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Introduction

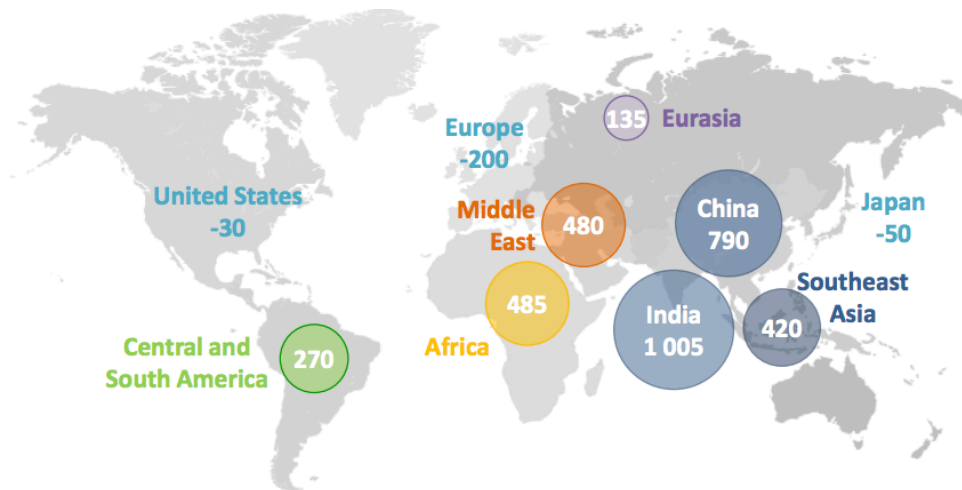
The International Energy Agency submits its views on global energy trends to 2040, which were last reviewed in its **World Energy Outlook (WEO) 2017**. This outlook, which marked the 40th anniversary since publication of the first WEO, features for the first time the **Sustainable Development Scenario**, which outlines an integrated approach to achieving internationally agreed objectives on climate change, air quality and universal access to modern energy, along with the two scenarios that have been retained from previous Outlooks: The **Current Policies Scenario**, which considers policies firmly enacted as of mid-2017; and the **New Policies Scenario**, the central scenario which incorporates existing and announced energy policies.

Global energy trends

As the global population rises to more than 9 billion people in 2040, a steady increase in energy needs of 1% per year on average means that primary energy demand in 2040 is almost 30% higher than today – the world is thus set to add the equivalent of today’s China plus India to its energy demand by 2040 under the **New Policies Scenario (NPS)**.

Developing economies in Asia represent around two-thirds of this growth (Figure 1). China remains the world’s largest energy-consuming country, but the largest contribution to the increase in global demand – almost 30% – comes from India, where rising incomes and population push energy demand up by 1 000 million tonnes of oil equivalent (Mtoe) between now and 2040. Southeast Asia is another rising heavyweight in global energy, with demand growing at twice the pace of China.

Figure 1: Change in energy demand, 2016-40 (Mtoe)



By contrast, some advanced economies see their overall energy needs fall back in the NPS: demand in Europe in 2040, for example, is 10% lower than today. So while Europe’s share of global demand (15%) in 2016 was double that of India (7%), by 2040 the rankings are reversed as India moves up to a share of 11% while Europe, with a population well under half as large, falls back to 10%.

If, on the other hand, the search is for the largest energy consumers on a per capita basis, the focus shifts towards North America, parts of Eurasia, to the advanced economies of Asia and to the Middle East. These consumers are characterised either by high incomes (in Australia, Canada, Japan, Korea, United States), high heating needs (especially in Russia and Canada) or fossil-fuel subsidies that encourage wasteful consumption (particularly in the Middle East and Russia, although efforts at pricing reform have accelerated in recent years).

In the NPS, there is some modest convergence in global per capita consumption levels, which rise in India (by 70%), Southeast Asia (40%) and Central and South America (20%). In the case of China, this is sufficient for average per capita consumption to overtake that of Europe. Nonetheless, in this scenario, the problem of incomplete access to energy remains: 675 million people, largely in rural areas of sub-Saharan Africa, remain without access to electricity in 2030.

The urban rural divide also significantly impacts energy demand. In 2007, the number of people living in urban areas worldwide exceeded those in rural areas for the first time and, by 2016, the share of the urban population had grown to 54% and accounted for some two-thirds of global primary energy demand. By 2040, our projections anticipate that a further 1.7 billion people will join the urban population (more than 90% of the increase taking place in developing economies), a shift with enormous implications for energy use.

This means a transition away from solid fuels (biomass and coal) to electricity, gas and oil products; generally higher urban incomes also translate into higher ownership rates for appliances; and the need to house millions of new urban inhabitants spurs demand for a range of energy-intensive products, especially steel and cement. However, there is no pre-set pathway for urban consumption: cities also have the potential to push electrification in new ways through electric vehicles, heat pumps and digital control technologies. Much depends on the way that public policy, urban design and infrastructure investment shape urban energy choices.

Patterns of consumption are different in the **Sustainable Development Scenario (SDS)**. The most significant contrast is that access to modern energy becomes universal by 2030, finally closing the gap in the world’s provision of energy for all. Since the energy consumption of those gaining access is often very small, this has the effect of bringing down the average per capita consumption of modern energy in Africa and some developing economies in Asia compared with today. With the achievement of universal access, the overall delivery of energy services (e.g. lighting, cooking, heat, mobility) in the SDS is higher than the NPS, even though the amount of energy consumed by 2040 to deliver these services is some 20% lower.

Outlook by Energy Source

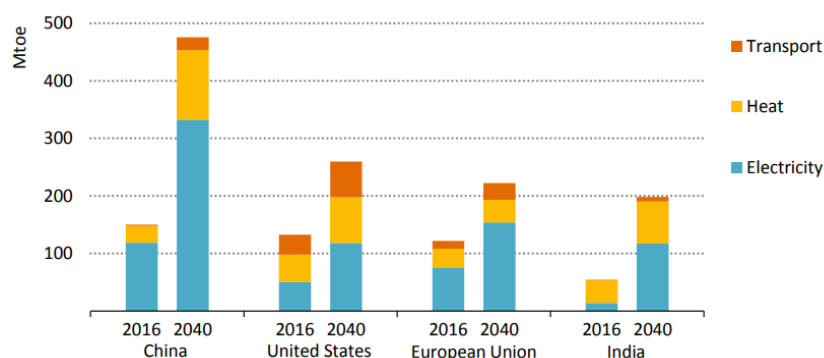
Renewables

Compared with the past twenty-five years, the way that the world meets its growing energy needs changes dramatically in the New Policies Scenario. Renewable sources of energy meet 40% of the increase in primary demand and their explosive growth in the power sector marks the end of the boom years for coal.

Renewables capture two-thirds of global investment in power plants as they become, for many countries, the least-cost source of new generation. Rapid deployment of solar photovoltaics (PV), led by China and India, helps solar become the largest source of low-carbon capacity by 2040, by which time the share of all renewables in total power generation reaches 40%. But growth in renewables is not confined to the power sector; the direct use of renewables to provide heat and mobility worldwide also doubles, albeit from a low base (Figure 2).

In the European Union, renewables account for 80% of new electricity generation capacity, and wind power becomes the leading source of electricity generation soon after 2030, due to strong growth both onshore and offshore. Policies continue to support renewable electricity worldwide, increasingly through competitive auctions rather than feed-in tariffs, and the transformation of the power sector is amplified by millions of households, communities and businesses investing directly in distributed solar PV.

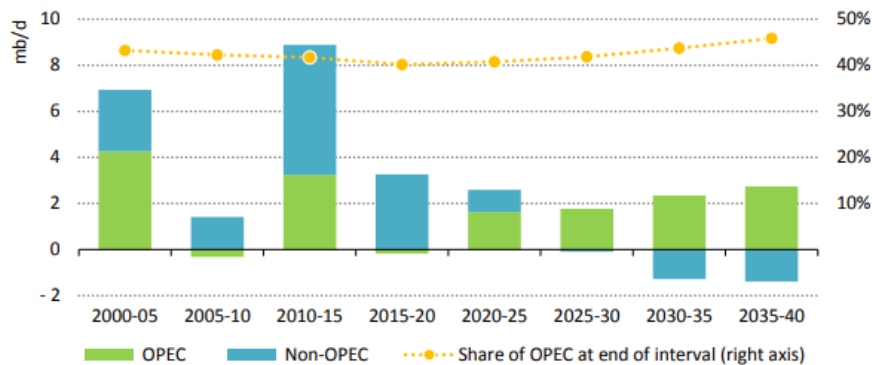
Figure 2: Renewable energy use by sector from a consumer perspective and by region in the NPS



Oil

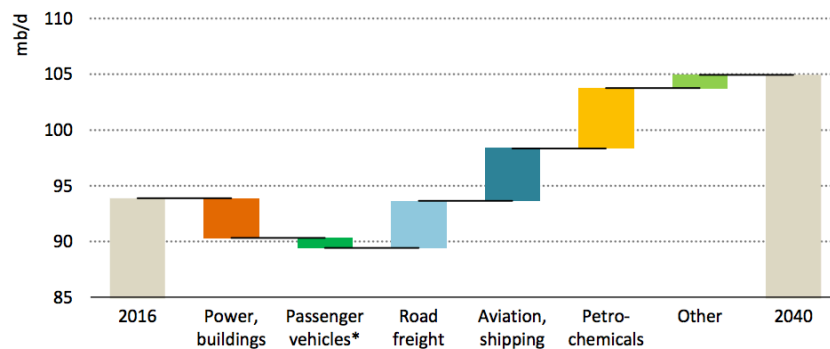
Oil markets in the New Policies Scenario go through two distinct phases to 2040. In the period to 2025, fuel efficiency policies, which at present cover 80% of global passenger car sales but only 50% of global truck sales, together with a rapidly growing fleet of electric vehicles, have an impact on demand but are insufficient to outweigh the near-term stimulus from lower prices. Production growth is dominated by non-OPEC countries, particularly the United States, which accounts for 80% of the net increase in oil supply to 2025 (Figure 3)

Figure 3: Change in non-OPEC and OPEC oil production in the New Policies Scenario



After 2025, the rise in global oil demand slows markedly. Continued growth in petrochemicals, road freight, aviation and shipping is partially offset by declining oil use for passenger cars (Figure 4). The global car fleet doubles between 2016 and 2040 but becomes steadily more efficient and there are almost 280 million electric cars on the road in 2040. On the supply side, the market becomes more reliant on OPEC countries to balance the market post-2025, as US output plateaus and then falls back.

Figure 4: Change in world oil demand by sector in the New Policies Scenario

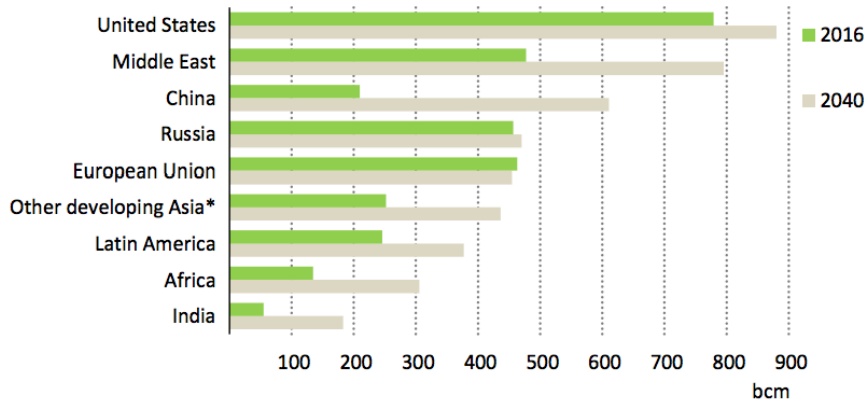


The New Policies Scenario is characterised by steady upward pressure on the oil price, which reaches \$83/barrel by 2025. But there is uncertainty about underlying assumptions. Estimates of US tight oil resources have been revised upwards and there could be further surprises ahead. Countries could step up policy support for electric vehicles, reducing their costs more quickly. A Low Oil Price Case, with a price below \$70/barrel to 2040, is based on more extensive US tight oil resources, faster upstream technology improvements and more rapid uptake of electric cars.

Natural gas

In the New Policies Scenario, global natural gas use increases by 45% in the coming 25 years, with industry accounting for a third of the growth (up from less than 20% over the last 25 years), slightly ahead of the additional gas used for power generation. Developing countries in Asia, Africa, Latin America and the Middle East account for 80% of the increase in global consumption (Figure 5). The tilt towards industrial gas use is particularly pronounced in the next ten years. In the second-half of the Outlook period, gas demand in the power sector picks up again as a move away from coal in some markets creates more room for gas to grow, alongside renewables.

Figure 5: Gas demand in selected regions in the New Policies Scenario



With projected growth of 1.6% per year, prospects for gas are favorable in the New Policies Scenario, but a return to the annual growth rate of 2.3% seen in the previous 25 years is unlikely. Depending on the circumstances, renewables can facilitate or curb gas demand growth. In addition, in many gas-importing countries, especially in Asia, beating coal on cost alone is a tall order, highlighting the importance of a supportive policy environment if gas is to thrive.

The United States adds some 300 bcm to global gas supplies over the next 25 years, more than any other country, followed by China (200 bcm), Russia and Iran (both around 145 bcm). Unconventional gas – shale gas in particular – accounts for over half of the incremental production worldwide over the period to 2040. North America continues to lead the unconventional gas revolution, but China, Argentina and Australia play increasingly important roles too.

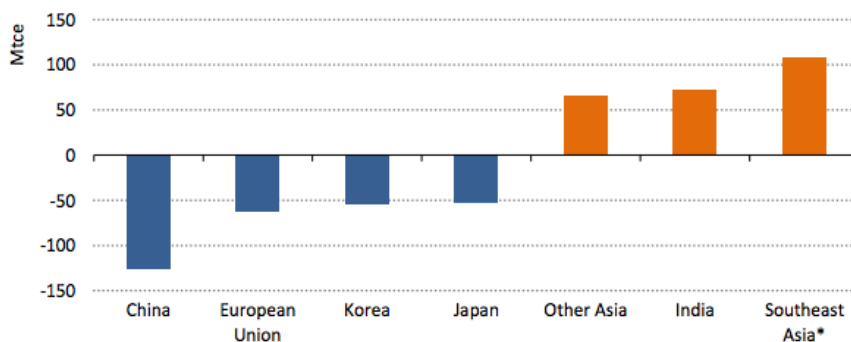
With 140 bcm of LNG capacity still under construction, gas markets remain well supplied for the next few years. By the mid-2020s, however, market over-capacity is absorbed by import growth. Investment in new capacity therefore is needed from 2020 onwards, and much of the new supply comes from low-cost sources of gas in the United States, Russia and Qatar.

Although the European Union remains the largest importer of gas, the Asia Pacific region accounts for some 85% of the growth in net imports, underpinning a shift in trade flows from the Atlantic basin to Asia. Much of the import growth in Asia comes from new importers in South and Southeast Asia, further strengthening the diversity and globalisation of gas markets.

Coal

Against a background of falling coal use in Europe, the United States and China, global coal demand fell by 2% in 2016, for the second year in a row. In the New Policies Scenario, consumption flattens at around 5 500 Mtce over the period to 2040, a stabilisation that is the product of counterbalancing trends: coal demand keeps falling in Europe (-61%), China (-13%) and the United States (-11%), but these declines are offset by increases in some developing countries, especially in India and Southeast Asia (Figure 6)

Figure 6: Change in net coal imports by key region in the New Policies Scenario, 2016-2040



In 2015, India overtook the United States as the second-largest coal consumer and its coal use more than doubles to 1 230 Mtce in 2040 in the New Policies Scenario. However, coal faces strong competition, in particular from solar PV, the costs of which have been declining rapidly. With policy-makers looking to limit reliance on imported energy and India's domestic output projected to grow at an annual rate of nearly 4%, coal import growth of 45% is significantly lower than in the *WEO-2016*.

China's coal industry restructuring is central to coal market dynamics. Various policies to manage the level of production have been implemented with the aim of keeping China's coal prices in a band of \$80-90/tonne, a price level acceptable to power companies, while providing a sufficient margin for most coal mines to stay in business. The influence of China's coal prices on global prices through arbitrage and trade sees international steam coal prices rise to over \$80/tonne in 2025 and then to \$86/tonne in 2040 in the New Policies Scenario.

Carbon capture and storage – an indispensable technology for the future of coal in scenarios that meet climate goals – has made limited progress in demonstrating its commercial viability in recent years. It is however an essential component of action to deliver the goals incorporated in the Sustainable Development Scenario, which sees some 210 GW of coal plant worldwide being fitted with CCS by 2040, implying that efforts to help it to become commercially viable need to be stepped up.

Modernisation of the IEA

These long-term trends in global energy demand point to a strategic challenge for the International Energy Agency (IEA). The energy world is simply very different from the way it was back in the 1970s, when the IEA was created to promote collaboration on oil security, technologies, data and sound policies. Member countries of the IEA, at that time, accounted for more than half of global energy demand and their actions held considerable sway over the way that energy markets functioned and developed.

Since its inception, the IEA has always had a global perspective; this is an analytical necessity in a highly integrated energy world. However, the hard data shows that its membership has, for some time, accounted for a shrinking share of global consumption, and by 2015 this share had fallen well below 40%. In response, the IEA has stepped up its efforts to adapt, in particular through the Association Initiative.

Since November 2015, seven countries have joined the IEA as Association countries – Brazil, China, India, Indonesia, Morocco, Singapore and Thailand, allowing the IEA to reflect more accurately the global nature of the energy system. Stronger institutional ties mean working collaboratively on improving energy data and statistics, co-operating closely on energy security and engaging on energy technologies and policies.

In addition to the Association countries, Mexico also joined the IEA as its 30th member in February 2018. With these new additions, the extended IEA family accounts for some 70% of the world's energy use – higher than when the IEA was created in 1974 and almost double the share in 2015. Based on our projections in the New Policies Scenario, the share of this extended family remains well above 60% through to the end of the projection period in 2040.