World Energy Outlook 2018

World Energy Outlook 2018 examines future patterns of a changing global energy system at a time of increasing uncertainties and finds that major transformations are underway for the global energy sector. Across all regions and fuels, policy choices made by governments will determine the shape of the energy system of the future.

Explore: Overview Scenarios Fuels Themes Q&A Commentaries Data

Special focus on: Electricity Producer economies Oil & gas innovation

Introduction

The electricity sector is witnessing its most dramatic transformation since its birth more than a century ago . For that reason, the *World Energy Outlook* features a special focus on electricity this year to examine what could lie ahead for global power systems.

Dr Fatih Birol, IEA Executive Director

Electricity is the fastest-growing source of final energy demand, and over the next 25 years it continues to outpace energy consumption as a whole. The power sector now attracts more investment than oil and gas combined – necessary investments as the generation mix changes and ageing infrastructure is upgraded.

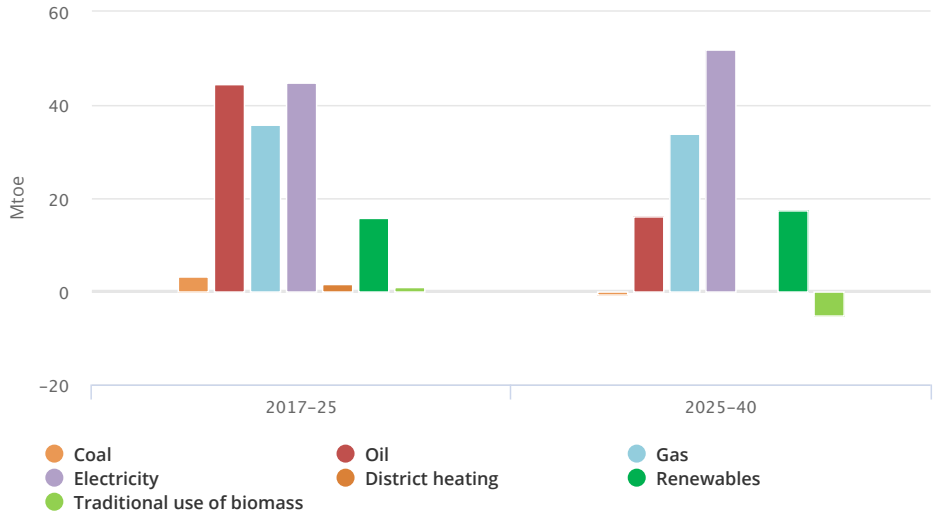
The global electricity supply is also being transformed by the rise of variable renewable sources of generation such as wind and solar PV. While this puts electricity at the forefront of the clean-energy transitions, providing access to the nearly 1 billion currently deprived, helping cut air pollution and meet climate goals, these changes will require a new approach to how power systems are designed and how they operate. Otherwise, rising electrification could result in less secure energy systems, underscoring the urgent need for policy action in this critical sector.

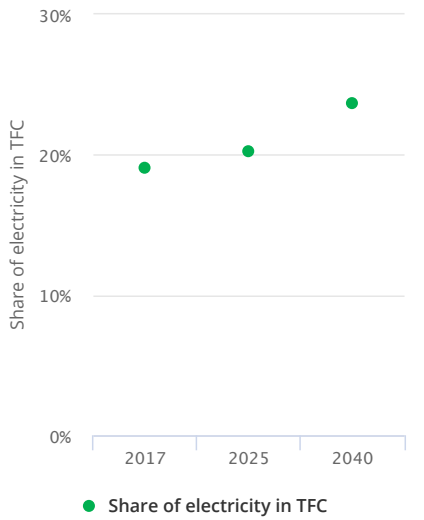
Key Findings

Electrification of end uses is a promising pathway to decarbonising energy use

Electricity today accounts for 19% of total final consumption of energy, a share that is set to increase as demand growth for electricity outpaces all other fuels. In the New Policies Scenario, the share reaches 24% in 2040, a far cry from full electrification. While there is considerable scope to push electrification beyond this level, not all end-uses can be readily electrified, such as high-temperature heat demand in industry, long-haul aviation and shipping, where electrification is harder to achieve due to either economic or technical barriers.

Annual growth in total final consumption by fuel (left) and share of electricity (right) in the New Policies Scenario

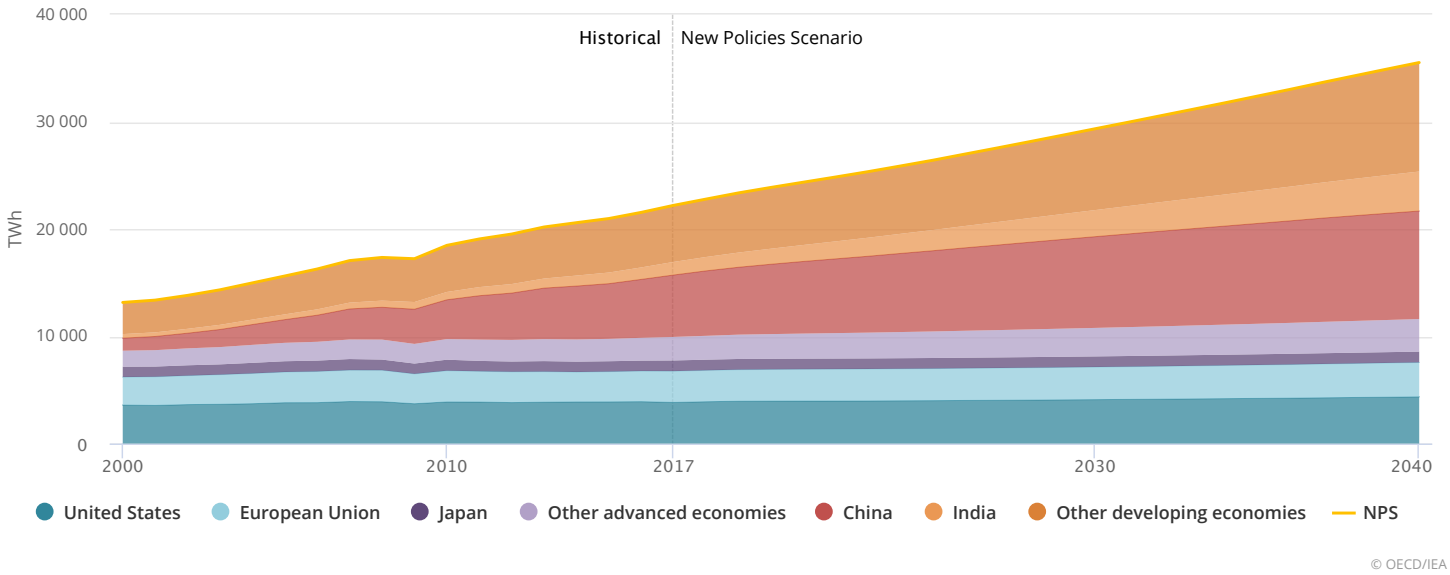




But electricity growth is a tale of two stories driven mostly by developing economies

Developing economies will account for the largest share of new demand, driven by rapid economic and population growth, the need for more goods and services and increasing policy push towards electrification. Motor systems used in Chinese industry alone will account for almost a fifth of the increase in global electricity demand to 2040. A similar increase is expected from growing needs for cooling, with the number of home air conditioners in developing economies rising to 2.5 billion units, up from about 600 million today. Accelerating uptake of electric vehicles and electric water heaters could see demand growth in developing economies increase even more rapidly.

Global electricity demand by region in the NPS



Meanwhile, in advanced economies, electricity growth is muted

Continued efficiency improvements in lighting, refrigerators, motors, etc. result in electricity demand staying relatively flat in advanced economies. Electricity gaining ground in providing electro-mobility and heat for homes, offices and factories provides a lifeline for growth. However, even widespread electrification will not be sufficient to drive a major increase in electricity demand in these regions, as the higher efficiency of electric cars and heat pumps reduces the additional amount of electricity needed for transportation and for heating our homes. For example, : pushing EVs to 100% of new car sales in advanced economies by 2040 (compared to 1% today) would increase electricity demand growth to an average of 1.1% annually, as EVs are more than twice as efficient as conventional cars and stock turnover low.

ıg the Future is Electric Scenario (FiES)

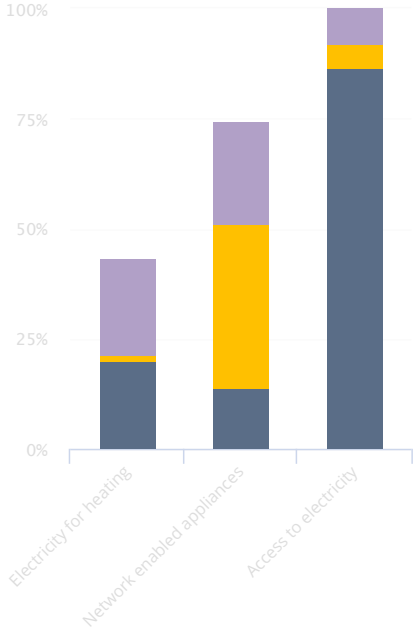
Policy choices will have a great impact on how the electricity sector develops in the future, especially what key levers are used to boost electricity demand growth. Policies and regulations play a determining role in unlocking higher electrification: encouraging efforts to accelerate the rollout of electric charging infrastructure for vehicles, simplifying switching to electric heating in both buildings and industry, or pushing to achieve universal access to electricity or improving standards of living.

The analysis this year introduces the **Future is Electric Scenario (FiES)** to examine what would happen to electricity demand if economic opportunities for electrification were maximized. For instance, in the FiES by 2040, almost half of the car fleet goes electric; electricity makes rapid inroads into heating needs for buildings and industry; a digital economy connects nearly all consumer devices and appliances; and full electricity access is achieved.

Electrification of end-uses in the Future is Electric Scenario and the New Policies Scenario

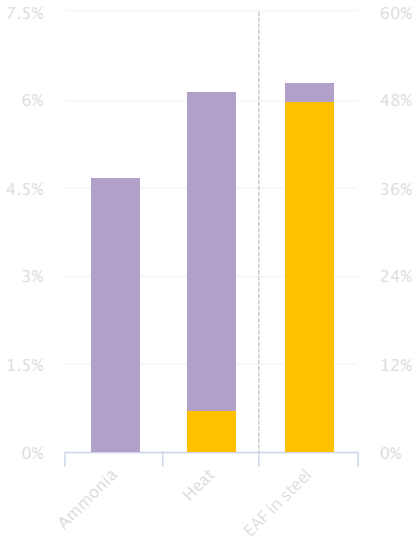
Buildings

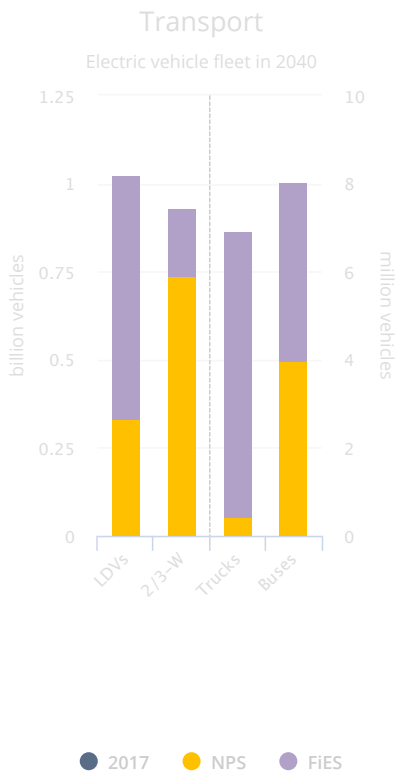
Level of household uptake (2040)



Industry

Electrification of end uses





Note: EAF = electric arc furnace, LDV = light-duty vehicles, 2/3-W = two/three-wheelers; Trucks = heavy-duty trucks only

A strong policy push to electrify end uses sees electricity demand increase to nearly 7 000 TWh above the New Policies Scenario in 2040, an increase equivalent to the electricity demand of China and India today. The biggest potential for demand growth lies with electrifying transport and heat. The deployment of EVs is aided by their improving competitiveness with internal combustion engine (ICE) vehicles in most major markets, but would require adequate infrastructure roll-out.

The implications for energy and the environment are significant. Oil demand would peak by 2030, and expenditures for electricity would overtake that of oil products before 2035. Electrification decreases air pollutant emissions, reducing premature deaths by nearly 2 million relative to the NPS.

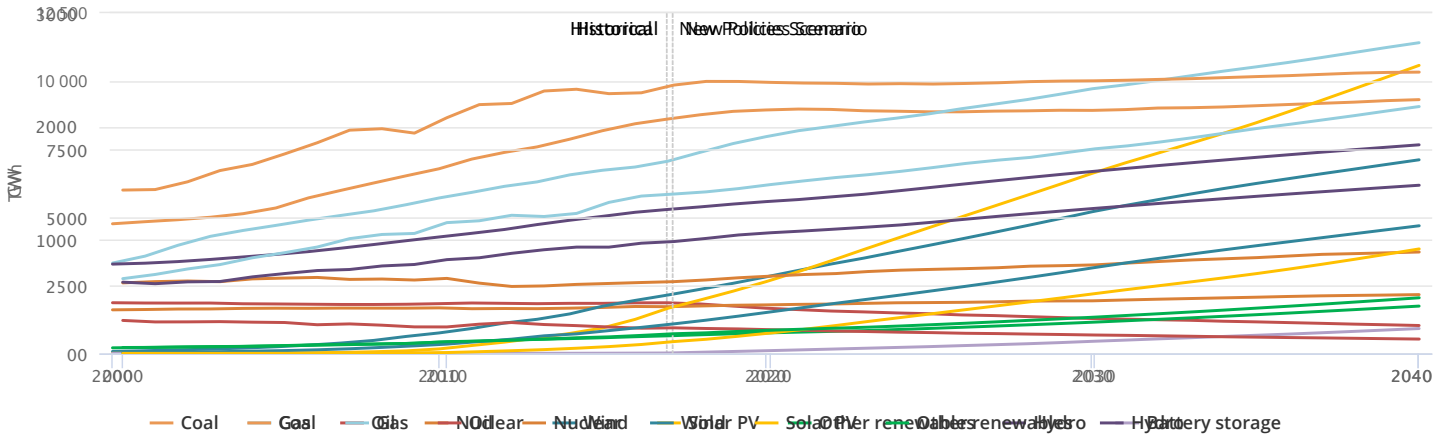
However, while electrification provides an avenue to decarbonise end-uses, overall energy sector carbon emissions will keep growing under this scenario without stronger efforts to decarbonise electricity supply. Electrification alone is not sufficient to put the world on track to meet climate goals; this would require a more comprehensive energy system strategy. Paired with a much more widespread deployment of renewables and other low carbon sources of electricity, electrification can help follow a more sustainable trajectory.

Change in electricity demand by sector in the FiES relative to the NPS, in 2040 (left) and energy related CO2 emissions by scenario (right)

Solar PV and natural gas are reshaping power sector capacity ...

Thanks to falling costs and favourable government policies, solar PV capacity is set to surge – overtaking wind by 2025 and overtaking coal in the mid-2030s to become the second largest installed capacity globally, after gas. Gas-fired capacity overtakes coal well before 2030, as countries look to address emissions and air pollution concerns, while meeting flexibility and adequacy needs.

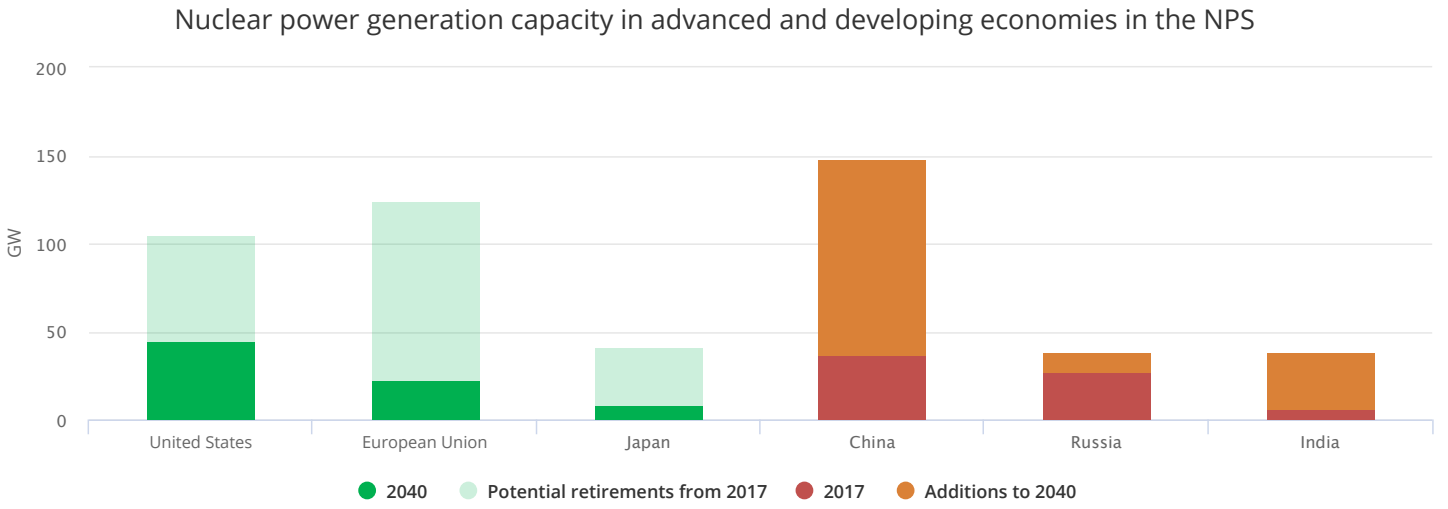
Installed power capacity in the NPS | Power generation in the NPS



… which also means that the power generation mix is evolving (though more slowly than capacity)

Coal remains largest source of electricity generation, though its share falls substantially over time and gas nearly closes the gap. Renewables increase of around 25% up to total 41% in 2040. Hydro remains the largest source of low carbon electricity, followed by wind power and solar PV.

Nuclear increases moderately, with a significant geographical shift. Traditional nuclear champions will see a wave of retirements to 2040 as the industry faces challenges in the leading markets of the United States, Europe and Japan. Meanwhile, a nuclear expansion is led by China, India and Russia in developing nations.



Flexibility will become the cornerstone of electricity security …

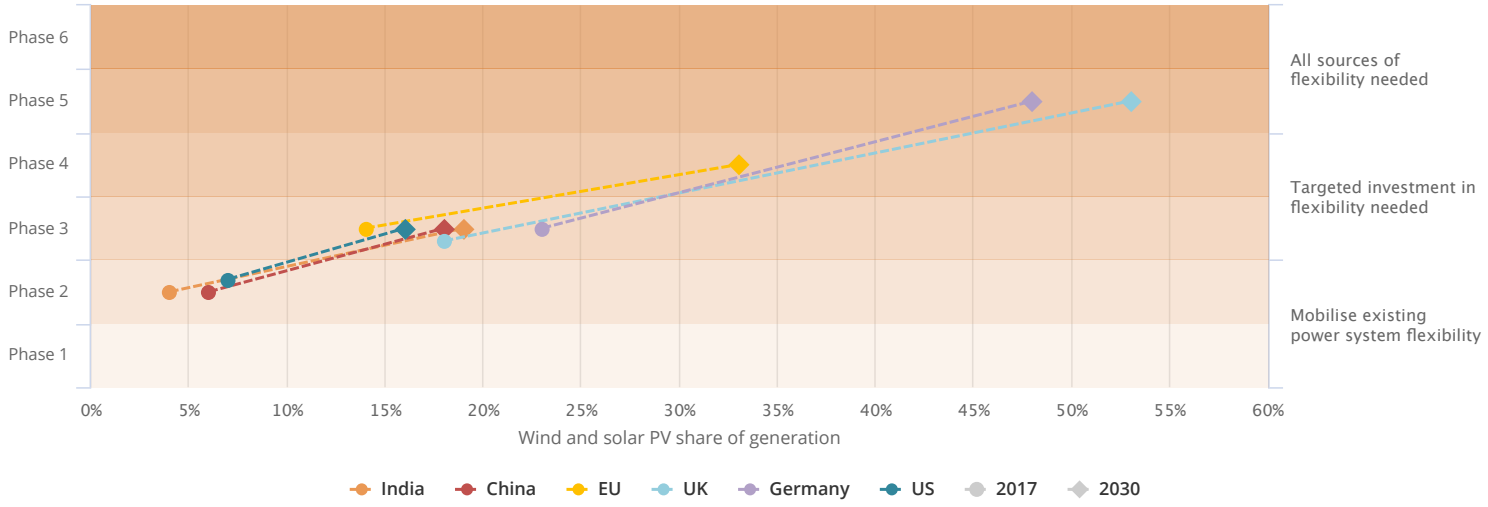
Building flexible power systems to accommodate the transition to more electrified, low-carbon and digitalised electricity systems of the future will be critical to ensure reliability. Government policies need to consider flexibility as a core component of electricity system design and management.

Flexibility needs are set to increase due to the evolving nature of electricity demand and supply; driven by electrification and other changes in the way electricity is used on a daily basis, greater flexibility may be needed to manage peaks in demand. The rising shares of wind and solar PV increase system flexibility needs to manage the variability of their output.

System flexibility needs can be characterised by a scale of six phases of integration. Moving to higher phases generally increases the need for dedicated practices, policies and investments to manage power systems. For systems in Phase 1 and 2, existing sources of flexibility are capable of meeting any flexibility needs. Beyond these initial phases of integration, targeted investment in advanced flexibility measures is needed to manage the integration of variable renewables. The phase a country is in depends not only on the share of variable renewables in annual generation, but also is influenced by existing flexibility resources and the match between solar PV, wind and demand profiles. Looking ahead, some countries are set to move into uncharted territory where regular periods of excess supply could become the norm.

As countries move up the phase scale, increased demand for flexibility will be met by a range of sources. Today, power plants and transmission interconnections provide the vast majority of flexibility in power systems. Going forward, demand-side response and energy storage technologies, including battery storage, will have a growing role in ensuring energy security.

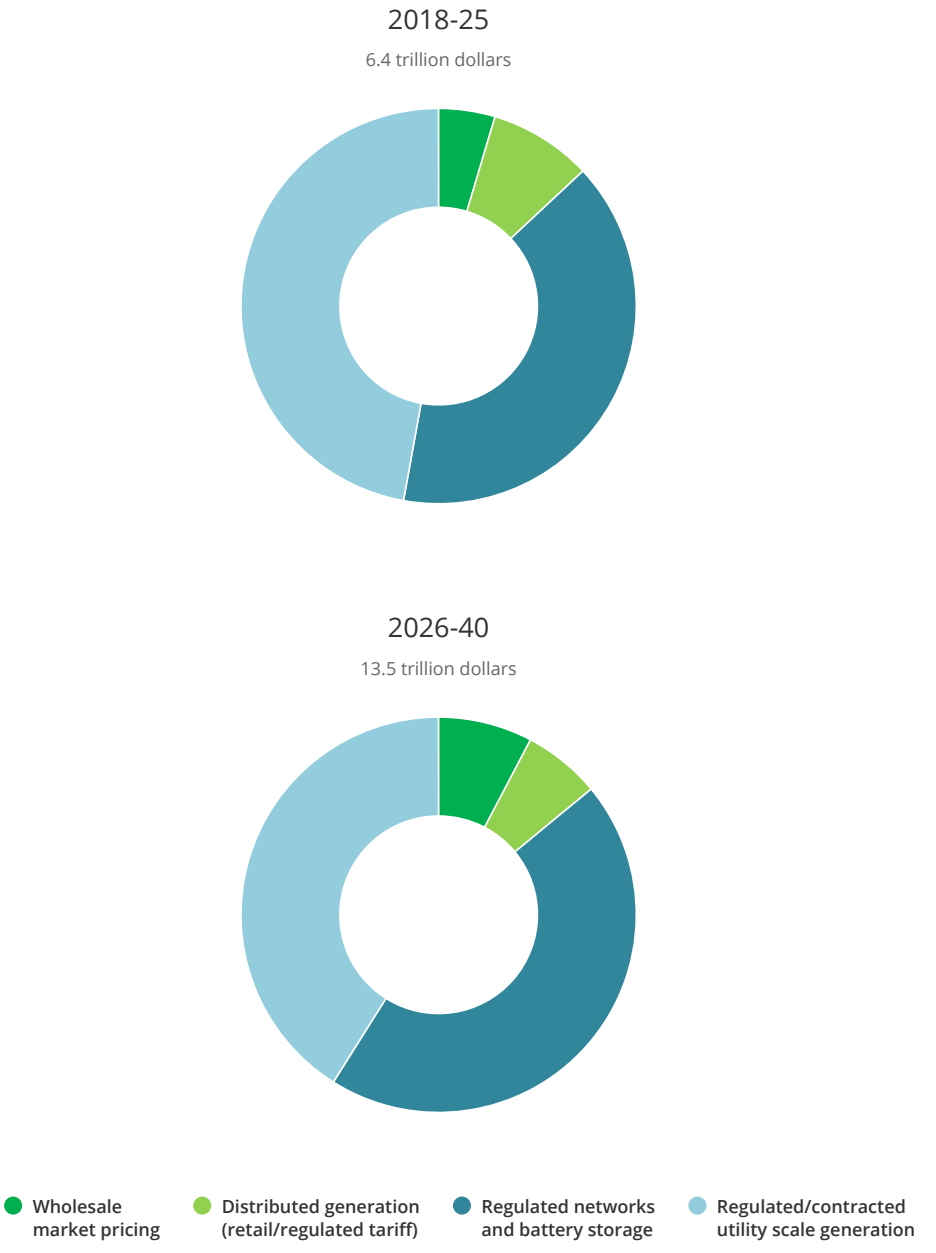
Variable renewables share of generation and phases of integration in the NPS



Investments are needed in the right place, at the right time to keep the lights on

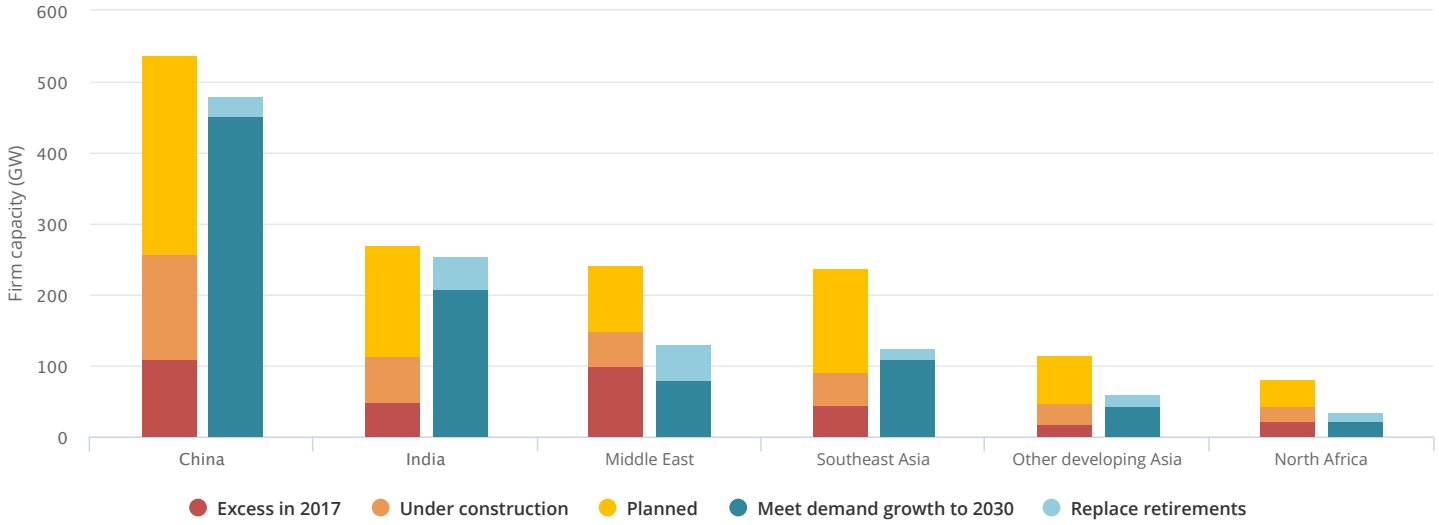
Power sector investment needs to be timely and efficient to ensure electricity security. Government policy will play an integral role in all markets. In competitive wholesale electricity markets, the rising share of variable renewables puts downward pressure on price signals needed for investment, and market reforms may be needed to secure sufficient levels of investment to keep the lights on.

Power plant investment in competitive markets and under regulated frameworks in the NPS



In heavily regulated markets, the risk of overinvestment continues, as capacity currently under construction, or in the planning phase, is set to outpace new needs for the system, threatening the affordability of electricity for more than a billion households. At today's levels, for example, excess capacity would cost households in developing economies close to $15 per year.

Planned capacity additions and system needs to 2030 in selected regulated markets in the NPS



Proper government policies - and market designs - will be critical

The risk of underinvestment in competitive electricity markets threatens the security of electricity supply. Without concerted action and market reform, the lights could flicker and go out on some advanced economies. In re-orienting electricity supply, policy makers must also look beyond technology costs, considering also the value of all the services provided to the system.

Downward pressure on wholesale electricity prices also reduces revenues to all sources of generation. To close the widening gap between energy sales revenue and total generation costs, the need for additional revenue streams is growing and can be delivered through capacity and flexibility markets. For example, energy sales have covered a falling share of total generation costs in the European Union, and this looks to become more pronounced in the future unless CO_2 prices rise to above $30 by 2030.

Share of long-run generation costs covered by energy sales in the European Union in the NPS