

WORLD ENERGY OUTLOOK 2014 FACTSHEET

How will global energy markets evolve to 2040?

- ▶ **In the New Policies Scenario, energy demand grows by 37% to 2040 on planned policies, an average rate of growth of 1.1%.** Demand grew faster over the previous decades; the slowdown in demand growth is mainly due to energy efficiency gains and structural changes in the global economy in favour of less energy-intensive activities. Natural gas use and the use of low-carbon fuels grow strongest, increasingly replacing coal and oil in the energy mix. By 2040, each fossil fuel accounts for around one-quarter of global energy demand, with the remainder from low-carbon fuels.
- ▶ **Energy demand growth shifts decisively away from OECD countries.** China dominates energy demand growth until the mid-2020s, but as its population levels off and its economic growth slows around that time, India takes over as the leading engine of energy demand. Despite the strong growth, energy use per capita in 2040 in non-OECD countries is still well below the average of OECD countries in the 1970s at comparable levels of GDP per capita. Technological progress and improved energy efficiency, however, allow a higher level of demand for energy services to be satisfied per unit of energy.
- ▶ **The re-ordering of energy trade flows towards Asian markets gathers pace.** Rising crude oil-import needs of China and India, from the Middle East and other regions, increase their vulnerability to the implications of a possible shortfall in investment or a disruption to oil supply. The share of natural gas in total inter-regional fossil-fuel trade rises by one-quarter to more than 20% by 2040; concerns about gas security are eased by the increasing availability of LNG. Coal trade grows by 40% to 2040, driven by strong Asian demand.
- ▶ **World oil supply rises by 14 mb/d to 104 mb/d in 2040, but the trend hinges critically on timely investments in the Middle East.** Until 2025, non-OPEC supply from the United States, Canada and Brazil contributes to output growth. But by the mid-2020s, total non-OPEC oil supply starts to fall back, increasing the call on major resource-holding countries in the Middle East. Over the *Outlook* period, the task of bringing production above 100 mb/d rests on a fairly limited number of shoulders.
- ▶ **All major regions, except Europe, contribute to the more than 50% rise in natural gas output.** Global production of natural gas rises in a near-linear fashion to 5 400 bcm in 2040, with an increasingly important role for unconventional gas which increases its share in output from 17% to 31%. Gas resources are more than sufficient to meet this increase in demand, but the required cumulative investment of more than \$11 trillion along the gas supply chain represents a stern challenge, with the way that gas will be priced on domestic and international markets a key uncertainty.
- ▶ **Global coal demand grows at a much lower rate than over the last 30 years, at 0.5% per year, to 6 350 Mtce in 2040.** Growth of coal demand is constrained by new air pollution and climate policies in the main markets – the United States and China – but also in Europe. Coal use continues to grow briskly in India. China, India, Indonesia and Australia alone account for over 70% of global coal output by 2040, underscoring Asia's importance in global coal trade and pricing.
- ▶ **Energy efficiency slows energy demand growth, diminishes supply-side investment and reduces international energy prices.** Without the cumulative impact of energy efficiency measures over the projection horizon, oil demand in 2040 would be 23 mb/d (or 22%) higher, gas demand 940 bcm (or 17%) and coal demand 920 Mtce (or 15%) higher. Beyond cutting energy use, energy efficiency lowers energy bills, improves trade balances and cuts CO₂ emissions. Improved energy efficiency compared with today reduces oil and gas import bills for the five largest energy-importing regions by almost \$1 trillion in 2040.
- ▶ **Many governments have announced new measures to curb CO₂ emissions in the run-up to the UN climate summit in Paris in 2015, but they fall short of reaching the 2 °C target.** Emissions rise by 20% to 2040, putting the world on track for a long-term global temperature increase of 3.6 °C. Increasing power sector decarbonisation through 2040 by about 25% is key to achieving climate goals and would take the world half-way towards limiting the temperature increase to 2 °C.

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What's in store for fossil fuels?

- ▶ **In the New Policies Scenario, demand for oil rises by 14 mb/d, to reach 104 mb/d in 2040, despite measures and policies aimed at promoting energy efficiency and fuel switching.** The pace of demand growth decreases markedly, from an annual average of 0.9% to 2020, down to only 0.3% per year in the 2030s, moving towards a plateau in global oil consumption. The net growth in demand comes entirely from non-OECD countries: for each barrel of oil eliminated from demand in OECD countries, two additional barrels of oil are consumed in the developing world. China becomes the largest oil-consuming country in the early 2030s.
- ▶ **The relative importance of non-OPEC producers increases this decade, but only the large producers of OPEC can meet long-term demand.** Output growth in the Americas, led by US tight oil, Canadian oil sands and Brazilian deepwater output, pushes non-OPEC production higher until the mid-2020s. However, a decline in US tight oil after this means that by 2040, non-OPEC supply falls back to 51 mb/d. OPEC production increases by less than 1 mb/d over the remainder of this decade, but then needs to increase substantially in the 2020s (by more than 6 mb/d) and by almost as much again in the 2030s.
- ▶ **The refining sector has to adjust to the new geography of oil demand and supply and the changing composition of feedstocks, a process that looks particularly difficult for Europe, which continues to have a large excess of refinery capacity.** By 2040, two out of every three barrels of crude oil traded internationally are destined for Asia, up from less than one in two today, drawing to Asia a rising share of the available crude from the Middle East and beyond.
- ▶ **Global gas use continues to grow, with demand of 5.4 tcm in 2040 – meaning that gas draws level with coal as the second-largest fuel in the global energy mix, after oil.** The main regions pushing global gas demand higher are China, which becomes a larger gas consumer than the European Union around 2030, and the Middle East. Within the OECD, US gas demand grows to 900 bcm by 2040, while in Japan consumption falls back as nuclear reactors are gradually restarted. Gas consumption in Europe returns to 2010 levels only in the early 2030s, with the outlook likewise heavily contingent on policy action, notably on CO₂ pricing.
- ▶ **Gas production increases in every major region except Europe.** Unconventional gas accounts for almost 60% of the growth in global production, helping China to register the fastest gas output growth among the major producers. The United States remains the largest global gas producer, although production tails off in the late 2030s as shale gas output starts to fall back. The way that gas will be priced on domestic and international markets is a key uncertainty, with the challenge of finding a price level and pricing mechanisms acceptable to consumers but nonetheless sufficient to incentivise large new investments in gas supply proving challenging.
- ▶ **Coal demand growth is driven by the stringency of carbon policies.** In the New Policies Scenario, demand grows on average by 0.5% per year between 2012 and 2040 (compared to 2.5% over the past 30 years) to over 6 350 million tonnes of coal equivalent. Almost two-thirds of the increase occurs in the next ten years. The outlook for coal varies significantly by region. Demand declines in all major OECD regions, including the United States, where coal use for power plunges by more than one-third between 2012 and 2040. Growth in China's coal use also slows, with demand peaking around 2030. India, where demand continues to rise briskly, overtakes the United States as the world's second-biggest coal consumer after China before 2020.
- ▶ **Coal production gradually shifts further to Asia-Pacific.** China, India, Indonesia and Australia alone account for over 70% of global coal output by 2040, underscoring Asia's importance in global coal trade and pricing. With increasing trade and rising production costs, the average OECD steam coal import price moves up from current low levels (it averaged \$86/tonne in 2013) to over \$110/tonne in 2040.

WORLD ENERGY OUTLOOK 2014 FACTSHEET

Power and renewables

- ▶ **In the New Policies Scenario, world electricity demand increases by almost 80% over the period 2012-2040.** The power sector represents over half of the increase in global primary energy use, a rise comparable to current North American total energy demand. Non-OECD countries account for the bulk of incremental electricity demand, led by China (33%), India (15%), Southeast Asia (9%) and the Middle East (6%).
- ▶ **Fossil fuels continue to dominate the power sector, although their share of generation declines from 68% in 2012 to 55% in 2040.** Coal-fired generation is on the decline in the OECD, including the United States where coal-fired power drops by almost one-third to 2040. In China, it grows more than anywhere else, but its share still declines sharply. The share of coal also drops in India, despite strong absolute growth. Oil-fired generation declines by more than half, falling in most regions. By contrast, gas-fired power generation almost doubles over 2012-2040, increasing in most regions. In Europe, gas-fired generation gradually regains favour versus coal on rising CO₂ prices, but only gets back to 2010 levels around 2030.
- ▶ **The share of renewables in total power generation rises from 21% in 2012 to 33% in 2040, as they supply nearly half of the growth in global electricity generation.** Renewable electricity generation, including hydropower, nearly triples over 2012-2040, overtaking gas as the second-largest source of generation in the next couple of years and surpassing coal as the top source after 2035. Rapid expansion of wind and solar PV raises fundamental questions about power market designs: their ability to ensure adequate investment in conventional power plants and long-term reliability of supply. China sees the largest increase in generation from renewables, more than the gains in the EU, US and Japan combined.
- ▶ **Global subsidies to renewables reached \$121 billion in 2013, up 15% on 2012, and expand to nearly \$230 billion in 2030 in the New Policies Scenario, before falling to \$205 billion in 2040 due to the end of support commitments for recently deployed capacity.** In 2013, almost 70% of subsidies to renewables for power were provided in just five countries: Germany (\$22 billion), the US (\$15 billion), Italy (\$14 billion), Spain (\$8 billion) and China (\$7 billion). The EU remains the largest financial supporter of renewables to 2040, though the US is a close second after 2035. Solar PV continues to receive the largest portion of subsidies until falling unit costs help to reduce subsidies below those for bioenergy for power just before 2040. The value of solar PV in the system also declines with more deployment, making competitiveness a moving target. Subsidies to onshore wind reach a peak just before 2020 and then decline steadily as it becomes competitive with conventional power plants in many locations.
- ▶ **Biofuels use more than triples, rising from 1.3 million barrels of oil equivalent per day (mboe/d) in 2012 to 4.6 mboe/d in 2040, by which time it represents 8% of road-transport fuel demand.** Advanced biofuels, which help address sustainability concerns about conventional biofuels, gain market share after 2020, making up almost 20% of biofuels supply in 2040. Reflecting limited cost reductions and increasing use, subsidies to biofuels increase steadily and make up 20% of cumulative renewable energy subsidies over the projection period.
- ▶ **Global investment in the power sector amounts to \$21 trillion through to 2040, with over 40% in transmission and distribution networks.** Residential electricity prices increase in nearly all regions, in part due to rising fossil fuel prices. However, electricity becomes more affordable over time in most regions, as income levels increase faster than household electricity bills.
- ▶ **CO₂ emissions from the power sector rise from 13.2 gigatonnes (Gt) in 2012 to 15.4 Gt in 2040, retaining a share of around 40% of global emissions over the period.** Increasing penetration of low-carbon technologies and deployment of high-efficiency coal-fired power plants help to slow the growth in CO₂ emissions from the power sector. The evolution of the power sector will be critical to meeting climate change goals, due to the sector's rapid growth and because low-carbon alternatives are more readily available.

WORLD ENERGY OUTLOOK 2014 FACTSHEET

Nuclear power: retreat, revival or renaissance?

- ▶ **At the end of 2013, there were 434 operating commercial nuclear reactors worldwide, with total installed capacity of 392 GW.** Nuclear power plants today account for 11% of global electricity generation, down from a peak of almost 18% in 1996. More than 80% of capacity is in OECD countries. Though their share of installed capacity is low today, non-OECD countries are set to account for the bulk of future growth: of the 76 GW presently under construction, more than three-quarters is in non-OECD countries.
- ▶ **In the New Policies Scenario, the share of nuclear power in global electricity generation increases slightly to 12% in 2040. Nuclear generation capacity rises by 60% to 624 GW in 2040.** This is the net result of 380 GW of capacity additions and 148 GW of retirements. The pattern of growth reflects the challenges facing all types of new thermal generation capacity in competitive power markets and the specific suite of other economic, technical and political challenges that nuclear power has to overcome. China, India, Korea and Russia see the most significant increases in installed nuclear capacity. The increase in China, of 132 GW, exceeds the current installed capacity of the United States and Russia combined. India's and Russia's nuclear power capacity rises by 33 GW and 19 GW, respectively. Despite capacity in Korea more than doubling, to 49 GW, the OECD share of global nuclear capacity falls from 80% in 2013 to 52% in 2040. The number of economies worldwide operating nuclear reactors increases from 31 in 2013 to 36 in 2040, as newcomers more than offset countries that phase out nuclear power. Uranium resources are more than sufficient to provide fuel to satisfy these projections.
- ▶ **Nuclear power's limited exposure to disruptions in international fuel markets and its role as a reliable source of baseload electricity can enhance energy security.** Although the upfront costs to build new nuclear plants are high and, often, uncertain, nuclear power can offer economic benefits by adding stability to electricity costs and improving balance of payments. In the Low Nuclear Case – in which global capacity drops by 7% compared with today – indicators of energy security tend to deteriorate in countries that utilise nuclear power. For example, the share of energy demand met from domestic sources is reduced in Japan (by 13 percentage points), Korea (by six) and the European Union (by four) relative to the central scenario.
- ▶ **Nuclear power is one of a limited number of options available at scale to reduce CO₂ emissions. It has avoided the release of an estimated 56 Gt of CO₂ since 1971, or close to two years of emissions at current rates.** By 2040, in the New Policies Scenario, nuclear power has avoided the release of almost four years of CO₂ emissions at current rates. The average cost of avoiding emissions through new nuclear capacity depends on the mix and the costs of the fuels it displaces, and therefore ranges from very low levels to over \$80/tonne.
- ▶ **In the New Policies Scenario, the cumulative amount of spent nuclear fuel that has been generated (a significant portion of which becomes high-level radioactive waste) more than doubles, reaching 705 000 tonnes in 2040.** Today – 60 years since the first nuclear reactor started operating – no country has yet established permanent facilities for the disposal of high-level radioactive waste from commercial reactors, which continues to build up in temporary storage. All countries which have ever had nuclear generation facilities have an obligation to develop solutions for long-term storage.
- ▶ **A wave of retirements of ageing nuclear reactors is approaching: almost 200 of the 434 reactors operating at the end of 2013 are retired in the period to 2040,** with the vast majority in the European Union, the United States, Russia and Japan. The industry will need to manage this unprecedented rate of decommissioning, while also building substantial new capacity for those reactors that are replaced. We estimate the cost of decommissioning plants that are retired to be more than \$100 billion. Considerable uncertainties remain about these costs, reflecting the relatively limited experience to date in dismantling and decontaminating reactors and restoring sites for other uses. Regulators and utilities need to continue to ensure that adequate funds are set aside to cover these future expenses.

WORLD ENERGY OUTLOOK 2014 FACTSHEET

Africa energy outlook

- ▶ **Despite a rapidly growing economy, sub-Saharan Africa accounts for 13% of the global population but only 4% of global energy demand.** Bioenergy, mostly fuelwood and charcoal, accounts for more than 60% of energy demand, coal makes up 18%, followed by oil (15%) and natural gas (4%). Modern renewables account for less than 2% but are growing quickly. On-grid power generation capacity was 90 GW in 2012, with around half of this being in South Africa.
- ▶ **Sub-Saharan Africa is rich in energy resources.** Huge renewable resources remain untapped: excellent solar across all of Africa, hydro in many countries, wind mainly in coastal areas and geothermal in the East African Rift Valley. In the last five years, nearly 30% of world oil and gas discoveries were made in sub-Saharan Africa, but the challenge to turn these discoveries into production and the resulting revenue into public benefits is formidable.
- ▶ **Access to modern energy services remains very limited.** Despite many positive efforts, more than 620 million people (two-thirds of the population) in sub-Saharan Africa are without access to electricity. Those who have access to electricity often face very high prices for a supply that is insufficient and unreliable. Nearly 730 million rely on the traditional use of solid biomass for cooking. Each year nearly 600 000 premature deaths in Africa can be attributed to household air pollution resulting from the traditional use of solid biomass.
- ▶ **The sub-Saharan energy system expands rapidly to 2040, but so do the demands placed upon it.** The economy quadruples in size, the population nearly doubles (to almost 1.8 billion) and energy demand grows by around 80% in the New Policies Scenario. The sub-Saharan power system evolves quickly, with generation capacity quadrupling to 385 GW. Almost half of the growth in electricity generation to 2040 comes from renewables.
- ▶ **Some 950 million people gain access to electricity in sub-Saharan Africa by 2040, but 530 million people remain without it at that time.** Urban areas see the largest improvement in the coverage and reliability of centralised electricity supply. Mini-grid and off-grid systems provide electricity to 70% of those gaining access in rural areas. The share of bioenergy in the energy mix declines to below half by 2040, but 650 million people still cook with solid biomass in an inefficient, hazardous way.
- ▶ **Oil production exceeds 6 million barrels per day (mb/d) in 2020 before falling back to 5.3 mb/d in 2040, and continues to be led by Nigeria and Angola.** Demand for oil products doubles to 4 mb/d in 2040, squeezing the region's net contribution to the global oil balance. Gas output reaches 230 billion cubic metres (bcm), led by Nigeria, and increasing output from Mozambique, Tanzania and Angola. LNG exports triple to around 95 bcm. Coal supply grows by 50%, and continues to be focused on South Africa, but it is joined increasingly by Mozambique and others.
- ▶ **The New Policies Scenario sets a demanding agenda for Africa's policy makers, but does not come close to meeting the full potential of energy to act as an engine for prosperity.** Power supply remains unreliable, energy consumption per capita remains very low and a huge population remains without modern energy. While only making a small contribution to global energy-related CO₂ emissions, sub-Saharan Africa is on the front line when it comes to the potential impacts of a changing climate.
- ▶ **In an "African Century Case", three actions boost the sub-Saharan economy by a further 30%, and deliver an extra decade's worth of growth in per-capita incomes by 2040.** These actions are:
 - **Upgrading the power sector**, reducing power outages by half and achieving universal electricity access in urban areas.
 - **Deeper regional co-operation and integration**, facilitating new large-scale generation and transmission projects and enabling a further expansion in cross-border trade.
 - **Better management of energy resources and revenues**, adopting robust and transparent processes that allow for more effective use of oil and gas revenues.