

# World Energy Outlook 2019

Executive Summary

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**The energy world is marked by a series of deep disparities.** The gap between the promise of energy for all and the fact that almost one billion people still do not have access to electricity. The gap between the latest scientific evidence highlighting the need for ever-more-rapid cuts in global greenhouse gas emissions and the data showing that energy-related emissions hit another historic high in 2018. The gap between expectations of fast, renewables-driven energy transitions and the reality of today's energy systems in which reliance on fossil fuels remains stubbornly high. And the gap between the calm in well-supplied oil markets and the lingering unease over geopolitical tensions and uncertainties.

**More than ever, energy decision makers need to take a hard, evidence-based look at where they stand and the implications of the choices they make.** The *World Energy Outlook* does not provide a forecast of what will happen. Instead, it provides a set of scenarios that explore different possible futures, the actions – or inactions – that bring them about and the interconnections between different parts of the system.

### *Understanding our scenarios*

**The Current Policies Scenario shows what happens if the world continues along its present path, without any additional changes in policy.** In this scenario, energy demand rises by 1.3% each year to 2040, with increasing demand for energy services unrestrained by further efforts to improve efficiency. While this is well below the remarkable 2.3% growth seen in 2018, it would result in a relentless upward march in energy-related emissions, as well as growing strains on almost all aspects of energy security.

**The Stated Policies Scenario, by contrast, incorporates today's policy intentions and targets.** Previously known as the New Policies Scenario, it has been renamed to underline that it considers only specific policy initiatives that have already been announced. The aim is to *hold up a mirror to the plans of today's policy makers* and illustrate their consequences, not to guess how these policy preferences may change in the future.

**In the Stated Policies Scenario, energy demand rises by 1% per year to 2040.** Low-carbon sources, led by solar photovoltaics (PV), supply more than half of this growth, and natural gas, boosted by rising trade in liquefied natural gas (LNG), accounts for another third. Oil demand flattens out in the 2030s, and coal use edges lower. Some parts of the energy sector, led by electricity, undergo rapid transformations. Some countries, notably those with “net zero” aspirations, go far in reshaping all aspects of their supply and consumption. However, the momentum behind clean energy technologies is not enough to offset the effects of an expanding global economy and growing population. The rise in emissions slows but, with no peak before 2040, the world falls far short of shared sustainability goals.

**The Sustainable Development Scenario maps out a way to meet sustainable energy goals in full, requiring rapid and widespread changes across all parts of the energy system.** This scenario charts a path fully aligned with the Paris Agreement by holding the rise in global temperatures to “well below 2°C ... and pursuing efforts to limit [it] to 1.5°C”, and meets objectives related to universal energy access and cleaner air. The breadth of the world's

energy needs means that there are no simple or single solutions. Sharp emission cuts are achieved across the board thanks to multiple fuels and technologies providing efficient and cost-effective energy services for all.

### *Energy security remains paramount, and oil stays in the spotlight*

**A fast-moving energy sector highlights the importance of a broad and dynamic approach to energy security.** The attacks in Saudi Arabia in September 2019 underlined that traditional energy security risks have not gone away. Meanwhile, new hazards – from cybersecurity to extreme weather – require constant vigilance from governments. We estimate that almost one-fifth of the growth in global energy use in 2018 was due to hotter summers pushing up demand for cooling and cold snaps leading to higher heating needs.

**Shale output from the United States stays higher for longer, reshaping global markets, trade flows and security.** Annual US production growth slows from the breakneck pace seen in recent years, but updated official estimates of underlying resources nonetheless mean that the United States accounts for 85% of the increase in global oil production to 2030 in the Stated Policies Scenario, and for 30% of the increase in gas. This bolsters the position of the United States as an exporter of both fuels. By 2025, total US shale output (oil and gas) overtakes total oil and gas production from Russia.

**Higher US output pushes down the share of OPEC countries and Russia in total oil production.** This share drops to 47% in 2030, from 55% in the mid-2000s, implying that efforts to manage conditions in the oil market could face strong headwinds. Pressures on the hydrocarbon revenues of some of the world's major producers also underline the importance of their efforts to diversify their economies.

**Whichever pathway the energy system follows, the world still relies heavily on oil supply from the Middle East.** The region remains by far the largest net provider of oil to world markets, as well as an important exporter of LNG. This means that one of the world's busiest trade routes, the Strait of Hormuz, retains its position as a crucial artery for global energy trade, especially for Asian countries such as China, India, Japan and Korea that rely heavily on imported fuel. In the Stated Policies Scenario, 80% of international oil trade ends up in Asia in 2040, propelled in large part by a doubling of India's import needs.

### *Electricity moves to the heart of modern energy security*

**Cost reductions in renewables and advances in digital technologies are opening huge opportunities for energy transitions, while creating some new energy security dilemmas.** Wind and solar PV provide more than half of the additional electricity generation to 2040 in the Stated Policies Scenario and almost all the growth in the Sustainable Development Scenario. Policy makers and regulators will have to move fast to keep up with the pace of technological change and the rising need for flexible operation of power systems. Issues such as the market design for storage, the interface between electric vehicles and the grid, and data privacy all have the potential to expose consumers to new risks.

## *The rise of the African energy consumer*

**Africa – the special focus of *WEO-2019* – is increasingly influential for global energy trends.** In the Stated Policies Scenario, the rise in Africa’s oil consumption to 2040 is larger than that of China, while the continent also sees a major expansion in natural gas use, prompted in part by a series of large discoveries made in recent years. The big open question for Africa remains the speed at which solar PV will grow. To date, a continent with the richest solar resources in the world has installed only around 5 gigawatts (GW) of solar PV, less than 1% of the global total. Solar PV would provide the cheapest source of electricity for many of the 600 million people across Africa without electricity access today.

**More than half a billion people are added to Africa’s urban population by 2040.** This is much higher than the growth seen in China’s urban population between 1990 and 2010, a period in which China’s production of materials such as steel and cement sky-rocketed. Africa’s infrastructure development is not set to follow the same path, but the energy implications of African urbanisation trends are still profound. The expected growth in population in Africa’s hottest regions also means that up to half a billion additional people would need air conditioners or other cooling services by 2040. Our Africa analysis underlines that the planning, design and governance of the world’s growing cities, the industrial materials that are used in their construction, and the transport options that are available to their inhabitants are critical issues for the global outlook.

## *An urgent need to take full advantage of the world’s “first fuel”*

**The faltering momentum behind global energy efficiency improvements is cause for deep concern.** It comes against a backdrop of rising needs for heating, cooling, lighting, mobility and other energy services. Improvements in the energy intensity of the global economy (the amount of energy used per unit of economic activity) are slowing: the 1.2% improvement in 2018 was around half the average rate seen since 2010. This reflects a relative lack of new energy efficiency policies and of efforts to tighten existing measures.

**A sharp pick-up in efficiency improvements is the single most important element that brings the world towards the Sustainable Development Scenario.** The pursuit of all economically viable opportunities for efficiency improvement can reduce global energy intensity by more than 3% each year. This includes efforts to promote the efficient design, use and recycling of materials such as steel, aluminium, cement and plastics. This increased “material efficiency” could be enough in itself to halt the growth in emissions from these sectors. Innovative approaches also include the use of digital tools to shift electricity demand to cheaper and less emissions-intensive hours of the day, reducing electricity bills for consumers and helping with system balancing, while also helping to reduce emissions.

## *Critical fuel choices hang in the balance*

**A three-way race is underway among coal, natural gas and renewables to provide power and heat to Asia’s fast-growing economies.** Coal is the incumbent in most developing Asian countries: new investment decisions in coal-using infrastructure have slowed sharply, but the large stock of existing coal-using power plants and factories (and the 170 GW of

capacity under construction worldwide), provides coal with considerable staying power in the Stated Policies Scenario. Renewables are the main challenger to coal in Asia's power sector, led by China and India. Developing countries in Asia account for over half of the global growth in generation from renewables. Demand for natural gas has been growing fast as a fuel for industry and (in China) for residential consumers, spurring a worldwide wave of investment in new LNG supply and pipeline connections. In our projections, 70% of the increase in Asia's gas use comes from imports – largely from LNG – but the competitiveness of this gas in price-sensitive markets remains a key uncertainty.

**In the Stated Policies Scenario, global growth in oil demand slows markedly post-2025 before flattening out in the 2030s.** Oil demand for long-distance freight, shipping and aviation, and petrochemicals continues to grow. But its use in passenger cars peaks in the late 2020s due to fuel efficiency improvements and fuel switching, mainly to electricity. Lower battery costs are an important part of the story: electric cars in some major markets soon become cost-competitive, on a total-cost-of-ownership basis, with conventional cars.

**Consumer preferences for SUVs could offset the benefits from electric cars.** The growing appetite among consumers for bigger and heavier cars (SUVs) is already adding extra barrels to global oil consumption. SUVs are more difficult to electrify fully, and conventional SUVs consume 25% more fuel per kilometre than medium-sized cars. If the popularity of SUVs continues to rise in line with recent trends, this could add another 2 million barrels per day to our projection for 2040 oil demand.

### *However fast overall energy demand grows, electricity grows faster*

**Electricity use grows at more than double the pace of overall energy demand in the Stated Policies Scenario, confirming its place at the heart of modern economies.** Growth in electricity use in the Stated Policies Scenario is led by industrial motors (notably in China), followed by household appliances, cooling and electric vehicles. In the Sustainable Development Scenario, electricity is one of the few energy sources that sees growing consumption in 2040 – mainly due to electric vehicles – alongside the direct use of renewables, and hydrogen. The share of electricity in final consumption, less than half that of oil today, overtakes oil by 2040.

**Solar PV becomes the largest component of global installed capacity in the Stated Policies Scenario.** The expansion of generation from wind and solar PV helps renewables overtake coal in the power generation mix in the mid-2020s. By 2040, low-carbon sources provide more than half of total electricity generation. Wind and solar PV are the star performers, but hydropower (15% of total generation in 2040) and nuclear (8%) retain major shares.

### *Battery costs matter*

**The speed at which battery costs decline is a critical variable for power markets as well as for electric cars.** India is the largest overall source of energy demand growth in this year's *Outlook*, and we examine how a cost-effective combination of cheaper battery storage and solar PV could reshape the evolution of India's power mix in the coming decades. Battery

storage is well suited to provide the short-term flexibility that India needs, allowing a lunchtime peak in solar PV supply to meet an early evening peak in demand. In the Stated Policies Scenario, a major reduction in battery costs means that some 120 GW of storage are installed by 2040. We also examine the possibility that battery costs could decline even faster – an extra 40% by 2040 – because of greater industrial economies of scale or a breakthrough in battery chemistry, for example. In this case, combined solar and battery storage plants would be a very compelling economic and environmental proposition, reducing sharply India’s projected investment in new coal-fired power plants.

### *Offshore wind is gathering speed*

**Cost reductions and experience gained in Europe’s North Sea are opening up a huge renewable resource.** Offshore wind has the technical potential to meet today’s electricity demand many times over. It is a variable source of generation, but offshore wind offers considerably higher capacity factors than solar PV and onshore wind thanks to ever-larger turbines that tap higher and more reliable wind speeds farther away from shore. There are further innovations on the horizon, including floating turbines that can open up new resources and markets.

**Increasingly cost-competitive offshore wind projects are on course to attract a trillion dollars of investment to 2040.** Europe’s success with the technology has sparked interest in China, the United States and elsewhere. In the Sustainable Development Scenario, offshore wind rivals its onshore counterpart as the leading source of electricity generation in the European Union, paving the way to full decarbonisation of Europe’s power sector. Even higher deployment is possible if offshore wind becomes the foundation for the production of low-carbon hydrogen.

### *Tackling the legacy issues head on*

**If the world is to turn today’s emissions trend around, it will need to focus not only on new infrastructure but also on the emissions that are “locked in” to existing systems.** That means addressing emissions from existing power plants, factories, cargo ships and other capital-intensive infrastructure already in use. Despite rapid changes in the power sector, there is no decline in annual power-related CO<sub>2</sub> emissions in the Stated Policies Scenario. A key reason is the longevity of the existing stock of coal-fired power plants that account for 30% of all energy-related emissions today.

**Over the past 20 years, Asia has accounted for 90% of all coal-fired capacity built worldwide, and these plants have potentially long operational lifetimes ahead of them.** In developing economies in Asia, existing coal-fired plants are just 12 years old on average. We consider three options to bring down emissions from the existing stock of plants: to retrofit them with carbon capture, utilisation and storage (CCUS) or biomass co-firing equipment; to repurpose them to focus on providing system adequacy and flexibility while reducing operations; or to retire them early. In the Sustainable Development Scenario, most of the 2 080 GW of existing coal-fired capacity would be affected by one of these three options.

### *What's in the pipeline for gas?*

**Gas grids provide a crucial mechanism to bring energy to consumers, typically delivering more energy than electricity networks and providing a valuable source of flexibility.** From an energy security perspective, parallel gas and electricity grids can be complementary assets. From an energy transitions perspective, natural gas can provide near-term benefits when replacing more polluting fuels. A key longer-term question is whether gas grids can deliver truly low- or zero-carbon energy sources, such as low-carbon hydrogen and biomethane. Low-carbon hydrogen is enjoying a wave of interest, although for the moment it is relatively expensive to produce. Blending it into gas networks would offer a way to scale up supply technologies and reduce costs. Our new assessment of the sustainable potential for biomethane supply (produced from organic wastes and residues) suggests that it could cover some 20% of today's gas demand. Recognition of the value of avoided CO<sub>2</sub> and methane emissions would go a long way towards improving the cost competitiveness of both options.

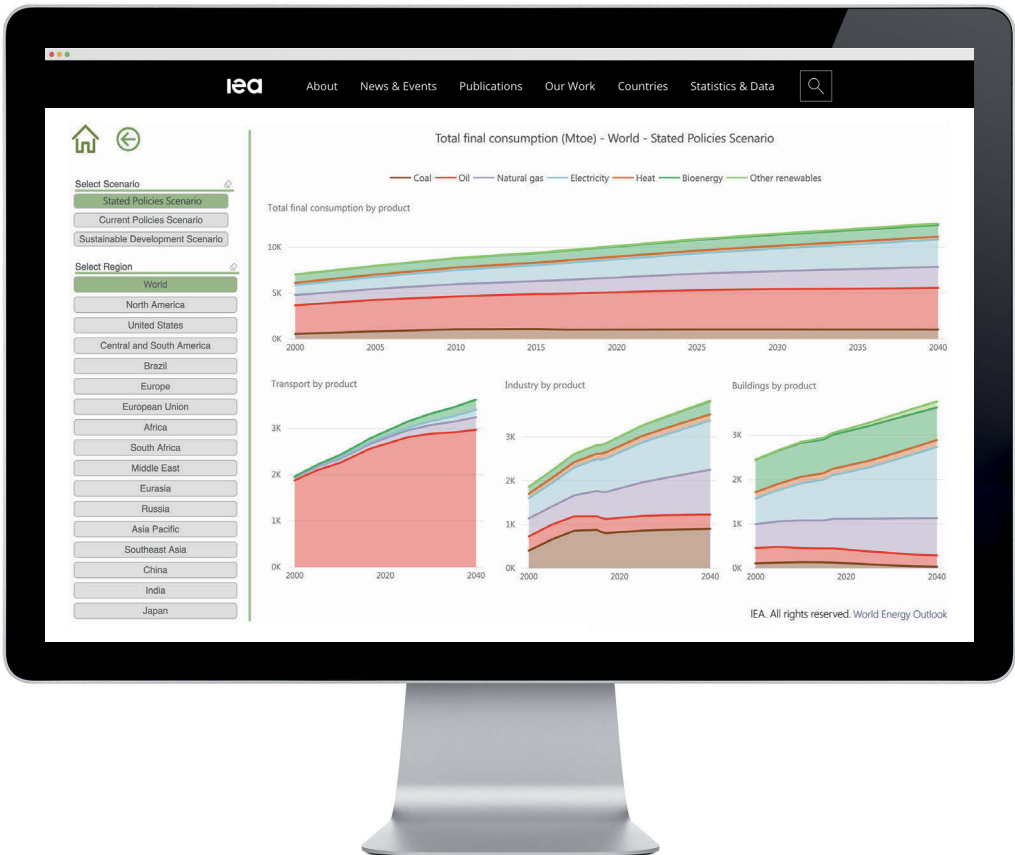
### *Shale and solar PV show that rapid change is possible, but the direction and speed is set by governments*

**Ten years ago, the idea that the United States could become a net exporter of both oil and gas was almost unthinkable.** Yet the shale revolution – and over \$1 trillion in upstream and midstream investment – is making this a reality. The foundations date back to a publicly funded research and development effort that began in the 1970s. This was followed by tax credits, market reforms and partnerships that provided a platform for private initiative, innovation, investment and rapid reductions in cost.

**Today, solar PV and some other renewable technologies – mostly in the power sector – are similarly turning initial policy and financial support into large-scale deployment.** Transforming the entire energy system will require progress across a much wider range of energy technologies, including efficiency, CCUS, hydrogen, nuclear and others. It will also require action across all sectors, not just electricity.

**Meeting rising demand for energy services, including universal access, while cutting emissions is a formidable task: all can help, but governments must take the lead.** Initiatives from individuals, civil society, companies and investors can make a major difference, but the greatest capacity to shape our energy destiny lies with governments. It is governments that set the conditions that determine energy innovation and investment. It is governments to whom the world looks for clear signals and unambiguous direction about the road ahead.

# Explore the data behind the **World Energy Outlook 2019**



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In addition, those who purchase the book will have access to the World Energy Outlook online database that includes the scenario results, full energy balances for key regions, and over 300 downloadable figures and tables.



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The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30 member countries, 8 association countries and beyond.

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Typeset in France by IEA – November 2019

Cover design: IEA

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## World Energy Outlook 2019

The World Energy Outlook series is a leading source of strategic insight on the future of energy and energy-related emissions, providing detailed scenarios that map out the consequences of different energy policy and investment choices.

This year's edition updates the outlooks for all fuels, technologies and regions, based on the latest market data, policy initiatives and cost trends.

In addition, the 2019 report tackles some key questions in depth:

- What do the shale revolution, the rise of liquefied natural gas, the falling costs of renewables and the spread of digital technologies mean for tomorrow's energy supply?
- How can the world get on a pathway to meet global climate targets and other sustainable energy goals?
- What are the energy choices that will shape Africa's future, and how might the rise of the African consumer affect global trends?
- How large a role could offshore wind play in the transformation of the energy sector?
- Could the world's gas grids one day deliver low-carbon energy?