

Energy Perspectives

Long-term macro and market outlook
June 2012



Statoil

Editorial process concluded 5 June 2012.

This report has been edited and coordinated by CFO Macroeconomics and Market Analysis in Statoil, based on input from different parts of the Statoil organisation.

Disclaimer: This report is prepared by a variety of Statoil analyst persons, with the purpose of presenting matters for discussion and analysis, not conclusions or decisions. Findings, views, and conclusions represent first and foremost the views of the analyst persons contributing to this report and cannot be assumed to reflect the official position of policies of Statoil. Furthermore, this report contains certain statements that involve significant risks and uncertainties, especially as such statements often relate to future events and circumstances beyond the control of the analyst persons and Statoil. This report contains a number of forward-looking statements that involve risks and uncertainties. In some cases, we use words such as "ambition", "believe", "continue", "could", "estimate", "expect", "intend", "likely", "may", "objective", "outlook", "plan", "propose", "should", "will" and similar expressions to identify forward-looking statements. These forward-looking statements reflect current views with respect to future events and are, by their nature, subject to significant risks and uncertainties because they relate to events and depend on circumstances that will occur in the future. There are a number of factors that could cause actual results and developments to differ materially from those expressed or implied by these forward-looking statements.

Hence, neither the analyst persons nor Statoil assume any responsibility for statements given in this report.

Energy Perspectives 2012

Crises come and go, usually as a surprise, sometimes as a consequence of previous developments. When many thought the financial crisis was history, the sovereign debt crisis in Europe hit with full force. The Arab spring was another surprise. The final outcome of these events is not yet clear. Still, they serve as a reminder that long-term development cannot be expected to follow a smooth line based on historical trends. Significant ups and downs, progresses and setbacks, must be expected. However, long-term projections are necessary and valuable for the global energy business. This outlook provides a 30-year global perspective on macroeconomics and energy markets, based on analysis of likely developments in key driving forces.

The long-term sustainability triangle of economic, energy, and environmental policies can be questioned. Economic policies are currently struggling to deliver strong, sustainable and balanced growth, e.g. in Europe. Energy policies should aim at diversity and stability in energy supply to meet demand. In some areas, developments over the last year bode well for the success of energy policies, as prospects for future gas production and cost competitive solar energy have improved. On the other hand, supply disruptions continue to mar global oil markets. The biggest sustainability challenge is probably environmental policies, which should seek to balance the world's need for energy against the need for protection against global warming and local pollution. Recent developments have not increased the optimism for politicians' ability to deliver long-term environmental sustainability.

This outlook projects annual growth in the world economy to average 2.8% to 2040, roughly in line with the average growth over the last 30 years. Emerging economies will continue to lead the way, with China and India expected to grow at 2.5-3 times the speed of the OECD countries. This outlook is based on a careful scrutiny of historical and current trends, as well as a detailed evaluation of important factors affecting long-term growth. Still, the actual forecast of economic growth is characterised by inherent uncertainty.

Economic growth depends on energy, and economic progress will continue to drive energy demand. The relationship between growth and energy is affected by changing industrial structure, technological progress, market dynamics and prices, as well as energy and climate policies. Continued progress is foreseen for energy efficiency, so that growth in energy demand gradually will slow over the coming decades, with an annual average of 1.1% from today to 2040. Demand will increase for all types of energy, but with individual growth rates ranging from 0.4% (coal and oil) to 7.4% (solar, wind and geothermal) per year.

Oil demand growth will most likely be damped by environmental policies, relatively high prices, and technological change and energy efficiency in the transport sector. Increased demand for private transport in the emerging economies pulls in the other direction. Overall, global oil demand is expected to peak around 2030. Key uncertainty relates to future oil supply, with positive surprises in US tight oil and the comeback of Libya as important signposts the last year, but also with potential supply disruptions and uncertain long-term recovery factors affecting the outlook.

Natural gas is still seen as a fuel of the future. Positive drivers include significant new available supply at moderate costs and environmental policies. Markets will continue to be regionally differentiated, but with increasing integration due to LNG in particular. Annual global gas demand is projected to add 60% by 2040, growing by 1.6% per year. Thus, natural gas is expected to increase its share of global energy demand from 21.3 to 24.4% over the same period.

Development of new renewable energy will contribute to increasing the renewables share of total primary energy demand from 13.5% to almost 20% in 2040. This development is driven by climate and environmental policies, by energy security concerns, and by price and cost developments, and is linked to growth in electricity as a source of final energy demand.

Given the projected economic growth, current trends in energy and climate policies and the stickiness of energy-consuming capital equipment, energy-related CO₂ emissions are projected to continue increasing until about 2030. Then, lower energy demand growth, increased share of renewables and the effects of CCS combine to deliver lower emissions going forward. Even lower emissions are possible if governments could agree on sufficiently tough coordinated policy measures.

Different states of the world are definitely possible. This outlook therefore includes two alternatives to the base case, based on different combinations of economic growth, energy efficiency, fuel shares and policies, and representing possible, but less likely outcomes. One alternative is characterised by higher growth and energy demand, higher energy efficiency and somewhat tougher climate policies, while the other is based on lower growth, lower energy demand and lower energy efficiency.

Eirik Wærness
Chief analyst

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 2011/2012.

The research process has been coordinated by CFO Macroeconomics and Market Analysis, 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.

This report has been drafted and edited by CFO Macroeconomics and Market Analysis in Statoil. We hereby extend our gratitude to everybody involved.

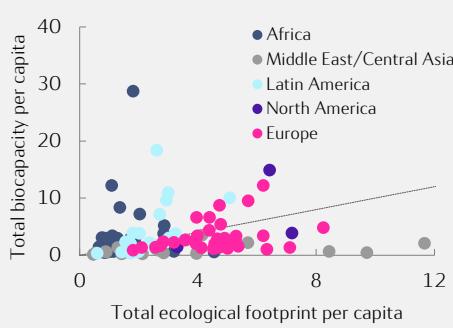
Table of contents

Energy Perspectives 2012	3
Acknowledgements	4
Key drivers in global energy markets	7
Recent developments with potential long-term effects.....	7
Geopolitics, globalisation and trade	7
Key uncertainties	8
Key variables driving global energy demand	9
Several states of the world are possible	11
The global economy	13
History and status	13
Medium-term outlook: risky recovery.....	14
Long-term growth: It's all about productivity	15
Overall energy market outlook.....	19
Energy demand and energy intensities	19
Global and regional energy mix.....	22
CO ₂ emissions	24
Energy use in transportation - facing strong headwinds.....	25
Power sector outlook.....	27
Manufacturing and other sectors	29
The Global Oil Market.....	31
Recent trends - Supply disruptions and concerns	31
US tight oil production - how rapid expansion?	32
Outlook towards 2020 - Revival of non-Opec production	33
2020-2040 Outlook - Towards peak in oil demand	35
The global gas market.....	37
Recent developments: Slow demand, growing supply.....	37
Medium-term market perspectives	37
Long-term market perspectives: gas demand will grow	40
Other energy sources.....	43
The coal market	43
Nuclear	45
High growth in renewable power generation	47
Outlook for global bio-fuels production	50
Exploring alternative development paths	51
Long-term development is uncertain.....	51
Consistent, alternative combinations of drivers	51
An alternative world: "Globalised expansion" (GE)	51
Another alternative: "Regionalised stagnation" (RS)	53
Alternative energy demand paths	54
Chart appendix	55



Arab spring, European economic crisis, Japanese disaster and North American shale gale could have lasting effects

Country-specific bio capacity and footprint
Hectares



Source: WWF/Global Footprint Network

Increasing strain and conflicts due to resource constraints and inequality could affect development negatively

Key drivers in global energy markets

Before embarking upon the description of the expected long-term development in global macroeconomics and energy markets, it is useful to summarise some important factors that could affect the development, and also pinpoint some of the most important overall uncertainties. This concerns both recent events that might have lasting impact; geopolitical implications of various global resource constraints, supply side developments and political developments; as well as major risk factors. This introductory chapter also discusses how different drivers combine to result in energy demand growth and fuel mix developments, preparing for further analysis at the end of the outlook, where a couple of alternatives to the base case assumptions are explored.

Recent developments with potential long-term effects

The last year has been a year of contrast: Disturbing as it may have seemed, the Arab spring entails increased hopes of democracy and freedom in the Middle East and North Africa (MENA), but also considerable sufferings and tragedy for victims of war and unrest in Libya, Syria and elsewhere. Economic development in OECD started out on a positive note early last year, but later turned for the worse and even critical in countries like Greece, Portugal and Spain. High unemployment, especially among the young, and urgent need to balance fiscal budgets entail risks of a long downturn in Southern Europe and other parts of OECD. A new country gained independence in Africa, but the political relations between South Sudan and Sudan quickly turned sour, with negative implications for global oil supplies and more importantly, for the well-being of poor people in the region.

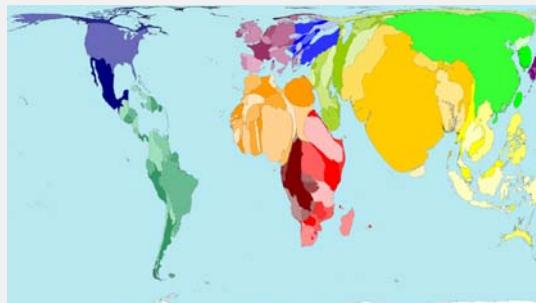
On the energy scene, the effects of the nuclear disaster following from the earthquake/tsunami in Japan continue and could potentially have long-lasting implications on the long-term role of nuclear energy and markets for other fuels. Supply disruptions following from unrest in MENA and elsewhere (e.g. Nigeria) are in stark contrast to the on-going revolution in unconventional oil and gas production in North America. The long-term implications of this development could be a very different net import balance between North America and the rest of the world, with implications for petro-political relationships across the globe. How key global actors will respond to this new market and industry dynamics, in terms of domestic and foreign policies, remains to be seen.

Geopolitics, globalisation and trade

Long-term challenge – balancing growth and resource availability

Earth's resources are under strain. Growing populations and incomes, spreading of developed countries' consumption habits and private exploitation of common resources contribute to put the sustainability of our development at risk. Evaluations of humanity's ecological footprint show that we use more than the available bio capacity. Enhancement in global bio capacity requires solutions through improved technology and productivity. Moreover, the required improvement will not be sufficient without changes in behaviour, habits and consumption patterns. Growing populations with growing aspirations also call for an equitable solution to the difficult distributional issue involved. Some use too much of the globe's capacity, while others aspire to a better life, which requires the ability to have a larger footprint. Some countries have large surpluses in bio capacity, even if their inhabitants leave a very substantial footprint. Other countries are in the opposite situation. A system for "trade" in bio

World by population in 2050

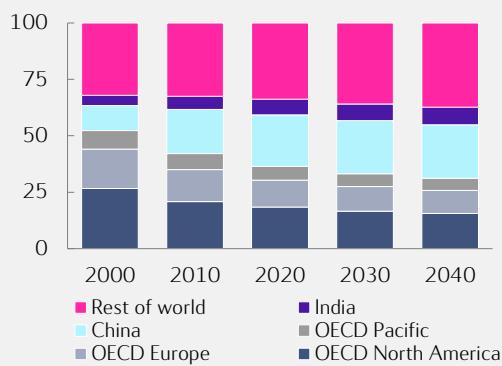


Source: Worldmapper, University of Sheffield

The geopolitical world order is changing rapidly

Shifting energy demand

Share in global energy demand, %



Source: IEA (history), Statoil (projections)



capacity would therefore be beneficial for a more efficient allocation of our common, total bio capacity, while reducing the overall strain on the planet.

Policy-makers' ability to address these and other issues will be crucial for the long-term economic development. Will resource conflicts on energy, water, food or other resources lead to conflicts, protectionism and lower growth? Will aging, unemployment and social unrest in the OECD countries lead to conflicts, protectionism and lower growth? Will climate changes and other environmental problems lead to higher costs, migration and thereby to conflicts, protectionism and lower growth? Or will policy-makers of the world face up to the global challenges, as they have in the past, with continued development guided by increased globalisation, increased literacy, reduced discrimination, continued economic development and technological improvements? These are critical questions for economic development and global energy markets going forward. In this outlook, the base case is founded on the assumption that "sanity will prevail", and that social, equity and resource conflicts will be handled without large implications for global economic development.

Changing geopolitical world order and alliances

Global political gravity is shifting to reflect global population distribution, as emerging economies catch up with advanced economies and achieve a voice at the table of global negotiations. The emergence of China, India, Brazil, South Africa and other emerging economies, perhaps especially in South East Asia, will affect trade policies, globalisation and type and level of conflicts in the coming decades. So will probably the decline of OECD countries' global economic and political importance. How this will play out, and what the final outcome will be, no one knows. In this outlook, it is assumed that globalisation and convergence in economic development continues, contained by counterforces, but not turned upside down by protectionism and trade conflicts. One implication is that emerging economies will continue to catch up with the developed countries, with trade in goods and services developing in accordance with overall development in economic activity.

Key uncertainties

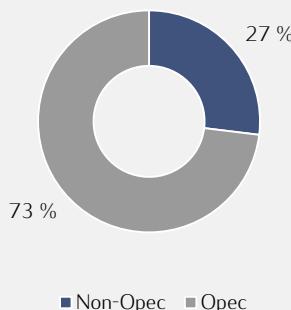
A few uncertainties stand out as especially important for the long-term global energy market development, in addition to the "normal" explanatory factors.

Economic and political development in China

The most significant global tour-de-force the last 20 years has been the phenomenal development in China, rocketing the country to the forefront across a number of dimensions. Continuing this development without significant setbacks or resource bottlenecks is in itself a tremendous challenge for current and future Chinese leaders. Doing this in parallel with the transition from an "emerging" state to a "developed" state with aging population, public sector development and social security measures, adds significantly to the challenge. The outcome will affect the world in many dimensions; supply of and demand for goods and services, competition for scarce resources, and global security. This outlook assumes a gradual moderation of Chinese growth and a continued, smooth development in other dimensions, without extreme setbacks.

Global oil reserves

Total: 1,523 bn bbl (+3.6% from 2011)



Source: Oil and Gas Journal

Opec still crucial for global oil and gas markets**Supply developments and disruptions**

Fundamental changes are taking place in the supply of both oil and gas, with potential impact for geopolitics and energy markets. This development is most visible in North America, where shale gas and tight oil in abundance will imply a shift in the region's import dependence. To what extent this change is a lasting one, and whether it will spread to other regions, is a key uncertainty. The impacts of the changes in North America are unclear. In this outlook it is assumed that the increased oil and gas supply from North America will raise economic and political challenges for Opec towards 2025, as the call-on-Opec is set to moderate while the organisation must accommodate growing oil supplies from Iraq. Opec's share of global oil and gas reserves is estimated at 75% and 50%, respectively, indicating that the organisation's key members remain critically important for the global oil market. It seems reasonable to assume that Saudi Arabia, Iran, Iraq and Qatar will continue to act in accordance with their own long-term economic and political interests.

Furthermore, the increased gas supply not only from North America, but also from East Africa and other regions is assumed to contribute to a closer integration between regional gas markets. The biggest unknown in global gas markets is probably the future of unconventional gas outside of North America, e.g. in Russia, China and Latin America.

Continued development of oil sands, oil and gas from ultra-deep offshore reservoirs, and potential growth from the Arctic represent other uncertainties for future supply of oil and natural gas.

The geopolitical hotspots affecting global energy supply, in particular the MENA region, Iran, Venezuela and Nigeria, are assumed to continue to be periodically affected by conflicts and disruptions. Such disruptions imply that medium-term tightness and slack in the global oil markets will influence prices around the long-term trend in costs of marginal supply.

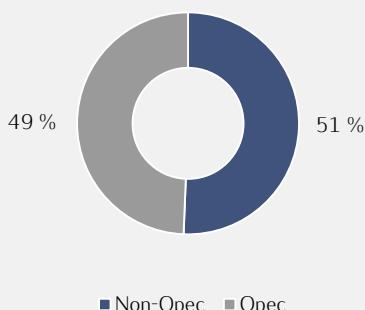
Key variables driving global energy demand**Economic growth is most important,...**

Global energy demand towards 2040 will to a large extent be driven by economic growth in the largest population centres. Continued progress goes hand in hand with energy demand, in a symbiotic cause-and-effect relationship: Growth depends on availability, affordability and sustainability of energy supply, and growth drives energy demand as consumption patterns and industrial composition change. The large emerging economies in Asia and Latin America, and in particular China and India, will be instrumental in determining how much energy demand will increase over the next 30 years. Larger populations (India), continued income growth for millions of people becoming middle-class consumers (India, China, Indonesia, Brazil, as well as Pakistan, Vietnam, Philippines, Thailand, and Nigeria) and transition from primary towards modern industries will increase their energy needs. The OECD countries' share of global energy demand will go down from 42 to 31 per cent, with China and India combined just surpassing OECD in 2040.

Economic growth, energy efficiency, and the extent to which lower energy demand in OECD countries compensates for demand increases elsewhere, will determine the global link between economic activity and total primary energy demand (TPED).

Global gas reserves

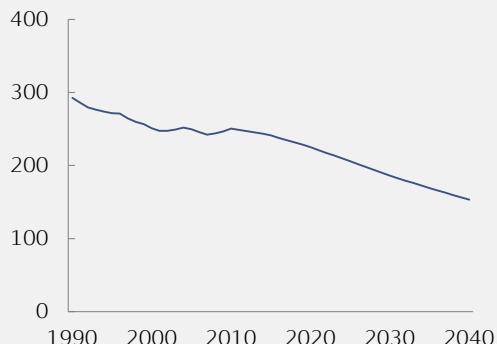
Total: 191,047 bcm (+1.5% from 2011)



Source: Oil and Gas Journal

Growth depends on energy...**...and progress drives energy demand**

Global energy use per GDP Toe/million 2005-USD

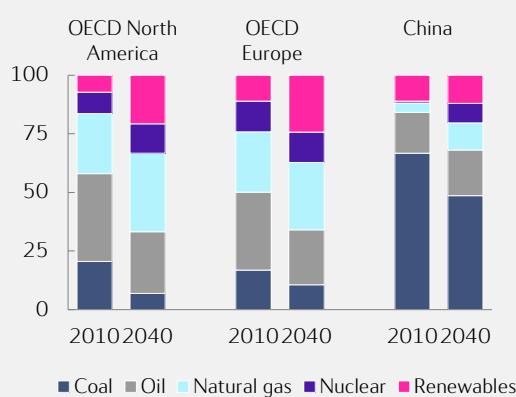


Source: IEA/IHS Global Insight (history), Statoil (projections)

Energy intensity to improve by 40%

Regional energy mix

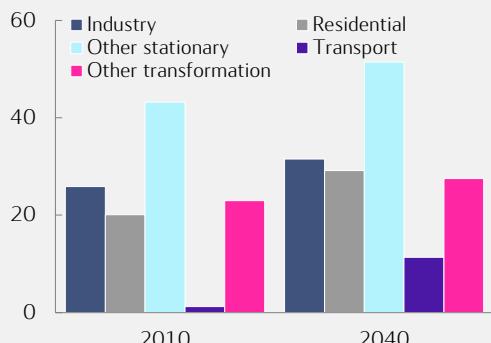
Shares in total primary energy demand, %



Source: IEA (history), Statoil (projections)

Going electric

Electricity as share of total fuel consumption, %



Source: IEA (history), Statoil (projections)

... but economic structure also plays a role

The path that emerging economies choose when catching up with the advanced economies will also affect the link between gross domestic product (GDP) and TPED. Energy-intensive manufacturing provided a foundation for growth during the industrial revolution in Europe, and has also been an important factor behind the Chinese growth miracle the last decades. If other emerging economies choose a different growth path, basing development on more human capital intensive industries, the historical relationship between economic development and energy demand growth may change.

Similarly, private transportation has been a crucial driver for oil demand in OECD after 1950. If the world's largest population centres find other solutions than congested highways to cater for their communication needs, e.g. via public mass transportation systems, future energy demand and fuel mix per unit of GDP could depart from their historical trends. However, given the substantial stock of long-lived capital equipment and infrastructure involved, any change in economic structure and the relationship between growth and energy demand will take time.

Energy efficiency will improve – but by how much?

A long-term trend that most likely will continue is the downward path for energy consumption per unit of GDP. New capital equipment is more efficient than old, and will contribute to global energy efficiency. Urbanisation, new family patterns with smaller households and increased living standards, and the fact that most of the economic growth takes place in countries that are less energy efficient than the OECD economies, will dampen the overall improvement in energy efficiency.

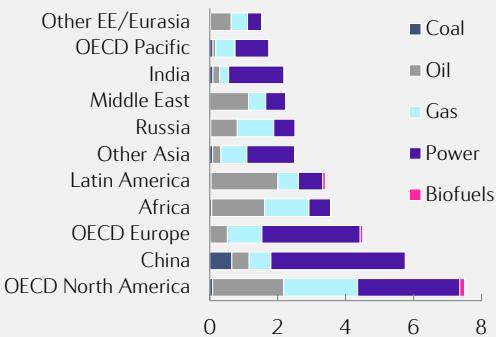
Technology and costs will play an important role in many dimensions

A key uncertainty for the future of global energy markets is technological development both on the demand side and the supply side. On the demand side, technology may impact the transportation sector, both in terms of consumers' choices of transport modes and the development of fuel mix and fuel efficiency.

Development of so-called smart grids in electricity distribution holds the potential for improving energy efficiency even further. Given the importance of power sector investments, increased efficiency in the electricity distribution would be beneficial both from a cost perspective and in order to improve overall energy efficiency.

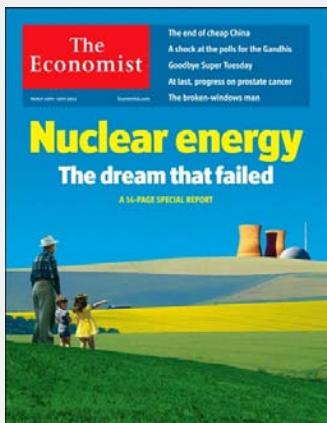
On the supply side, long-run marginal costs of different types of energy resources depend on the physical availability of the resource, extraction technologies, distance from the resource to the market, availability and costs of capital, pricing of risk, regulation and policies, as well as costs of labour. Several factors will contribute to gradually higher long-run marginal costs, e.g. increasing scarcity of key resources, gradual introduction of climate costs or climate abatement requirements, pricing of other environmental effects, as well as competition for capital and labour resources. On the other hand, technological progress is not likely to stop any time soon, and human aspiration will continue to provide innovative solutions to challenges as they arise. Solar energy is an example of technology bringing marginal costs down. In this outlook, a

Energy supply investments 2011-2035, trillion 2011-USD



Source: IEA WEO 2011 NEW Policies scenario

Energy and climate policies will affect investments and technology development



The future is unknown

continued incremental technological progress is assumed across various sources of energy supply, contributing to reduced costs of renewable energy and offsetting the cost increases from increasing scarcity and complexity.

Importance of energy and climate policies on the rise

As population and income growth add increasing pressure on Earth's resources, energy and climate policies should play an even more important role on the global scene. Whether this will actually happen, depends on the balancing of individual countries' and regions' interests with those of humanity as a whole, in other words, on our ability to overcome the "tragedy of the commons".

Energy policies are expected to develop on a national and regional level, contributing to increased energy efficiency, depending on individual countries' technological ability, priorities and energy balances (endowments). Fuel efficiency and local emission standards will continue to evolve and improve energy efficiency, and some fuel subsidies will gradually become less important. However, energy subsidies will continue to impact energy demand for the foreseeable future.

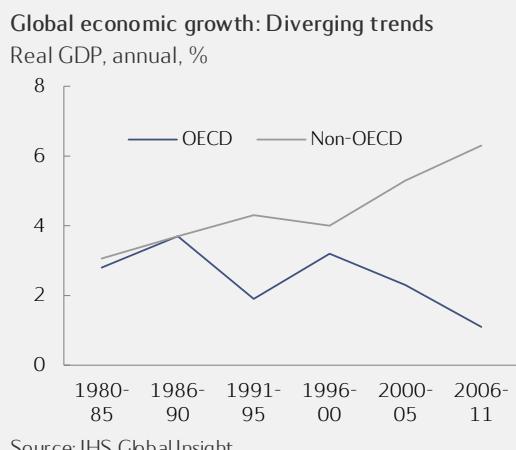
International climate policy negotiations, while showing some progress in Durban in December 2011, have failed to produce significant, binding results, progress. Recent developments do not bode well for those hoping for sufficiently tight policies to stem further global warming. Still, some momentum seems to be building, with countries such as China, Australia, Mexico and South Korea having prepared climate legislation. An increasing number of countries and regions are expected to put a price on carbon emissions and require carbon capture and storage for new investments in power production and manufacturing once the technology is developed. Consequently, this outlook is based on assumptions of a gradual tightening of climate policies, affecting key demand regions, including USA and China, moving step by step towards common, global solutions. However, the pace of policy change implied by this outlook is far from sufficient to reduce emissions to a sustainable 450 ppm-level.

Several states of the world are possible

This outlook builds on the combination of assumptions which are perceived to be the most likely way forward. In what follows, the key assumptions and results for economic development, energy demand, fuel mix and development in the most important fuel markets are presented in detail. Other plausible developments paths and outcomes, with lower probabilities, are illustrated in the final chapter.

In some dimensions, surprising trend breaks and very different developments cannot be excluded. It is inherently difficult to predict the unknowns, and they have therefore not been incorporated in any of the forecasts. Readers should therefore be aware that all projections of this outlook are surrounded by substantial uncertainties, both on the upside and on the downside.

The global economy has been solid as non-OECD economies continue to catch up with OECD countries



Non-OECD GDP: Dawn of the Pacific Century



The financial crisis nurtured a growing pessimism in many Western societies...

...which could challenge the gains made in international trade and cooperation over the past decades

The global economy

History and status

Global energy demand has been supported by solid economic growth over the last three decades, with the world economy growing by an annual average of 2.9%. These seemingly steady gains mask a widening discrepancy in growth between advanced and emerging economies. Annual OECD growth averaged a meagre 1.1% over the period 2006–2011 whereas the non-OECD countries enjoyed a robust 6.3% average economic growth in the same period. The recent growth gap reflects the fact that the 2008 financial crisis hit hardest in the Western OECD countries. However, the crisis only amplified a general long-term trend that has been driven by shifting demographics and resultant variations in nations' relative labour market strength in addition to regional variation in productivity growth. The result is a fundamental impetus for convergence of income levels between less industrialised and advanced economies. This convergence is still at a nascent stage: while inhabited by only around 20% of the global population, the OECD economies generate nearly 70% of global GDP.

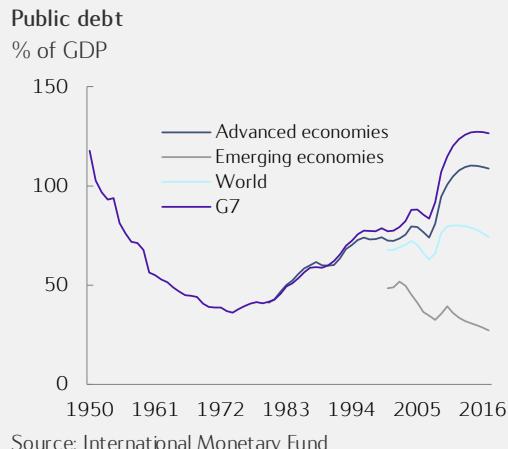
Despite sizeable contributions from the Middle East and South America, the bulk of non-OECD growth has come from emerging Asia, whose share in global GDP increased from a marginal 3.5% in 1980 beyond 15% in 2011 (aggregation at market exchange rates; MER). At the centre of this global economic power shift is China, whose real GDP grew 17-fold over the past 30 years, making it the world's second largest economy by 2010 (MER). China's rapid ascent owes to a fortuitous combination of massive rural-to-urban labour migration, a state-directed export-oriented growth model and heavy investment inflows. Although China may recently have embarked on a somewhat slower growth trajectory, together with other emerging Asian countries it still outpaces the growth of Western economies. In large parts of OECD cheap Asian imports weighed on unskilled labour markets and inexpensive credit fuelled an unaffordable spending spree of households and governments over the last decade. This development has delayed crucial reforms and nurtured unsustainable fiscal deficits and household debt, the implications of which became painfully apparent in the aftermath of the 2008 financial crisis.

Following widespread lay-offs during the financial crisis and a muted recovery, unemployment levels in OECD countries remain at relatively high levels, while income inequality has continued to rise. Monetary and fiscal policy arsenals are nearly exhausted, and the private sector has failed to generate sufficient job growth in the OECD despite ample corporate savings. In many Western societies, the experience of the past four years has nurtured a growing pessimism and doubt in the benefits of globalisation. Such sentiments have spread deeply into the middle class, which is confronted with creeping impoverishment in the wake of increasing unemployment and stagnating real wage growth. This gloomy mood conflicts starkly with the optimism in most emerging economies.

Protectionism on the rise

As history repeatedly has shown, prolonged economic uncertainty make people look for alternative political solutions. This is reflected in the current political climate in the US as well as Europe, with the Greek elections in May 2012 being one prominent example. The alternative agendas vary widely, ranging from the radical rejection of established state institutions to a greater embrace of government involvement, but

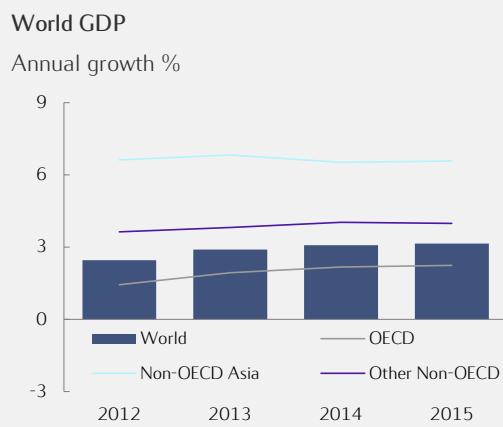
After several negative shocks in 2011, the start of 2012 was more stable...



Source: International Monetary Fund

...but the recovery is fragile due to the high debt and deficit levels in OECD

....and rebalancing of private and public sector will have a dampening impact on growth



Source: Statoil

they all typically share a greater inward focus to protect domestic growth. Policymakers in non-OECD economies also face constituent pressure for a level playing field in trade and capital flows. International cooperation is therefore key to continued benefits from globalisation.

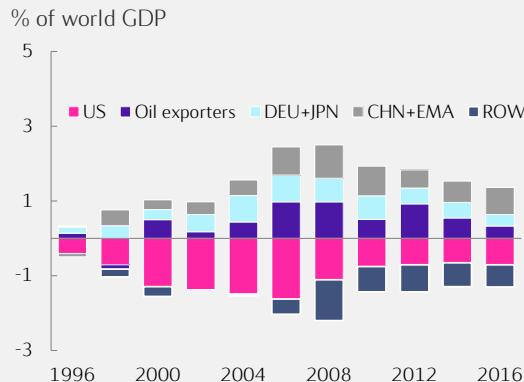
Medium-term outlook: risky recovery

The global economy showed signs of stabilisation at the start of this year after experiencing several shocks and headwinds in 2011, including the Japanese disaster, political and sovereign debt concerns in the US and Europe, higher oil prices on the back of the Arab spring and the Iranian nuclear dispute. Still, the recent reigniting of financial market concerns related to Euro area sovereign debt illustrates that the recovery in key OECD economies is fragile. Sovereign debt and deficit levels in OECD countries are still dangerously high, which make the on-going recovery muted and vulnerable to further financial market turmoil. Banks and households also need to strengthen their balance sheets over the coming years, which will impact the broader economy through tight credit supply, high savings, and muted consumption. Persistently high unemployment in OECD adds pressures on governments and consumers and is also a potential source of escalating social instability. Emerging economies are not immune to these developments. Lower OECD growth is already dampening export growth in these economies. As opposed to advanced economies however, most emerging economies have policy tools at hand to support solid growth. Further, emerging economies are growing increasingly interdependent due to expanding intra-regional trade.

OECD reforms needed

In the medium term OECD economies face the challenge of adjusting public and private sector debt towards more sustainable levels. This is a necessary adjustment, which will have a dampening effect on growth. Cautious consolidation is needed to avoid choking growth and derailing a fragile recovery. Some immediate reduction is required for credibility, but policy makers should aim for more long-term commitments like strengthening fiscal institutions, adopting and committing to sound fiscal rules and reforming entitlement programs. In Europe there seems to be a movement in the right direction with the Fiscal Compact. These policies should probably be accompanied by somewhat more weight on economic growth as a part of the debt readjustment process. Governments in several countries have started potentially important reform programs to reduce trend spending and improve structural weaknesses in their economies. The US and Japanese situation could be more challenging as they have yet to forge a consensus for longer term deficit reduction.

High unemployment, weak growth in wages and income combined with austerity focus in fiscal policies make the OECD household deleveraging process a laborious one. It has started, most evidently in the US, but until balance sheets are restored it will imply higher savings and lower consumption. Germany and some other less indebted countries may deviate from the average pattern, but the overall deleveraging dampens OECD growth prospects to around 1.5–2.0% the next few years, with the US and Euro area at the high and low end of this interval, respectively. In contrast, the corporate sector (apart from banks) enjoys a more robust financial position and holds investment potential for the OECD in the medium term, which could be unlocked through resolved uncertainty and/or improved market prospects.

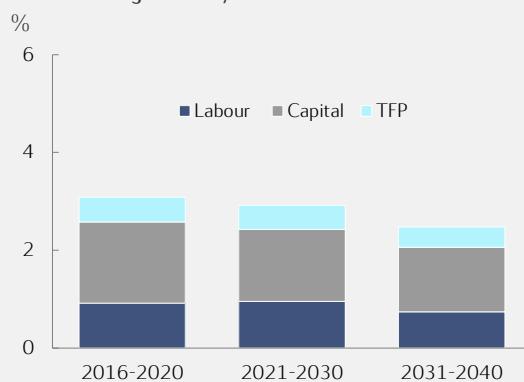
Global Imbalances*

Source: International Monetary Fund

*Global Imbalances: the large current account deficit in advanced countries and the matching surpluses in other, mainly emerging and oil exporting countries

A gradual improvement for the global economy is foreseen towards 2015, lifted by non-OECD ...

...but risks still remain

World GDP growth by source

Source: Statoil

Long-term growth is determined by the economies' input endowments and how these are combined to produce output

Non-OECD moderation, but still solid

Non-OECD economies are foreseen to remain the key driver of global growth. Although the rate of growth has moderated recently also in the emerging part of the world, these countries are expected to continue to grow at a robust pace providing support for the global economy and energy demand. China's economic growth is likely to temper slightly to around 7.5% the next few years. In India and Brazil domestic policy issues are impacting short-term growth and must be tackled in the near term to ensure that potential growth does not decline. The Indian growth outlook is close to the Chinese, whereas Brazilian economic growth is expected in the 4-5% range. Russian short-term economic prospects are lifted by energy prices and announced fiscal stimulus, but a dampening is expected as these effects will ultimately have to fade. Investment flows and related impact on business activity remain key risks. During the decade prior to the 2008 financial crisis, global imbalances in capital and trade flows were building with the flow of goods and capital from the East to the West. These imbalances are now moderating as softer OECD growth improves the trade balance and there is an on-going shift in policies in non-OECD economies to spur domestic demand.

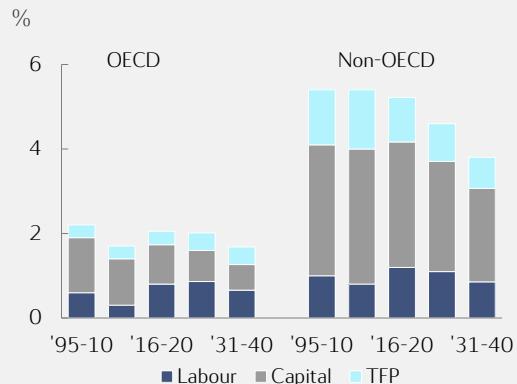
This outlook forecasts an average growth of 1.9% for OECD economies towards 2015 as most of the countries, especially in Europe, face major brakes on growth. The growth is in line with historical patterns of a post-financial crisis recovery and will hardly be sufficient to bring down the elevated unemployment levels across industrialised countries. The key driver of the world economy remains emerging economies growing close to 5% on average. This supports a global economic growth outlook of 2.5% this year rising gradually to 3.2% in 2015. Although sentiment and downside risks have eased somewhat since the end of last year, risk and uncertainty remain substantial due to the challenging fiscal and growth issues many of the advanced countries face. There is also some upside potential to the outlook, as growth in non-OECD economies could exceed expectations and a shift in sentiment could unlock business investments.

Long-term growth: It's all about productivity

Compared to the demand-side focus of a short- and medium-term approach to economic activity, the long-term approach shifts attention to the supply side, i.e. the production potential of individual economies. An economy's long-term growth depends on how effectively it utilises its given entitlements (inputs), i.e. labour, capital, natural resources and energy to produce a unit of output. In economic theory, this relationship between inputs and output is usually described by a production function which also includes a specific set of framework conditions (state variables) related to market and regulatory environment. Such a mind-set is applied in this outlook, and forms the basis for estimates of economic growth for key regions and countries towards 2040. Global growth is projected at an average of 2.8% per year over the coming three decades, which is broadly in line with historical figures. Non-OECD economies are expected to continue to catch up with more advanced economies and are foreseen to expand 4.5% per year on average in this timespan. Maturing OECD economies, conversely, are foreseen to grow 1.9% on average.

Methodological approach: convergence, input factors and productivity

Estimating an economy's potential output has always posed challenges to economists, both in terms of methodology and reasonable assumptions

GDP growth by source

Source: Conference Board (history), Statoil (projections)

The process of lower income countries catching up towards richer ones is expected to continue

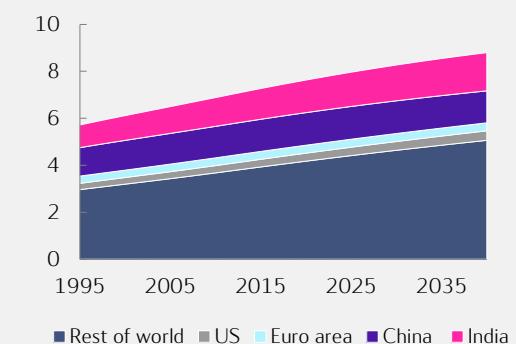
Short-term shifts and shocks do usually fade over time, but could also have a longer term impact through policy and behavioural adjustments. Two methods that are particularly popular amongst most economists, namely the stylised growth accounting framework and the regression-based approach. Both these methods use a Total Factor Productivity (TFP) based production function approach, i.e. deducing information on capital, labour and TFP components to estimate growth.

A growth accounting stylised production function approach has been adopted in this outlook to estimate these components of GDP. According to the famous Nobel Laureate and economist Robert Solow; "All theory depends on assumptions which are not quite true. That is what makes it a theory". Accordingly, this outlook combines theory of economic growth with historical data and professional judgment in a detailed accounting framework to the various components of economic growth.

A key part to this forecast is the assumption about convergence between nations i.e., implying that low-income countries will grow faster than high-income countries to facilitate catch-up in per capita income. Using GDP per capita as a point of departure, it is assumed that China aspires at convergence with the average OECD per capita income over a given timespan, while US is assumed to converge slowly towards an even more advanced economy. To assess the mechanics behind each component of GDP, the applied forecasting process breaks the contribution to economic growth from each input into a number of sub-elements. In addition to focusing on main variables such as capital stock, population growth rates, and technological progress, this outlook goes deeper in assessing various factors behind labour force development, capital accumulation and technological progress (TFP). 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 saving to productive investments. Labour contribution includes factors impacting both quantity and quality of the labour force. Population growth, work age population, number of hours worked, labour market efficiency are variables taken into account to describe the quality of labour force and its direct and indirect impact on GDP growth. Similarly, elements such as globalisation, regulation and reforms, research and development (R&D) and technological progress are used to forecast contribution from TFP on economic growth prospects.

World population

Billions of persons



Source: IHS Global Insight

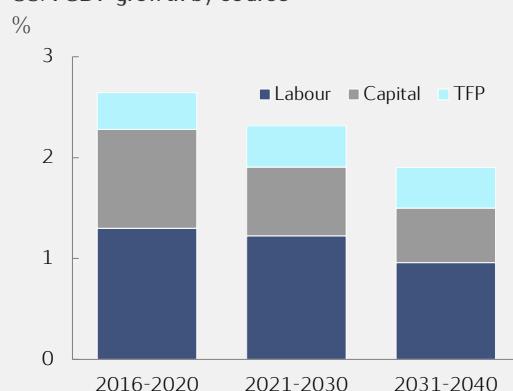
Global population growth is moderating, and OECD share is falling as population growth is seen at half the global growth

Key trends in major regions and countries the next 30 years

Population patterns are important for the economic outlook. Global population growth is expected to steadily decline from around 1% the coming decade to 0.5% in 2040, with an average 0.8 % annual growth for the whole period. Most non-OECD nations are faced with a somewhat higher pace of population growth than the global average, but with a similar moderating pattern. The slowing pattern is also evident for OECD economies at roughly half of the global annual growth rate. Among the major economies, USA has the most fast-growing population in the OECD. India will lead amongst the non-OECD, whereas China's population growth rate is forecasted to turn negative in the 2020s and worsen further as the century progresses. Moreover, both Middle East and North African countries are foreseen to have a high average population growth rate of 1.3% over the long term, which implies expanding growth potential.

Non-OECD economies remain drivers of global economy at more than double the OECD growth

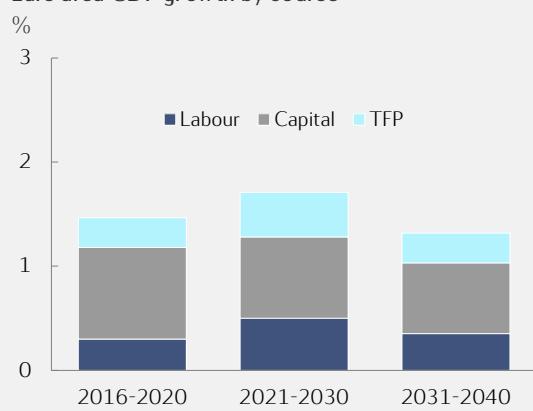
USA GDP growth by source



Source: Statoil

The US economy has higher growth prospects than Europe as population patterns weigh more on Europe

Euro area GDP growth by source



Source: Statoil

Between 1981 and 2011 the global economy grew by an average rate of 2.9% a year. Through larger parts of this period capital was the main driver of growth and added broadly half the rate of overall GDP growth. The remaining half is roughly divided by labour and productivity (TFP) contributions. As a general pattern, this overall composition is largely expected to remain over the next thirty years. Growth contribution from all the three sub-components is expected to dampen in absolute terms, and GDP growth will continue to be dominated by the contribution from real capital. In this outlook, global economic growth is expected to moderate gradually from 3.1% in 2016-2020 to 2.9% in the 2020s. Slower population growth, diminishing catch-up potential in non-OECD economies, and slowing productivity growth are foreseen to moderate global growth to 2.5% in the 2030s. OECD economies are foreseen to expand less than global growth towards 2040. Growth is foreseen at close to 2% the coming decade and to remain at this level also in the 2020s, mainly driven by resurgence in US and Europe as it is assumed that structural reforms will be implemented to improve competitiveness and provide a slight uplift. Through the 2030s global growth is expected to moderate to around 1.7%. This moderating pattern is also evident in the outlook for non-OECD economies and the current pace of around 5% growth on average is foreseen to remain the next decade before moderating to 4.5% in the 2020s and 3.8% in 2030s. Although both OECD and non-OECD economies see moderating growth, higher growth in non-OECD will gradually add to their combined share in the world economy. Consequently, global growth the next 30 years is expected to be close to the average of the previous 30 years.

The US has higher growth potential than Europe

The US and Euro area forms 2/3 of the OECD area. Hence it is essential to understand how these economies are expected to perform over the long run. The US is likely to remain among the world's largest economies, as its growth rate is projected to average around 2.2% over the next 28 years. Following a muted post-crisis recovery, the US economy is foreseen to see some support towards the end of the coming decade, mainly due to the revival in business investments, an increase in quality of labour force (post crisis adjustment process), improving imbalances in capital and trade flows, and diminishing impact from deleveraging of debt. Key to this forecast is the assumption that the US and Europe will manage their debt problems mostly through public finance adjustments and structural reforms to restore competitiveness. In the 2030s, US GDP growth is set to ease gradually to 1.9% due to moderation in capital investments, TFP and labour productivity. Euro area economic activity is projected to expand by 1.4% on average between 2012 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 pay dividends during the 2020s. Hence, the Euro area is expected to increase the growth rate to 1.7% in the 2020s. However, aging population and slowing capital investments are foreseen to pull down growth to 1.3% in the 2030s.

China and increasingly India foreseen as growth engines

China and India currently represent almost half of the non-OECD region and high growth rates will increase this share going forward. China now accounts for about 12% of the world GDP in nominal terms. The Chinese economy is set to almost quadruple by 2040. Annual GDP growth in

China GDP growth by source

Source: Statoil

China TFP growth by source

Source: Statoil

Non-OECD outlook lifted by China and India – Indian growth supersedes Chinese growth in the 2020s and 30s

India GDP growth by source

Source: Statoil

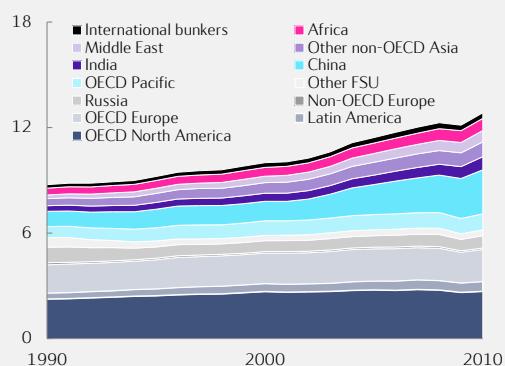
China is estimated to average about 5.6% between 2012 and 2040, well above the non-OECD average of 4.5%, but way below the 10% growth rate that has been realised for the last three decades. Growth in China is seen quite robust between 2016 and 2030 due to strong contributions from capital investments, including infrastructure projects and social housing. In this time frame, contributions from TFP and labour market productivity are also expected to be solid at about 1.8% and 0.9% respectively. Both globalisation and technological change factors will contribute significantly to TFP. China still has the bulk of its population in rural areas and the capital investments required to develop these territories are substantial. Over the long term, this forecast assumes that China will move from an investment-driven economy to a more consumption-driven society at a gradual pace. In this process of transition contributions from labour and capital will remain substantial. The pace of transition is also contingent on how speedy and efficient the necessary welfare schemes are implemented. In the 2030's however, the aging population, declining working age population, and maturing stage of capital investments limit China's growth potential to close to 4%.

The Indian economy, on the other hand, is currently only $\frac{1}{4}$ of the Chinese economy. Still, India has a solid growth potential and is expected to grow faster than China the coming 30 years and advance India's role as a major consumer of both energy and non-energy products. India's annual growth is estimated to average about 6.8% between 2016 and 2020. Lack of growth-supporting policies coupled with slow progress in financial, infrastructure and institutional reforms will act as a drag on growth. Abundance of human resources, capital expenditures (government financed) and the continued growth in Indian middle class will however assist the economic prospects. Economic growth through the 2020s is forecasted to average 6%, with the main contribution coming from capital and labour. During this decade, India is seen to experience a positive technological shift caused by solid R&D investments and a significant positive spill-over effect from urbanisation and infrastructure investments to support a growing population. The contribution to annual GDP growth from TFP growth is expected to increase to 1.1%. In the 2030s, India's economic growth is estimated to average 5%, given its burgeoning labour force and further need to invest in capital-intensive projects such as housing and infrastructure.

Other countries with large populations increasingly important

In addition to the economies assessed above, there are also other regions and countries of importance for the global economic outlook. Japan is still one of the biggest economies in the world, but declining population outlook and muted GDP growth of around 1% the coming three decades imply that its share will be reduced. Brazil has experienced relatively solid growth over the last decade and contributions from both capital and labour are foreseen to support the economy to grow 4% on average between 2016 and 2040. Russia faces mounting challenges such as negative population growth and slowing investment inflows and economic growth is projected at around 3% between 2016 and 2040. Although the average GDP level in African countries is low compared to the US, Europe and Asia, several of the African economies are among the high-growth performers and countries like South Africa and Nigeria are set to increase their share of global GDP over the next three decades. The same goes for Asian countries like Indonesia, Vietnam, Pakistan, Bangladesh, Thailand and the Philippines.

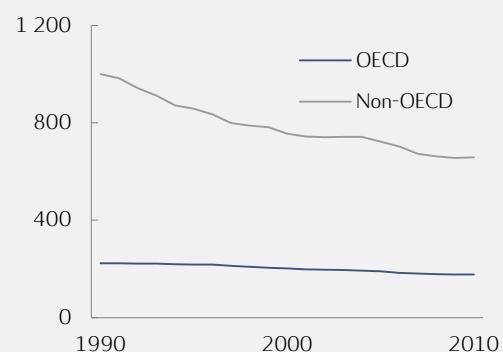
World primary energy consumption by region 1990-2010, bn toe



Source: IEA

The world has become more energy efficient...

Energy intensity 1990-2010, toe/2005-USD



Source: IEA

...and this is expected to continue

Overall energy market outlook

Energy demand and energy intensities

The classical top-down approach to fuel market forecasting begins with an analysis of the relationship between economic activity and energy demand. A key metric in analyses of energy demand is the energy intensity ratio, i.e., energy consumption per unit of GDP produced.

Energy intensities down, but with big variations

Between 1990 and 2010 world GDP increased by an average of 2.7% per year (MER). Over the same period, world primary energy consumption increased by an average of 1.7% per year. Hence the energy intensity of the world economy declined by around 1% per year. Regional and national decline rates varied strongly with China's energy use per unit of GDP produced plummeting by an average of 4% per year while the Middle East's energy intensity increased by an annual 1.6%. The North American and European OECD countries saw declines of 1.7% and 1.4% per year respectively. The overall decline rate decelerated in the 2000s mainly because of China's and a few other emerging economies' rapid, energy intensive industry based economic growth.

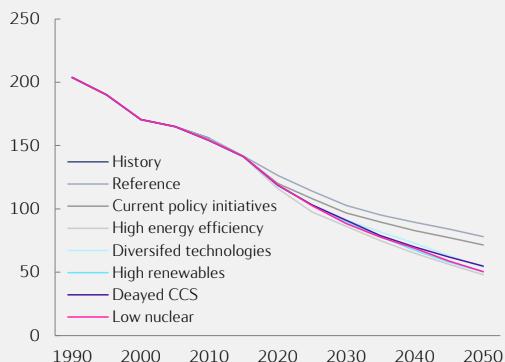
Many analysts believe energy intensities will decline faster in the future than in the recent past. This is because of the current emphasis on policy to speed up the development and deployment of energy efficient solutions. This emphasis originated in the 1980s along with the rise in attention to climate change. Energy efficiency has been a buzzword for much longer than 20-25 years. Experts in the field have for decades advocated measures to make consumers change their energy inefficient ways and invest in smart equipment. Some politicians have listened, energy efficiency targets have been formulated and many measures have indeed been enacted. But for as long as it was driven by energy supply security and "ordinary" pollution concerns only, the policy push remained half-hearted and inconsistent. The severity of the global warming challenge will, it is assumed, ensure a wider awareness and better understanding of the issues and a stronger will to trade the upfront costs associated with investments in energy efficiency off against the longer term benefits.

Exactly how much the will to commit to tough energy efficiency targets and act on them has changed, remains however to be seen, and so do the longer term impacts of the policies under discussion.

Europe: High ambitions and tough talk, but ...

Of particular interest to energy suppliers dealing with Europe is the EU ambition agreed five years ago to lower member countries' energy consumption in 2020 by one fifth relative to the union's 2007 baseline energy demand scenario. In 2011 the Commission found that members were on track to accomplish only half of the agreed target in spite of the 2008-09 recession. Apparently member countries had exploited the fact that among the EU's 20-20-20 targets this one had not been made legally binding. To put things right the Commission unveiled an Energy Efficiency Directive proposing to accelerate the renovation of buildings and oblige energy retailers to lower annual sales by a certain percentage each year. However, one year after the draft directive was released; member country governments and EU bodies are still haggling over amendment, exemption and milestone proposals. Governments hesitate to yield authority in this area to Brussels, especially in times of economic

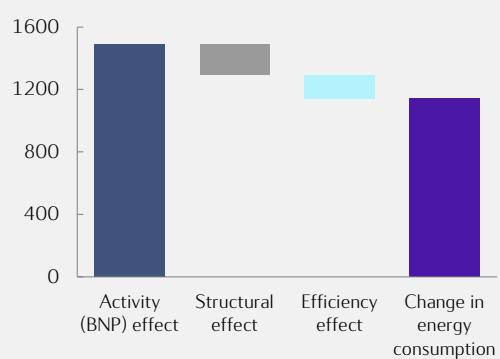
No lack of ambition: In the Energy Roadmap 2050 scenarios EU27 energy intensity drops by 2/3 2010-2050, toe/million 2005-Euro



Source: EU Commission

Energy efficiency targets flourish, but are not always backed up by policies

Structural factors may be at least as important as energy efficiency in reducing energy consumption Australia 1990-2008, petajoules



Source: ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences)

Energy efficiency not as straightforward as it may seem

crisis. Also there is concern that implementing tough energy efficiency measures would further unsettle EU's already struggling carbon emission allowance trading system. Meanwhile the Commission has set its sights on the longer term and published an Energy Roadmap for the entire period to 2050. This is a scenario study with five different images of a greener future. Energy efficiency is important across scenarios with energy use per unit of GDP produced declining by 2.5-2.9% a year which is roughly twice the pace of historical gains. The roadmap is silent on policies, so it remains to be clarified how the green scenarios may be realized.

US and Chinese targets: A mixed picture

A number of countries in addition to the EU member states have adopted energy efficiency targets and policies. In the US most energy policy making takes place at state rather than federal level. However, the US Environmental Protection Agency (EPA) has been instrumental in formulating rules to raise the efficiency of cars. Last year automakers which already had been instructed to raise the average fuel economy of their passenger vehicle fleets from 27.5 miles per gallon (mpg) in 2011 to 35.5 mpg by 2016, were presented with a 54.4 mpg target for 2025. China's 11th Five Year Plan which covered the period 2006-10 targeted a 20% decline in energy consumption per unit of GDP produced. In the event the provinces managed 19% though in some cases by brute force, e.g., by shutting down energy inefficient factories and power plants just before reporting time. The 12th Five Year Plan stipulates a further 16% drop in the energy intensity of the national economy and indicates a partial shift from command-and-control measures to price incentives.

Energy intensities: Less controllable than assumed?

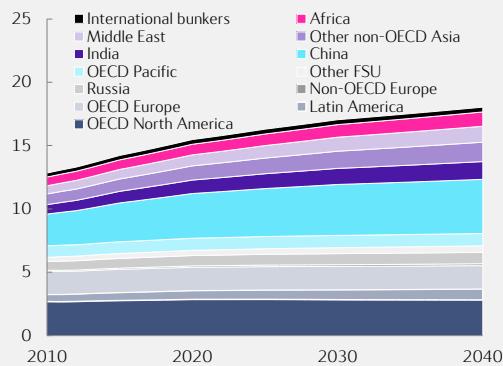
Policies such as taxing fuel use or obliging builders, car makers, appliance manufacturers and others to meet progressively tougher efficiency standards will have an impact on future energy intensities. There may still be a risk of expecting too much from the policy side. Past energy intensity declines are often seen as indicative of past energy efficiency improvements only, reflecting in turn past decisions on energy efficiency policy. The conclusion that future energy intensity declines may be easily accelerated by shifting energy efficiency policies into higher gears is near at hand. However, energy intensity changes at aggregate levels reflect uncontrollable as well as controllable factors – in the short term events such as freak weather, fuel price spikes or business cycles interfering with the turnover of capital, in the longer term underlying structural trends. Overlooking these exogenous factors may lead to overly optimistic assessments of the manageability of energy intensities.

Another problem is that by lowering the demand for energy products, energy efficiency measures may depress energy product prices and thereby bring about a rebound in energy demand. This is not pure theory. History is full of examples of efficiency improvements leading to increases in demand for the resources needed in smaller amounts to produce the same amounts of goods and services.

A third issue is the long lifetimes of much capital equipment and the sunk cost advantages of running existing buildings, plants and machines until

Seemingly low-hanging fruit is not always picked

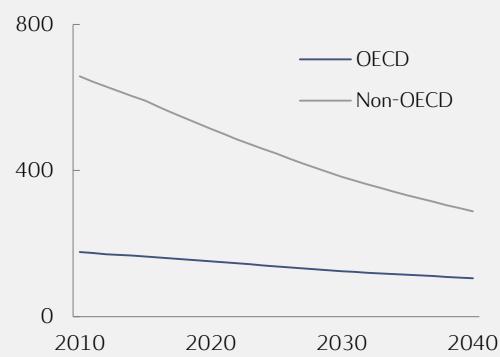
World primary energy consumption by region 2010-2040, bn toe



Sources: IEA (history), Statoil (projections)

Energy efficiency driven by several factors – autonomous progress, prices, policy

Energy intensity developments 2010-2040, toe/2005-USD



Source: Statoil

they are ripe for scrapping. There are energy efficiency cost curves challenging this perception by showing a wide range of investments in energy efficiency carrying negative costs, i.e., being able to pay for themselves by freeing up money from energy consumption. Critics note, however, that these alleged savings opportunities have been known for a long time. When they have not been taken up already, for plain commercial reasons, it could be because they on closer inspection are not as cheap as they are believed to be.

Modelling energy efficiency improvements

In this outlook the scope for energy intensity declines is modelled in a step-wise manner. The starting point or “zero hypothesis” is that a sector’s energy demand will increase at the same pace as GDP. Typically the relationship between energy demand growth and GDP growth is everything but one to one. While developing economies may experience faster energy consumption growth than economic growth, developed economies’ energy consumption normally increases much slower than their GDP. However, proceeding from an assumption of no change in energy intensities allows for a transparent adjustment of the ratio taking different influences into account one by one.

As a first step we reduce our starting point, assumed GDP growth (or where possible, sector value added growth), by a small fraction representing “autonomous” energy efficiency growth. This factor is hard to observe and estimate, but needs to be there to account for the fact that even in periods of limited price and policy impetus to efficiency improvements, the mere turnover of capital will typically ensure some change in energy intensities. Next we try, in separate steps, to account for assumed price and policy impacts on intensities. The policy impact is for obvious reasons assumed to be strongest in the regions that have taken clear stands in the climate policy debate. Estimates need to consider not only targets but also factors such as price elasticities, the estimated gaps between the energy efficiencies of the best available technologies and the average technologies in individual sectors, and normal capital turnover rates.

Main results

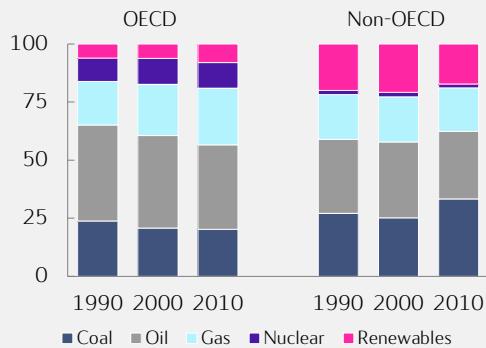
If regional energy intensities remain at their current levels, economic growth rates in line with this outlook’s assumptions would push global primary energy demand by 2040 past 29 bn toe per year. If history repeats itself – i.e., if regional energy intensities remain on their current trends so that the ratio of world primary energy demand to world GDP continues to decline at 1% a year – the result would be a global primary energy demand in 2040 slightly above 22 bn toe per year.

But history seldom repeats itself. In spite of our reservations with regard to the political malleability of energy intensities, this outlook assumes the latter not only to go on declining but to drop faster in the future than in the recent past in most of the regions which have been on downward sloping trends. Furthermore, energy intensity is expected to peak and start declining also in the Middle East. As a result world total primary demand is expected to increase to 17.1 bn toe by 2030, 17.6 bn toe by 2035 and 18.1 bn toe by 2040. In comparison the IEA and the US DOE EIA in their 2011 New Policies and Reference scenarios put world primary energy demand by 2035 at 17.0 and 18.6 bn toe respectively.

Coal was the winner of the energy race in the last decade

Regional energy mix

Share of TPED, %



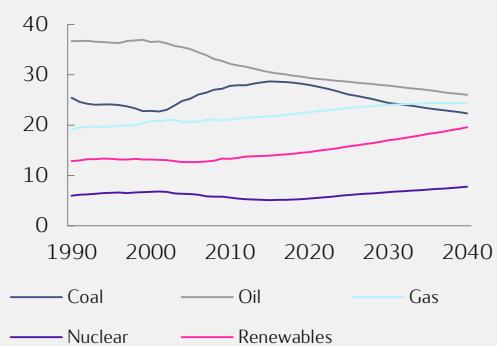
Source: IEA

OECD economies have seen moderate greening since 1990...

...while coal has been on the rise in non-OECD economies

Shares of global primary energy demand

TPED, %



Source: IEA (history), Statoil (projections)

Natural gas partly compensates for the relative decline in fossil fuels

Global and regional energy mix

Stable shares of fossil fuels since 1990

During the last two decades total fuel demand has increased by 47%, from 8.7 bn toe in 1990 to 12.8 bn toe in 2010. Total energy demand and energy mix have shown various development paths across regions during this period. While FSU and non-OECD Europe reduced their energy demand after the communist breakdown, all other regions experienced significant growth in energy demand. China was leading the way with 40% of total growth. Fossil fuels accounted for more than 80% of the growth, with coal dominating and taking 33% of the growth. Consequently, coal actually increased its share in the global energy mix from 25% in 1990 to 28% in 2010, due to the strong expansion of coal fired power generation in China and India. Gas increased its share with 2%-points to 21% in 2010, mainly due to increased demand in the OECD economies and the Middle East. The increasing relevance of coal and gas have caused the position of oil to erode somewhat, from a 37% share in 1990 to 32% in 2010. Most of this erosion of market share has taken place over the last decade, where (relative) price developments may also have contributed. Although on a steady growth path, a 37% and 52% increase in nuclear and renewables, respectively, has not been enough to change their relative position in the energy mix.

Future drivers and emerging trends

The future energy mix will continue to be fundamentally driven by the level of economic development in the various regions. Inter-fuel competition within transportation, power generation and other sectors will reflect three main forces; (i) the relative tightness of the various primary energy markets and regional availability of different fuels, (ii) the aggressiveness of future regional energy and climate policies, and (iii) technological improvements in the consumption and production of energy, and in carbon capture and storage (CCS) technology.

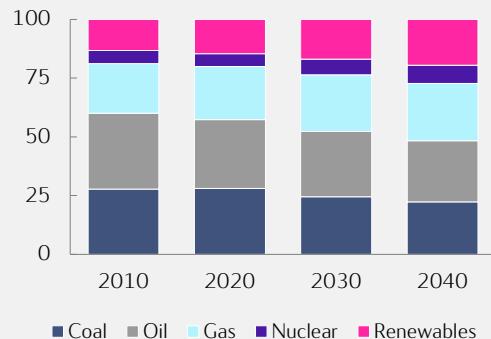
Currently, the most noteworthy emerging trend affecting the inter-fuel competition is probably the extremely low gas prices in the US after the shale gas revolution. In addition, climate and environmental concerns continue to be high on the political agenda and are likely to affect the relative competitiveness in favour of renewables compared to fossil fuels in the longer term.

Non-fossil fuels gaining ground

According to this outlook, demand is projected to increase for all energy carriers towards 2040, although the trend varies, as well as different regional development paths. Despite increasing prices and environmental concern globally, fossil fuels account for 52% of the increase in total primary energy demand (TPED), equivalent to 2.7 bn toe. Coal won the energy race in the last decade, but is expected to grow only moderately towards 2040 with an annual growth rate of 0.4%. Oil is estimated to follow coal with equivalent growth rates, while natural gas continues on its strong development path with 1.6% per year. Nuclear and renewables are projected to outpace all fossil fuels with growth rates of 2.2% and 2.5% per year respectively, with the clear winner being solar, wind and geothermal, with 7.4% annual growth rate. Consequently the fossil fuel share is expected to drop from 81% in 2010 to 73% in 2040, reflecting a steady greening of the fuel mix.

Global energy mix

Shares of total energy demand, %

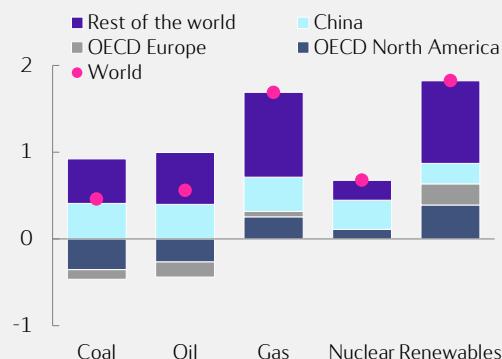


Source: IEA (history), Statoil (projections)

The sun shines on new renewables in the OECD economies

Regional change in energy demand per fuel

2010-2040, Bn toe

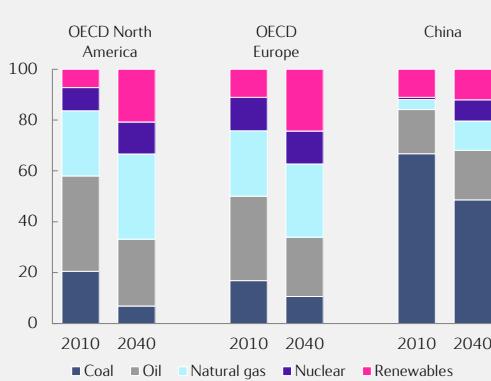


Source: IEA (history), Statoil (projections)

It is all about China

Regional energy mix

Shares of TPED, %



Source: IEA (history), Statoil (projections)

OECD North America reduces coal and oil demand

In 2010, OECD North America was the largest energy consuming region globally, accounting for 21% of TPED. Towards 2040, demand is expected to grow modestly by 5% (130 mtoe), equivalent to an annual growth rate of only 0.16%. Approximately 70% of the increase is expected to be consumed by the manufacturing and power sectors. Demand is expected to peak in 2025, before flirting with negative growth rates thereafter. OECD North America is likely to reduce its reliance on oil, like all OECD economies, expecting negative growth rates of 1.0% per year towards 2040. Coal is expected to reduce its importance even stronger, with an annual decline rate of 3.4%, significantly dampening the overall growth in coal globally. These trends are partly driven by the remarkable increase in the US domestic gas resources and following reduction in gas prices. Gas demand is expected to grow by close to 40%, equal to an annual growth rate of 1.1%. Thus, although the fossil fuel share is expected to drop from 84% to 67% between 2010 and 2040, this is partly offset by the steady increase of gas. Nuclear is growing gradually with 1.2% per year, causing its share in the energy mix to increase from 9% to 13% in the outlook period. With the largest absolute growth globally, renewables is expected to be three times higher by 2040. Thus, its share in the energy mix will increase from 11% to 21% between 2010 and 2040; of this 8% is new renewables.

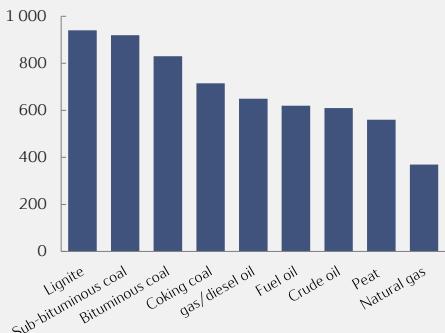
Zero growth in OECD Europe – shifting to renewables

Steady state is expected from OECD Europe in the next three decades, but it is expected to withhold its position as the third largest energy consuming region in the world. Both coal and oil are expected to trend downwards, with negative growth rates of 1.5% and 1.1% respectively. Their relative importance in the energy mix will decrease by more than 16%-points, leaving coal with 11% and oil with 23%. Natural gas is expected to grow by 0.4% per year towards 2040, which is one of the lowest growth rates for natural gas globally. However, gas is gaining ground in OECD Europe, expecting to surpass oil as the most important fuel by 2040. Even with gas increasing, the fossil fuel share will decline, from 76% in 2010 to 63% in 2040. Zero growth is expected for nuclear towards 2040, mainly due to the ongoing shut down of nuclear plants in Europe. Renewables is expected to more than double towards 2040, and becoming the second most important fuel in OECD Europe with a 24% share in the energy mix, of this 9% is new renewables.

China's coal demand grows, but less than gas and nuclear

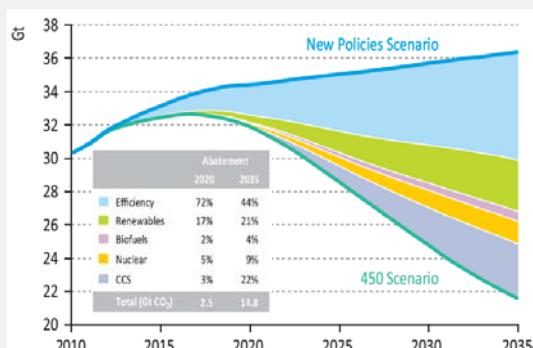
Total primary energy demand in China is expected to grow by 1.8% per year, accounting for 34% of total growth in TPED (1.8 bn toe), making China the largest consuming region globally within 2040. With economic growth continuing though at a declining rate, China contributes with the largest absolute growth in all energy carriers, except for renewables. Coal will reduce its relative position in the energy mix in China significantly, from 67% to 49%. However, even with a relatively moderate growth rate of 0.7% per year, China still accounts for 90% of the increase in global coal demand. Oil and gas is expected to grow by 2.2% and 5.5% per year respectively, claiming a combined share of 31% in 2040. An average annual growth rate of 10% per year is expected for nuclear, more than any other region, accounting for 50% of the global increase in nuclear demand. The renewables share in China is increasing only marginally; however, new renewables is expected to grow by 8% per year, on average, reaching 4.2% in the energy mix.

CO₂ emissions from electricity and heat generation g CO₂/kWh



Source: IEA Emissions from fuel combustion 2011

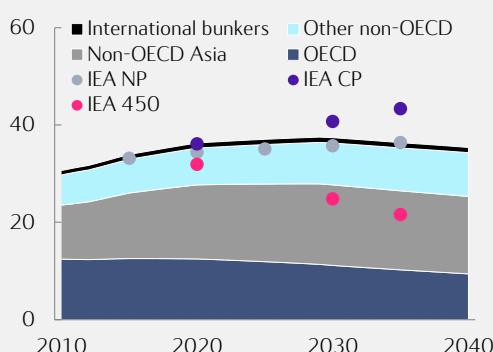
IEA's scenarios and the changing roles and impacts of the different drivers of the 450 scenario



Source: IEA World Energy Outlook 2011

World CO₂ emissions

2010-2040, billion tonnes



Source: IEA (history), Statoil (projections)

CO₂ emissions

Energy demand growth and distribution determining emissions

Global CO₂ emissions increased by an annual average of 1.8% between 1990 and 2009; totalling around 30 billion tons per year in 2009. OECD emissions were up 0.4% per year while non-OECD emissions grew by 2.9%/y. The former region's share of world emissions dropped from 53% in 1990 to 41% in 2009 reflecting widening gaps between regional energy demand growth rates. Energy demand has increased at different speeds in different regions for several reasons. One factor is that energy intensive manufacturing has relocated from high cost OECD to lower cost non-OECD, dampening emissions in one place but boosting them in another. The OECD countries' emissions have levelled out partly due to such relocations. Their achievements seem less impressive when adding the CO₂ embodied in their imports to their domestic emissions.

The financial crisis and the economic set-back that hit the OECD countries in 2008-09, and strong economic growth in China, India and certain other non-OECD countries, have further widened the gaps between regional emission experiences.

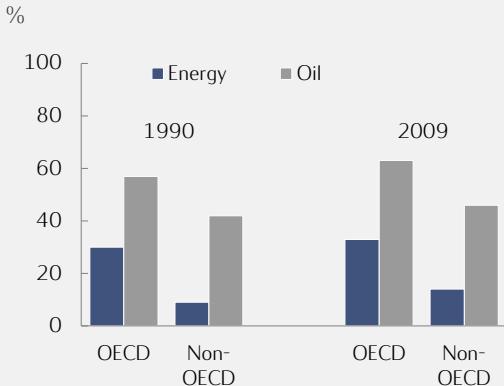
A need for emission reductions

With very few exceptions climate scientists agree that CO₂ emissions must come down significantly if temperature increases are to be contained at a safe level. In the IEA's so-called 450 ppm scenario where global warming during this century is capped at 2 degrees C, world emissions drop by some 25% from today's level to 21.5 billion tons a year by 2035. However, this scenario or similar assumptions would not be appropriate as a base case. CO₂ emission cuts on the recommended scale would require immediate, radical action across countries and regions. The world does not yet seem prepared for such action. The COP 17 conference in Durban last year laid down a process for bringing a global climate agreement into effect by 2020. However, if that agreement will look anything like a credible framework for a 450 ppm scenario is too early to say. Regional and national carbon market initiatives and tighter fuel mix standards will dampen emission growth, but probably not to a degree delivering sufficient cuts in global emissions.

Carbon capture and storage will be crucial to meeting the 2 degrees target. IEA vests 22% of the responsibility for realising the 450 ppm scenario with CCS. However, power plant and industrial CCS technology is developing much slower than envisaged a few years ago. CCS is not yet a commercial proposition and there is not for the moment sufficient will to invest in pilot projects with a view to make it commercial.

In this outlook it is assumed that CCS will start playing a role in the OECD countries and in select non-OECD countries from around 2030, and by 2040 capture between 10 and 30% of carbon emissions from power plants and smaller amounts from industry. The effect of this measure, other assumptions being unchanged, is a reduction in global CO₂ emissions by 6% in 2040. Global CO₂ emissions peak at around 37.5 billion tons a year around 2030 before beginning a descent to some 36.5 bt in 2035 and 35.5 bt in 2040. The peak is slightly higher than in IEA's "New Policies" scenario due mainly to slightly different economic growth and fuel mix assumptions, but emissions in this outlook fall into line with IEA's emission profile later in the period.

Transport sector's share of total final energy use and oil consumption*

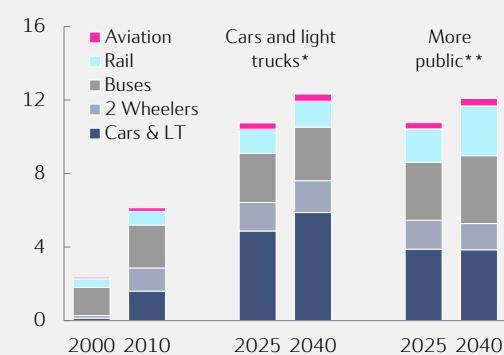


Source: IEA

*Excluding international bunkers

Chinese passenger travel activity

Two scenarios, trillion passenger km/y



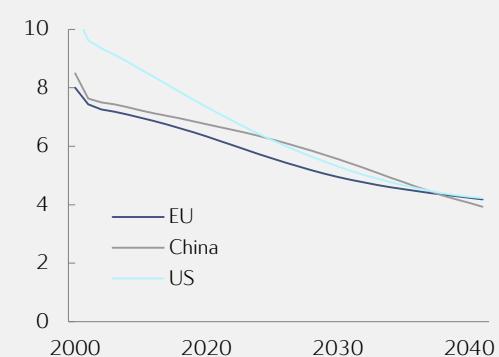
Source: IEA (history), Statoil (projections)

* Based on relatively high distance travelled per car

**Based on steady decline in distance travelled per car

Fuel efficiency fleet average

L/100 km



Source: IEA (history), Statoil (projections)

Energy use in transportation – facing strong headwinds

Rising demand for mobility and goods transportation

Over the last two decades global energy demand in the transportation sector has on average increased by 2.0% annually, which is significantly stronger than the 1.5% rise in total final energy demand (TFE). Its share of TFE has increased both in the advanced and emerging economies, a reflection of the underlying, solid demand for individual mobility and for goods transportation, nearly at all stages of income development. Globally, oil has traditionally had almost a monopoly position in the transportation sector, with a share of 94%. However, since the mid-2000s, the introduction of bio-fuels has gradually started to penetrate the road transportation markets in the advanced economies.

Three key forces: policy, technology and markets

Looking forward, rising income levels and demand for mobility in all regions will continue to stimulate energy demand in transportation. However, several counter-forces will increasingly dampen the growth rates of energy use, and especially oil use, in all regions:

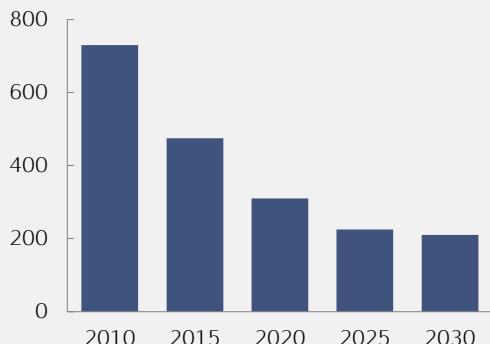
- Overall transport and regional policies aiming to move travel from individual (less energy-efficient) to public (more energy-efficient) modes of transportation.
- Technology improvements and policies to enhance the engine efficiency of all types of vehicles and carriers.
- Technology improvements and policies with the purpose of stimulating the use of alternative technologies to the internal combustion engine (ICE), including hybrids, plug-in hybrids and pure electric vehicles.
- Market-driven penetration of natural gas in some regions and market segments, with the largest potential in North America.

Eventually the consumers' choice of transportation modes, the size of vehicles and types of engines are critical. Also in this context the development of the Chinese transport sector is decisive for global trends.

The future Chinese transportation sector – many critical unknowns

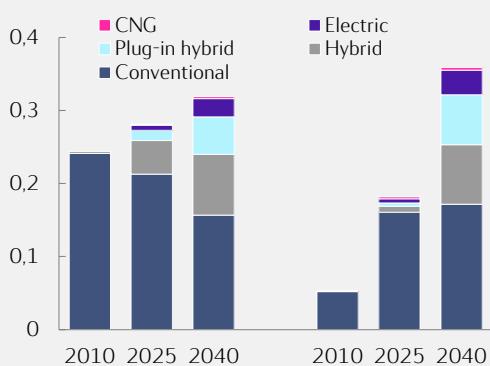
In addition to the rising income levels, the future city and regional structure of the Chinese economy, including the development of regional and intra-city transportation networks, driven by the visions and ambitions of the government, will be a critical determinant of future energy use. The very high population density together with severe air pollution in most large cities and broader environmental concerns suggest that the development in public transportation system will be given a high priority. Still, a rising number of Chinese consumers would like to own their own car, perhaps as much a status symbol as an efficient means of transport. In several big cities, where lack of road infrastructure has led to severe congestion, the local government has implemented restrictions on the purchase of new cars. In aggregate recent trends and future policies suggest that although private car ownership will continue to grow over the next decades, the distances travelled per vehicle will most likely decline significantly during the period. Still total distance travelled (by the rising car fleet) will increase towards 2040, a variable which probably is among the most uncertain and critical ones in this outlook and potentially calls for alternative assumptions.

Battery costs
USD per kWh pack



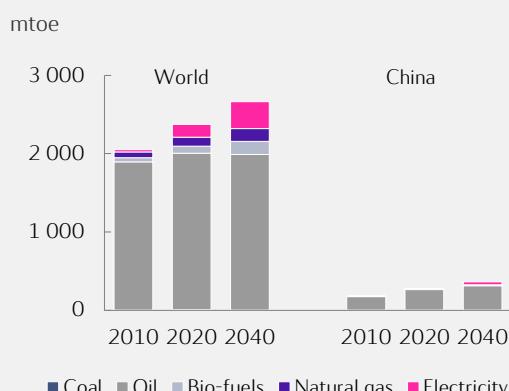
Source: Elementenergy

World passenger vehicle fleet
Number of units, billion



Source: IEA (history), Statoil (projections)

Energy use in the transportation sector*



Source: IEA (history), Statoil (projections)

*Excluding international bunkers

Towards a steady tightening of efficiency and emission standards

Driven by concern about oil security and visions for a low carbon economy all major countries have embarked on a process of improving the energy efficiency of vehicles and other carriers. In the US the Obama administration has, after a first round of tightening in 2010, proposed further sharpening of the mandated corporate fuel efficiency for 2017-2025. EU has plans to tighten the joint emission and efficiency standards further beyond 2020, and China has announced ambitious targets for fuel economy. The trend towards tightening standards is expected to continue through the 2030s. Overall, the energy efficiency of traditional engines will most likely improve by more than 30%. The on-road efficiency of all light duty vehicles in main markets, incl. hybrids and EVs, is expected to improve and come down to the 4-5 litre/100 km range.

Battery costs will come further down and make EVs more competitive

Several institutions expect that battery costs will continue to fall and most likely come down below USD 350/kWh by 2020. This means that a battery pack for an electric car with 100 km range will cost about USD 8000, which will make battery driven electric vehicles (BEVs) more cost competitive to ICEs. EVs with longer range are assumed to be too costly.

Alternative technologies will gradually make inroads

The traditional ICEs, fuelled by gasoline and diesel, currently have a dominant position in nearly all main markets. Although the sales of hybrids, plug-in hybrids (PIH) and EVs has picked up in recent years, the scepticism of average consumers indicates that the penetration of alternative technologies will be rather modest over the medium term. However, eventually the assumed positive experiences of consumers suggest that hybrids and PIH gradually will increase their market shares. During the 2020s EVs are expected to gain more widespread popularity in urban environment driven by governmental support. By 2040, 12% of energy use in the transportation sector is assumed to be electricity.

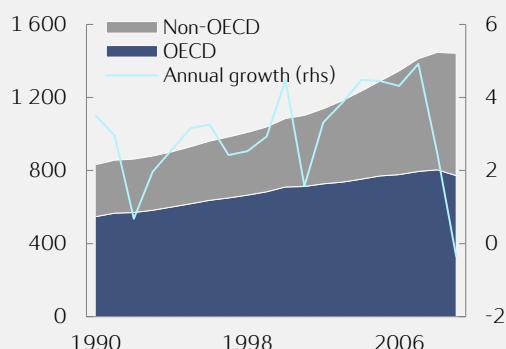
Natural gas will probably penetrate the US trucking segment

Technology for natural gas in passenger vehicles is proven, as there are more than 12 million natural gas vehicles globally. Due to abundance of natural gas in the US and the outlook for relatively moderate gas prices, there are opportunities for gas in various segments of the US market. However, the lack of infrastructure remains a barrier, and joint initiatives between the Truckers' Association, the public sector and the gas industry are necessary to develop an effective infrastructure. There are signs that a process has started. This analysis expects a modest penetration of the trucking segment of the US transport sector, but not of the car segment.

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 transportation sector. China and generally the emerging markets will experience the strongest growth, driven by the rising demand for mobility and continued preference for passenger vehicles. Regional policies to redirect travel from road to rail and to public transportation and enhanced efficiency are not sufficient to arrest the underlying growth. However, due to increasingly stronger penetration of alternative vehicle technologies oil demand in the world's transport sector is projected to peak around 2030.

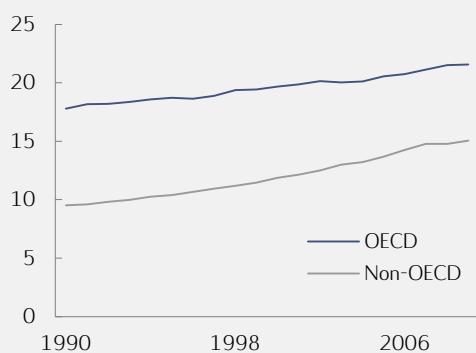
World electricity consumption 1990-2009, mtoe and % (rhs)



Source: IEA

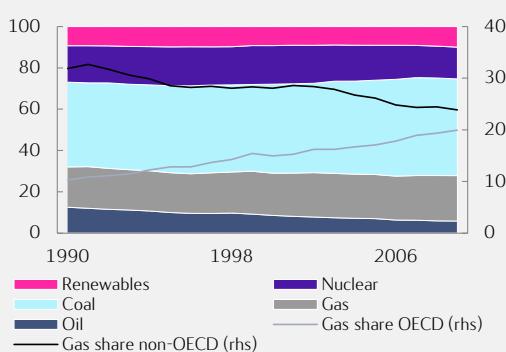
Electricity demand up, in absolute terms and relative to other final energy use

Electricity shares of final energy consumption 1990-2009, %



Source: IEA

World electricity generation by technology/fuel and gas shares in OECD and non-OECD generation %



Source: IEA

Costs favour gas based power generation

Power sector outlook

Between 1990 and 2009 world electricity consumption increased by an average of 2.9% a year. In comparison, world total final energy consumption increased by 1.5%/y. Consumers have switched from coal, oil, gas and biomass to electricity for convenience reasons, because higher incomes have allowed for air-conditioning and other quality of life enhancing equipment, in response to the IT revolution and because of explosive growth in the range of appliances on the market. The switch may accelerate rather than decelerate in the future with continued electrification of residential and commercial energy use in emerging markets and with electric cars gaining market share.

In most markets incremental non-power related gas demand will likely be overwhelmed by incremental gas supply. For oil companies, the power sector therefore represents a crucial source of future demand. The pace of electricity demand growth and the power sector's technology and fuel choices are therefore important.

The power sector's fuel mix varies across countries and regions and also changes over time. In the OECD regions the gas share has increased considerably. Coal has lost ground in Europe and North America, but still accounts for a higher share of North American power generation than any other single fuel. In Asia, the coal share has increased since 1990. It may seem paradoxical that two decades of attention to global warming have seen further growth in these countries' already heavy reliance on coal, but rapid economic growth, domestic resource endowments skewed towards solid fuels and major cost advantages associated with exploiting these fuels are powerful drivers.

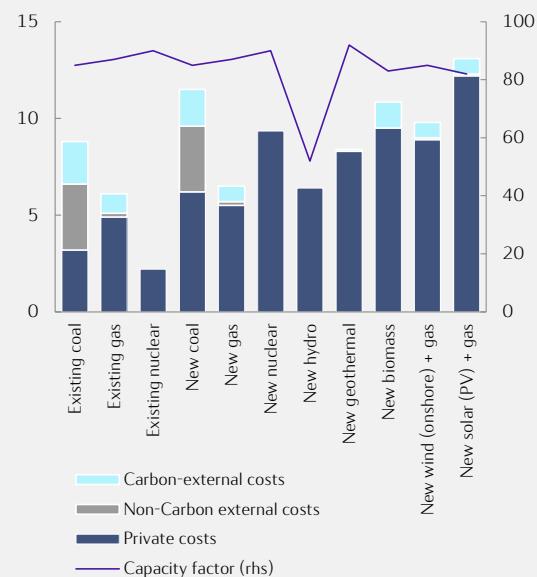
Oil is on its way out of the power sector in most regions, but remains important in the Middle East, Latin America and parts of Asia. The nuclear share was down in Europe and parts of non-OECD Asia between 1990 and 2009, but it was stable in North America and up in most other regions. Power generation based on wind, solar, geothermal energy and biomass remains small in most regions, but had by 2009 gained a respectable 8.5% market share in Europe.

The power sector's future technology and fuel choices will reflect the availability and cost development of different options. These variables will in turn depend on resource endowments, technology developments and the legal and regulatory framework. Politicians may tilt the playing field by establishing markets in carbon emission allowances, taxing different fuels differently, offering feed-in tariffs or introducing so-called renewable portfolio standards.

Levelised cost comparisons – of which the MIT chart on the next page is a recent example – typically show combined cycle gas power as the cheapest new capacity option alongside new hydro, with new geothermal, new nuclear and new onshore wind with gas back-up in the middle, new biomass power struggling and new solar PV in need of heavy subsidization to be viable. Solar thermal power and offshore wind remain in many such comparisons beyond the horizon for cost reasons.

Though useful such comparisons should be taken seriously only up to a point. Generation technologies are evolving and cost rankings inevitably rest on debatable assumptions on capacity utilization and fuel price

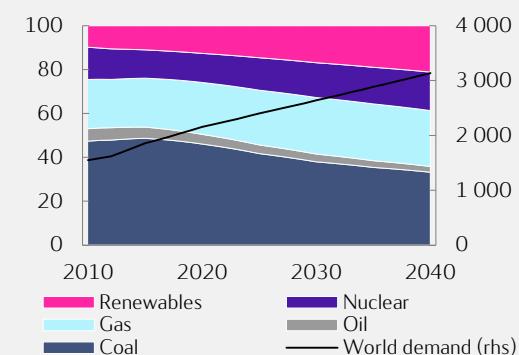
Total cost of electricity US cents/kWh and % (rhs)



Source: MIT CEEPR: Paying Too Much for Energy? The True Costs of Our Energy Choices (2012)

Towards rapid growth in renewables based generation, also as gas is expected to gain market share

Assumed growth in electricity consumption and changes in technology/fuel shares 2010-2040, % and mtoe (rhs)



Source: IEA (history), Statoil (projections)

developments. Recent events that may or may not be fully reflected in today's levelised cost estimates include firstly a significant decline in the costs of solar PV generation thanks to mass production and tough competition among the manufacturers of solar panels, and secondly Fukushima which has led to calls for stricter regulation of nuclear projects, with more complicated permitting processes, additional investment requirements and higher costs as inevitable results. Introducing CCS costs means adding another layer of uncertainty. The jury on the future attractiveness of individual options is therefore still out.

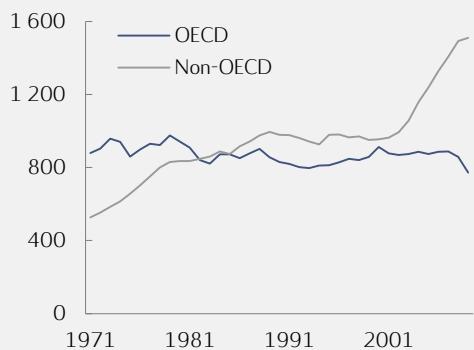
Policy intervention typically favours renewables, in particular wind and solar energy. Policy efforts have varied strongly across countries. Some countries have offered feed-in tariffs so generous that intermittent power generation capacity now bumps up against transmission and load balancing capacities. Also, policy commitments have become a burden on some countries' funding capabilities. At the other end of the spectrum, many countries have yet to adopt any measures in support of renewables. Debates on the future place of gas in a greener power sector fuel mix, are on-going. Realising that the pace of deployment of renewables may not be pushed beyond certain limits and needs to be accompanied by the deployment of flexible and cost effective backup solutions, both the US government and EU leaders have recently signalled a will to secure a role for gas alongside renewables also in the long term.

World electricity consumption is expected to increase by an average of 2.4% per year between 2010 and 2040. OECD consumption is assumed to increase by 1.4% per year and Non-OECD consumption by 3.2% per year. There may well be upsides to these projections since most global warming risk mitigation scenarios require accelerated electrification combined with accelerated growth in renewables based power generation. These features of almost any conceivable solution to the climate change problem reflect both the high share of CO₂ emissions stemming from fossil fuel based power generation, and the concentrated nature of power sector emissions.

As for the power sector's fuel use coal based power is expected to lose market shares across regions, including China and India. Gas based power is expected to gain market share in North America, reflecting an expected abundance of gas and new regulations boosting the costs of coal based power. Gas will also gain significantly in China, but less in other regions and not at all in the FSU where gas is already the dominant power sector fuel. In sum, gas based power generation is expected to constitute some 25% of world power generation by 2040 against 22% in 2009.

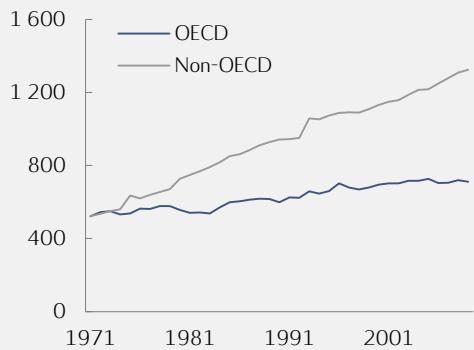
The consequences of given rates of growth in coal, gas or oil based electricity generation for fossil fuel demand depend on the energy conversion efficiency of power plants. These efficiencies vary across technologies and over time. Among fossil fuel based plants combined cycle gas turbine power plants are the most efficient. They are able to convert up to 60% of the energy content in the source gas to useful energy. This outlook assumes that energy conversion efficiencies will continue to increase in the years ahead, dampening the impact of electricity consumption growth on fossil fuel demand growth. However, barring unforeseen technological breakthroughs, efficiency improvements will proceed in small steps, not in major leaps. It is further anticipated that gas will remain in the lead in this respect.

Industry final energy use 1971-2009, mtoe



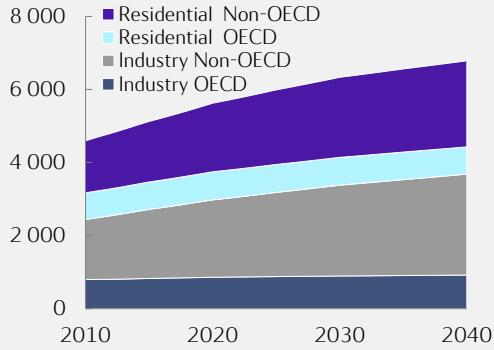
Source: IEA

Residential final energy use 1971-2009, mtoe



Source: IEA

Industrial and residential final energy use 2010-2040, mtoe



Source: IEA (history), Statoil (projections)

Manufacturing and other sectors

Major differences between sectors and regions

The outlooks for industrial, commercial and residential energy demand vary considerably across regions. In the OECD countries industrial energy use has for decades fluctuated around a declining trend. It was 12% lower in 2009 than in 1971. Comparatively sluggish economic growth, major structural changes within the OECD countries with resources migrating from heavy to light industry and from manufacturing to services, relocation of industry from the OECD area to lower cost non-OECD countries, and energy efficiency improvements have been the main drivers behind the downward sloping trend. In the rest of the world industrial energy demand has increased, especially since the turn of the century, reflecting rapid growth in key economies and again structural changes and relocation. World industrial energy use was up by 62% between 1971 and 2009 with the non-OECD share increasing from 38% to 66%.

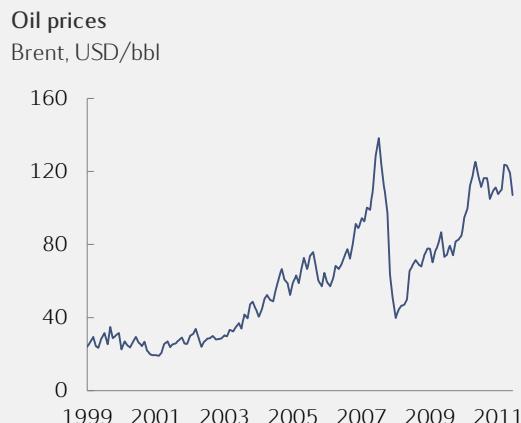
Manufacturing and buildings to become more efficient

These trends will prevail but with the difference between the OECD and the non-OECD industrial energy demand growth gradually diminishing. The lightening of the OECD industrial base must slow since much energy intensive manufacturing has already left the developed economies. Foreign direct investment will continue but shift towards lighter, knowledge based manufacturing with a less divisive impact on regional industrial energy intensities. Industrial energy efficiency will continue to improve, at different paces in different industries but generally as rapidly in the future as in the past, since the political pressure on industry to become more efficient will not ease up. The G8 countries aim to reduce industrial energy intensity by 1.8% a year by 2020 and 2%/y by 2030. The more advanced emerging economies will likely echo this ambition by adopting efficiency and emission standards. In sum OECD industrial energy demand is seen to stabilize and stage a slight recovery, with non-OECD demand continuing to grow but at a declining pace.

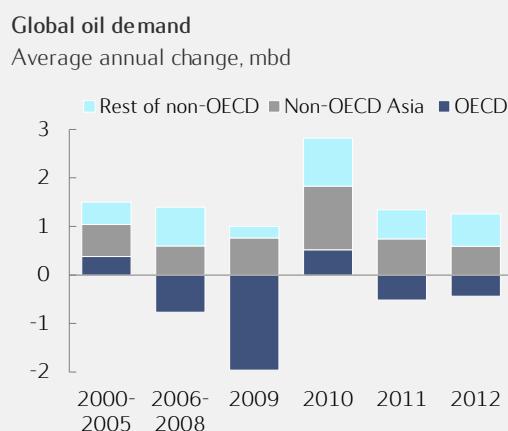
Residential energy demand growth beyond the short term is a function of population growth, demographic shifts, household sizes, income growth, changes in people's habits and expectations, access to energy services and the energy efficiency of buildings. Demand has increased everywhere since the early 1970s but only one third as fast in the OECD as in the non-OECD countries; growth rates have been 0.8% and 2.4% a year respectively. Looking ahead, growth will likely dampen in the OECD countries as populations stagnate, building standards are tightened and certain appliance markets become saturated. Similar shifts will eventually manifest themselves in the emerging economies too, but hundreds of millions of people still have no access to cars, heating and cooling devices, TVs, PCs etc., and will likely prioritize such goods and services when they get to the point where they can afford them. Therefore, while some emerging economies will soon see declines in the pace of residential energy consumption growth, others have some way to go to reach the tipping point, sustaining comparatively rapid growth in total non-OECD residential energy use.

Industrial and residential energy demand is seen to become increasingly electrified, though with North American industrial gas use picking up in response to current price relationships

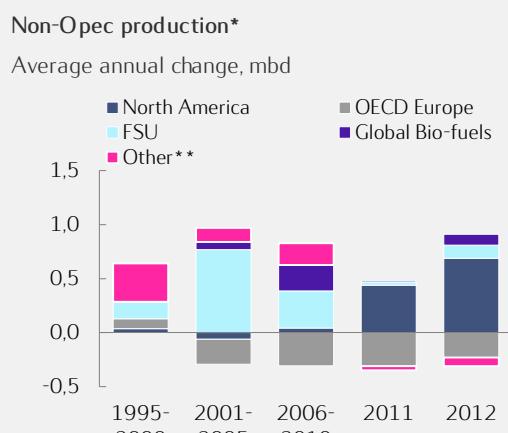
The Global Oil Market



Source: Reuters EcoWin



Source: IEA (history), Statoil (projections)



Source: IEA (history), Statoil (projections)

*Including crude oil, condensate, NGL, bio-fuels, other

**Including processing gains

Recent trends – Supply disruptions and concerns

Rising production costs – the fundamental driver

Over the last ten years the level of oil prices has more than tripled from around 30 USD/bbl in 2002-2003 to a level above 110 USD/bbl in 2011-2012. This is a reflection of the sharp rise in the costs of marginal projects outside Opec between 2004 and 2008. Global oil demand also rose during these years, but not any stronger than in the 1986-2000 period. Although the cost level fell somewhat during the economic recession, costs of marginal projects are still perceived to be in the 75-90 USD/bbl range. Over the last few years cyclical factors like Opec's spare capacity and oil supply disruptions and concerns have lifted prices above long-term marginal cost.

Supply disruptions and risk premium were the key drivers in 2011

2010 was characterized by a broad based and record strong growth in global oil demand, partly driven by the catch-up from the recession-affected 2009 level and partly supported by temporary factors. However, the pace of demand growth fell sharply in 2011 driven by warm weather, high oil prices and a normalization of the Chinese energy markets.

However, fears that the democratic uprising in Tunisia would spread to several oil producing countries in the MENA region raised the market's concern for oil supply disruptions. When the uprisings reached Libya in February oil prices rose further to 110-120 USD/bbl. During summer nearly all of the Libyan oil production of 1.6 mbd was shut in. Supply disruptions also occurred in many other countries, partly triggered by social unrest – in Yemen, Syria and Nigeria – and partly due to operational problems. For 2011 as a whole the production losses outside Opec amounted to 0.6 mbd, implying that non-Opec production hardly grew at all last year. To prevent prices from spiralling and destroying oil demand Saudi Arabia increased its production by more than 1.0 mbd from the start of 2011 to almost 10 mbd in December – the highest level since 1980. However, at the same time its spare capacity was reduced to only 1.5 mbd.

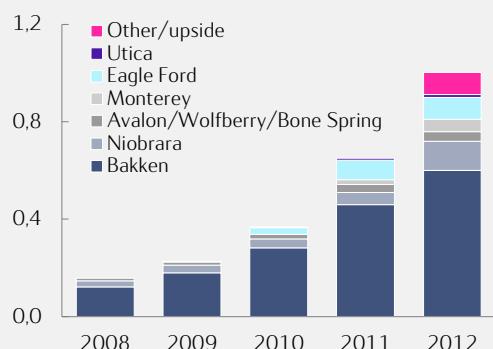
Sanctions towards Iran and further supply disruptions in 2012

The weakness in global oil demand continued into 2012, affected by a warm winter in the US and Europe and by slower economic growth in China. However, at the beginning of the year the long-lasting conflict between Iran and the West about the nuclear issue resumed and escalated. The broadening of the US economic sanctions and EU's decision to embargo Iranian oil, formally starting 1 July, has so far led to a reduction in Iranian oil production by about 0.5 mbd. Furthermore the conflict between the two Sudanese states has led to supply loss of about 0.3 mbd. In aggregate low Opec spare capacity and a high risk premium kept oil prices above USD 115/bbl until April. Since then renewed economic concerns and high Opec production, which led to rising oil stocks, have alleviated some of the supply concern.

US tight oil production accelerates – a game changer?

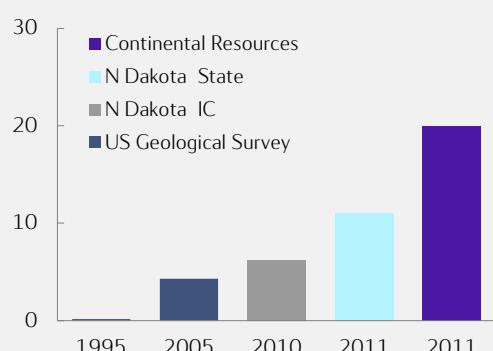
US tight oil production has continued to expand strongly during the first 5 months of 2012 and may reach about 1.0 mbd for the full year. The current momentum in US tight oil plays exceeds even the optimistic outlook presented in Energy Perspectives 2011 and raises questions about its potential to change the fundamental equilibrium of the future oil market.

US tight oil production
Mbd



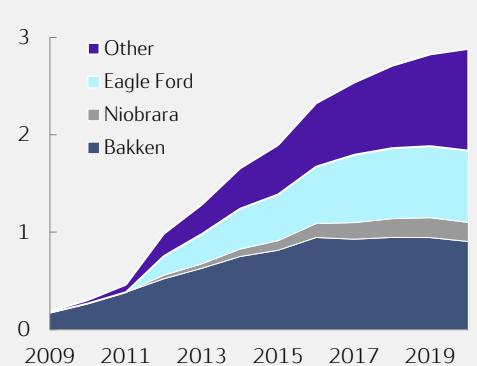
Source: USDOE (history), Statoil (projections)

Recoverable resources of the Bakken formation
Million barrels



Source: Energy Policy Research Foundation (2011)

US tight oil production
Mbd



Source: USDOE (history), Statoil (projections)

US tight oil production – how rapid expansion?

The shale gale spreads to oil

The US shale gas revolution which started in 2007 was triggered by the high gas prices of the mid-2000s, which encouraged small independents with access to land to combine known technologies – horizontal drilling and multi-stage hydraulic fracturing – in new ways. This creativity made it possible to produce large volumes of gas from low-permeability rocks. The success of the US shale gas production has not surprisingly also encouraged companies to explore similar opportunities in liquid-rich formations. The large and widening price spread between high oil prices and depressed gas prices has strengthened the economic incentives.

The resource potential is huge

The Williston Basin, including the Bakken formation in North Dakota, which also spreads into Montana and Canada, has for many decades been seen as a potential oil resource. In addition there are similar rock formations in several other regions of the US. According to various studies of the Bakken formation undertaken some years back the oil in place amounts to 200-400 billion barrels. Based on an estimate in the lower range, and a recovery factor of (only) 1-2%, recoverable resources were in 2008 estimated to be around 4 billion barrels. Since then, the resource estimates have been revised significantly upwards. If Continental Resource's estimate of 20 billion barrels of recoverable oil is approximately right, Bakken alone would double the remaining oil reserves of the US. Furthermore, if the largest US shale oil formation; the Monterey/Santos play in southern California, and all the other plays are included, the total tight oil volumes could be even bigger.

Project based projections suggest a huge expansion ...

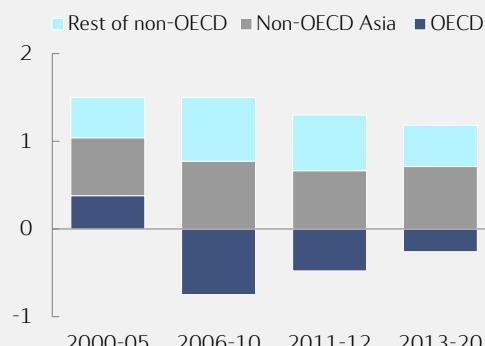
From a level of only 0.26 mbd in 2008, US tight oil production has accelerated steadily over the last few years. Production data so far in 2012 suggests that tight oil production will increase by 0.4 mbd and reach about 1.0 mbd in 2012, with contributions from several new plays. This impressive expansion illustrates the widespread interest of the oil and gas industry to engage in the tight oil plays. Based on detailed models of the most important oil plays, including assumptions about the available acres, the number of wells, well productivity and depletion rates, bottom-up analyses suggest that total tight oil production has the potential to grow massively over the next 5-10 years, and significantly stronger than expected only a year back.

...but bottlenecks and potential surplus may lead to delays

However, a very fast expansion in oil production could potentially create bottlenecks in the domestic infrastructure for production, transport and processing. Furthermore, although the cost level of the current production is rather moderate, an overheated market may lead to upward pressure on unit costs, which could motivate the producers to slow the planned ramp-up of production. Moreover, the outlook for a rise of other sources of oil supply in the North American market may lead to periods of surplus, which also suggests that expansion could be delayed. Thus, from a top-down perspective US tight oil production will most likely increase by an average of 0.25 mb per year between 2012 and 2020. Concerns about potentially harmful environmental effects of hydraulic fracturing are assumed to diminish, but adds to the uncertainty about the production level over the medium term.

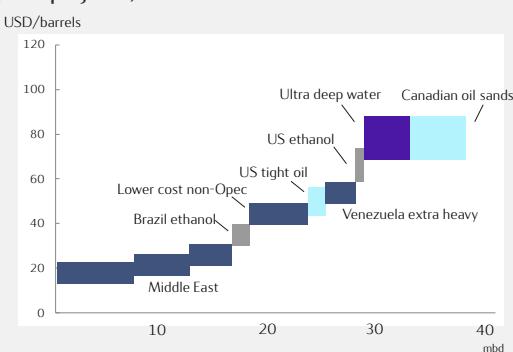
Global oil demand

Average annual change, mbd



Source: IEA (history), Statoil (projections)

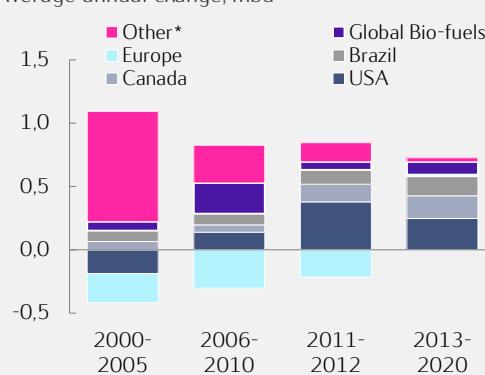
Marginal cost of production. Incremental supply (new projects)



Source: Neftegaz, IEA, Statoil

Non-Opec production

Average annual change, mbd



Source: IEA (history), Statoil (projections)

*Including processing gains

Outlook towards 2020 – Revival of non-Opec production

The balancing factors of the market

Moving beyond the short to medium term, the alignment of oil demand and oil supply will be settled by four key elements:

- Economic growth and the strength of the announced policies to curb the growth in energy and oil demand
- Non-Opec marginal cost and corresponding supply projections
- Opec and effectively Saudi Arabia's market perceptions and strategies to preserve the health of oil demand and a high and sustainable oil price
- Country and geopolitical risk which occasionally may lead to supply disruptions

The price formation which eventually will align demand and supply receives balancing signals from the size of Opec's spare capacity, the supply risk and more fundamentally long-term marginal costs.

Global oil demand – Policies will gradually moderate growth rates

Between 2000 and 2011, global oil demand on average increased annually by 1.2 mbd. Since the middle of the decade global demand has been characterized by steady reductions in OECD oil demand and strong and more than compensating growth from the rest of the world, especially from China. After the 2009 recession the reduction in OECD oil demand has been driven by modest economic growth and moderately higher efficiency gains, and in some countries conservation efforts. In the US relatively high gasoline prices have been an important driver behind the 0.3 mbd fall in gasoline demand. The structure and outlook towards 2020 are expected to be shaped by the same forces, and increasingly by policy-induced efficiency standards. In aggregate, global oil demand is expected to grow annually by only slightly more than 1.0 mbd.

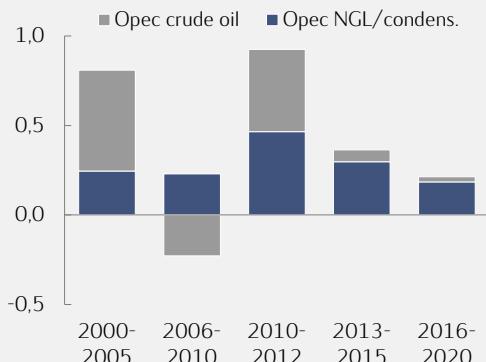
Full cycle marginal costs have increased to USD 75-90/bbl

Full cycle costs (FCC) of new projects outside Opec, and especially the most expensive, but profitable ones, are assumed to remain a key benchmark for future non-Opec production and for the medium- to long-term price formation. The market's aggregated cost structure – the cost curve – should theoretically slope upwards, but in real life the cost curve is stepwise, determined by project characteristics like reservoir quality and water depth, and access to resources. Over time the various segments of the supply curve are continuously affected by four key driving forces; reservoir and project complexity, technological progress, unit costs of input factors and government regulations, incl. fiscal payments.

In the early 2000s the FCCs of marginal projects were assessed to be in the 30-35 USD/bbl range, and actual prices were most of the time more or less in line. The steep rise in marginal FCCs which started in 2004 were primarily driven upwards by the tightening of all supplier markets, but rising complexity of reservoirs and projects has also contributed to the higher cost level. The most expensive Canadian oil sands projects have globally been perceived as the marginal ones, with estimated break-even prices in the 75-90 USD/bbl range.

Opec oil production

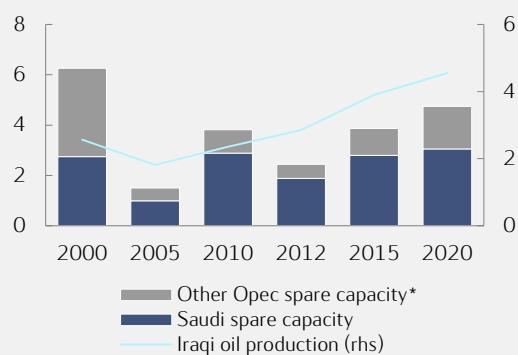
Average annual change, mbd



Source: IEA (history), Statoil (projections)

Iraqi oil production and Opec spare capacity

Mbd

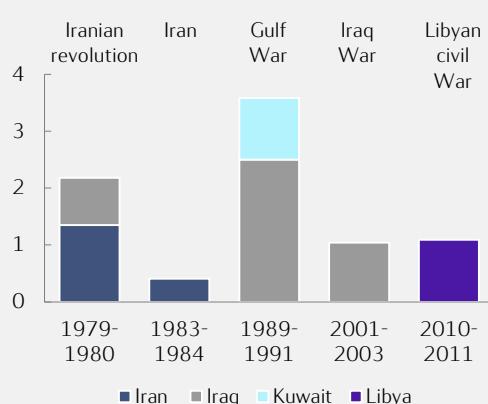


Source: IEA (history), Statoil (projections)

*Excludes Angola, Nigeria, Venezuela and Iraq

Major oil supply disruptions

1979-2011, mbd



Source: IEA, PIRA Energy, Statoil

Rising complexity will most likely push long-term costs further up

The fracking technology which reduced the production costs of US tight oil production and the costs at this specific level of the supply curve, is not automatically relevant for the future marginal project outside Opec. Over time the ultra-deep water (UDW) projects in Brazil and possibly Angola are perceived to be among the most expensive projects globally. Although a steady technological improvement of these UDW projects can be expected, the net effect of high and rising complexity will probably push the long-term FCC higher. Globally the nature of the supplier markets is more cyclical than structural. However, regional tightness, driven by local content requirements, may well push unit cost upwards also over the longer-term.

Strong revival of North American and non-Opec production

Over the last five years total non-Opec production including NGL and bio-fuels increased by about 0.4 mbd annually, of which 0.15 mbd were bio-fuels. The higher level of oil prices during this period have clearly been supportive, while social unrest and supply disruptions in several countries in 2011-2012 have shaved off some of the potential growth. Looking forward, the emerging US tight oil revolution and also a more vigorous outlook for other sources of non-Opec supplies indicate that total non-Opec production are bound for a very strong revival through this decade. The forecast of an annual growth of 0.6-0.7 mbd is a significant upward revision compared with last year's projection. In addition to US tight oil production, the largest contributions are still expected to come from Canadian oil sands and Brazilian UDW. This means that the Americas are re-emerging as a major supply province outside the Middle East. Still, the production outlook for various regions is either vulnerable to the oil price level, potential infrastructure bottlenecks or social unrest.

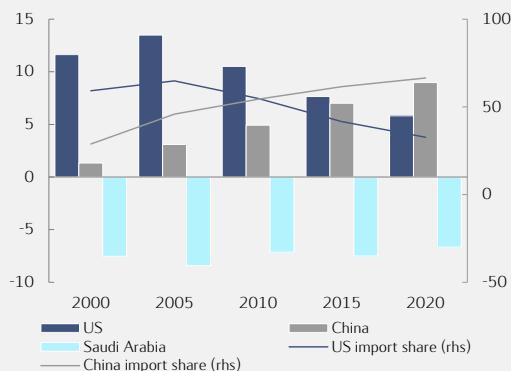
Outlook for stagnant Opec crude production ...

Opec's NGL production will most likely continue to grow strongly over the next few years before it moderates beyond 2015. In order to balance the tight 2011 and 2012 oil market, Opec on average produced 29.9 mbd in 2011, but production was lifted to more than 31.0 mbd in the first half of 2012. Most likely Opec has to cut production significantly later this year. Based on the forecasts for global oil demand, non-Opec and Opec NGL production, the outlook for Opec crude production is rather bleak. Towards 2015 there is limited room for any growth in its crude output, and beyond 2015 the picture does not improve much.

... and expansions of Iraqi production will lead to higher spare capacity

With Libyan production already back to pre-civil war level of 1.6 mbd the planned expansion of Iraqi oil production will increasingly turn out to be the largest challenge for Opec's management of the crude oil market. However, given the rising fragmentation of the Iraqi political environment and the bottlenecks and obstacles on the ground, Iraqi oil production will most likely expand much more slowly than planned by the government. From the current production level of 3.0 mbd, a production level of about 4.0 mbd in 2015 and 4.5-5.0 mbd in 2020 is within reach. Thus, Saudi Arabia and the other members have to cut their production in order to leave room for the rise in Iraqi production. This implies that Opec's spare capacity will rise significantly over the next three-four years. The re-integration of Iraq into the quota system will most likely become troublesome. Given the limited growth in call-on Opec crude oil, Iraq's

Key players' net oil imports Mbd and % (rhs)

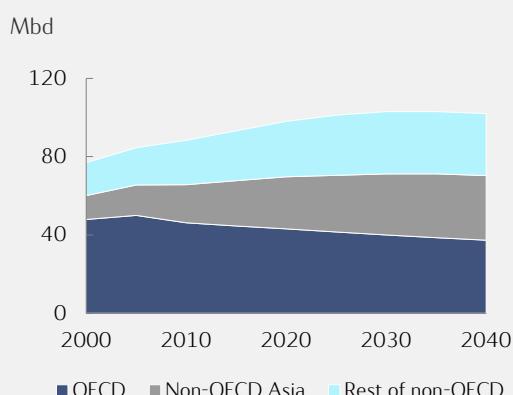


Source: IEA (history), Statoil (projections)

Radical changes in Saudi energy policy

US oil imports position improves significantly

Global oil demand*



Source: IEA (history), Statoil (projections)

*Including international bunkers and bio-fuels

production quota may well become the effective restriction for the further expansion of Iraqi oil.

Instability, supply disruption and need for strategic reviews

However, both the historical experiences of the Middle East, the political dynamics set in motion by the Arab Spring and the current conflicts clearly suggest that political outlook for several Middle East oil producing countries is very uncertain. The final outcome of the civil war in Syria and the conflict between Iran and the West may well affect the stability of the whole region. In addition many conflicts in several oil producing countries in Africa and Latin America suggest that further significant supply disruptions are likely in the decades ahead. Thus, the outlook for periods with production losses and risk premiums will remain important supporting factors in the price formation of the crude oil market – also in the years ahead. In addition Saudi Arabia's strategic assessment about the sustainability of high prices, given the fundamentals and the political landscape will remain critical.

2020-2040 Outlook – Towards peak in oil demand

The positions of key players are changing

At the turn of the current decade the positions of several key oil market and geopolitical players are probably undergoing significant changes, which raise questions about their future strategies and market behaviour.

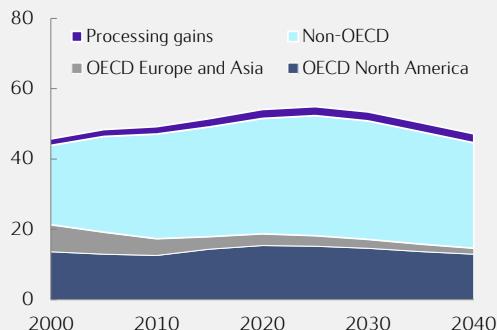
Driven by the revival of non-Opec production through the 2010s, Saudi Arabia's oil market position is coming under a heavy threat. Furthermore, without correcting measures, its public finances will probably deteriorate due to a combination of rising pressure to increase welfare spending, rising domestic oil demand and potentially falling net oil exports, driven by rising incomes and high oil subsidies. At some point the regime will probably be forced to make rather radical changes in its energy policy.

The US oil imports position will improve significantly over the next eight years. The policy-driven stagnation in domestic oil demand and the revival of domestic oil supply means that its net oil imports will be reduced from 9 mbd in 2011 to less than 6 mbd in 2020. Moreover, the growth of almost 2 mbd in Canadian oil production further improves the US oil security position. Despite these improvements, its ambition to raise energy efficiency standards and high priority to renewables will remain unchanged. Furthermore, although the country will be less dependent on physical deliveries from the Middle East, both the exposure to international oil prices and its broad geopolitical interests suggest that the US will keep a strong presence in the Middle East. On the other hand China's oil imports dependence grows sharply, as the oil imports almost doubles from 5.4 mbd to 9 mbd in 2020. Thus, political pressure to curb oil demand and stimulate oil production will intensify.

Oil may gradually lose its monopoly position in transportation

For decades oil products have held almost a monopoly position in the transportation sector. The future use of energy and oil in transportation is driven by three main factors; the demand for mobility and goods transportation, including the various modes of transportation, the efficiency of vehicles and other carriers and finally the competitions between various engine technologies. Based on the experience of the

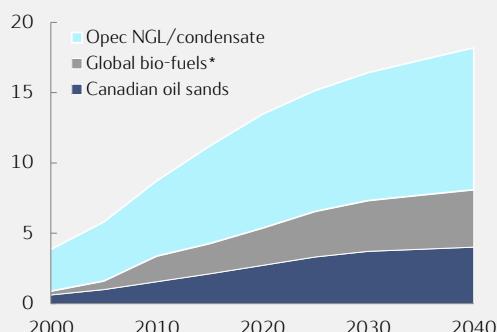
Conventional* non-Opec production, incl. NGL Mbd



Source: IEA (history), Statoil (projections)

*US tight oil is included

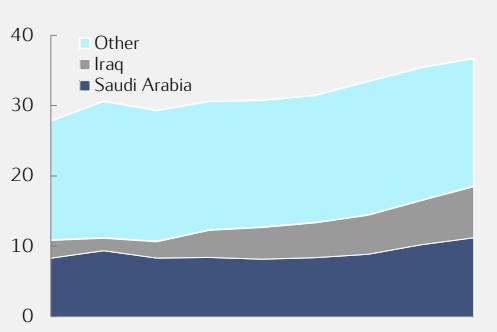
Production of Canadian oil sands, global bio-fuels and Opec NGL/condensate Mbd



Source: IEA (history), Statoil (projections)

*Not energy content adjusted

Opec crude oil production Mbd



Source: IEA (history), Statoil (projections)

advanced economies, there is a huge potential for rising mobility in China and other emerging economies. However, the energy policies of all major countries have a clear ambition to curb the growth in energy and oil demand in this sector. Following the tightening of fuel efficiency standards of vehicles in key economies over the last few years and the proposal for further tightening up to 2025, our expectation is that these trends will continue towards 2040. Furthermore, progress in hybrid and battery technologies suggest that these alternative technologies will be gradually more competitive beyond 2020, which means that electricity and partly natural gas will take increasingly larger market shares.

Oil demand growth decelerates and peaks around 2030

Oil demand in industry and in the household sector has declined over the last two decades. This trend is expected to continue in the decade ahead, while the use of oil in the petrochemical sector is expected to increase somewhat. In aggregate global oil demand growth is expected to decelerate during the 2020s, before it levels out at 103 mbd around 2030. The slowing of economic growth, rising efficiency and further penetration of electricity and gas lead to a reduction of oil demand in most regions through the 2030s.

Eventually conventional non-Opec production starts to decline

Due to the stronger, combined effect of high prices and technological progress the forecast for conventional non-Opec production of crude oil, including tight oil and NGL/condensate for the 2020-2040 period has been revised up somewhat relative to Energy Perspectives 2010 and 2011. Contributions come from several sources. The huge resource base of shale oil in the US suggests that tight oil production may continue to increase well into the 2020s. As noted in Energy Perspectives 2011 there are also prospective shale oil formations in countries outside the US, i.e. in Canada, Argentina and China as well as in Europe. However, for various reasons these resources will most likely be developed more gradually than in the US. In aggregate conventional production of crude and NGLs is now assumed to peak between 2020 and 2025.

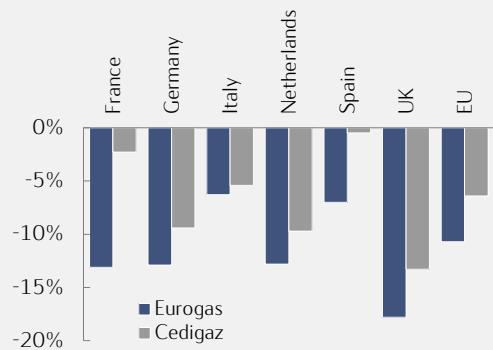
Contribution from oil sands and bio-fuels, and Opec NGL production

The huge oil sands resources in Canada are potentially an important source of oil supply. However, the risk of rapid local cost escalations and the broader environmental challenges suggest that production growth through the 2020s will continue to be moderate. In addition the global production of bio-fuels will continue to grow steadily over the next two-three decades. Finally driven by increased production of natural gas, the production of OPEC NGL/condensate will also grow steadily from 6.3 mbd in 2012 to about 10 mbd by 2040.

Eventually a need for more Opec crude oil

During the second half of the 2020s there will gradually be room for more OPEC crude. Despite a moderately declining oil market beyond 2030, OPEC production grows steadily in the 2030s and reaches 36-37 mbd of crude oil by 2040. Resource depletion suggests that the African members; Angola, Algeria, Libya and Nigeria will struggle to maintain their capacities, while most of the Middle East members and Venezuela have a resource base that allows steady production over these decades. Iraq and Saudi Arabia should see the largest increases in production towards 2040.

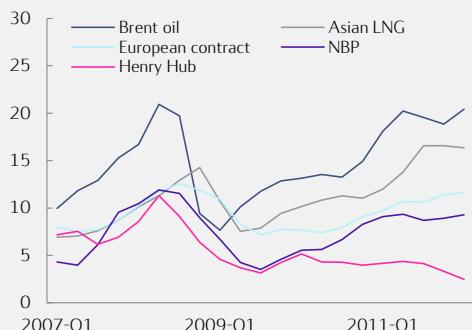
First estimates of changes in EU gas consumption 2011 vs. 2010, %



Sources: Eurogas, Cedigaz

Europe lagging, Asia and North America growing

Key fuel price developments 2007-2011, USD/MMBtu



Source: CERA

A gas glut has developed in the US

The global gas market

Recent developments: Slow demand, growing supply

Europe's gas suppliers will hardly remember 2011 as an inspiring year. According to Eurogas, EU 25 gas consumption dropped by 10.7% or some 56 bcm. First estimates are always uncertain and Cedigaz, another leading source, puts the decline in EU gas demand at "only" 6.4%. In any event there was a drop and it was due to lacklustre economic growth, mild weather and gas, coal and carbon emission permit prices increasingly favouring coal rather than gas for power generation.

US gas consumption increased by 2.5% in 2011. Mild weather capped residential and commercial demand, but a steady decline in US gas prices allowed gas to capture market share in the power sector and stimulated gas intensive industrial production.

Asia's and other emerging markets' gas consumption remains on an upward trend. Cedigaz believes Asian gas use was up 7% last year, led by a 22% jump in Chinese demand and an 11% increase in Japanese gas use. Developments in China, now the world's fourth largest national gas market, show that Beijing is serious about gasification. Japan's current appetite for gas, which belies a 0.5% decline in GDP in 2011, is related to the Fukushima disaster which triggered a craving for substitute fuels.

World gas price developments in 2011 and early 2012 brought fresh evidence that a unified global gas market with price differences reflecting only transportation cost differences will not be a reality any time soon. While Asian LNG import prices in early May 2012 hovered just below 18 USD/MMBtu, European spot prices were in the 9-9.50 USD/MMBtu range. The US Henry Hub reference price dipped below 2 USD/MMBtu in the spring of 2012 before staging a modest recovery to around 2.50 USD/MMBtu in May. Forecasters now ask themselves how long interregional gas price gaps on this scale can be sustained.

Medium-term market perspectives

In the short term, gas prices are dictated by the weather, the state of the economy, supply side shifts and fluctuations in competing fuel prices. In the medium term extending 3-5 years into the future, gas prices reflect many of the same drivers, minus the weather which typically is assumed to revert to "normal" in perspectives longer than one year, plus changes in energy and climate policies.

Current US prices unsustainable

US gas prices will in the medium term be driven by on the one hand the price elasticity of gas supply and on the other hand US power sector economics.

Today's depressed prices reflect above all a turnaround in US gas production adding 142 bcm of mainly shale gas to supply between 2005 and 2011. Over the same period US gas consumption increased by 67 bcm. To accomplish only this annual 1.7% increase in demand, prices had to come down. Sharp declines in the US' net imports of pipeline gas and LNG, and growth in storage capacity, have been necessary to keep the market in balance. An important issue is how robust to the current price trough US shale gas production will prove to be. Most observers think that today's USD 2-2.5 USD/MMBtu Henry Hub price range is below the threshold for sustaining, let alone increasing, production in the medium to

Number of rigs drilling for oil and gas in the US
2007-2012, Weekly averages



Source: Baker Hughes

European gas demand in the medium term a question of economic recovery and carbon price developments

long term. Though producers make money from their ongoing operations, shale gas production requires constant development effort, and gas directed drilling activity is down. The number of gas rigs operating in the US which peaked at 1606 in August-September 2008 was 594 in the last week of May 2012; many rigs have been moved to liquids-rich plays. On the demand side, the only development that can make a dent in the current gas bubble is continued switching to gas in the power sector. Several analysts expect the US power sector to use 40-50 bcm more gas this year than in 2011. In the medium term changes in the regulatory framework could be a major driver. The US Environmental Protection Agency (EPA) has proposed emission standards that will – if they are enacted – raise the costs of coal based power generation to the point of making many plants uneconomic.

In sum we expect US gas prices to recover but only moderately in the medium term. Lease commitments will continue to underpin gas drilling, and associated gas production from the wet shale gas or shale oil plays to which the industry has migrated will dampen the impact of declines in gas drilling on gas production.

The European market: Balancing between policy and supply uncertainty

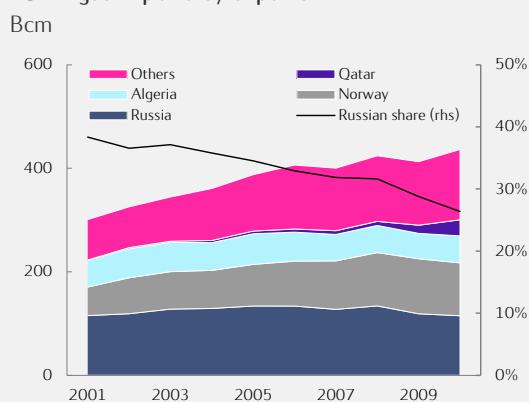
European gas price dynamics differ from US dynamics in a number of respects. Indigenous production which is key to US prices matters in Europe too, but does not represent a major medium-term uncertainty. Demand is as important to European as to US prices, with European gas use being even harder to predict than US demand considering the evolving Eurozone crisis and persistent climate policy and carbon price uncertainty. Imported gas price developments which are irrelevant to US gas price formation, matter very much to Europe.

Imported gas prices may vary depending on global gas supply growth, interregional competition for supply, the market powers of individual suppliers and – since there are suppliers exercising monopolist or oligopolist powers – these suppliers' marketing strategies. In the medium term this list of imported price impulses boils down to two issues: Russia's/Gazprom's marketing and pricing strategy and the European-Asian competition for LNG supply.

Gazprom's design on the European market is subject to much speculation. Gazprom defends oil-linked gas pricing and has to date not been willing to budge even in the face of losses of market share and arbitration threats. Attempts to model Gazprom's revenues indicate that serving as swing producer in periods of oversupply may be a good long-term strategy for the Russian company. Gazprom leaders seem however to consider their current challenges temporary, expecting that European buyers and regulators will soon come to their senses and realise that hub-based pricing as the dominant rather than as a subsidiary principle will erode Europe's gas supply security. Gazprom could, depending on events, come to the conclusion that the swing producer role has too much downside and change tack.

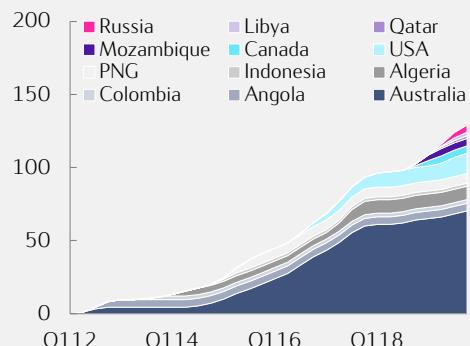
LNG supply added 9.4% in 2011 following an increase of almost 20% in 2010 when 28 bcm/y of new Qatari capacity was launched. This boom

EU 27 gas imports by exporter



Source: Eurostat

Incremental liquefaction capacity by country 2012-2019, mt per year



Sources: Wood Mackenzie, company information, press clippings

European and Asian gas price formation increasingly interlinked by LNG

Chinese shale gas basins



Source: PacWest

Japan's, South Korea's and Taiwan's traditional willingness to pay an LNG price premium under pressure

has helped dampen competition for flexible cargos and contained internationally traded gas prices. However, the Fukushima disaster and the ensuing Japanese scramble for supply boosted the traditional Asian price premium and lifted the Asian share of world LNG imports from 60% to 70% with flexible Atlantic basin LNG meeting a high share of the incremental demand.

For another couple of years the interregional competition for LNG may harden. In 2012 only two single train LNG projects with a combined capacity of less than 10 mtpa will be commissioned, and in 2013 no new LNG plants will be opened at all. In 2014-15 the market could slacken with the launching – barring delays – of the first of the Australian and PNG projects that have received final investment decisions since 2009. LNG market developments will however depend on many more factors, including key North African and Asian producers' ability to sustain exports in the face of stagnant feedgas supply and booming domestic gas demand.

Asian contract prices sustained by oil – forever?

Asian gas demand is set for rapid medium-term growth. Drivers include China's economic expansion and ambitious fuel diversification targets, India's less radical but still noticeable gasification ambitions, South Korea's and the other mid-sized Asian economies' dynamism and Japan's need for substitute fuels for the electricity industry.

Supply will consist of a mix of indigenous gas and LNG. Chinese gas production was 107 bcm in 2011, up from 57 bcm in 2006. China aims to become a leading shale gas producer, but for the next 3-5 years continued output growth will depend on the pace of conventional gas E&D and pipeline construction. India accomplished the same production growth as China between 2006 and 2010, but has run into problems sustaining output from the offshore Krishna Godavari basin.

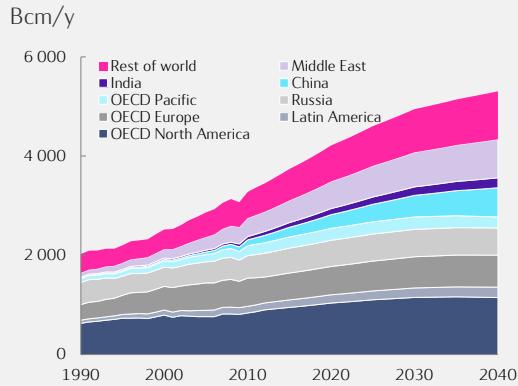
LNG is crucial to Japan, South Korea and Taiwan, important to China and India and entering the fuel mix of several other Asian countries. Asian LNG demand is supplied primarily from within the region and secondarily from the Middle East. The share of Persian Gulf LNG in Asia's supply portfolio – currently about one third – will decline from 2014-15 when Australian liquefaction capacity takes off.

Asian traded gas prices have typically exceeded European prices by a couple of dollars per MMBtu, reflecting transportation cost differences, and a supply security premium the established Asian buyers have been both willing and able to pay. The Japanese, Korean and Taiwanese governments have enabled their utilities to pay this premium by limiting inter-utility competition and maintaining frameworks for cost plus pricing of gas and electricity. These structures are under pressure. Japanese industry can ill afford, on top of its other problems, to continue paying more for fuel and power than its competitors. Steps have been taken to abolish the utilities' local monopolies. The utilities facing increased competition have in turn become reluctant to renew their long-term LNG supply contracts on unchanged price terms.

Buyers and sellers are however reluctant to switch to hub-based pricing. There are no gas hubs in Asia and it is open to question whether hubs liquid enough to provide reliable price signals will emerge any time soon.

Hub based gas pricing a distant prospect in Asia

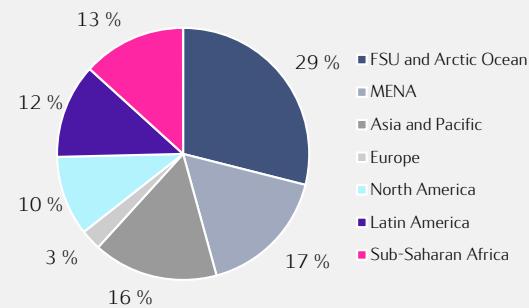
Baseline gas demand assumption



Sources: IEA (history), Statoil (projections)

Ample gas reserves and resources

Regional distribution of yet-to-find gas resources



Source: US Geological Survey

Long run supply cost curves keep changing

The Asian national gas markets may be too dispersed, fragmented and heterogeneous in terms of maturity and policies for that to happen. Adopting price signals from the US or the UK may be attractive for minor shares of total imports, as witnessed by the Asian interest in North American LNG. But doing the same for major shares of imports, i.e., putting them at the mercy of supply, demand and price developments unrelated to Asian fundamentals, would be a risky strategy. Asian market actors have not in the past displayed much appetite for the highest reward - highest risk options. It is assumed that oil-linked gas pricing will prevail in Asia, for the medium if not necessarily for the long term, with buyers using the spot market mainly to top up contracted supply.

Long-term market perspectives: gas demand will grow

Beyond the medium term, the ranges of possible gas price paths widen. However, certain limits to where gas prices can go, and stay for extended periods of time, can be indicated with some confidence.

We see world gas consumption increasing from 3080 bcm in 2009 - the last year for which IEA provides historical figures - to around 4200 bcm/y by 2020, 4950 bcm/y by 2030 and 5300 bcm/y by 2040. These figures imply an average yearly growth of 1.6% in world gas use.

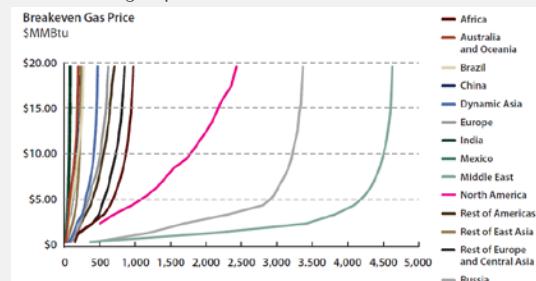
A basic indicator of future supply scarcity or abundance is the level of world gas reserves and resources. BP last year put world proven gas reserves at 187.1 trillion cubic meters corresponding to 59 years of production at 2010 level. In April 2012 the United States Geological Survey published the results of a major mapping of global yet-to-find conventional gas reserves; the USGS believe these total 158.8 tcm with 80% being dry gas and 20% associated gas producible from oil fields. Finally there are the world's shale gas resources, which in in a much quoted study published by the US DOE are put at 163 tcm (net of the FSU's and the Middle East's resources), and whatever volumes that in a more distant future may be produced from the world's gas hydrate endowments. All resource estimates are uncertain and gas in the ground is no guarantee for gas supply. Still the figures leave an impression of a future where gas will not be a particularly scarce commodity.

North America: A matter of supply costs and safety valves

The main long-term issues for the US gas market are the shape of the long-term marginal supply cost curve (LRMC) and market actors' success in identifying and exploiting new sources of demand.

The LRMC is an indispensable but slippery tool for price forecasting. It indicates how much gas that will be economically producible at different price levels. The higher the price, the more gas will be available for evacuation and marketing at a profit. Hence the curve typically slopes upwards. The intersection between this curve and the downward sloping demand curve determines the market clearing gas price at any given point in time, given a competitive market situation. Hence a well-researched supply cost curve and a good understanding of the pace of demand growth - i.e., the pace at which the demand curve will shift to the right in the price-volume axis system - should in principle allow for fairly accurate price forecasting. However, the LRMC only represents a snapshot of reserves and costs as seen at a particular point in time. A secondary problem is that costs and volumes may be inaccurately estimated. The curve may in other words not even be a good, sharp

Example of gas supply cost curves Breakeven gas prices, USD/MMBtu



Source: MIT The Future of Natural Gas (2011)

North American LNG exports set to take off, but scope for growth uncertain

GTL, gas penetration into road transportation more challenging opportunities

A future for gas powered vehicles?



Source: Los Angeles Times

snapshot. For these reasons, supply cost curves keep changing – in times characterized by technological upheavals, the opening up of new production zones, etc., often substantially. A vivid illustration of these dynamics is the LRMC chart to the left, which was published as recently as in 2011 but relies on 3-4 year old data and therefore has a North American curve that today seems questionable.

The current consensus view on the North American LRMC is that it has a long, flat segment dominated by shale gas and allowing for considerable demand growth at virtually unchanged prices. The exact height of this segment in dollars per MMBtu, and where it ends and the curve starts to slope upwards, are however controversial issues. As noted, the recently observed 2-2.5 USD/MMBtu Henry Hub price range is widely considered to be below the curve. Hence prices are widely expected to increase. But exactly where they will be 10 years from now is a moot point.

The hunt for new sources of demand for the oversupplied North American gas market, has so far expressed itself mainly in a drive to establish US and Canada as major LNG exporters. At today's price gaps, liquefying North American shale gas and shipping it abroad makes commercial sense. The US and Canadian gas actors have therefore proposed a dozen LNG projects with a combined capacity of some 200 bcm a year. However, only one of these projects has managed to secure all necessary permits, sales contracts and enough financing to get started.

The outlook for US LNG exports is clouded by push-back from US industry and consumer interests worried about the domestic price impact of shipping US gas abroad at a time when industry and households still struggle to climb out of recession. There is limited sympathy for the gas industry's argument that today's prices are unsustainable. Studies on the price impacts of LNG exports are inconclusive. The issue may nonetheless prevent the permitting of more projects in 2012. The Canadian projects on the list face less resistance, and one of them could well become the second North American LNG project to proceed past the planning stage.

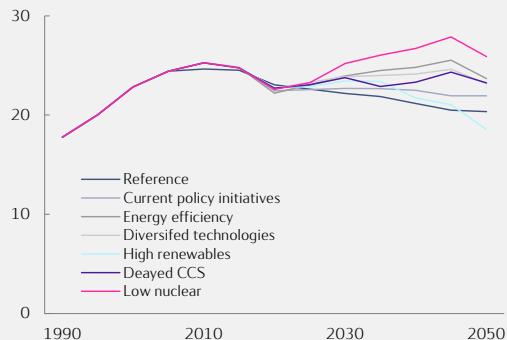
Another two more or less untried usages for North American gas are gas to liquids (GTL) and gas as a road transportation fuel. Some of the companies that have pursued GTL elsewhere talk about setting up shop in North America. However, GTL involves technologies and processes unfamiliar to most actors with a high risk of cost overruns as a result. Building out gas powered vehicle fleets would be comparatively simple; such fleets exist in other countries. But gas vehicles must be perceived as better along all important dimensions than electric, biofuel powered and hybrid vehicles for this to happen. Putting the necessary infrastructure in place will in any event take considerable time.

The US gas market is expected to tighten in the long term. Further substitution from coal to gas in the power sector for as long as gas remains cheap, some growth in industrial gas demand, a gradual build-out of liquefaction capacity and a modest degree of gas penetration into the road transportation sector will eventually put the market back on the upward sloping portion of the supply cost curve.

Europe and Asia: Linked by LNG

Long-term gas price developments in Europe will reflect the impact of policies on gas demand, future Russian priorities, the future availability of

Gas share of EU's total primary energy demand in the Energy Roadmap 2050 scenarios %



Source: EU Commission

European gas imports via the "Fourth Corridor" could fall short of EU visions

LNG supply beyond the Australian projects under construction uncertain, but gas reserves exist to support major growth

Major growth potential for East Africa LNG

Mozambique LNG project: Conceptual Design



Source: Anadarko

supply via the so-called Fourth Corridor and from North Africa, and the future LNG supply-demand balance – to name only some of the pieces in a very complicated puzzle of drivers and constraints.

The impact of policies on gas price formation could be more pronounced in Europe than elsewhere given the EU bodies' will to take the lead in global warming risk mitigation. EU attitudes to gas have changed. In the Energy Roadmap 2050 gas demand is seen to decline, but mainly because total energy demand declines; the Commission no longer sees gas dropping out of the European fuel mix.

The view that Gazprom will still in the 2030s prioritise sustainment of European gas prices could be overly static. Gazprom is already under pressure to liberalise LNG exports. Third party access to Gazprom's export pipelines, or other companies constructing their own pipelines, cannot be ruled out. If the Russian domestic gas market stagnates or shrinks following price reform, calls for liberalising exports could become stronger. However, there are also plausible scenarios where competition does not materialise. Moscow's conviction that Russia is best served by monopolised gas exports could harden rather than soften. Gazprom's potential competitors could find it prohibitively expensive to build out remote reserves and secure transportation to Europe. Gazprom and partners could succeed in Asia and relegate Europe to a residual market.

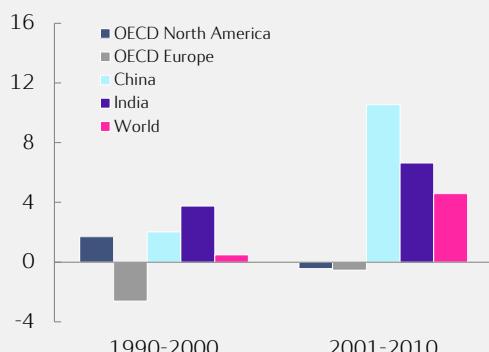
The European Union has invested much prestige in securing "Fourth Corridor" gas, i.e., Caspian and/or Central Asian and/or Middle Eastern pipeline gas imported via Turkey. However, supply via this route may well be limited to Shah Deniz phase 2 gas with the Central Asian exporters currently courting Asia more actively than Europe, and with Russia and Iran continuing to resist a Trans-Caspian pipeline. Also the outlook for North African gas supply to Europe is uncertain.

The level of competition for LNG supply 10-20 years from now will depend on Asian gas demand and indigenous supply growth, the number of new importers on the LNG scene and the pace of LNG supply growth once the string of Australian projects at various stages of implementation or planning are up and running. Asian gas demand will hinge on economic growth rates and Japan's nuclear policy decisions but above all on China's resolve to deliver on its stated gasification ambitions. Observers see Chinese gas demand reaching 4-500 bcm/y by 2030, provided that supply can be found. A key long-term uncertainty is China's degree of success with indigenous shale gas. Available resource estimates suggest that production could become very significant during the 2020s and 2030s, but water availability and infrastructure remain issues.

As for future growth in LNG supply, two regions could conceivably become the "next Qatar" or "next Australia": North America and East Africa. Whether North America gets to play host to 1-2 or 10-20 LNG projects depends on US and Canadian authorities' preparedness to permit more projects, and investors' preparedness to believe that the crucial gas price gaps will remain wide enough for long enough to support these projects. East Africa looks set to become an LNG exporting region with companies announcing new gas discoveries offshore Mozambique and to a lesser extent offshore Tanzania by the month, and with little domestic market pull on the gas. However, as plants, harbours and infrastructure will have to be built from scratch, development will be costly.

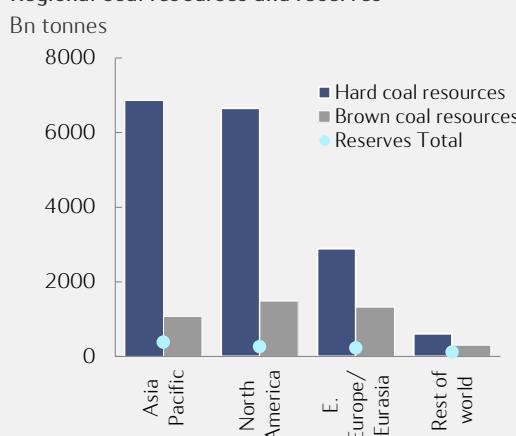
Regional growth in coal demand

CAGR in %



Source: IEA

Regional coal resources and reserves



Source: IEA

Types of coal

Hard coal

High rank coal with a gross calorific value greater than 5700 kcal/kg (23.9 GJ/tonne) on an ash free, but moist basis. Two main types:

- Coking coal: Quality that allows the production of coke utilised in blast furnaces and is necessary in the production of pig iron. Often referred to as metallurgical coal.

- Steam coal: All other hard coal not classified as coking coal. Is used to produce heat/electricity. Often referred to as thermal coal.

Brown coal

Lower rank, non-agglomerating coal with a gross calorific value less than 5700 kcal/kg on an ash free, but moist basis. Mostly used as fuel for electric power generation. Two main types:

- Sub-bituminous coal: Non-agglomerating coal with a gross calorific value between 4165 and 5700 kcal/kg.

- Lignite: Defined as non-agglomerating coal with a gross calorific value less than 4165 kcal/kg.

Source: IEA

Other energy sources

The coal market

Coal was the fastest growing fuel in the last decade, with an annual growth rate of 4.6%, incremental coal use made up almost half of the increase in global energy use. In most Western economies coal demand declined since the turn of the century. The growth in global demand was due to growth in coal fired power generation in China and India, which again was directly linked to the high economic growth in these countries. With a 28% share of the world energy mix in 2010, coal held the position as the second most important source of primary energy behind oil.

Coal remains a preferred fuel for several reasons; (i) it is abundant, (ii) it is typically cheaper than oil and gas, and (iii) reserves are geographically dispersed, implying security of supply and enabling many countries to increase consumption at limited foreign exchange costs. However, coal is also the most carbon-intensive fuel among the energy carriers, and coal burning also releases nitrogen oxides, sulphur dioxide and particulates causing local air pollution problems. In addition, as distances from resources to consumers increase and demand continue to surge, port and inland transportation capacities may become bottlenecks.

Ample supply potential

Availability is one of coal's prominent features. According to IEA, proven global reserves add up to 1 trillion tonnes, equivalent to 150 years of 2009 production. Measured in energy terms, proven coal reserves are approximately 1.4 times larger than proven oil and gas reserves combined. The largest reserves are found in United States, China, Russia, Australia and India. The resource base is significantly greater at an estimated 21 trillion tonnes distributed among 90 countries.

Costs on the rise?

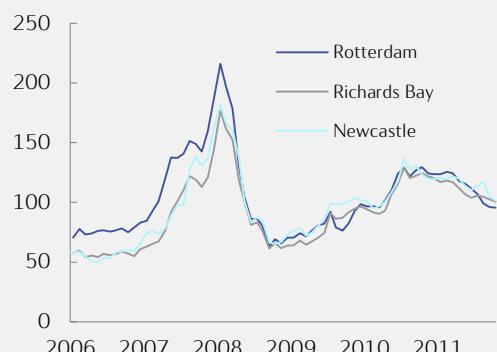
Relative to oil and gas exploration and extraction, coal mining is less capital intensive with operational costs making up most of the overall cost. Increasing input prices have pushed up supply costs in recent years. Differences in geological conditions, mining techniques and labour costs, drive differences in supply costs across exporting regions. Free-on-board (FOB) cash cost for international traded steam coal range from 30-40 USD/tonne in Indonesia and Colombia to close to 80 USD/tonne in Russia, with an average cost of 56 USD/tonne in 2010. Coking coal is generally more costly than steam coal, ranging from 70 USD/tonne for South African and Indonesian coal, to 100 USD/tonne for Canadian coal. High extraction rates, depletion of the most attractive reserves and a gradual shift of mining investments to less productive or more remote deposits are likely to increase the cost of supply going forward. The tightening of environmental standards observable in many countries will also put upward pressure on the costs of coal production.

Domestic and international markets

More than 85 % of coal mining globally is used domestically, reflecting the fact that a high share of countries has their own deposits. Only hard coal is traded internationally - due to brown coal's low calorific value, long haul transportation is not economic. While coking coal is characterised by a relatively uniform world market, seaborne traded market for steam coal is divided between the Pacific market (74 %) and the Atlantic market (26%).

Coal prices

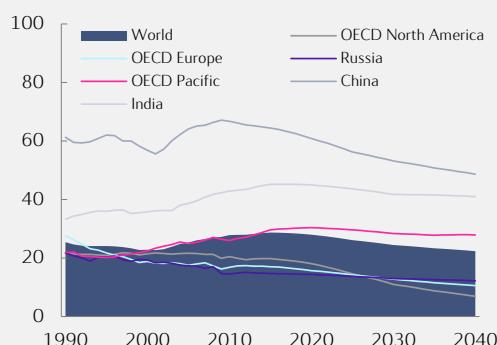
2011-USD/metric ton



Source: Reuters EcoWin

It's all about Asia and coal for power**Coal share of TPED**

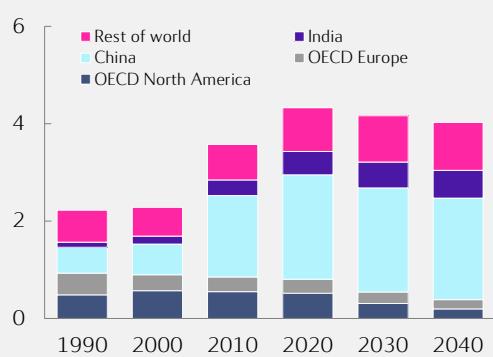
%



Source: IEA (history), Statoil (projections)

Overall growth will peak and gradually decline**Regional composition of coal demand**

Bn toe



Source: IEA (history), Statoil (projections)

Coal prices, like other energy prices on a roller-coaster

International steam coal prices increased from approximately 30 USD/tonne at the beginning of the century to peak of more than 200 USD/tonne during summer 2008. Due to the financial crisis prices fell by 70% to approximately 60 USD/tonne in the spring of 2009. Thereafter they picked up driven by strong demand in China, who became a net importer in 2009, and floods in Australia, to a new peak of some 130 USD/tonne. Recently prices have trended downwards to 90-100 USD/tonne, due mainly to oversupply, switching from coal to gas caused by low gas prices in North America, and sluggish demand growth in Europe.

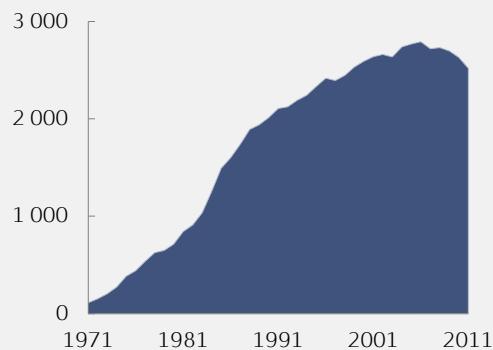
Demand continues to grow, but much slower

This outlook forecasts global coal demand to grow by some 0.4% per year until 2040. This is considerably slower than expected growth in total energy demand. The power sector, which already accounts for 65% of coal demand, is expected to further increase its weight in the coal market. Coal's future position will depend on its competitiveness towards gas, nuclear and renewables. This position will be influenced by the future rules on CO₂ emissions, including the pricing of carbon, and by future local pollution policies and regulation.

Although a global agreement on CO₂ emissions remains elusive, regional and national targets and policies, on CO₂ as well as other emittants, are being enacted. Examples include EU's Large Combustion Plant Directive, 20-20-20 targets and Emission Trading System, the US Environmental Protection Agency's recent New Source Performance Standard and Mercury and Air Toxics standard proposal, and California's and other western North American state's emission reduction and carbon trading schemes. Although these climate policies are seen to have only marginal effect in the current decade, a long-term decline in coal-based power generation is expected. Carbon capture and storage is often referred to as key in reducing CO₂ emissions. Even though the technology exists, only a few demonstration projects have so far been implemented. Successful large scale CCS faces a number of challenges; financing of relatively high investments, higher operating costs and reduced efficiency compared to plants without CCS, development and financing of CO₂ transport infrastructure and safe and permanent CO₂ storage. CCS is assumed to be gradually implemented in the power sector from 2030 in all regions, except Africa and the Middle East. In addition, the industry sector is assumed to undertake some degree of CCS in the OECD economies and China. However, the implementation is assumed to start at a slow pace so that by 2040, only a minority of fossil fuel power plants and small shares of industrial facilities are assumed to be equipped with CCS.

Global coal demand is expected to continue growing until 2020, but decline slightly thereafter. The share of coal in the world energy mix is expected to decline from the current 28% to 22% by 2040. This drop is primarily driven by the mature economies, which are currently moving away from coal, partly due to climate policies. In addition, the shale gas revolution is playing a key role in reducing coal demand in North America. In 2010, Asia accounted for 67% of total coal demand. With a 35% growth towards 2040, Asia is expected to further increase its dominance in the coal market boosting its share to 80%. While India is expected to see positive growth rates throughout the period (2% per year), China may experience marginally negative growth rates from 2020, but will still account for 90% of total increase in coal demand towards 2040.

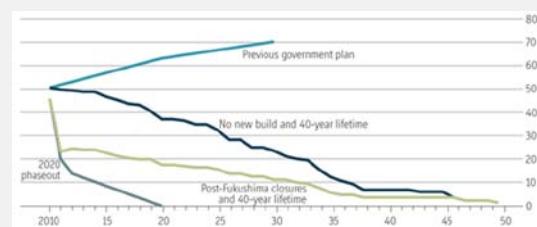
World nuclear power generation 1971-2011, TWh



Source: IAEA, NEI

The renaissance for nuclear has been derailed...

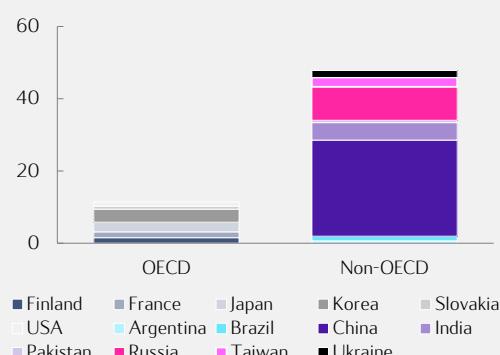
Japanese nuclear power scenarios



Source: The Economist quoting Japan's Institute for Sustainable Energy Policy

...but major expansion is still ongoing

Nuclear power generation capacity under construction Early 2012, GW



Source: IAEA PRIS

Nuclear

Growth, stagnation, growth, stagnation...

Between 1980 and 1988 global nuclear power generation increased by a stunning 13% a year, but in the late 1980s – after the Chernobyl disaster – the curve flattened. Public distrust, mounting regulatory challenges and spiralling costs bred an image of a sunset industry. In 2003, 2007 and 2009 nuclear generation declined not only in relative terms, as a share of total generation, but also in absolute terms.

By 2010, however, power sector observers were expecting a renaissance for nuclear. The industry claimed to have fixed the safety problems that had marred its reputation, and with memories of Chernobyl fading, the public seemed ready to give it the benefit of doubt. The industry also claimed to have rebuilt its competitiveness through standardisation of designs and streamlining of operations. The global warming threat had sharpened the OECD countries' attentiveness to the nuclear industry's claims. China's rapid economic growth had boosted India's and other non-OECD countries' hunger for energy in general and energy that would fix local pollution problems in particular. Existing plant life extensions and major new build programs were being announced.

The Fukushima accident in March 2011 dealt the anticipated renaissance a body blow. Germany, Belgium and Switzerland responded by promising to completely dismantle their nuclear industries. The Japanese government decided to take the country's nuclear power plants off line one after another for extensive safety inspections. By May 2012 not a single one of Japan's 50 nuclear units was up and running. The government hopes to bring most of them back online, but its assurances that the inspected plants are safe do not seem convincing to the public.

...leaving outlook highly uncertain

The Japanese government has also signalled fundamental changes to its long-term energy strategy. It intends to shift energy supply from nuclear and fossil fuels towards renewables. Scenarios portraying different ways of – and timelines for – phasing out nuclear power generation are being discussed. A similar discussion is underway in another country that has betted heavily on nuclear, France. Incoming President Francois Hollande wowed last year to reduce the nuclear share of French power generation from 77-78% today to 50% by 2025, prioritising instead renewables and energy efficiency.

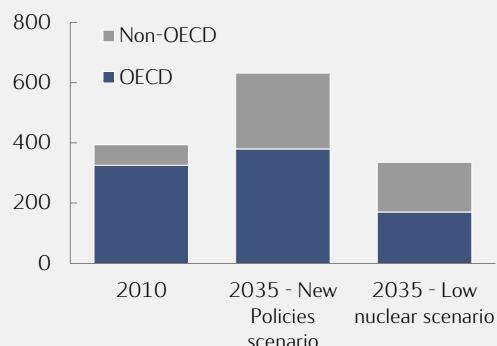
Elsewhere interest in nuclear power remains mixed. China has lowered its 2020 target for nuclear generation capacity from 86 GW – announced before the Fukushima accident – to 70 GW. This is still an ambitious target (though no more aggressive in terms of capacity additions per year than the US and France managed in the 1970s and 1980s, respectively) and construction of 26 new reactors is ongoing. Russia and India have 11 and 7 reactors under construction with combined capacities of 9.3 GW and 4.3 GW, respectively. South Africa, Argentina and Poland are vocal about their nuclear expansion plans. In the Middle East, however, talk about large scale nuclear programs has so far not led to much action.

In the US the Nuclear Regulatory Commission permitted the building of four new 1000 MW reactors in Georgia and South Carolina in February this year. That was an event since the NRC had not given the green light

Still political support for nuclear, but commercial and regulatory hurdles

World nuclear capacity in IEA's New Policies and Low Nuclear scenarios

GW

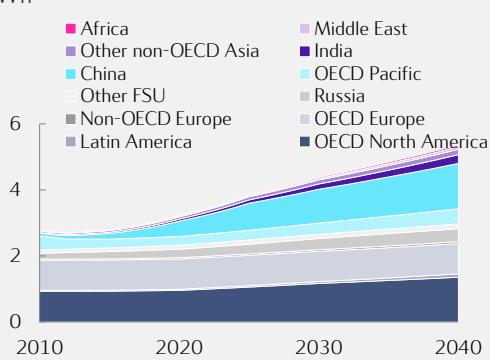


Source: IEA World Energy Outlook 2011

Costs are a major issue

Nuclear power generation assumptions

PWh



Source: IEA (history), Statoil (projections)

to new builds since the Three Mile Island accident in 1979. President Obama supports nuclear energy, and the permits were hailed by some as proof that the government's incentives were working and that the renaissance was underway after all. Others are less sure, pointing out that nuclear electricity requires electricity pricing on a cost plus basis which is available only in a handful of US states, limiting the scope for growth.

The UK government is also trying to pave the way for nuclear, but its calls on industry to invest have met with limited success. Last autumn UK utility Scottish and Southern Energy pulled out of a consortium planning to build new capacity at Sellafield, and in March E.ON and RWE announced that a plan to build up to 8 GW of nuclear capacity in the UK was off. A third project owned by EDF and Centrica looks likely to become much more expensive than envisioned with the sponsors requiring clarification of the price guarantees for low-carbon generation included in the proposed UK electricity market reform.

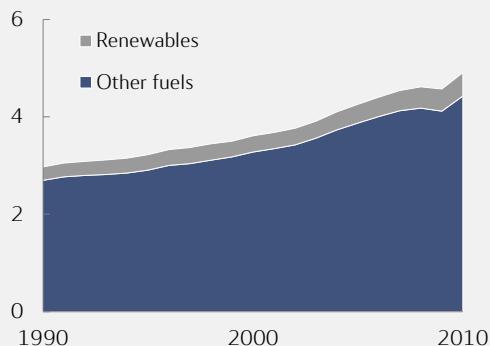
Nuclear energy struggling to be cost-competitive

Costs remains an issue for nuclear. Levelised cost estimates are inconclusive (see discussion on p. 26-27). What is clear is that the shale gas revolution depressing gas prices in the US to 2-3 USD/MMBtu has seriously weakened the commercial case for nuclear in North America, and could eventually erode it in other regions as well.

Non-OECD countries' share of world nuclear power generation capacity increased from slightly below 12% in the mid-1990s to almost 17% in 2010. That shift will accelerate. Eight non-OECD countries account for almost 80% of nuclear capacity currently under construction. China alone accounts for 47%. China, and to lesser degrees India and other emerging economies, face increasingly cumbersome combinations of energy scarcity and pollution problems, and therefore need to pursue all available energy options with a particular emphasis on the cleaner ones. Although costs and safety matter everywhere, a country like China cannot afford to turn its back to an option even if it is not the cheapest one available and have caused losses of lives in other countries. These problems arguably pale against China's other challenges.

In this outlook nuclear power generation is projected to increase by an average of 2.2% per year between 2010 and 2040 with growth accelerating from 2020-25. In OECD Europe and especially in the OECD Pacific countries the nuclear share of total power generation is seen to decline. On a global basis a moderate increase driven by strong capacity growth in particular in China, India and Russia is expected. The major emerging economies are as noted not in position to ignore any proven energy production technology, and if the global warming threat continues to manifest itself, the developed world will not be able to ignore the leading zero carbon option for long either. That being said, another major nuclear accident while people are still pondering the learnings from Fukushima could undo these arguments and force massive declines in nuclear power generation irrespective of the CO₂ emission consequences.

Power generation 1990-2010, Bn toe



Source: IEA

Diversification enabling energy security

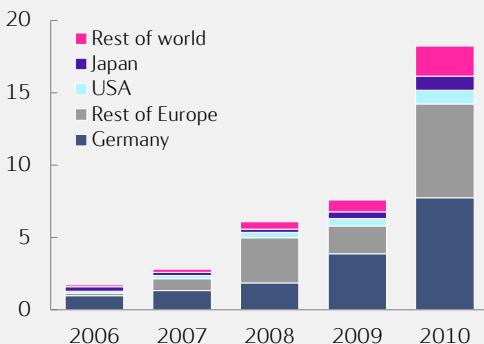
Hydro power consumption 2010, Mtoe



Source: IEA

Record levels of new wind and solar capacity

New solar photovoltaic (PV) installations GW



Source: Solarbuzz

High growth in renewable power generation

Since 1990, the power sector's use of renewables has grown at an annual rate of 2.8%, while overall renewables consumption has increased by 2.1% per year. Growth has accelerated since the turn of the century. Geothermal, wind and solar power generation, i.e. the so-called new renewables, have seen the highest growth rates, expanding by 5.8% per year, compared to hydro and biomass and waste with annual growth rates at 2.2% and 2.5% respectively. In spite of the progress for new renewables, the combined share of all renewables in power generation has remained fairly constant at approximately 10%, since hydro power generation has increased comparatively slowly. More than 80 countries have renewable energy policies such as feed-in tariffs and tradable green certificates. However, the shares of new renewables and biomass/waste in power generation remain so low that even stronger incentives than those in effect today may be needed to alter this share significantly.

Attractive renewables on the rise

Power generation based on renewables will continue to capture market shares. Renewables is key to all green scenarios. They also benefit from widespread availability of sunshine and wind, they represent an answer to countries' fuel diversity and security needs, and there are expectations of further technological progress and cost declines.

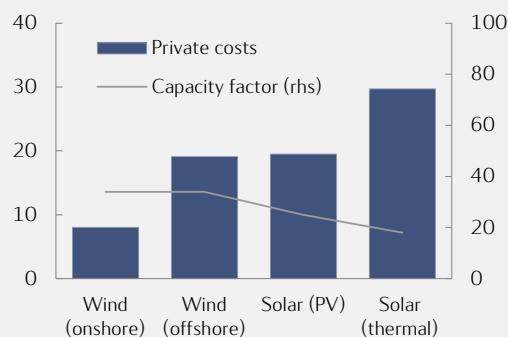
Since 1990 global hydro power generation has increased at about the same rate as total generation. Consequently its contribution to the total has been fairly constant at around 6%. Global hydro power generation reached an estimated 3430 TWh in 2010, with OECD North America, Latin America, China and OECD Europe accounting for more than $\frac{3}{4}$ of the total. As there is limited remaining potential in the OECD economies, emerging economies are expected to account for the bulk of new hydropower capacity in the coming years. Significant investments in transmission capacity will be required to connect remotely located resources with load centres and to increase the capacity of existing grids.

Wind energy has raced ahead since the mid-90s with an annual growth in global capacity of more than 25%. By 2011 global installed wind power capacity had reached 238 GW, up 21% from 2010. China accounted for 44% of all new capacity in 2011, contributing to the emerging economies surpassing the developed economies in annual installation of capacity. Currently wind power is generated in 80 countries, with close to 75% of capacity located in China, the US, Germany, Spain and India.

Solar photovoltaic electricity (PV) generation exploded in 2010, marking a 139% increase in one single year. More than 18 GW of new capacity was installed, raising total capacity to 40 GW. Solar PV remained on a steeply rising trend in 2011 when another 27 GW of capacity – representing a near 60% growth on the 2010 total – was installed. Europe dominates the global market with more than 80% of installed capacity in 2010, closely followed by Japan and the US. China is expected to surpass Japan and the US in 2011 and become the largest generator after Europe. Apart from its other attractions, solar PV's growing success can be attributed to recent cost reductions, driven by new technology, economies of scale, increasing efficiency – and an emerging solar panel oversupply situation that could lead to bankruptcies, consolidations and possibly trade wards and cost set-backs in the future.

Wind and solar are changing the game...
... requiring flexible power systems

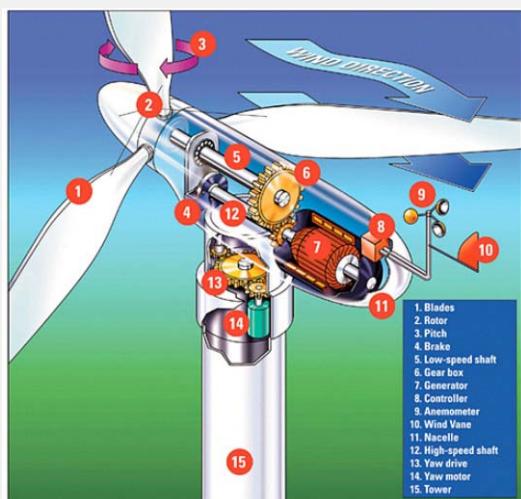
Private electricity cost of solar and wind US cents/kWh and % (rhs)



Source: MIT CEEPR: Paying Too Much for Energy? The True Costs of Our Energy Choices (2012)

True cost of electricity indicates renewables approaching competitive levels

Components of a modern wind turbine



Source: Alternative Energy

The increasing share of new renewables in total power generation is not without challenges. Wind and solar power supply depends on the weather and on daylight, and is consequently intermittent. Moreover the new renewables convert directly into electricity and cannot be stored and transported like conventional energy sources. The call for load-balancing services will increase significantly. Thus, power systems must become more flexible, able to turn on and off the various energy sources and able to shift electricity from oversupplied to undersupplied regions frequently and quickly. Consequently, large infrastructure investments will be needed in expanded transmission power lines and smart grids.

Renewables reducing the cost gap

Despite recent cost reductions, their expensiveness remains an important barrier to further growth in the new renewables' shares of power supply. While the variable production costs are relatively low or close to zero, the initial investments are significant.

MIT estimates (see chart on p. 27 and the chart on this page) that hydro power is very competitive and geothermal viable. However, these options have limited growth potential. Onshore wind is approaching cost competitiveness, but the solar technologies – in particular solar thermal – and offshore wind appear to have some way to go. Wind and solar plants suffer in cost terms from their intermittent nature. To achieve capacity factors comparable to those of fossil fuels based power plants, they need output prices that cover the costs of having gas or other back-up capacity at hand, when the wind does not blow or the suns does not shine. They also as a rule need to be able to pay for new power transmission infrastructure since the ideal places for wind and solar power plants may be far from consumption centres.

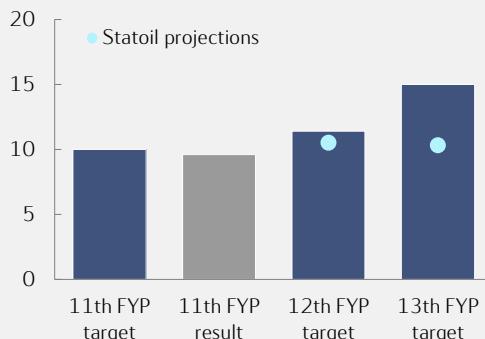
Medium-term renewable targets adopted globally

Increased reliance on renewables is widely considered a key tool in climate-change mitigation. Examples of targets in key regions are:

- The EU member countries in 2007 agreed to raise the share of renewables in their final energy consumption to an average of 20% by 2020.
- In the US 24 states accounting for more than half of US electricity consumption, have adopted renewable portfolio standards and aim on balance for a 17-18% share of renewables in their power supply within 2020. In addition, California signed a law in 2011 raising the state renewables target for 2020 to 33%.
- China's 12th five year plan envisages a growth in the share of non-fossil fuels in primary energy supply from 9.6% in 2010 to 11.4% by 2015 and 15% by 2020. Wind-based power generation capacity is planned to go from 42 GW by the end of 2010 to 150 GW by 2020. As for solar photovoltaic energy, China is targeting 5 GW of capacity by 2015 and 20 GW by 2020.

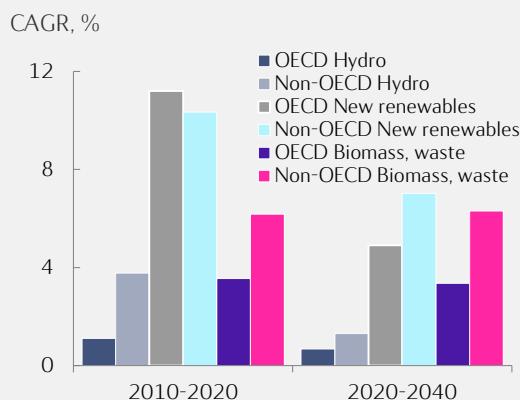
Various policy incentives are in place or under consideration with a view to attain these targets. The optimisation of incentives is however a tricky task, for several reasons. If they are set too low they do not work. If they are set too high they may attract investments in intermittent energy to the point of threatening the integrity of power systems. They may also – as several countries affected by the Euro area crisis experienced in 2011

China five year plan targets for new energy Share of total consumption



Source: HSBC: Delivering Low Carbon Growth – a Guide to China's 12th Five Year Plan, Statoil (projection)

Growth in renewables



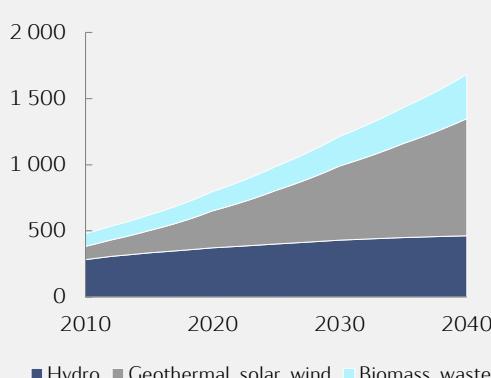
Source: Statoil

New renewables drives growth in power generation...

....incentives and stable policy framework crucial

Renewables in power generation

Bn toe



Source: IEA (history) Statoil (projections)

- become difficult to finance. A challenging trial-and-error process lies ahead.

This outlook expects policy frameworks to remain supportive of new renewables, though not to the point of delivering in full on announced capacity and supply targets. By 2020 renewables are assumed to make up 15% of total primary energy supply, and contribute 22% to power generation, in OECD Europe. By 2040 the latter contribution has reached 32%. In OECD North America renewables is expected to amount to approximately 21% of total primary energy supply and account for 28% of power generation by 2040. The share of renewables in China is expected to be in the 10-11% range 2015 and 2020.

Fast growth – claiming a material market share

Hydro electricity is currently the dominating component of renewable energy supply, but is seen to grow no faster than 1.7% per year. Non-OECD is expected to provide most of the increase. The projected share of hydro in power generation is expected to provide most of the increase. The share of hydro in global power generation is expected to remain at its current level throughout the period.

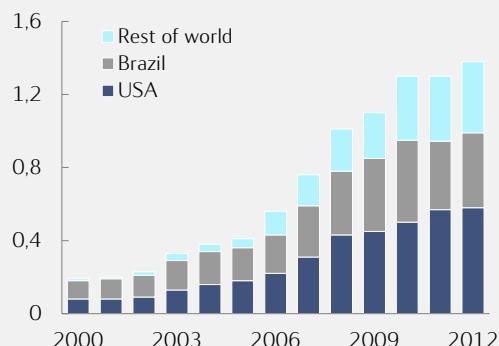
According to this outlook, wind and solar power generation taken together will increase at a rate of 7.5% per year going forwards, resulting in a level in 2040 almost 10 times higher than in 2010. Globally these renewables are expected to see the highest growth rates in the first decade. At the regional level the OECD area is expected to see the fastest expansion in these early years. Since economic growth is expected to hold up better in the non-OECD than in the OECD economies, the former area will provide the bulk of growth in renewables after 2020. Wind, solar and geothermal power generation starts from low levels in 2010, but is expected to make up 11% of global power generation by 2040.

Energy production from biomass and waste (including biofuels, see next chapter) is projected to grow at an annual 4.2% throughout the period. With a share in power generation increasing from 2% to 4%, these fuels will remain the smallest renewable item in the global power sector's fuel mix.

Sustainment of high growth rates for renewables will depend on a number of factors; such as continued efficiency improvements and cost declines, stable and long-term policy incentives ensuring competitiveness, and investments in infrastructure ensuring a smooth integration of renewables into the local power systems.

While this outlook sees renewable energy supply doubling towards 2040, with an annual growth rate of 2.5%, an even higher growth rate of 4.3% per year is expected for the use of renewables in power generation. Growth is seen to amount to 5.2% per year in the 2012-20 period, before abating to 3.8% per year in the last two decades. The envisaged growth performance boosts the share of renewables in global power generation to 21% 2040. Renewables are seen to outperform the power sector's other energy sources - which are assumed to grow by 1.2% per year – and to contribute close to 40% of total growth in power generation. They are seen to expand at the expense of mainly coal and oil, which consequently lose market share in the power sector.

Global bio-fuels production Mbd*



Source: IEA (history), Statoil (projections)

* On an energy adjusted basis

Outlook for global bio-fuels production

Renewable and sustainable energy carrier?

Although bio-fuels, hydrogen and electricity often are deemed as renewable fuels for the transportation sector, questions have been raised about their true renewable nature. IEA 2010 concludes that bio-fuels – produced from biomass – are unquestionable renewables when produced in a sustainable way. In the energy accounting system, bio-fuels are part of the “Biomass and waste” category. In 2009 the global use of biomass and waste was 1230 mtoe, which represented 10% of the world’s total primary energy demand. However, global bio-fuels represent only a small fraction of that; 54 mtoe on an energy adjusted basis in 2010. Up to now bio-fuels are used almost exclusively for road transportation, but interest in the use for aviation is growing.

Global bio-fuels production has risen strongly

Global production of bio-fuels increased strongly from the mid-2000s and reached 1.3 mbd in 2010 on an energy adjusted basis. USA and Brazil, the world’s largest producers, account for about 75% of global production of bio-fuels for transportation. Due to a poor sugarcane harvest and high sugar prices in 2011 Brazilian bio-fuels production fell by 15%, which led to stagnation in global production. Despite the rapid growth in their use in some countries, bio-fuels consumption only represents 2-3% of total energy demand in the transportation sector.

The rise in production has been policy driven

The rising production and consumption of bio-fuels have been strongly driven by government intervention, primarily in the form of obligations to blend bio-fuels into conventional fuels (blending mandates), production subsidies or both. Many bio-fuels programmes were conceived as part of farm-support policies, but a growing number of governments are now expanding or introducing such programmes for energy security, economic and environmental reasons. The EU’s bio-fuels target is part of its ambitions to reduce CO₂ emissions.

High production costs outside Brazil

Outside of Brazil, bio-fuels generally cost much more to produce than conventional gasoline and diesel. By using existing technologies, through upscaling and improving logistics, further cost reductions are achievable. Advanced bio-fuels, like BTL bio-diesel or ligno-cellulosic ethanol, are currently not competitive with conventional fuels and are mostly in the demonstration phase, but are expected to be commercialized by 2020.

Continued and steady rise in production

Although bio-fuels have grown strongly over the last five years, the future pace of expansion is dependent on how the sustainability challenges are handled. These include net greenhouse gas effects, food security and bio-diversity. Based on the assumptions that a constructive policy framework will be put in place, including dedicated government support for research, development and deployment of advanced bio-fuels, global bio-fuels production is expected to grow further over the next three decades. From a level of 1.3 mbd in 2010, global production is projected to reach 2 mbd in the first half of the 2020s and almost 3 mbd by 2040. Production growth is expected in most key regions.

Conventional bio-fuels

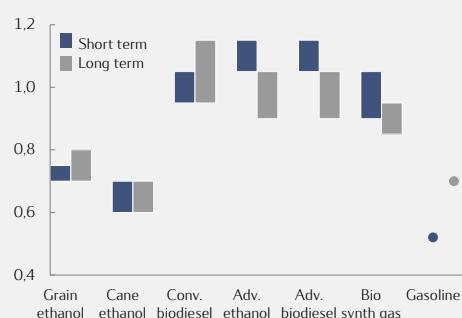
Include well established technologies, that are producing bio-fuels on a commercial scale today. These bio-fuels are commonly referred to as first-generation and include sugar cane ethanol, starch-based ethanol biodiesel, Fatty acid methylester (FAME) and Straight vegetable oil (SVO).

Advanced bio-fuels

Sometimes referred to as second- or third-generation bio-fuels comprise different conversion technologies that are currently in the research and development, pilot and demonstration phase. More specifically this category includes emerging bio-fuels technologies, such as hydrogenated bio-diesel, which is based on vegetable, as well as those based on ligno-cellulosic ethanol biomass to liquids (BTL) diesel and bio-derived synthetic natural gas.

Bio-fuels production costs by technology

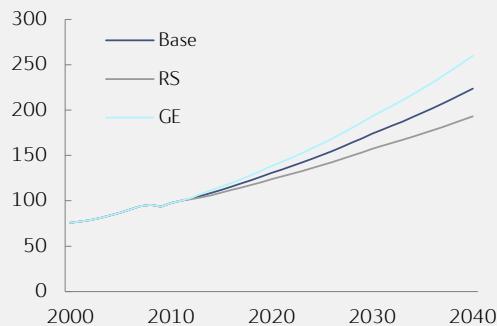
USD/litre gasoline equivalent



Source: IEA

Exploring alternative development paths

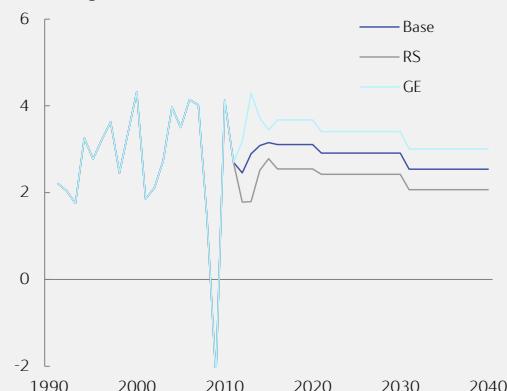
Global GDP development in the three alternatives
Index, 2011=100



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

Several futures are possible...

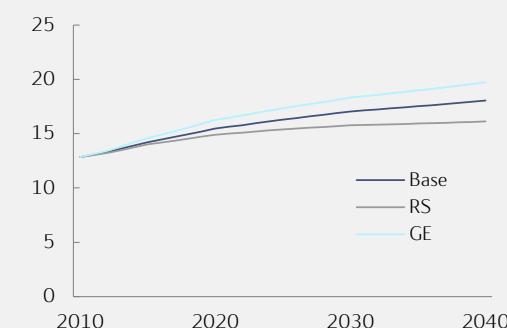
Global GDP development in the three alternatives
Annual growth, %



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

... differing in terms of growth, energy efficiency and policy

Total primary energy demand in three alternatives
Bn toe



Source: IEA (history), Statoil (projections)

Long-term development is uncertain

30-year forecasts of the global economy and energy markets are uncertain. The estimates presented in the previous chapters represent the most likely trajectory for total primary energy demand and fuel mix, based on initial conditions and the most likely development in the key energy market drivers. However, “most likely” forecasts over a 30-year horizon are not necessarily the same as “very likely”, and the probabilities associated with various alternative paths are indeed non-negligible.

This chapter illustrates a couple of alternatives for how total primary energy demand and fuel mix could evolve if the key energy market drivers develop differently from what we have assumed in the base case. Two alternative “states of the world” are explored, where some assumptions are different from the base case, and consistently so. These alternative “states of the world” are not complete descriptions of a different development path, but rather illustrations to highlight that the world could develop in different directions from the most likely development captured by the base case.

More revolutionary changes, trend breaks and completely unforeseen changes with large impact (so-called “black swans” or “unthinkables”) could of course also not be excluded. Examples include energy technology breakthroughs, large-scale civil unrest, pandemics, climate-driven hunger and water conflicts, or a combination which go beyond our current imagination. The very nature of such events is that they are difficult to predict. They are therefore not included in the alternative scenarios of this outlook.

Consistent, alternative combinations of drivers

The key energy market drivers are: economic growth and consumption patterns; energy and climate policies; technological developments affecting costs of supply as well as level of demand; relative prices; and the availability of critical resources affecting production. The latter driver, or constraint, is not only the energy resource itself, but also the availability of necessary resources to transform the energy resource into reserves and production. A concrete example could be the availability of water in areas with tight oil and shale gas resources.

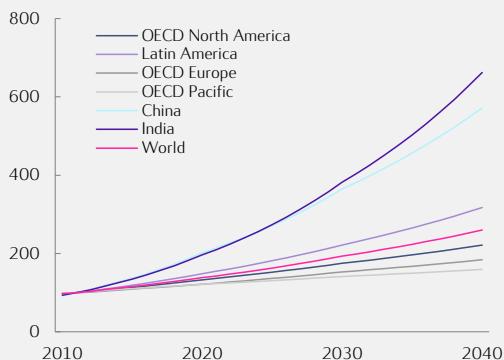
When establishing alternative development paths, plausible assumptions are combined in a consistent manner, so that the result stands out as more likely and relevant than any accidental combination of events. This reflects a conscious decision not to choose an approach which would maximise the difference to the base case in terms of final outcome in total primary energy demand or fuel mix. Rather, the focus has been to find alternative assumptions on economic growth, energy and climate policies and technological progress that are possible in isolation and plausible in combination. The disadvantage of this approach relative to a more radical one is that the difference between the alternatives may turn out relatively small. The advantage is that the result could be credible.

An alternative world: “Globalised expansion” (GE)

Higher GDP growth ...

The base case forecasts annual global GDP growth at 2.8% per year towards 2040, with regional growth rates ranging from 5.9% (India) to

Regional GDP development in the GE alternative Index, 2011=100



Source: Statoil

Higher growth based on technological progress will increase energy demand...

... but also increase the share of renewables in the fuel mix

Regional GDP growth in the different alternatives CAGR 2010-2040, %



Source: Statoil

1.3% (OECD Asia Pacific). It is possible to envisage a development path with a higher average growth. This could be caused by higher technological progress and consequent productivity growth; less impediments to competition; extended globalisation and thereby market efficiencies; structural reforms yielding higher capital efficiency and generally higher returns from R&D investment.

Embedding somewhat larger expansion in the relevant assumptions of the growth-accounting framework of this report produces an alternative path where global GDP increases by 3.3% per year towards 2040, with regional differences ranging from 6.7% (India) to 1.6% (OECD Asia Pacific). Realising such a higher growth trajectory would imply that structural policy reforms are implemented more swiftly in Europe than what is assumed in the base case. It would also imply demographic headwinds in emerging markets are offset by market reforms to ensure extended progress in capital efficiency and technology improvements, in particular in China.

... and improved energy efficiency, driven by technology and policy

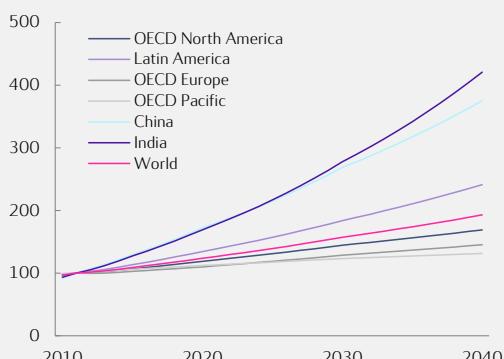
A technology-driven improvement in GDP growth caters for even more optimistic assumptions on energy efficiency development in OECD and some emerging economies. Presumably, part of the reason for higher productivity development and capital efficiency could be a quicker transfer to energy-efficient capital equipment through "green investments", in combination with the removal of energy and other subsidies. However, given that the largest increases in growth rates are in economies that are less energy-efficient at the point of departure, this reduces the impact on overall energy efficiency.

In a situation where the economy's ability to grow is higher, there will be more room of manoeuvre and political acceptance for tighter energy and climate policies. Therefore, improved global economic development is believed to facilitate implementation of somewhat tougher energy and climate policy measures both in OECD and elsewhere. The isolated effect of such measures would contribute to lower energy demand and a larger shift towards climate friendly fuels, both via the price mechanism and via direct regulations affecting fuel mix, moderating the direct expansionary effect of higher energy demand. Technological improvements and higher impact of R&D could also lower the long-term marginal cost of unconventional oil and gas resources, as well as the costs of new renewables, improving the ability to balance supply with demand at only moderately higher prices than in the base case.

This alternative therefore contains these differences from the base case:

- Higher GDP growth and moderately higher oil, gas and coal prices
- Higher policy-driven energy efficiency improvement in all sectors
- Increased penetration of new renewables and nuclear energy in the power sector
- Higher share of electricity in final energy demand in the residential and transport sectors
- Quicker removal of some of the subsidies to fossil fuel consumption
- Faster and more extensive implementation of CCS along with more widespread pricing of CO₂ emissions.

Regional GDP development in the RS alternative Index, 2011=100

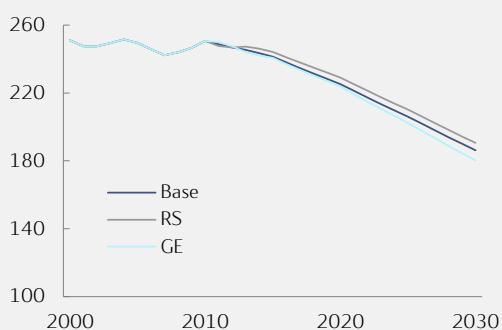


Source: Statoil

Slower growth in GDP and energy demand...

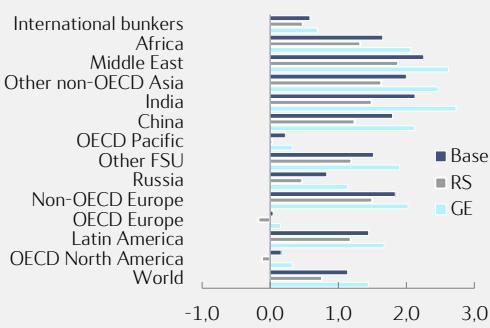
... combined with slower development of new energy

Energy use per GDP in three alternatives Toe/million 2005-USD



Source: IEA/HIS Global Insight (history), Statoil (projections)

Regional energy demand growth in the alternatives CAGR 2010-2040, %



Source: Statoil

Another alternative: "Regionalised stagnation" (RS)

We are not out of the woods yet – growth could be lower...

Given the uncertainties around the base case GDP growth, it is also easy to envisage a less positive development. This is particularly so in light of the on-going troubles in the aftermath of the financial crisis (Europe and elsewhere); after the Arabian spring (Middle East and North Africa); and generally in aging societies (Japan and other low growth economies). Increased protectionism between trade regions, failure at delivering on structural reforms, and unrest due to high unemployment and income inequalities are factors that by themselves or in combination could bring the overall GDP growth lower than in the base case. Another alternative is therefore developed, assuming that the structural challenges in Europe are not pursued with vigour. Furthermore, fiscal deficits and sovereign debt continue to constrain a positive labour market development across OECD and limit productivity-enhancing, public investments in education and R&D. Finally, aging of the workforce is not compensated by other productivity developments. Thereby, globalisation efforts, exploitation of comparative advantages and productivity will contribute less to capital efficiency than in the base case. In this scenario, average GDP growth would amount to 2.3% per year on average, ranging from 5.1% (India) to 0.9% (OECD Asia Pacific).

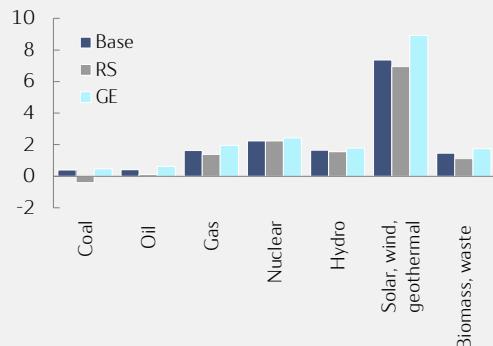
... with efficiency and renewables developing more slowly

Slower growth means less money is available for the promotion of energy efficiency. Less economic resources are also available for private sector investments in new, more energy-efficient capital equipment or in new energy solutions, including renewables. And there is potentially less need (lower energy demand) and less ability (lower tax revenues) to subsidise the transition to a low-carbon future through CCS and CO₂-saving fuel-switching. On the other hand, given that the climate policy assumptions in the base case only takes significant effect in a decade or so, the policy assumptions on CO₂ pricing and CCS from the baseline scenario could also apply in this alternative. Fiscal budget challenges could lead to a moderately quicker phase-out of fossil fuel subsidies in some regions, while medium-term stimulus to growth in new renewables in the power sector could be dampened. Consequently, energy efficiency and fuel switching will tend to develop more slowly in this scenario than in the base case. More moderate energy demand and slower technological progress will also reduce growth in unconventional oil and gas supply outside North America, dampening the reduction in energy prices.

This alternative therefore contains these differences from the base case:

- Lower GDP growth
- Moderately lower oil, gas and coal prices
- Lower policy-driven energy efficiency improvement in all sectors
- Slower medium-term penetration of new renewables in the power sector
- Quicker removal of some of the subsidies to fossil fuel consumption

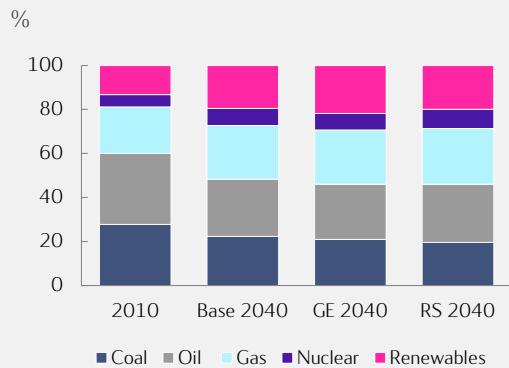
Fuel specific growth rates in the three alternatives CAGR 2010-2040, %



Source: Statoil

22% difference in energy demand, 35%
in GDP

Global energy mix in the three alternatives

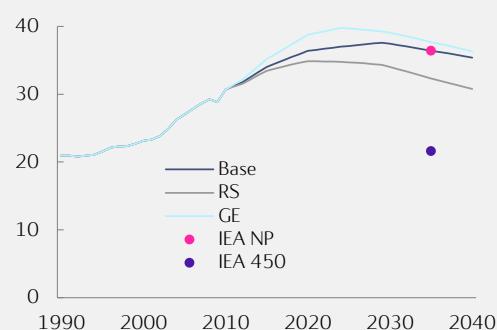


Source: IEA (history), Statoil (projections)

Fossil fuels dominant in all alternatives

CO₂ emission trajectories in the three alternatives

1990-2040, billion tonnes



Source: IEA (history), Statoil (projections)

Alternative energy demand paths

Total primary energy demand developing differently

The three alternative states of the world differ across a large set of assumptions. This is so even if key assumptions have been combined in a plausible and consistent manner, rather than choosing revolutionary differences in assumptions across the alternatives. Given the relatively slow, non-revolutionary, adjustments projected to take place in household behaviour, industrial structure, capital structure and power production equipment in the different economies, the differences in total primary energy demand in the three alternatives are also moderate. Average annual growth in TPED ranges from 1.4% in the GE alternative, via 1.1% in the base case to 0.8% in the RS alternative. The result is that TPED is some 22% higher in the GE alternative in 2040 than in the RS alternative. GDP levels, on the other hand, differ by 35%.

The variation in assumptions across alternatives has implications for the regional variation in energy demand. In the low alternative, overall energy demand declines from 2010 until 2040 in OECD Europe and North America. In the RS alternative, energy demand growth is highest in the Middle East, at 1.9% per year on average, while India delivers the highest energy demand growth in the GE alternative, at 2.7%.

Moderate differences in global energy mix

The different trajectories for energy demand combine into varying growth rates per energy carrier. In all the three alternatives, coal grows at the lowest pace, between 0.5% (GE) and -0.4% (RS) per year on average. Conversely, new renewables (solar, wind and geothermal) has average growth rates between 6.9% and 8.9% annually.

As a consequence, the global fuel mix varies only moderately across alternatives. Observe that the coal share of the fuel mix is lower in both alternatives than in the base case. Coal demand is other things equal the fuel alternative that is most directly associated with variations in GDP growth. Therefore, GDP growth drives the coal share of fuel demand higher in the GE alternative, and lower in the RS alternative. The assumptions on efficiency, technology and policies change this result in the GE alternative, where the assumptions combine to increase the market share of gas and especially new renewables at the expense of coal.

CO₂ emissions also differ

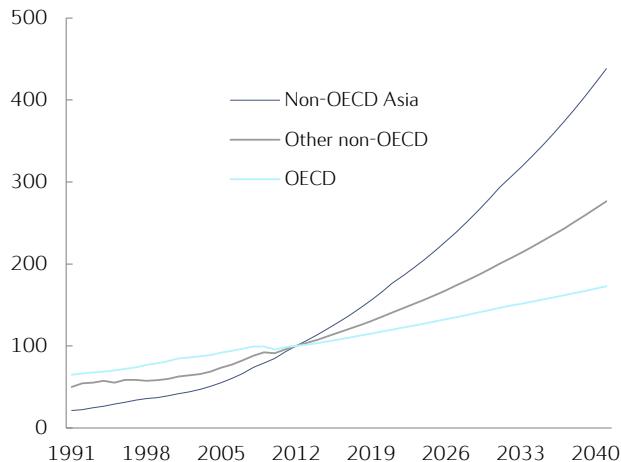
The three alternatives differ noticeably in terms of energy-related CO₂ emissions. The base case CO₂ emissions peak in 2029, before lower energy demand growth, increased impact of renewables, and CCS start playing a role. In the GE alternative, higher energy demand leads to higher emissions, but the peak is in 2024, since stricter climate policy assumptions and faster penetration of new renewables gradually kick in. The peak in CO₂ emissions is even earlier in the RS alternative, driven by the very moderate development in overall energy demand growth. In 2040, the CO₂ emissions in the GE alternative are 18% higher than in the RS alternative, a smaller difference than that in energy demand, but still considerable. This illustrates that an alternative with high growth will call for much tighter energy and climate policies than a world characterised by low rates of growth in activity and energy demand

Chart appendix

Economic growth

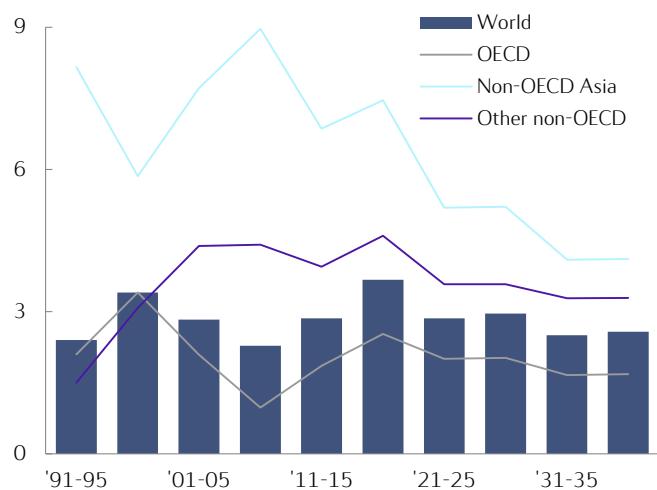
World GDP levels 1991-2040

Real, index, 2011 = 100



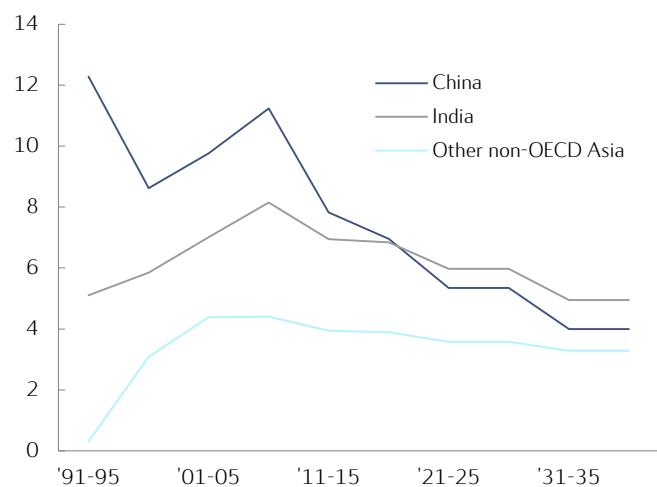
World GDP 1991-2040

5-year annual growth rate (CAGR), %



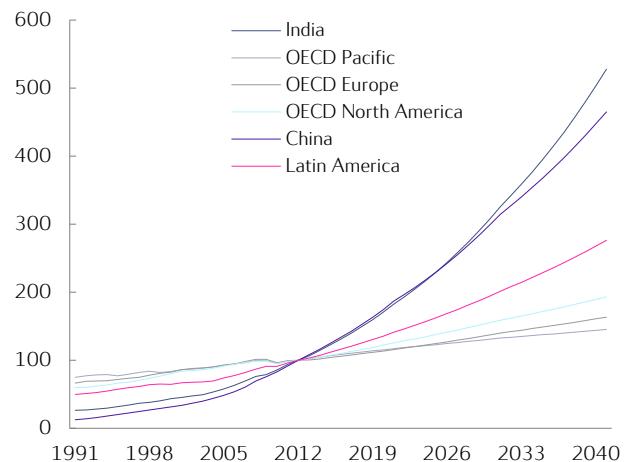
Non-OECD GDP 1991-2040

5-year annual growth rate (CAGR), %



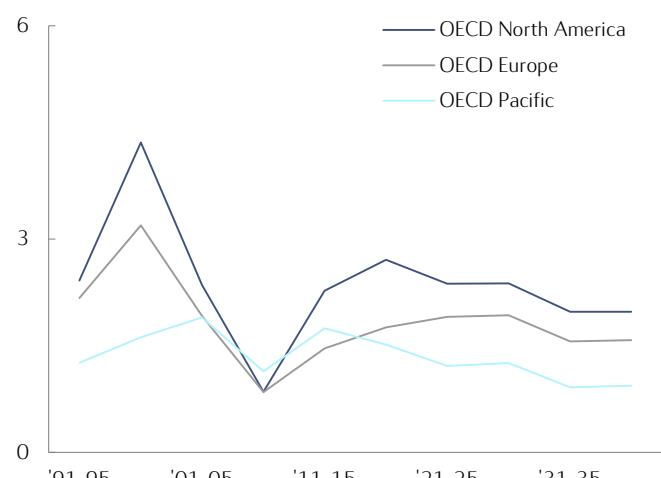
World GDP levels 1991-2040

Real, index, 2011 = 100



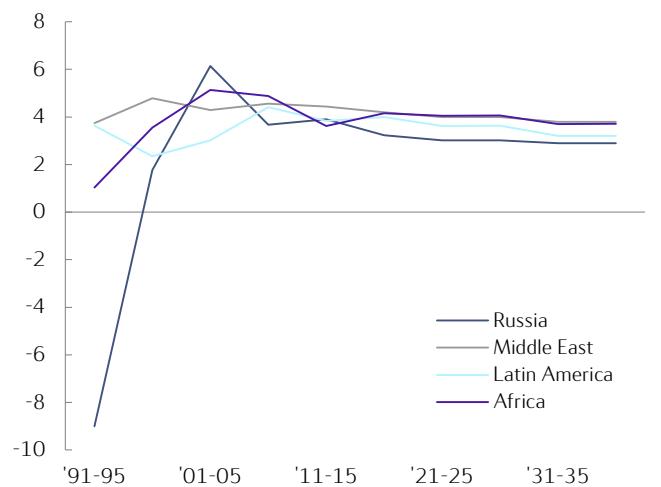
OECD GDP 1991-2040

5-year annual growth rate (CAGR), %



Other countries/regions GDP 1991-2040

5-year annual growth rate (CAGR), %

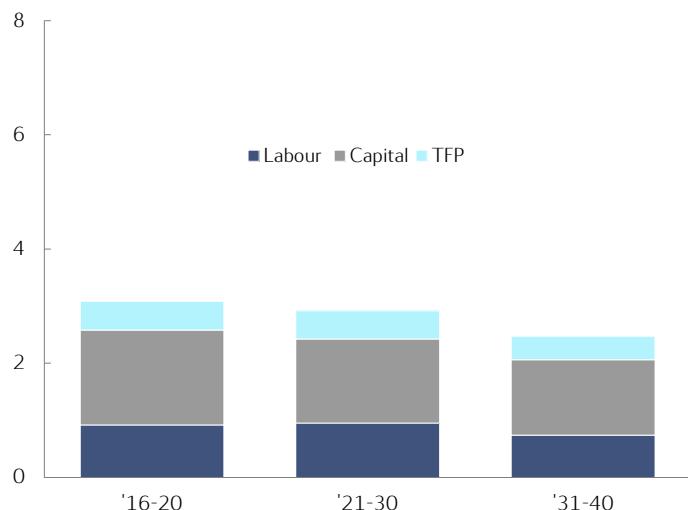


Source: IHS Global Insight (historical figures), Statoil (projections)

Long-term GDP growth

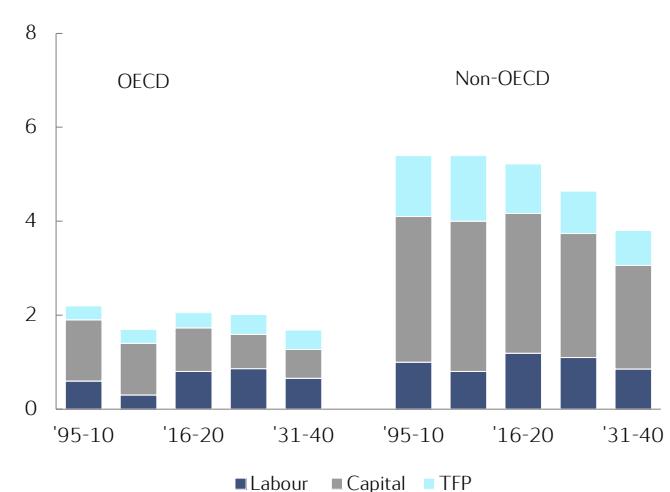
GDP growth by source

World, %



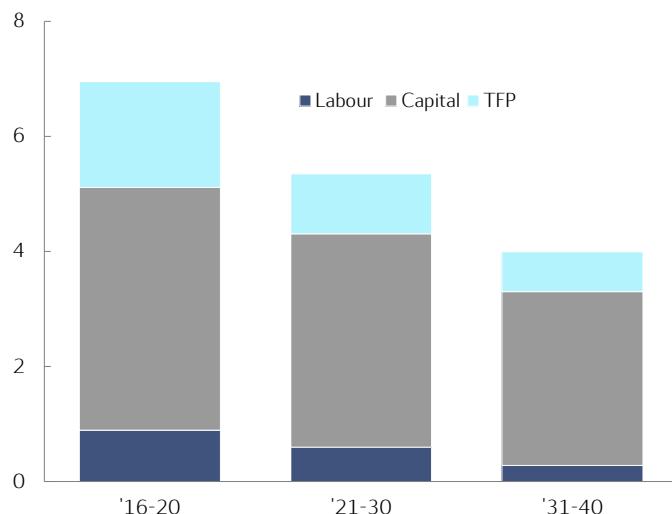
GDP growth by source

OECD and Non-OECD, %



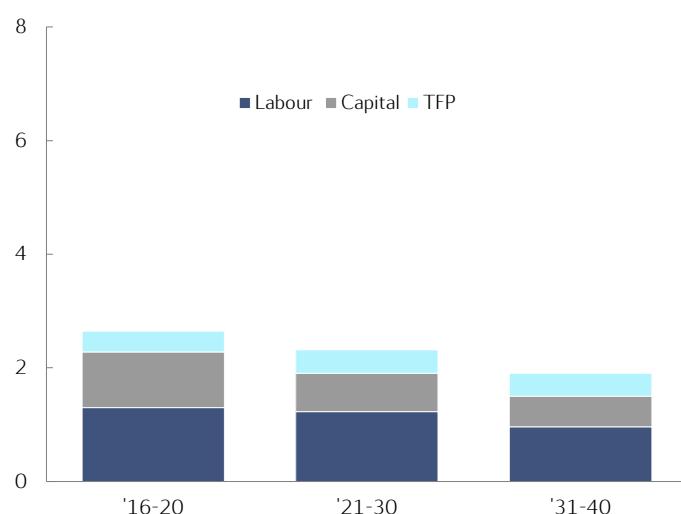
GDP growth by source

China, %



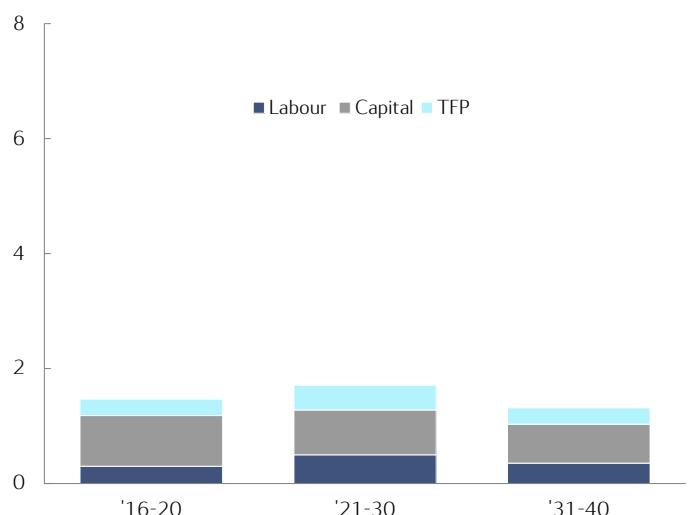
GDP growth by source

USA, %



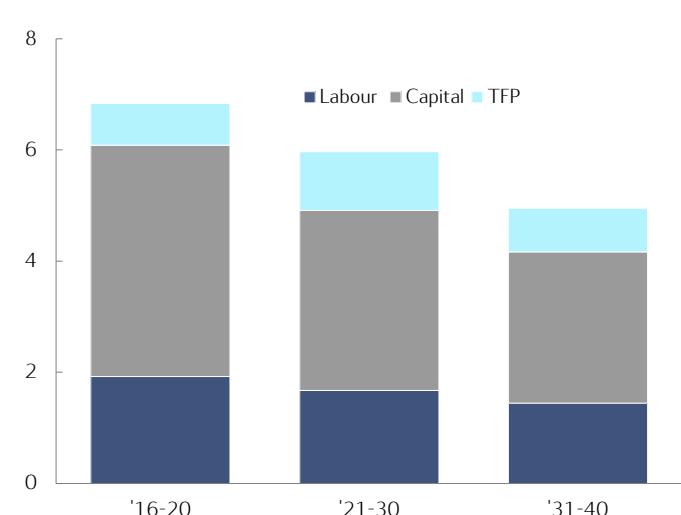
GDP growth by source

Euro area, %



GDP growth by source

India, %

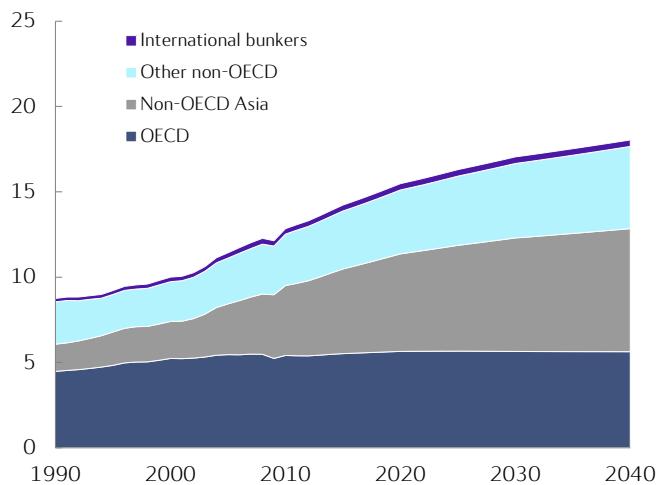


Source: Statoil

Global and regional energy demand

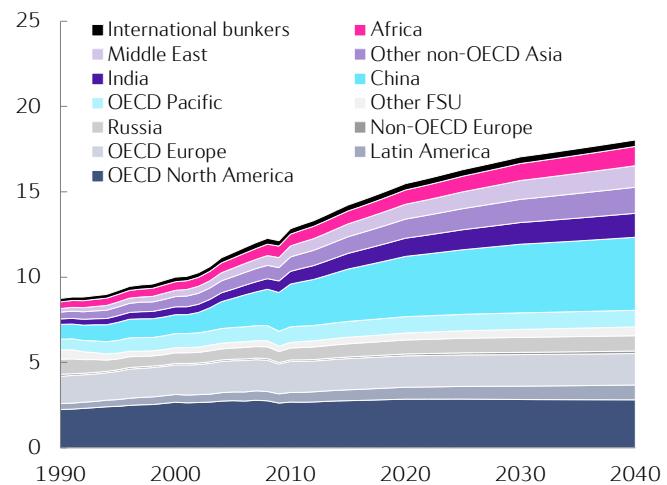
World energy demand 1990-2040

TPED, bn toe



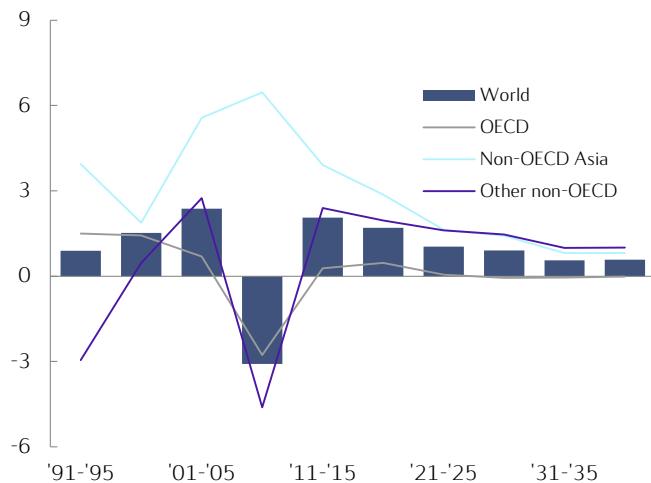
World energy demand 1990-2040

TPED, bn toe



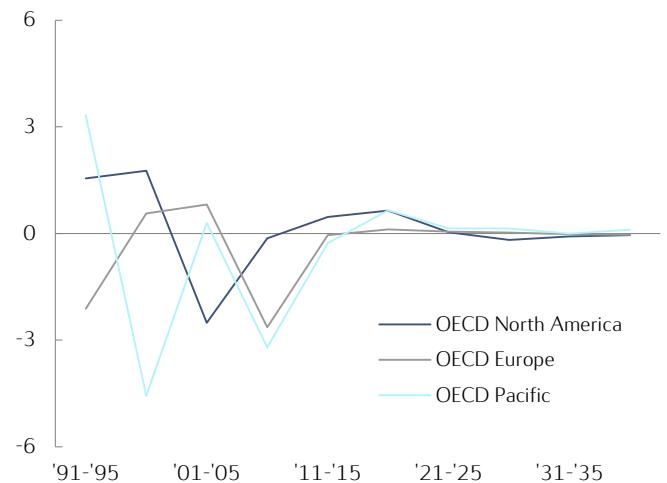
World energy demand 1991-2040

5-year annual growth rate (CAGR), %



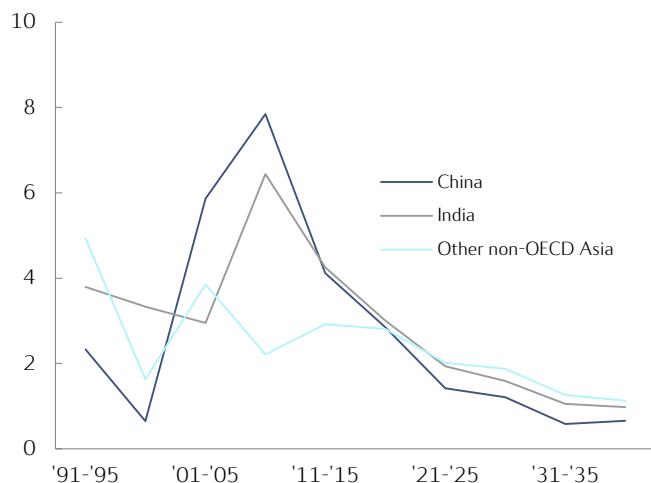
OECD energy demand 1991-2040

5-year annual growth rate (CAGR), %



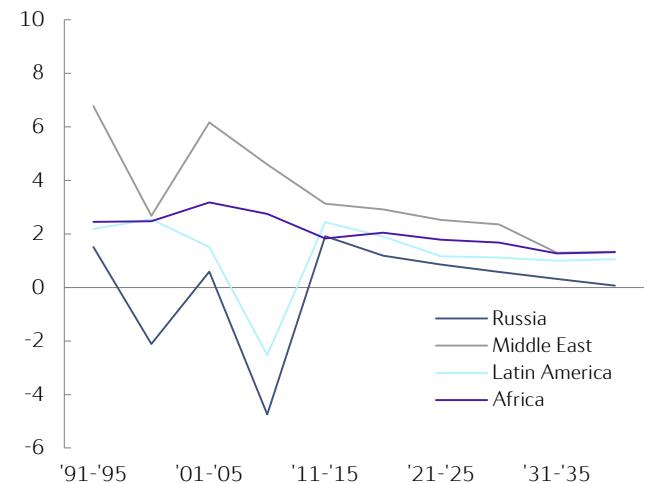
Non-OECD Asia energy demand 1991-2040

5-year annual growth rate (CAGR), %



Other countries/regions energy demand 1991-2040

5-year annual growth rate (CAGR), %

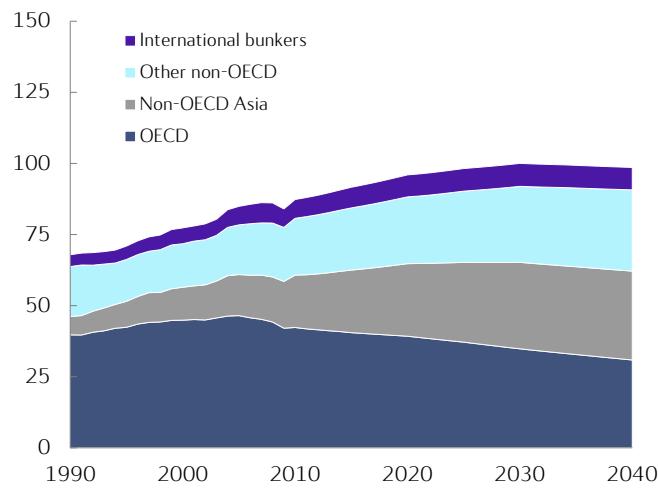


Source: International Energy Agency (historical figures), Statoil (projections)

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

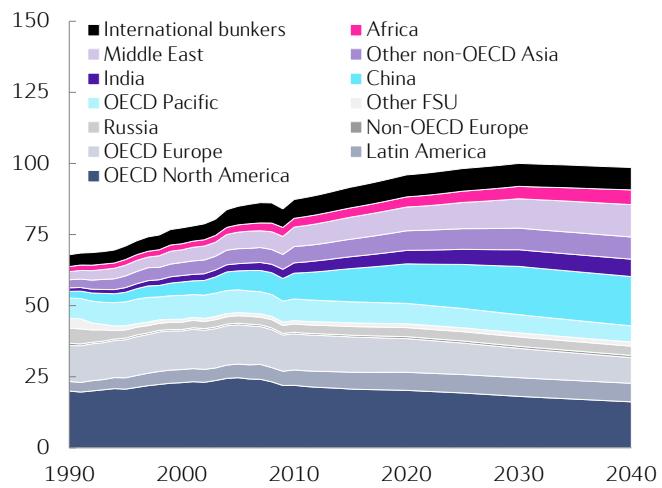
World oil demand 1990-2040

Million barrels per day



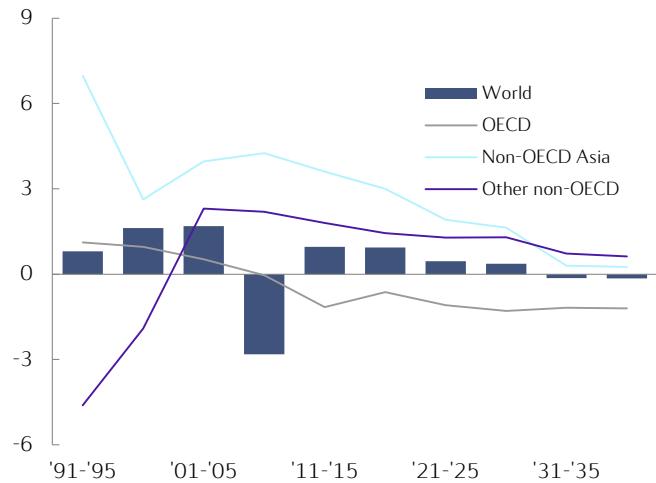
World oil demand 1990-2040

Million barrels per day



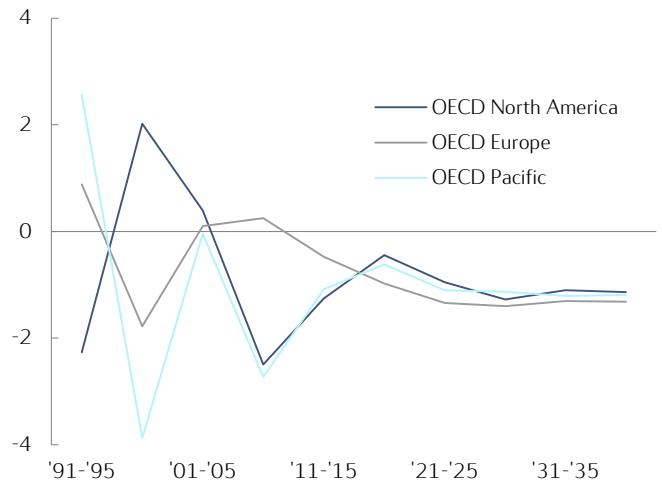
World oil demand 1991-2040

5-year annual growth rate (CAGR), %



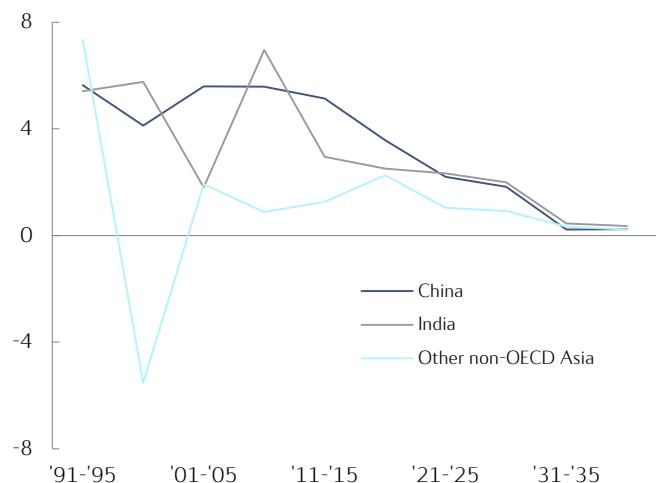
OECD oil demand 1991-2040

5-year annual growth average (CAGR), %



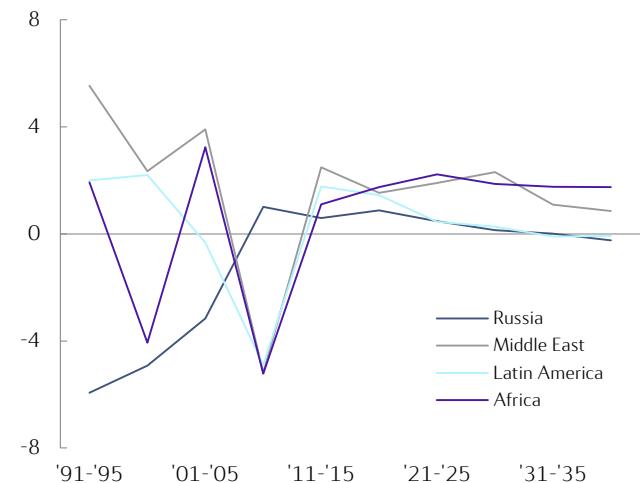
Non-OECD Asia oil demand 1991-2040

5-year annual growth average (CAGR), %



Other countries/regions oil demand 1991-2040

5-year annual growth average (CAGR), %

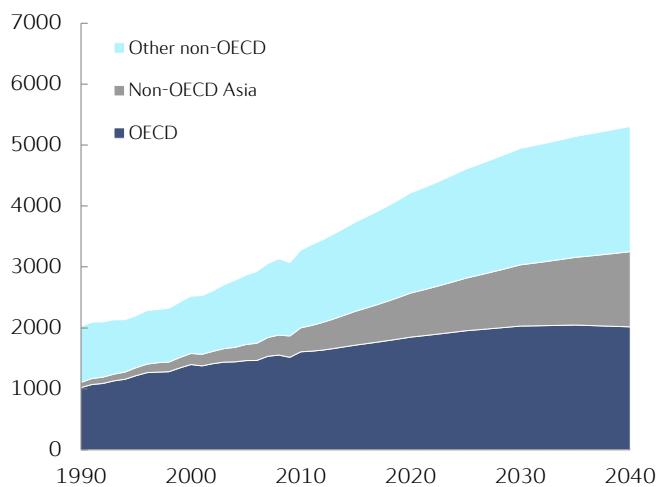


Source: International Energy Agency (historical figures), Statoil (projections)

Global and regional gas demand

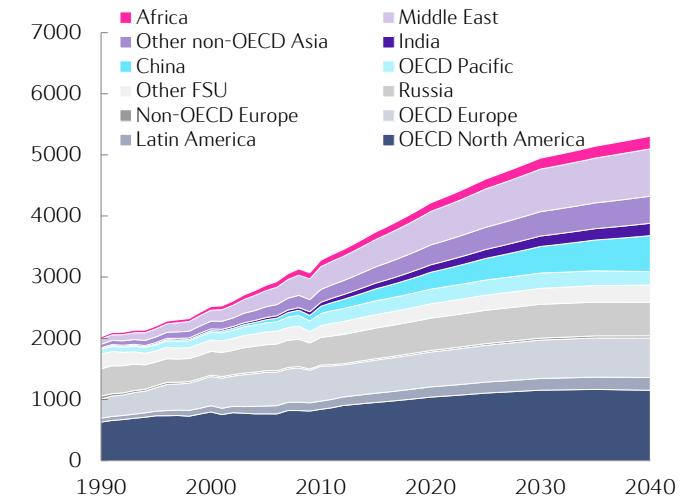
World gas demand 1990-2040

Bcm



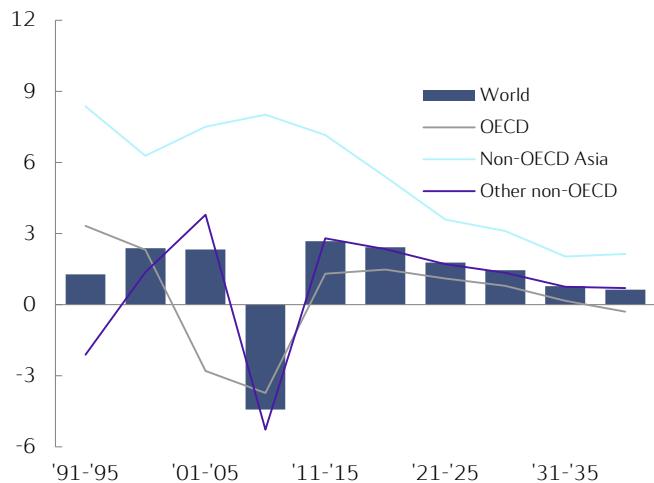
World gas demand 1990-2040

Bcm



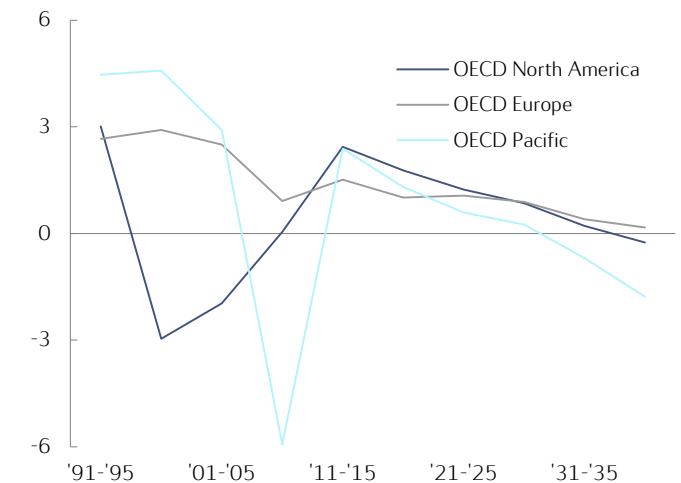
World gas demand 1991-2040

5-year annual growth average (CAGR), %



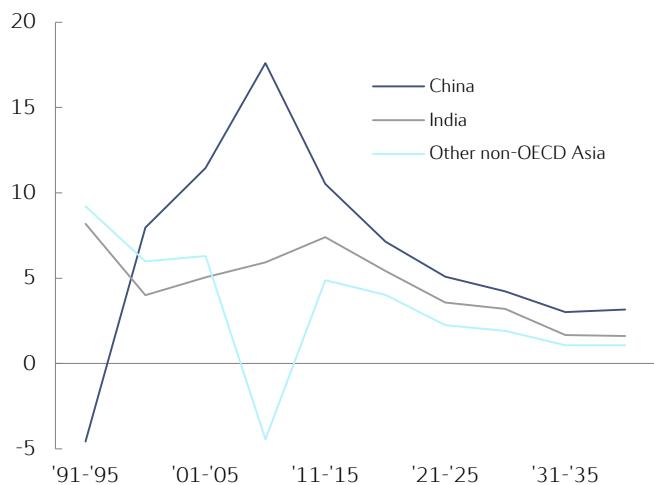
OECD gas demand 1991-2040

5-year annual growth average (CAGR), %



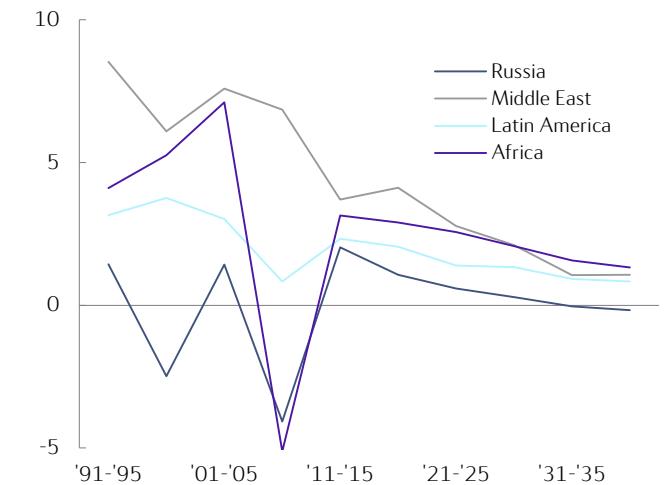
Non-OECD Asia gas demand 1991-2040

5-year annual growth average (CAGR), %



Other countries/regions gas demand 1991-2040

5-year annual growth average (CAGR), %



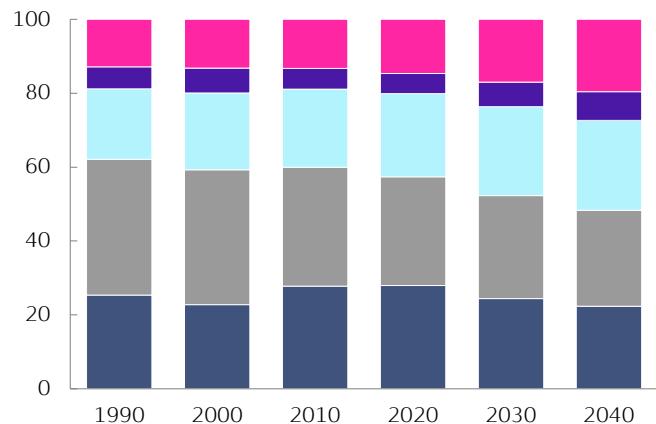
Source: International Energy Agency (historical figures), Statoil (projections)

Global and regional energy mix

World energy mix

Share of total energy demand (TPED), %

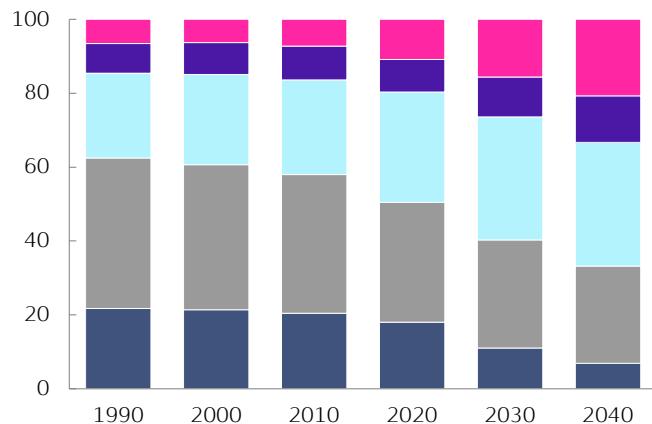
■ Coal ■ Oil ■ Natural gas ■ Nuclear ■ Renewables



OECD North America: Energy mix

Share of total energy demand (TPED), %

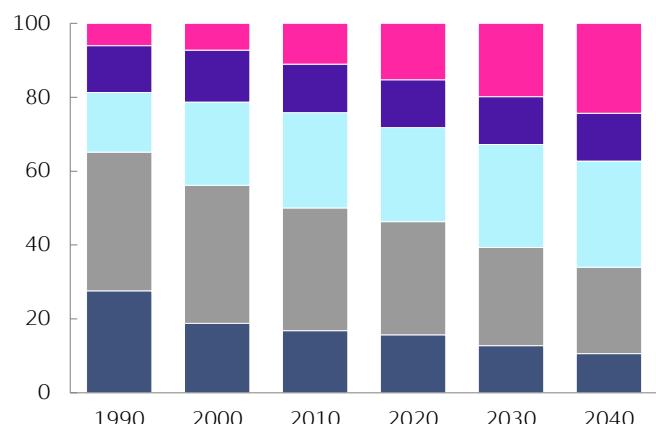
■ Coal ■ Oil ■ Natural gas ■ Nuclear ■ Renewables



OECD Europe: Energy mix

Share of total energy demand (TPED), %

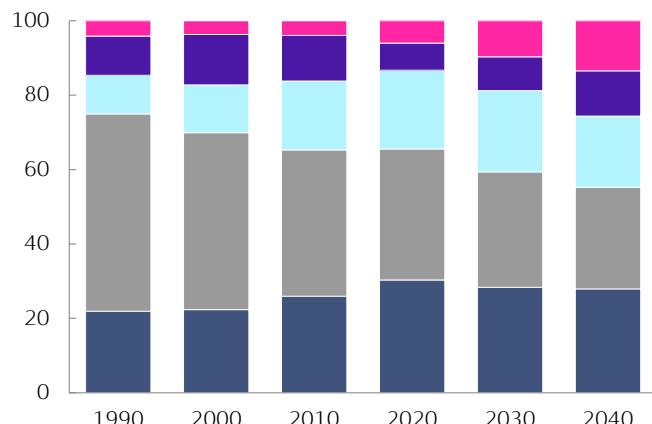
■ Coal ■ Oil ■ Natural gas ■ Nuclear ■ Renewables



OECD Pacific: Energy mix

Share of total energy demand (TPED), %

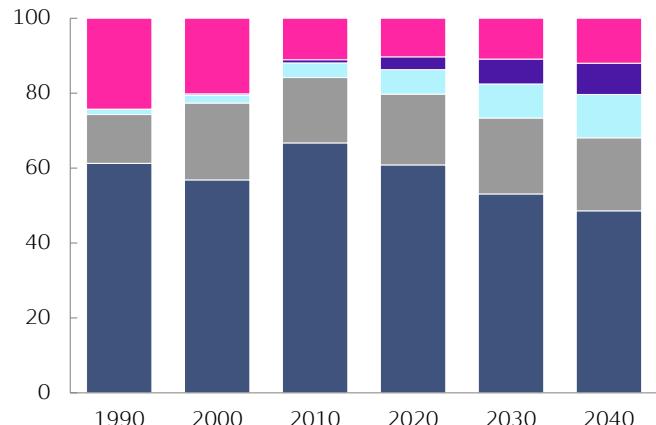
■ Coal ■ Oil ■ Natural gas ■ Nuclear ■ Renewables



China: Energy mix

Share of total energy demand (TPED), %

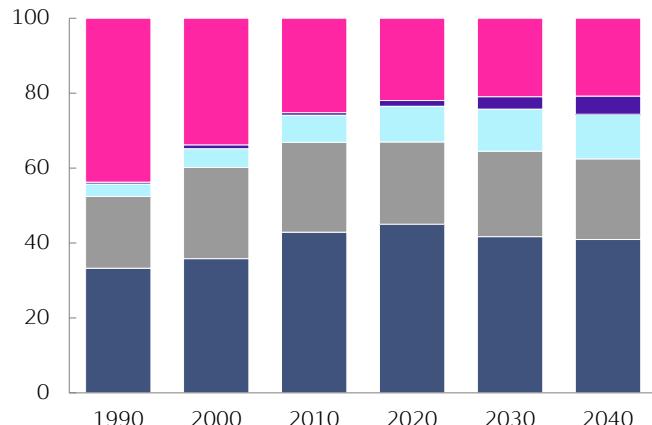
■ Coal ■ Oil ■ Natural gas ■ Nuclear ■ Renewables



India: Energy mix

Share of total energy demand (TPED), %

■ Coal ■ Oil ■ Natural gas ■ Nuclear ■ Renewables

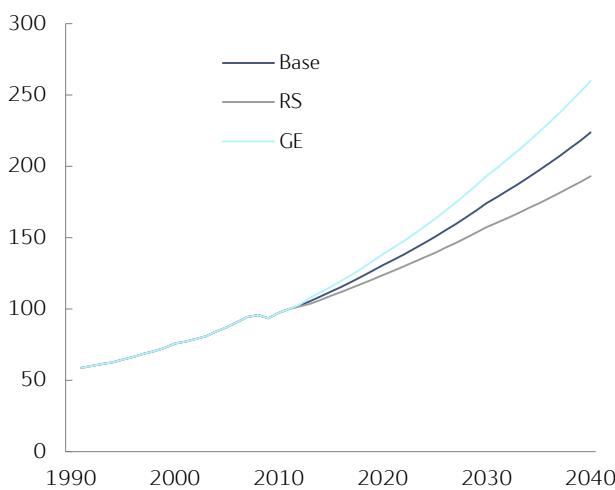


Source: International Energy Agency (historical figures), Statoil (projections)

Different alternatives*

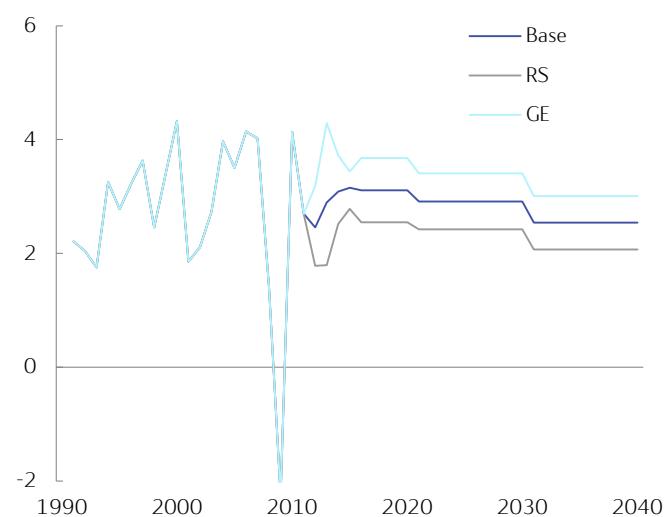
World GDP levels

Real, index, 2011 = 100



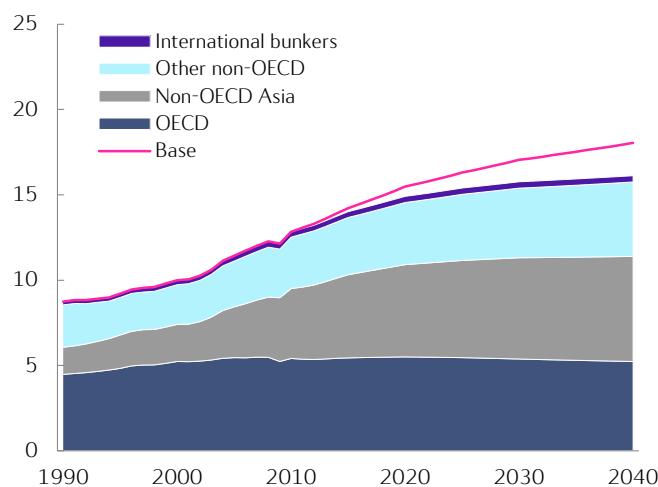
World GDP

Annual growth, %



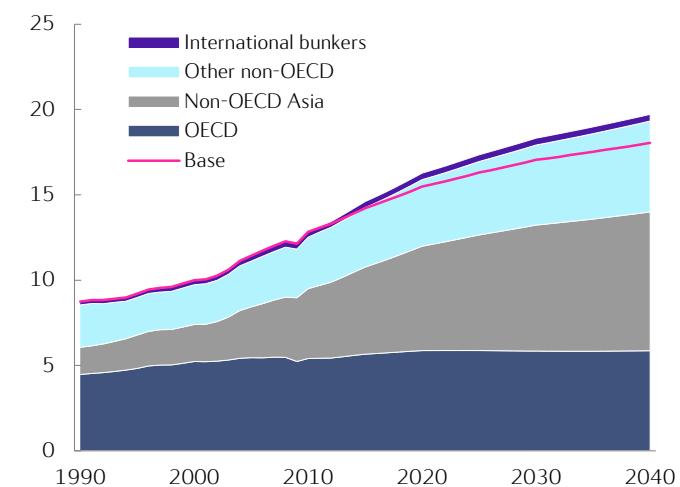
RS alternative: World energy demand

TPED, bn toe



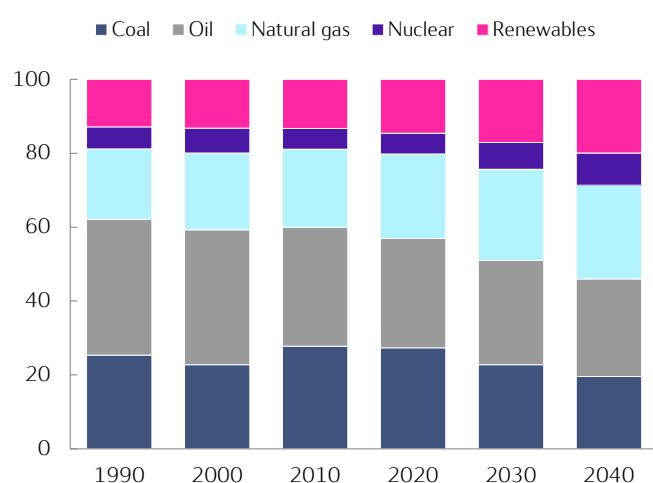
GE alternative: World energy demand

TPED, bn toe



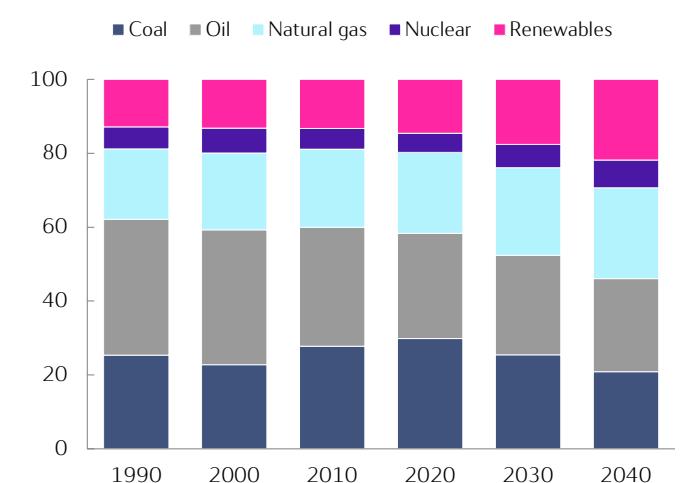
RS alternative: World energy mix

Share of total energy demand (TPED), %



GE alternative: World energy mix

Share of total energy demand (TPED), %



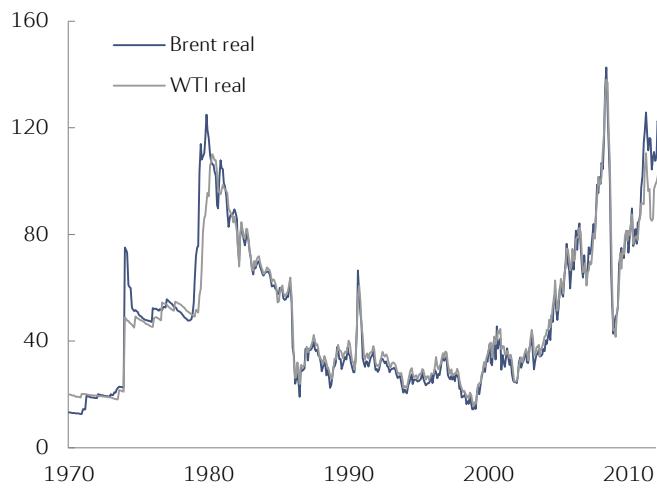
Source: IHS Global Insight (historical GDP figures), International Energy Agency (historical energy figures), Statoil (projections)

*RS=Regional Stagnation, GE=Globalised Expansion

Historical energy prices

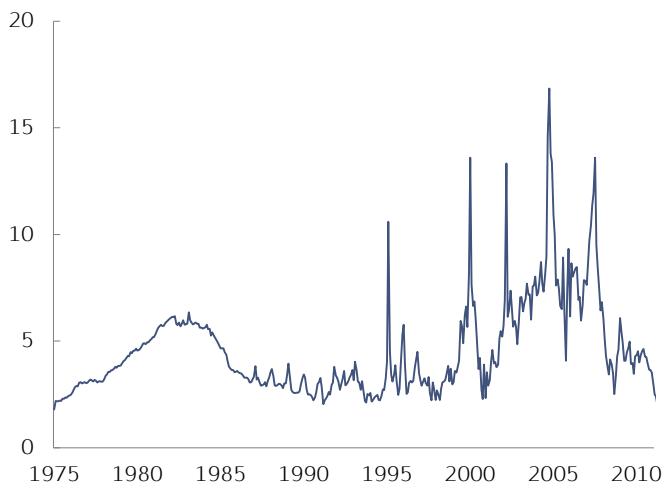
Real oil prices

2011-USD/bbl



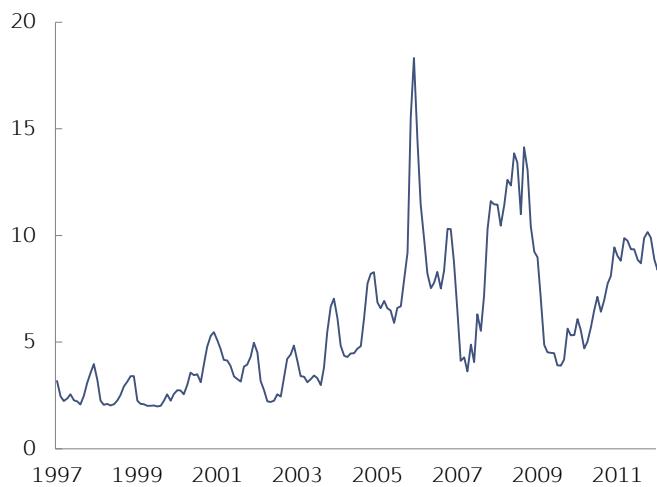
Real US gas prices

Henry Hub, 2011-USD/MMBtu



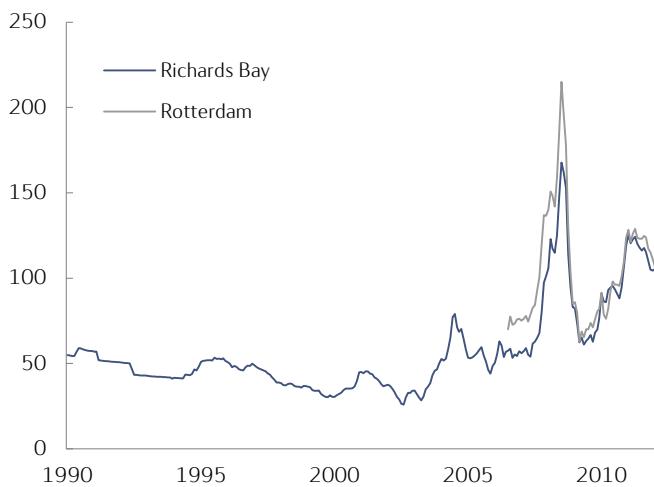
Real UK gas prices

NBP, 2011-USD/MMBtu



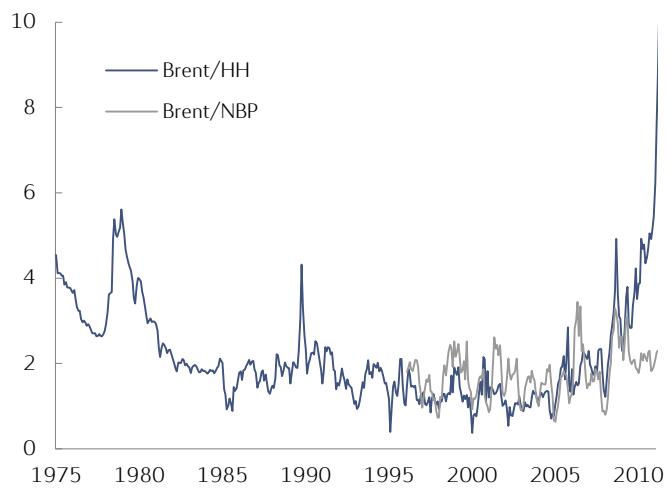
Real coal prices

2011-USD/metric ton

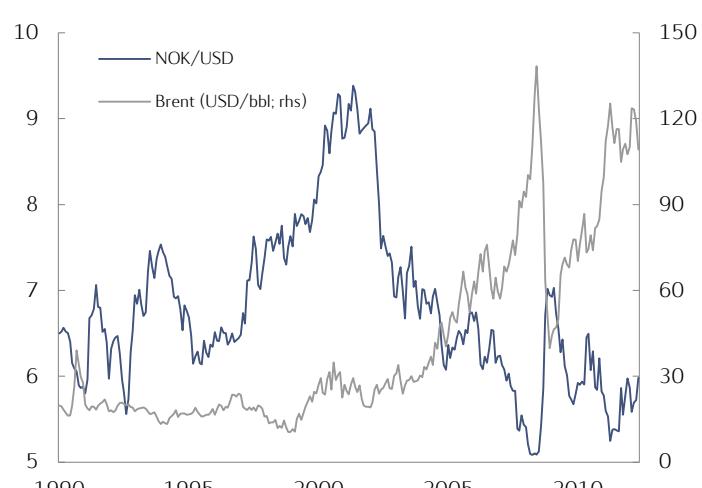


Oil-to-gas price ratios

Based on MMBtu



NOK/USD and nominal oil prices



Source: Reuters EcoWin

