world, only deteriorating the situation and conflict level further.

Impact on economic growth and energy markets

Global economic growth is considerably reduced in this scenario compared to our Reference scenario, with the largest difference over the medium term. Furthermore, we assume climate regulations and different forms of allowance markets will be limited to the existing policies and regions, and with no expansion. There is still interest in energy efficiency since cutting down on energy use is advisable for energy self-sufficiency and security reasons as well as for environmental reasons. However, impediments to the cross-border exchange of technology make policies less effective and progress slower. There is no real willingness to implement CCS or other technologies that demand significant development costs. Fuel price subsidies will be dismantled at a much slower pace. The energy mix is coloured by security of supply concerns. Hence the coal shares of regional energy demand generally do not fall as in the Low Carbon scenario or in the Reference scenario, since coal as a mainly domestic and comparatively cheap fuel benefits in a situation with

World CO_2 emissions by region in the Reference and Policy Paralysis scenarios

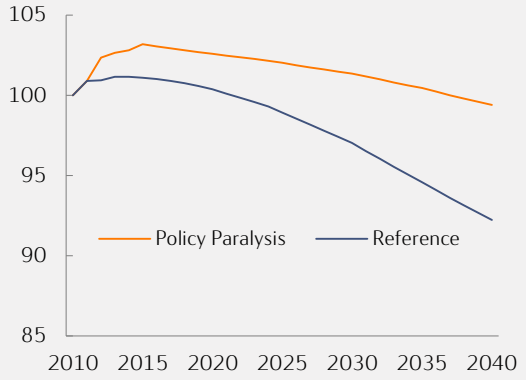
Tn tons



Source: IEA (2010), Statoil (projections)

CO_2 emissions/TPED

Index, 2010=100

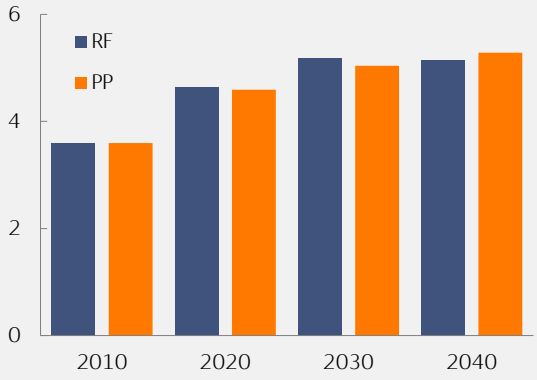


Source: IEA (2010-11), Statoil (projections)

Global fuel mix evolves in a less green direction

World coal demand in the Reference and Policy Paralysis scenarios

Bn toe



Source: IEA (2010), Statoil (projections)

declines in international energy trade, economic challenges and distractions from the fight against global warming.

The oil shares decline slightly due to oil's characteristics as an international commodity, and also because of weaker economic growth. The gas shares decline in regions with net imports (e.g. OECD Europe), mainly due to increasing supply security concerns, but increase in net export regions (e.g. OECD North America, Russia and the Middle East). The nuclear shares generally hold steady – energy supply security concerns underpin interest in electricity not based on fuels that have to be imported and could be held back for political reasons, but economic problems dampen countries' ability to prioritize this costly option. The new renewables shares are subject to the same conflicting forces – there is continued interest, but less money to spare in the Policy Paralysis scenario for subsidization and costly technology development, and certainly no appetite for importing for example North African solar power into Europe. Hence the new renewables shares continue to grow, but slower than in the Reference scenario and much slower than in the Low Carbon scenario. Carbon emissions are also affected by two drivers with opposite sign – lower economic growth pushes energy demand and emissions down, but higher energy intensities and an energy mix based more on coal and other fossil fuels push emissions up again.

The Policy Paralysis scenario outcome

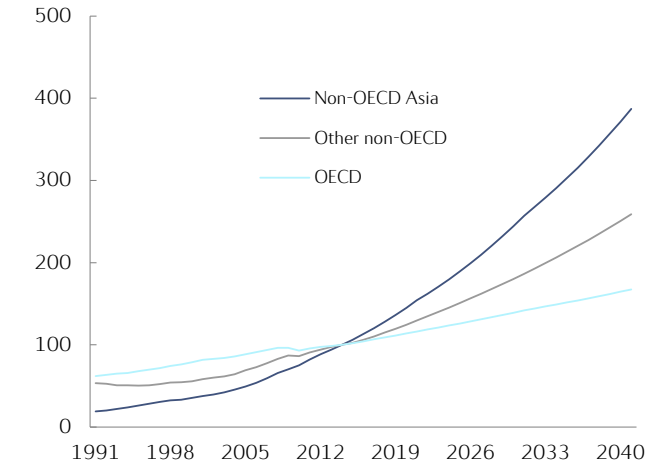
- The energy intensity of the world economy decline by an average of only 1.1% per year between 2011 and 2040, against 1.5% per year in the Reference scenario.
- World primary energy demand increases by 26% between 2011 and 2040, or by an annual average of 0.8%, in this scenario against a total growth of 43% and an annual average growth of 1.3% in the Reference scenario.
- The global fuel mix evolves in a less green direction in the Political Paralysis scenario than in the Reference scenario. The coal share of world primary energy consumption increases from 29.2% by 2011 to 32.8% by 2040. The oil share drops from 30.7% to 26.4%.
- Global gas use increases by 14% between 2011 and 2040, or by an average of less than 0.5% per year. The gas share of global primary energy production declines slightly from 21.5% to 19.5%. But there are big regional differences. In OECD North America the gas share of TPED goes up from 26.8% to 35.0% as resource endowments and energy self-sufficiency considerations combine to push gas further into the power sector and industry on a massive scale. In import dependent OECD Europe the gas share drops from 24.4% to 20.8%. In China it increases by almost 80% in absolute terms and from 4.0% to 6.9% as a share of TPED, but that is significantly below Chinese targets.
- While wind, solar and geothermal energy and biomass and waste accounted for 4.5% of world electricity generation in 2011, and account for 18% by 2040 in our Reference scenario, their combined share is less than 4% by 2040 in the Political Paralysis scenario.
- World CO_2 emissions increase to 39.5 billion tons in 2040 which is slightly below the level in our Reference scenario – though much higher in emissions per unit of GDP terms – and 24% higher than they were in 2011. We expect no CCS build-out in this scenario.

Chart appendix

Economic growth

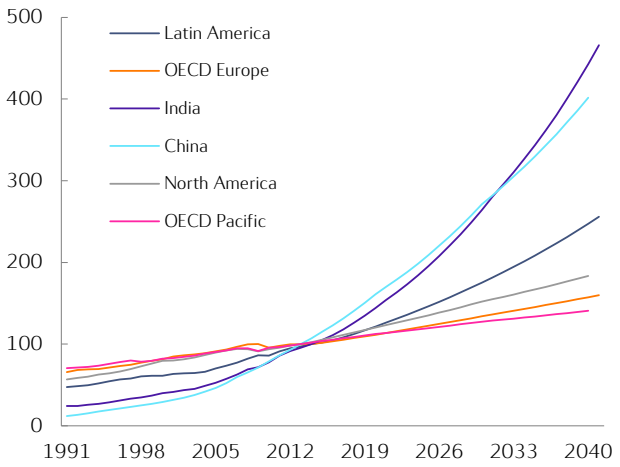
World GDP levels 1991-2040

Real, index, 2013 = 100



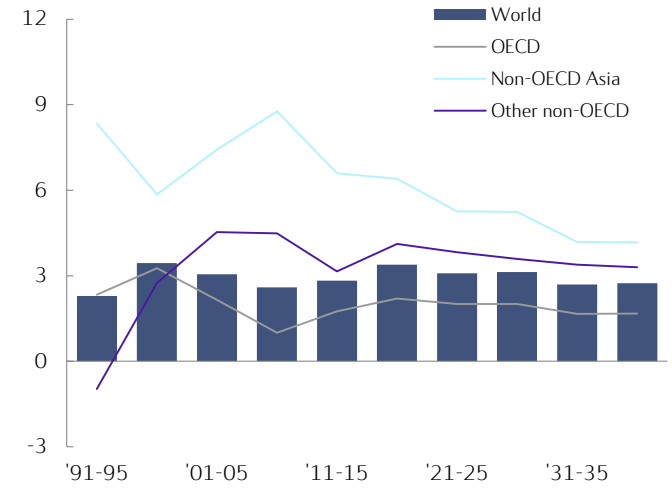
World GDP levels 1991-2040

Real, index, 2013 = 100



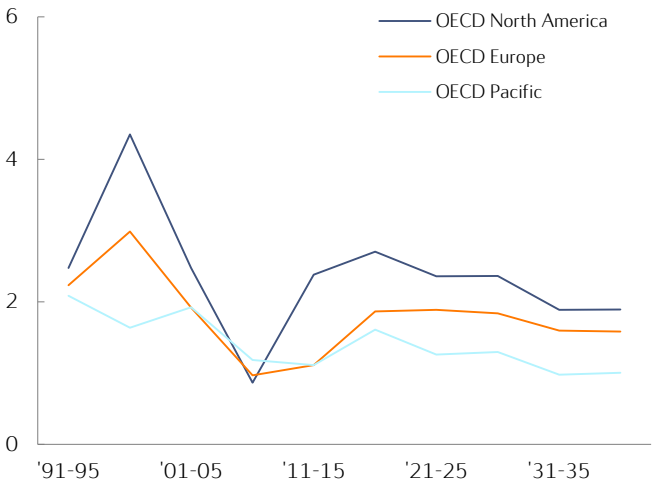
World GDP 1991-2040

5-year annual growth rate (CAGR), %



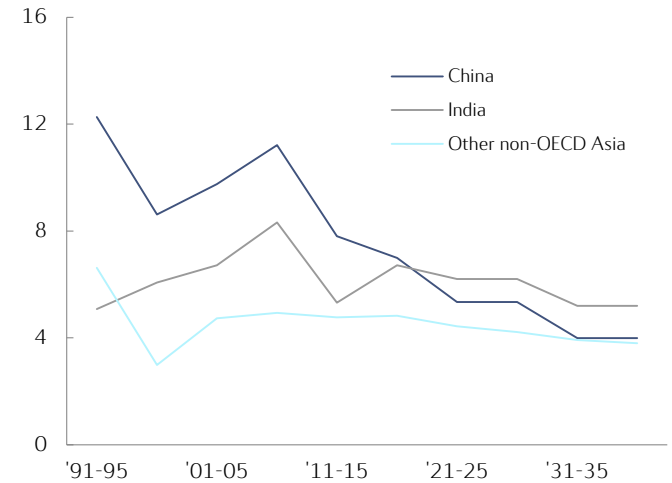
OECD GDP 1991-2040

5-year annual growth rate (CAGR), %



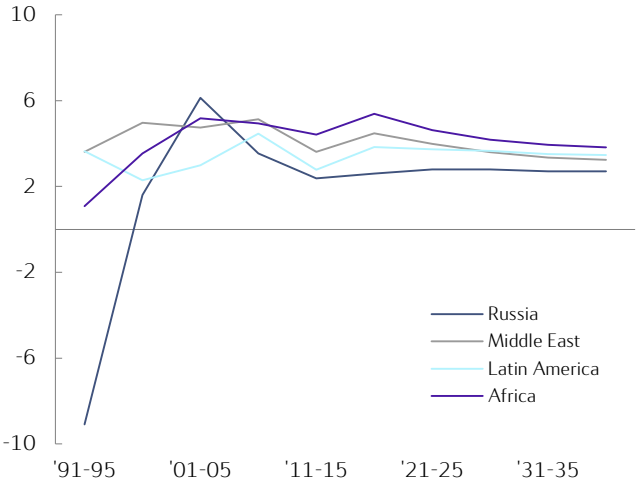
Non-OECD GDP 1991-2040

5-year annual growth rate (CAGR), %



Other countries/regions GDP 1991-2040

5-year annual growth rate (CAGR), %

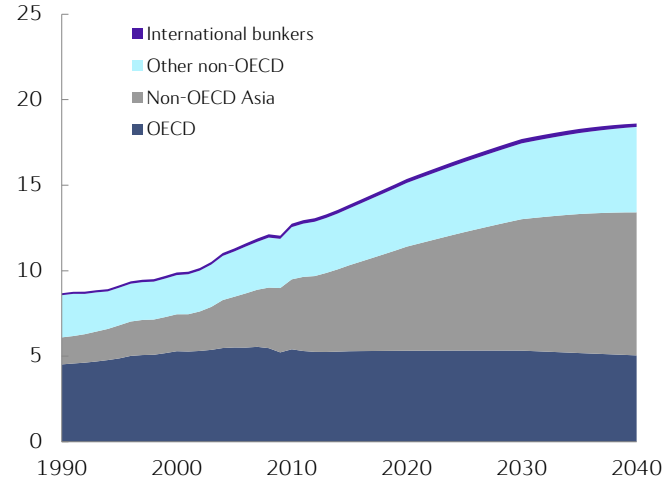


Source: IHS Global Insight (history), Statoil (projections)

Global and regional energy demand

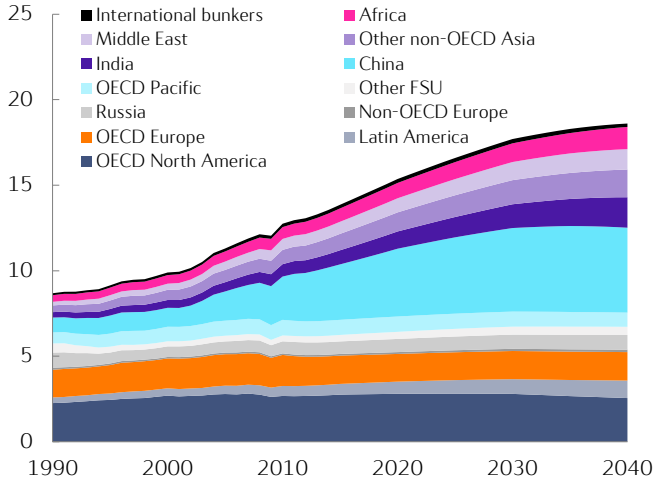
World energy demand 1990-2040

TPED, bn toe



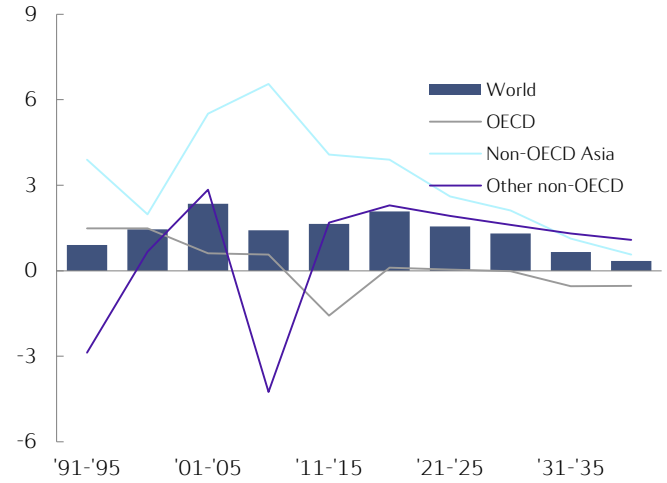
World energy demand 1990-2040

TPED, bn toe



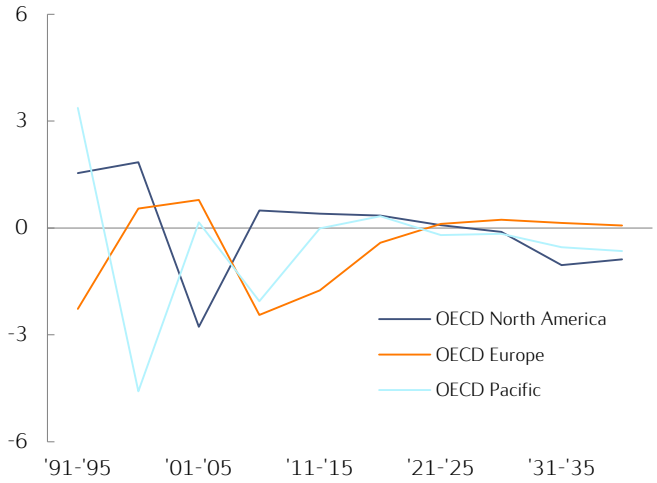
World energy demand 1991-2040

5-year annual growth rate (CAGR), %



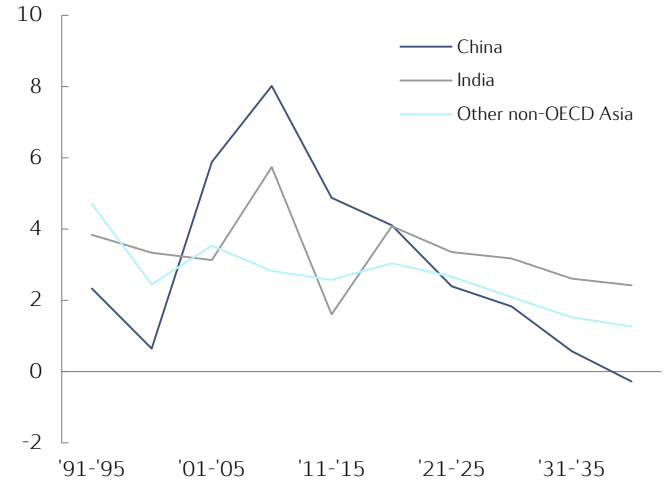
OECD energy demand 1991-2040

5-year annual growth rate (CAGR), %



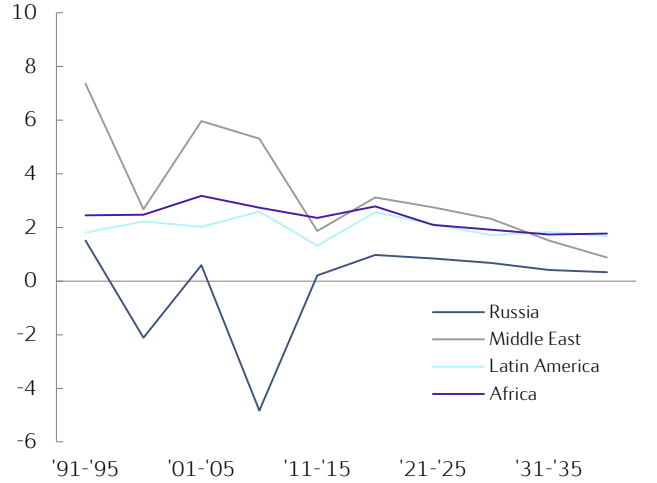
Non-OECD Asia energy demand 1991-2040

5-year annual growth rate (CAGR), %



Other countries/regions energy demand 1991-2040

5-year annual growth rate (CAGR), %

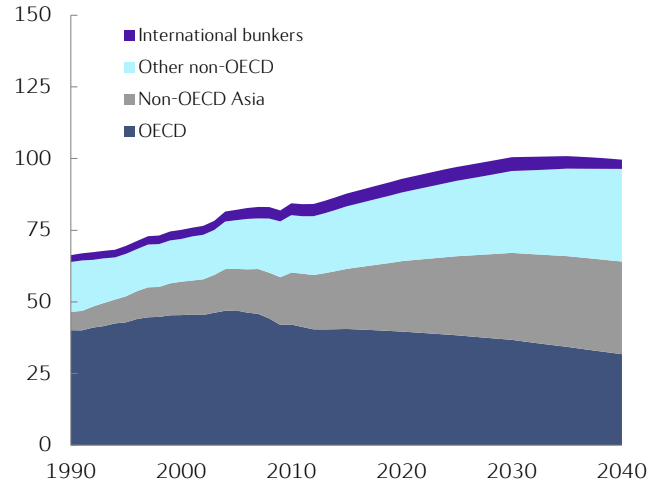


Source: IEA (history), Statoil (projections)

Global and regional oil demand (excl. bio-fuels)

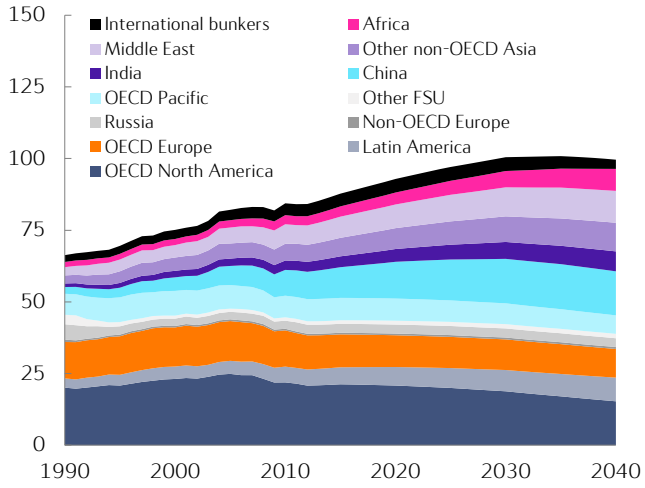
World oil demand 1990-2040

Million barrels per day



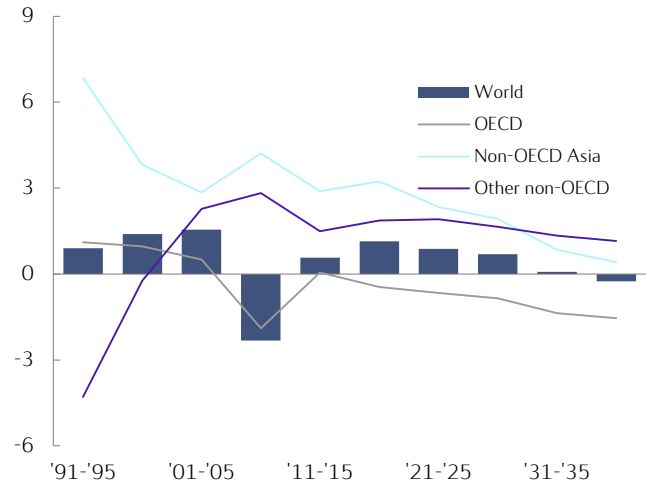
World oil demand 1990-2040

Million barrels per day



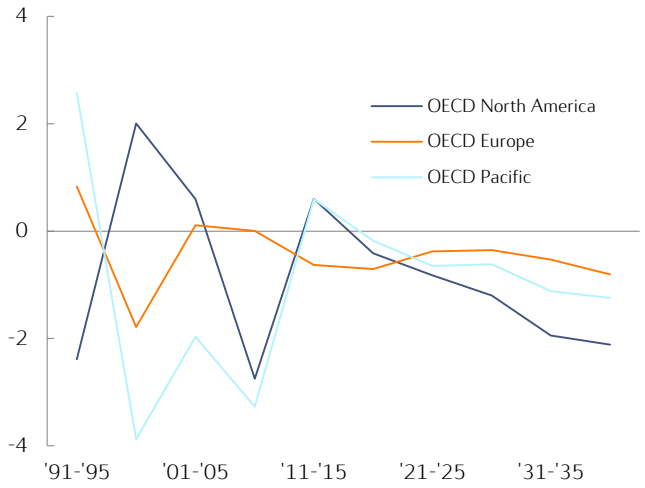
World oil demand 1991-2040

5-year annual growth rate (CAGR), %



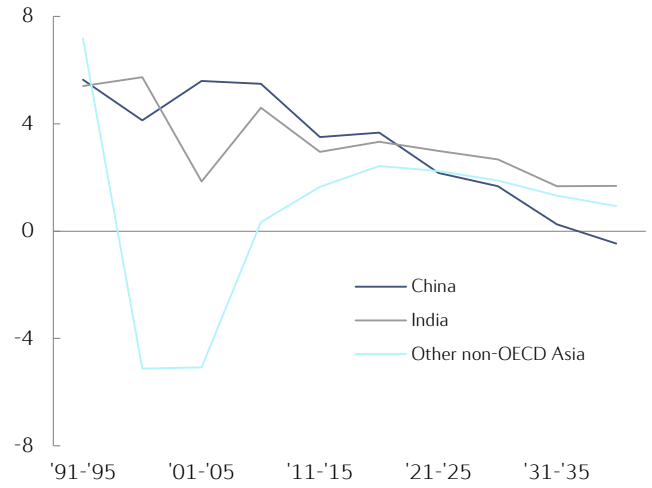
OECD oil demand 1991-2040

5-year annual growth average (CAGR), %



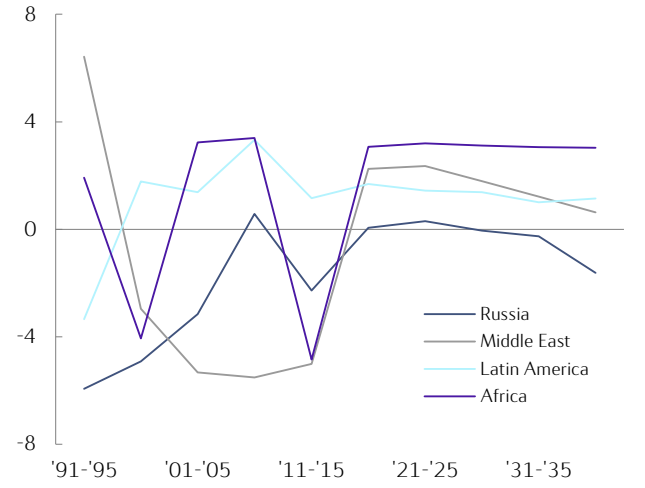
Non-OECD Asia oil demand 1991-2040

5-year annual growth average (CAGR), %



Other countries/regions oil demand 1991-2040

5-year annual growth average (CAGR), %

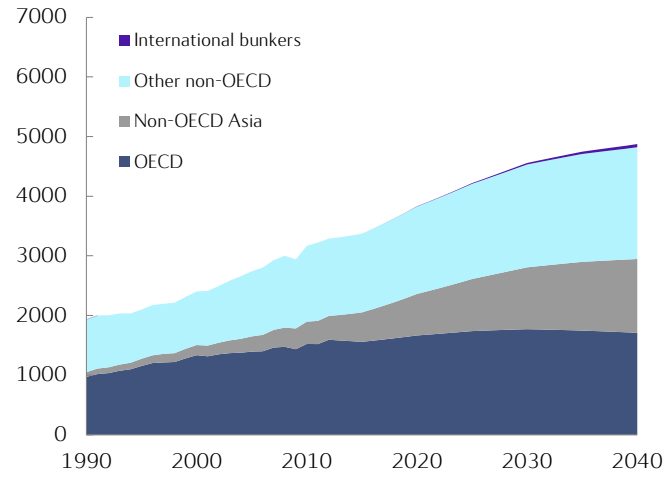


Source: IEA (history), Statoil (projections)

Global and regional gas demand

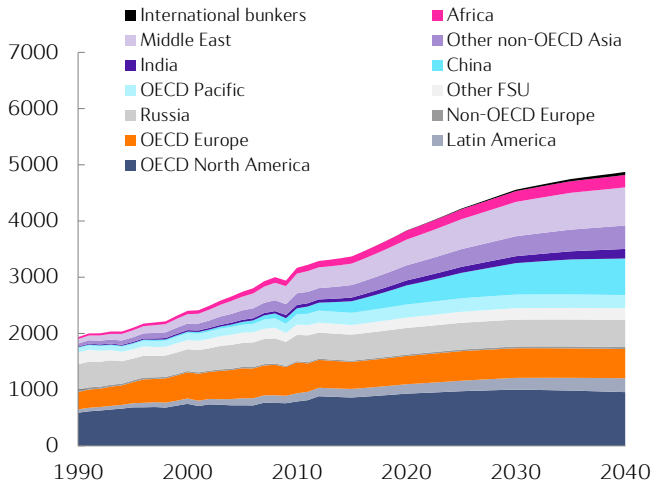
World gas demand 1990-2040

Bcm



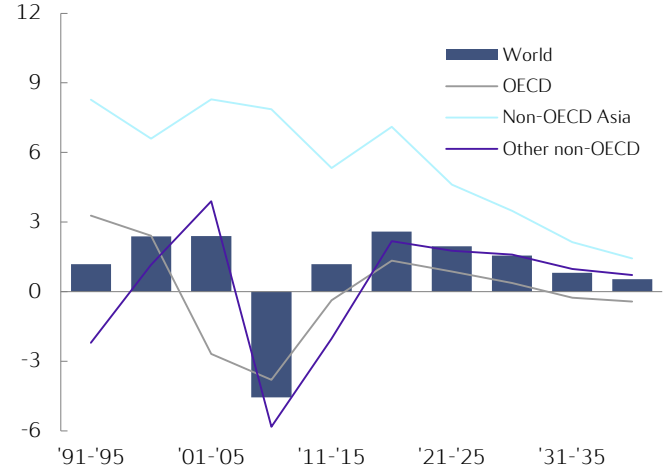
World gas demand 1990-2040

Bcm



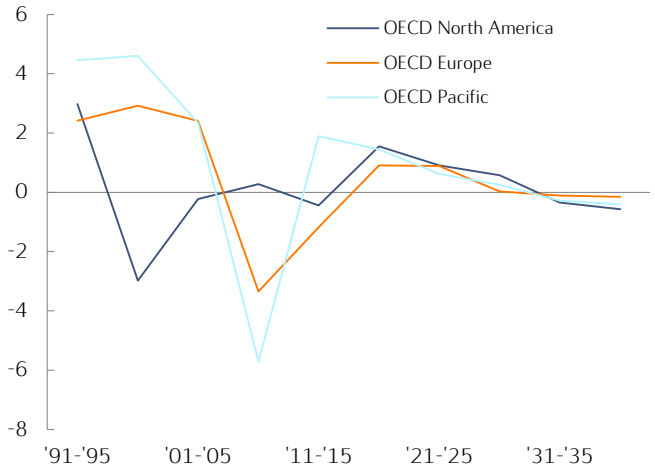
World gas demand 1991-2040

5-year annual growth average (CAGR), %



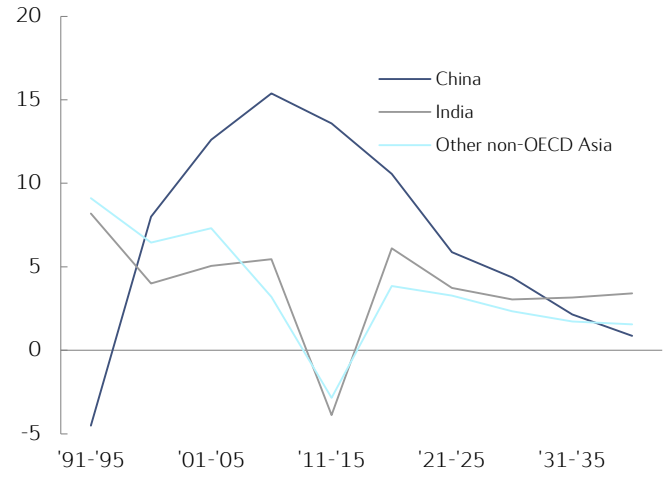
OECD gas demand 1991-2040

5-year annual growth average (CAGR), %



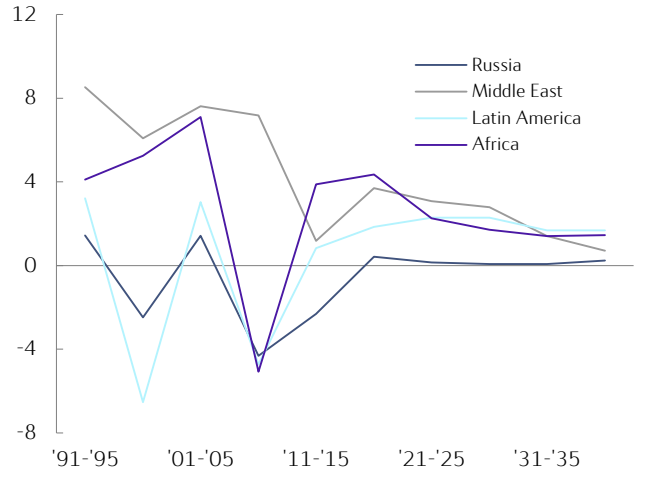
Non-OECD Asia gas demand 1991-2040

5-year annual growth average (CAGR), %



Other countries/regions gas demand 1991-2040

5-year annual growth average (CAGR), %

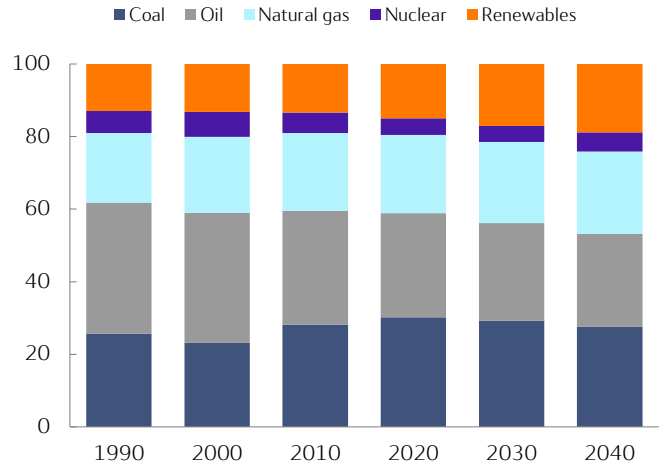


Source: IEA (history), Statoil (projections)

Global and regional energy mix

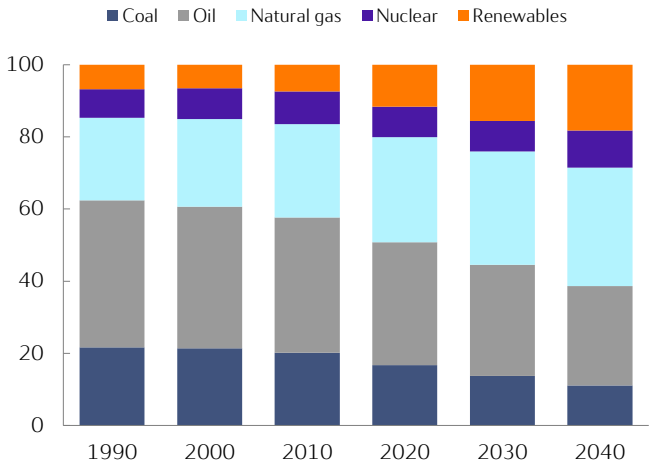
World energy mix

Share of total energy demand (TPED), %



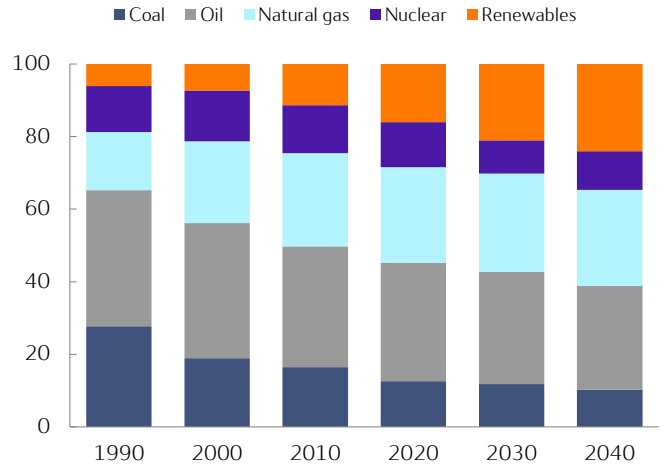
OECD North America: Energy mix

Share of total energy demand (TPED), %



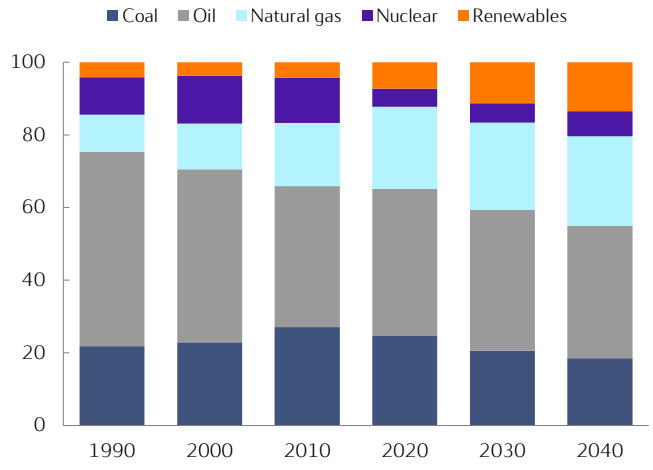
OECD Europe: Energy mix

Share of total energy demand (TPED), %



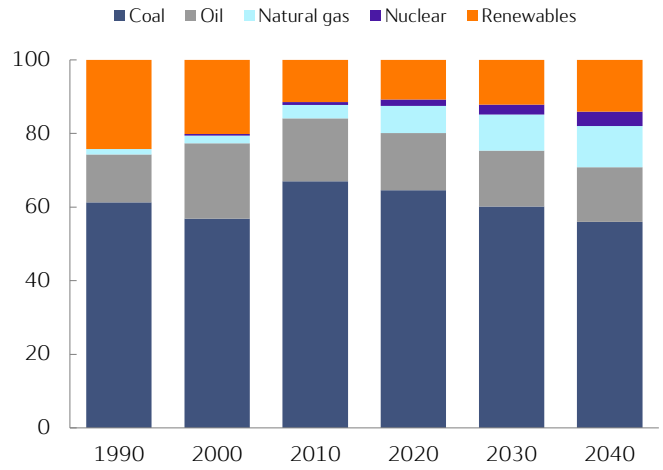
OECD Pacific: Energy mix

Share of total energy demand (TPED), %



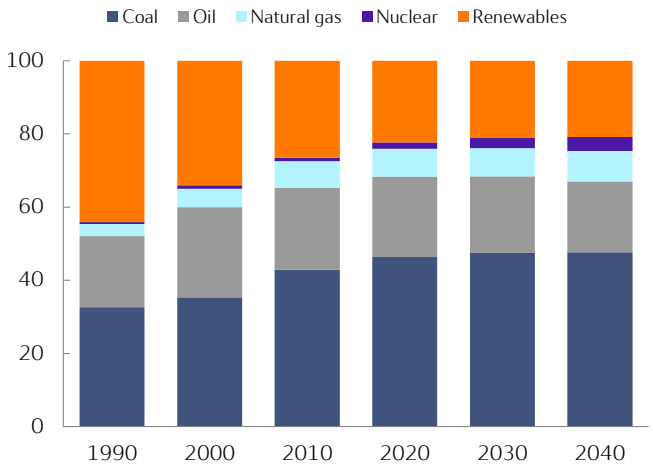
China: Energy mix

Share of total energy demand (TPED), %



India: Energy mix

Share of total energy demand (TPED), %

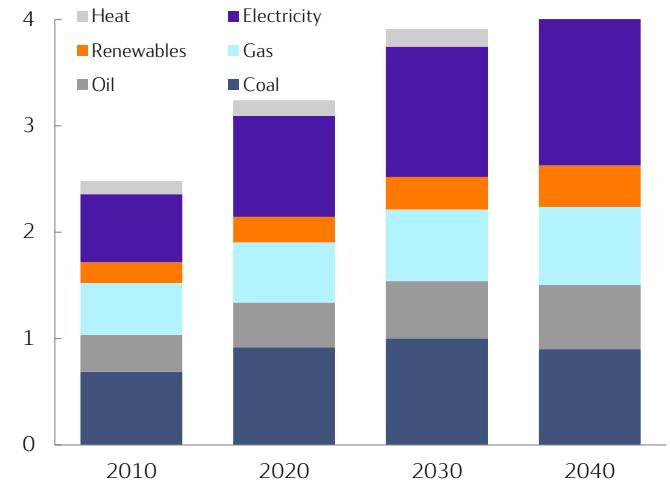


Source: IEA (history), Statoil (projections)

Sectorial energy mix

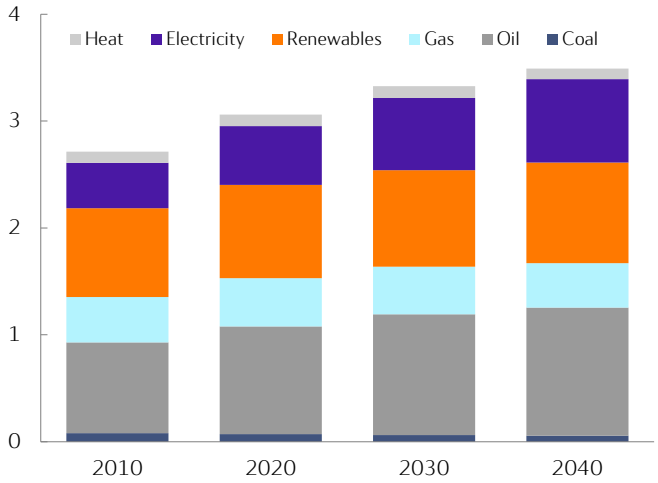
Industry

Bn toe



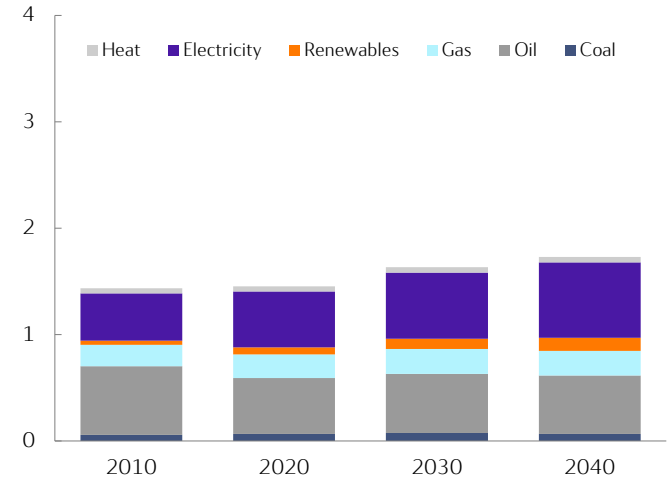
Residential

Bn toe



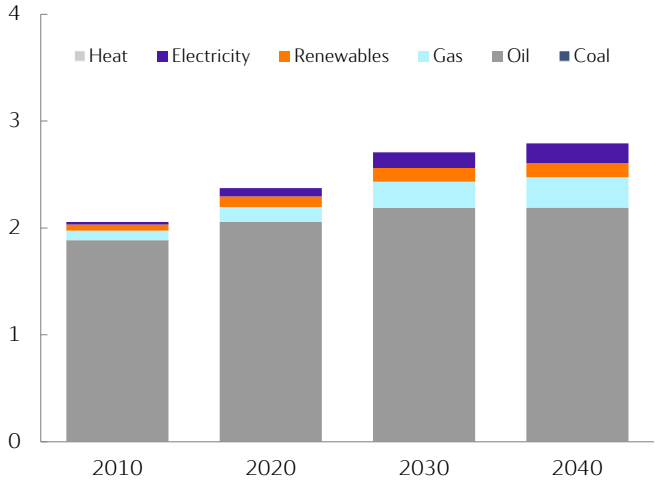
Other stationary

Bn toe



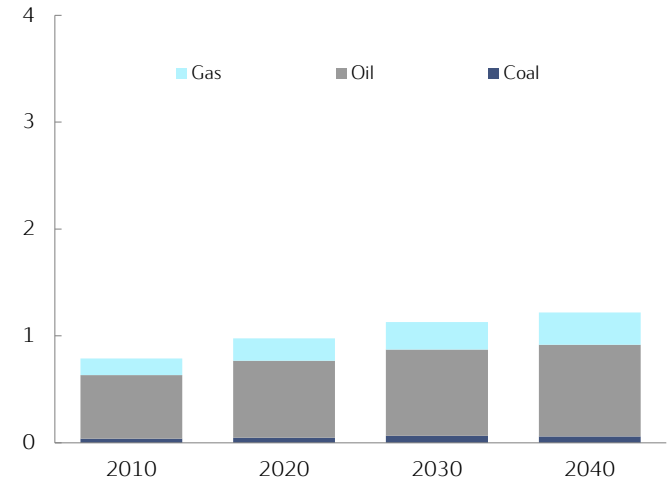
Transport

Bn toe



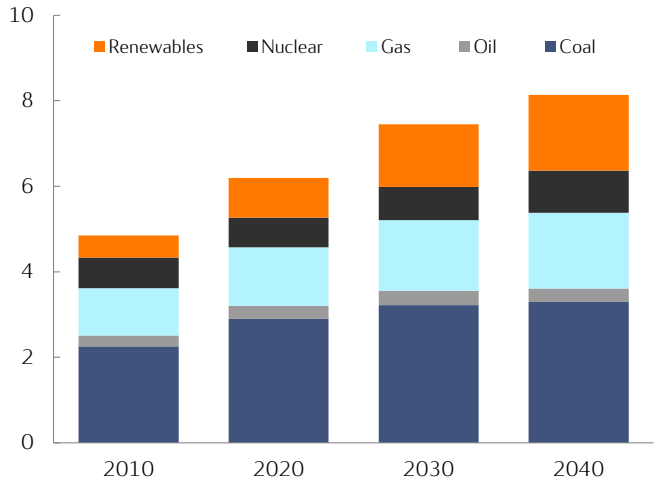
Non-energy

Bn toe



Power

Bn toe

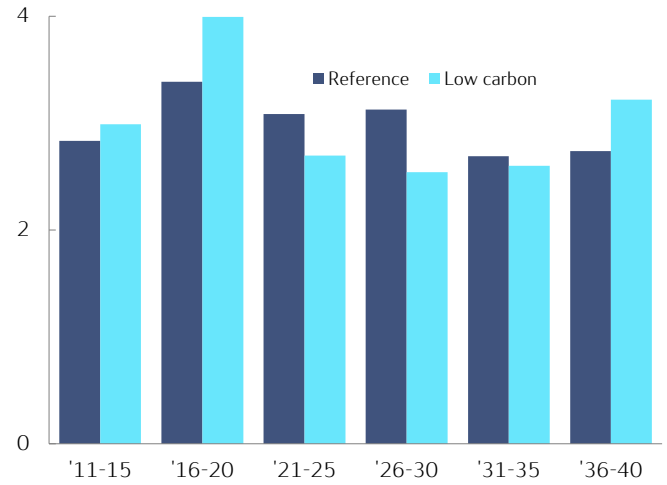


Source: IEA (history), Statoil (projections)

Low Carbon scenario

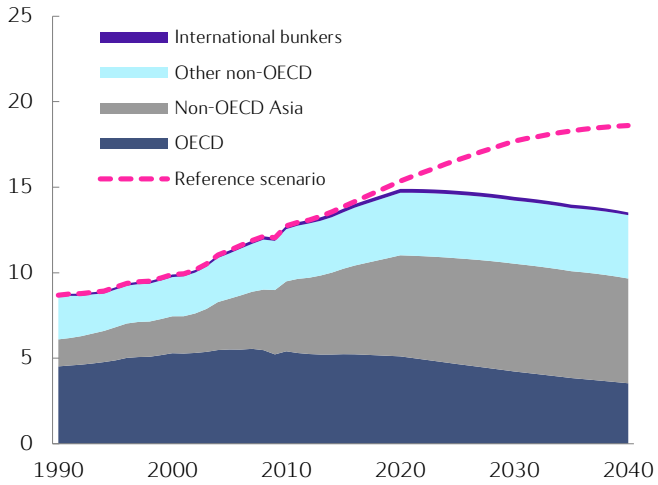
World GDP growth rates

5-year annual growth average, %



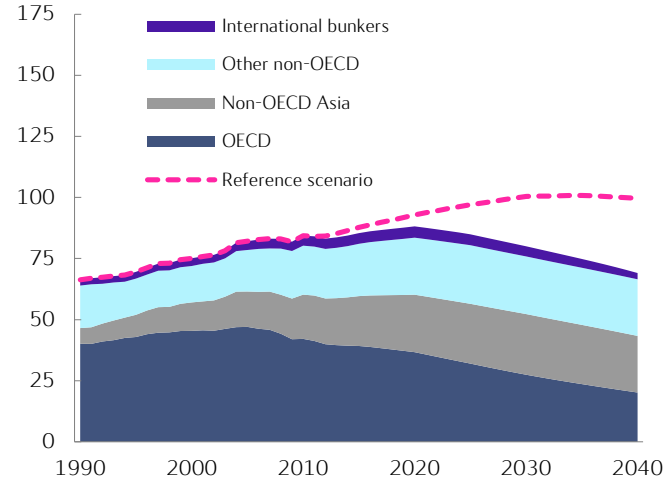
World energy demand 1990-2040

TPED, bn toe



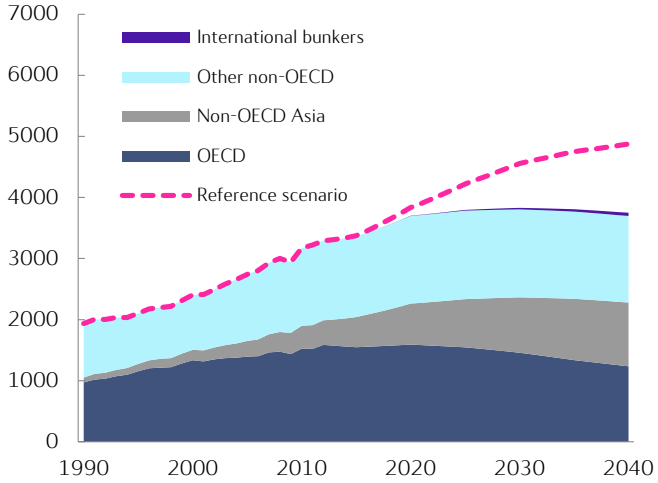
World oil demand 1990-2040

Million barrels per day



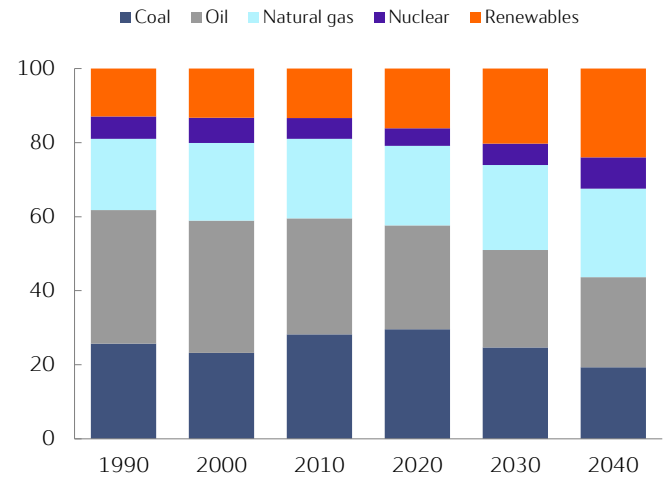
World gas demand 1990-2040

Bcm



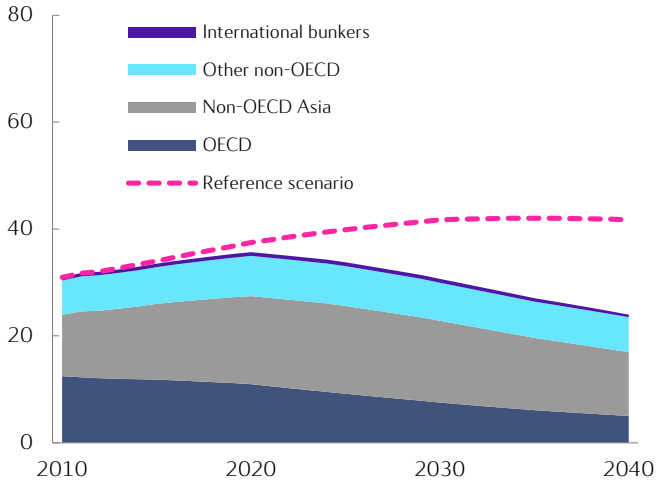
World energy mix

Share of TPED, %



CO_2 emissions

Bn t

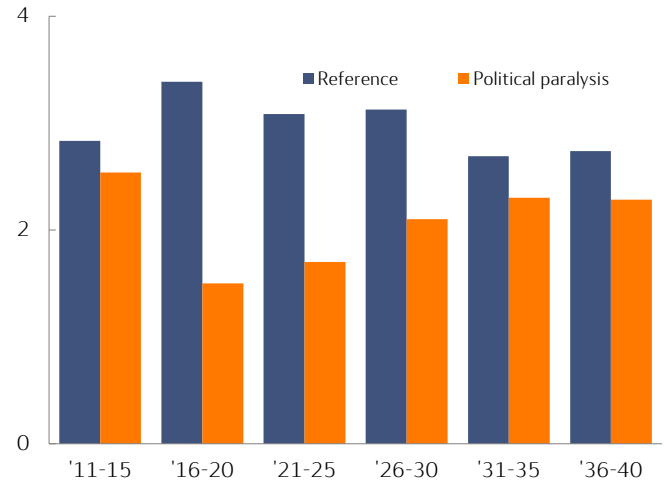


Source: IEA (history), Statoil (projections)

Political Paralysis scenario

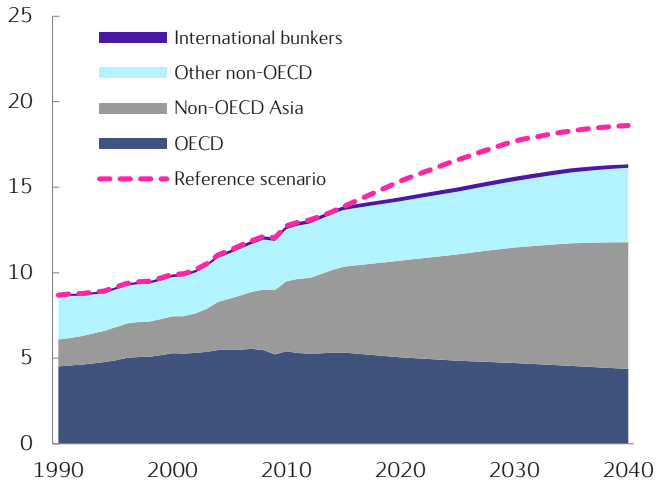
World GDP growth rates

5-year annual growth average, %



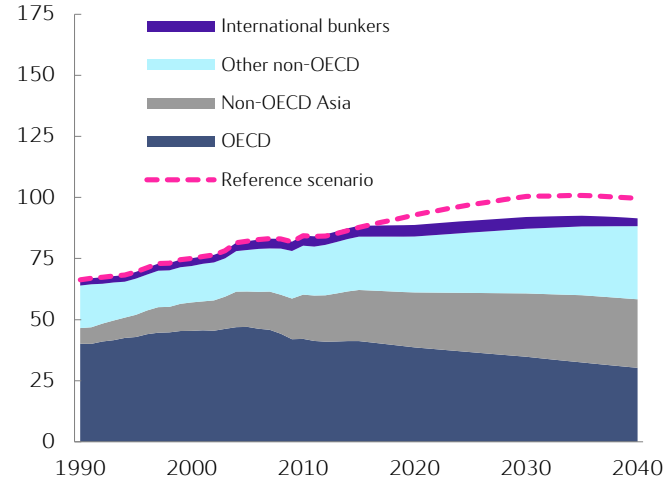
World energy demand 1990-2040

TPED, bn toe



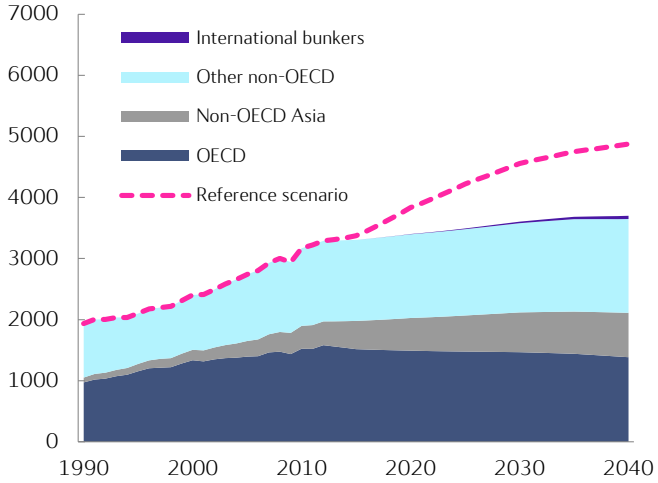
World oil demand 1990-2040

Million barrels per day



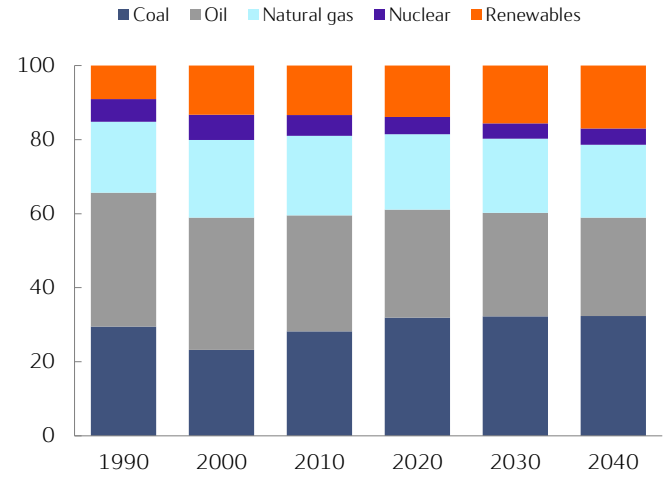
World gas demand 1990-2040

Bcm



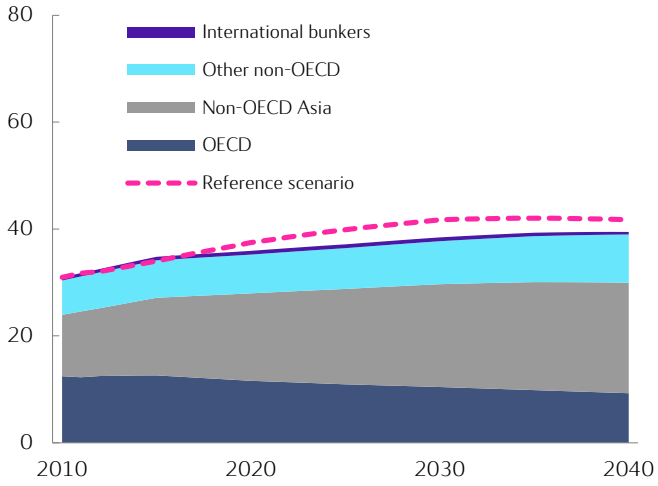
World energy mix

Share of TPED, %



CO_2 emissions

Bn t



Source: IEA (history), Statoil (projections)

Energy Perspectives 2014

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