

# Overview & key findings

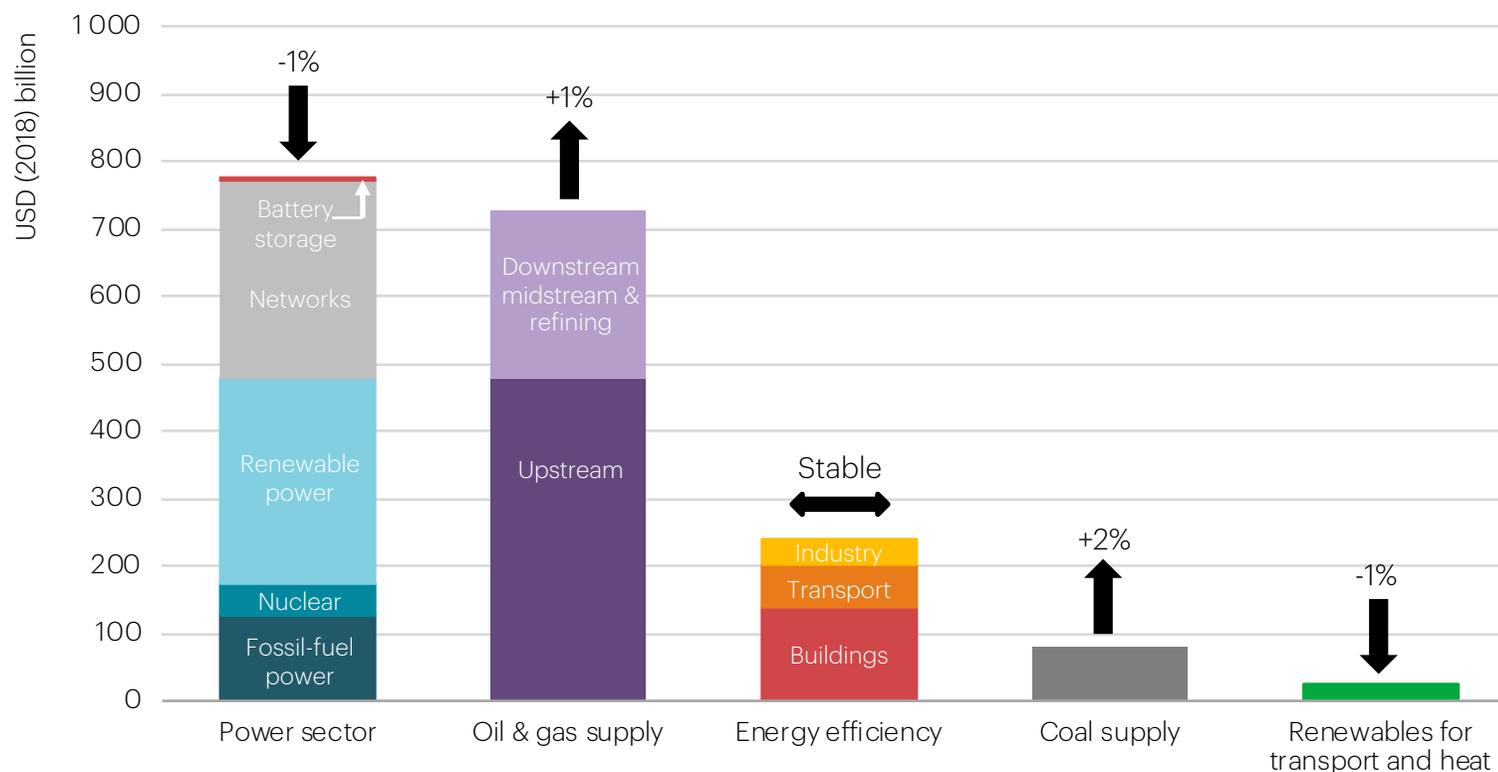
# Energy investment by sector

Overview of energy investment (9-11)

Energy investment cost and project trends (12-16)

# After three years of decline, global energy investment stabilized in 2018

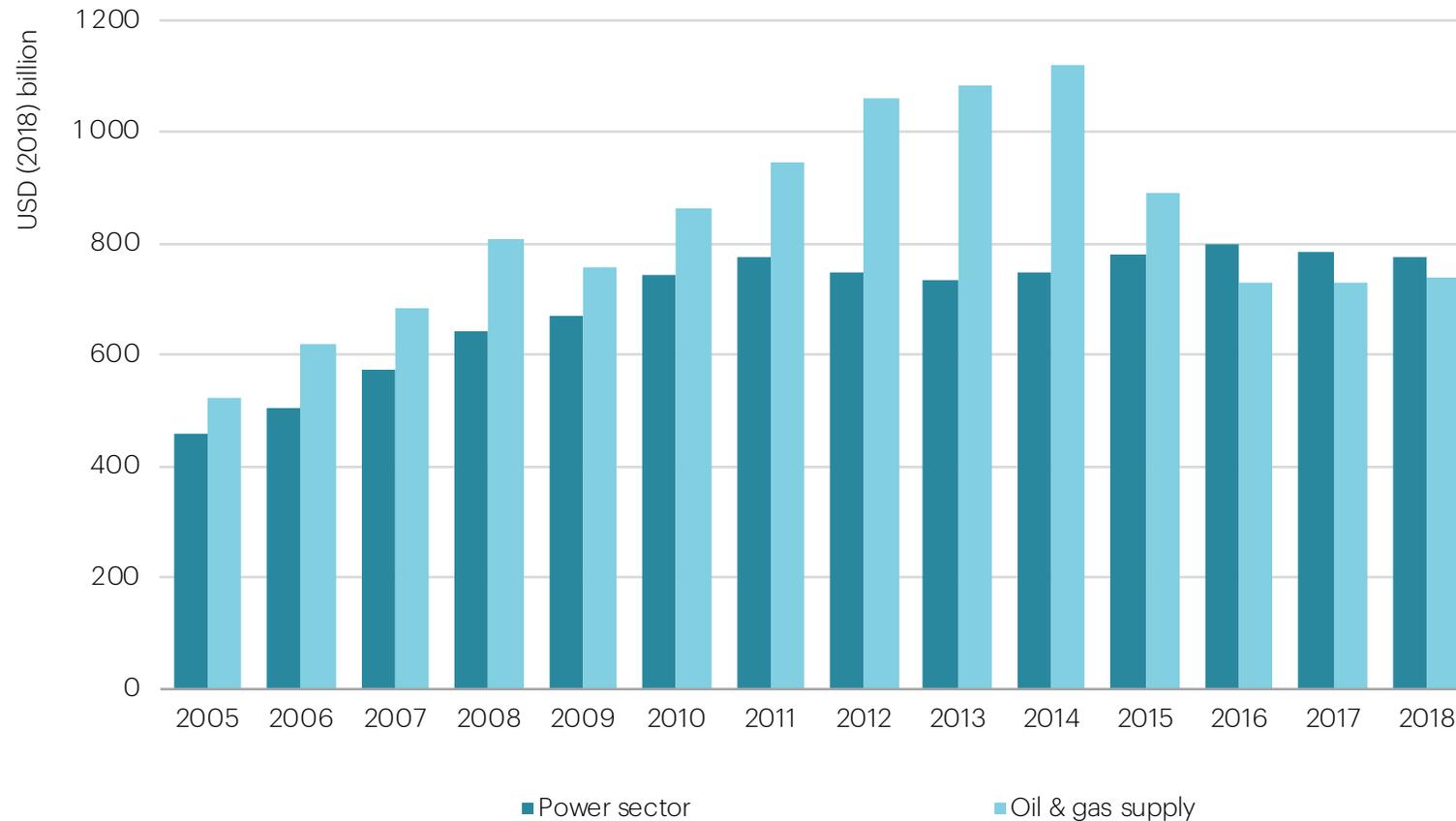
Global energy investment in 2018 and change compared to 2017



Note: Investment is measured as the ongoing capital spending in energy supply capacity and incremental spending on more efficient equipment and goods (in energy efficiency). The scope and methodology for tracking energy investments is found in the Annex of this report as well as at [iea.org/media/publications/wei/WEI2019-Methodology-Annex.pdf](https://www.iea.org/media/publications/wei/WEI2019-Methodology-Annex.pdf). Renewables for transport and heat include biofuels for transport and solar thermal heating. Electricity networks include transmission and distribution.

# Despite a downtick, power was again the largest sector for investment

Global investment in the power sector compared with oil and gas supply



## Investment was driven by higher upstream oil & gas and coal supply spending while that in energy efficiency was stable and renewables spending edged down

In 2018, global energy investment remained relatively stable, at over USD 1.8 trillion (United States dollars), following three years of decline. More spending in upstream oil and gas and coal supply was offset by lower spend on fossil-fuel based generation and renewable power. Investment in energy efficiency was relatively stable.

For the third year in a row, power exceeded oil and gas supply as the largest investment sector. While partly due to shifting costs in both sectors, the trend also reflects the growing importance of electricity, whose demand growth in 2018 was nearly twice as fast as overall energy demand.

A 1% fall in power investment stemmed from less spending on coal power in the People's Republic of China ("China") and gas power in the United States. Renewables investment edged down, as net additions to capacity were flat and costs fell in some technologies, but was also supported by plants under development. Lower solar PV investment in China was partly offset by higher renewable spend in some areas (e.g. United States, developing Asia).

A 4% rise in upstream oil & gas spending was underpinned by a higher oil price, and a shift to shorter-cycle projects and shale. Spending plans for 2019 point to a potential new wave of conventional projects; for the moment, project approvals are below the level needed to match robust demand.

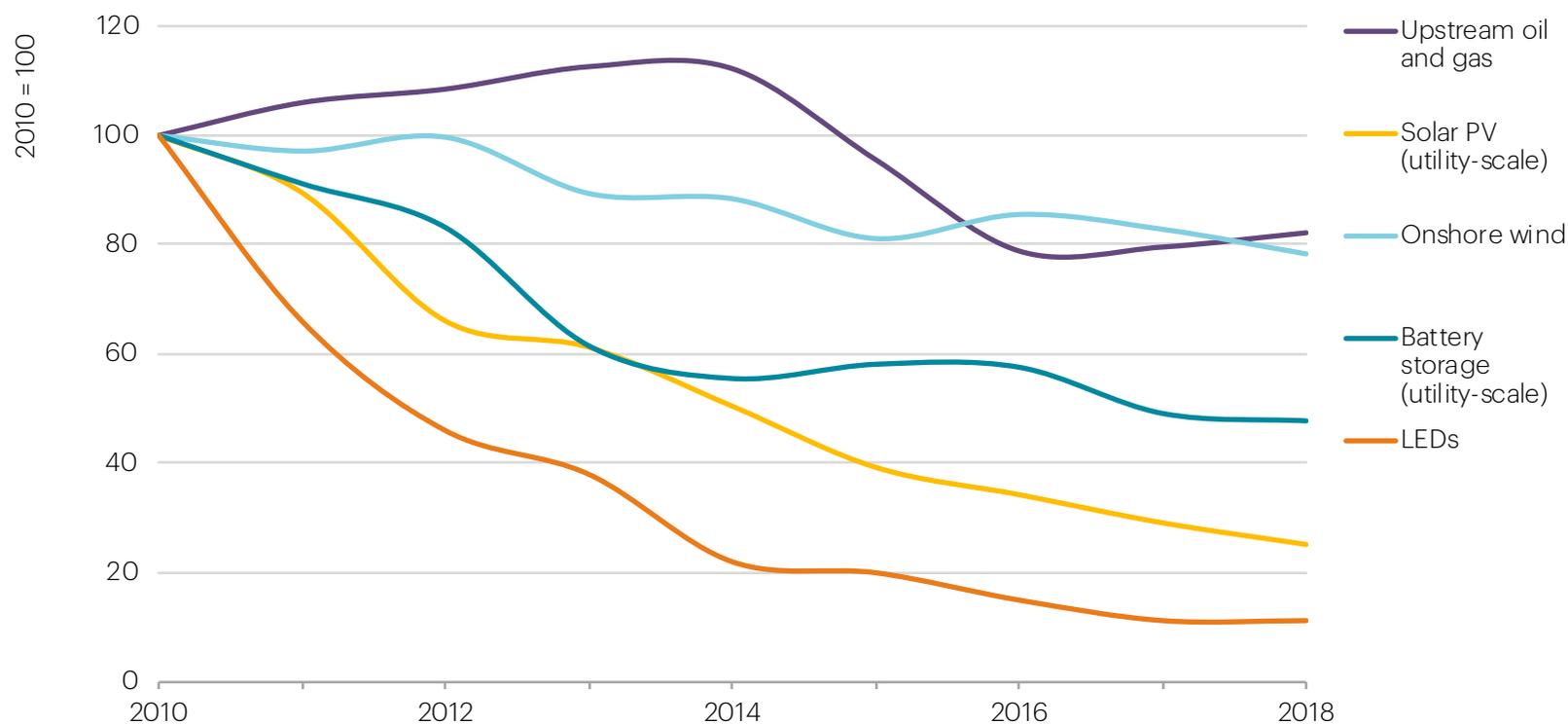
Energy efficiency spending was stable a second year in a row, with limited progress in expanding policy coverage. Despite soaring EV sales, transport efficiency has stagnated, while spending in buildings dipped.

Investment in coal supply increased by 2% – the first such rise since 2012 – although the total remains a long way below the peak levels reached at the start of the decade.

Investment in renewable heat and transport edged down, but spending on new biofuels plants grew.

# Changing costs have reshaped the investment landscape in some areas

Capital costs in selected energy-related sectors

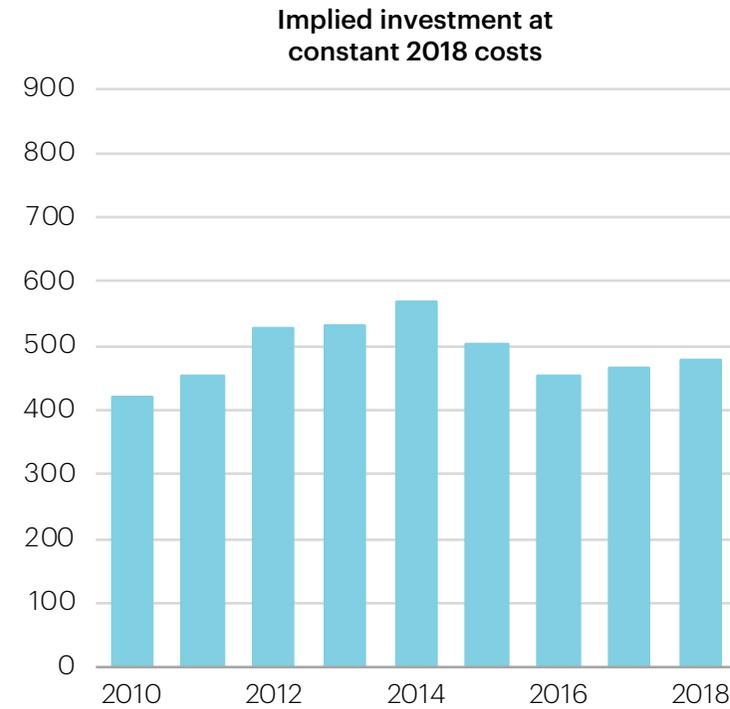
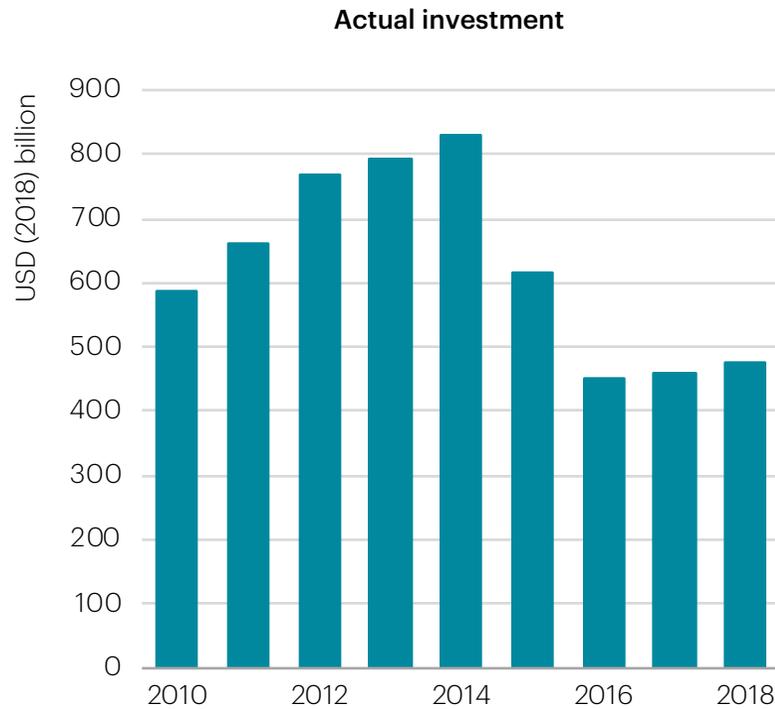


Note: LEDs = light-emitting diodes, PV = photovoltaic. Capital costs reflect global weighted average costs of components or commissioned projects in a given sector.

Source: IEA analysis with calculations for solar PV and wind costs based on IRENA (2019).

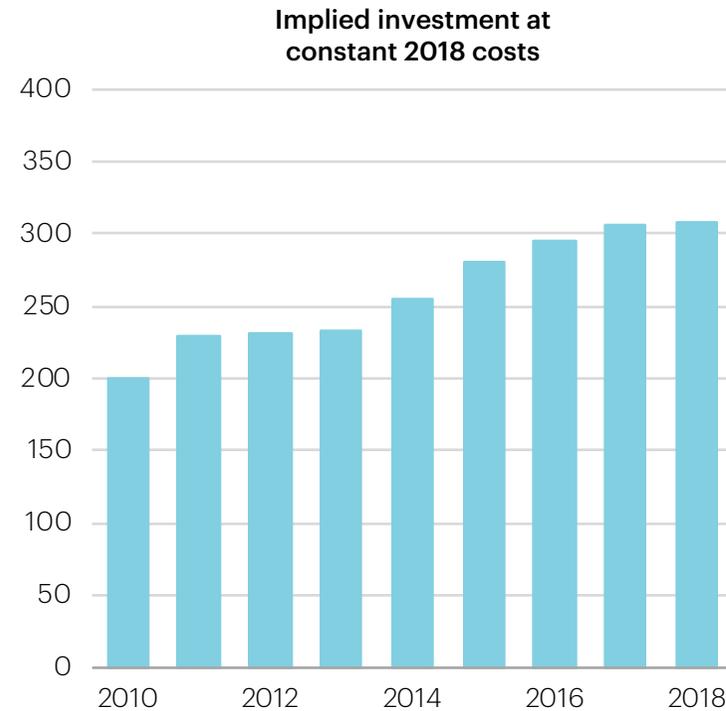
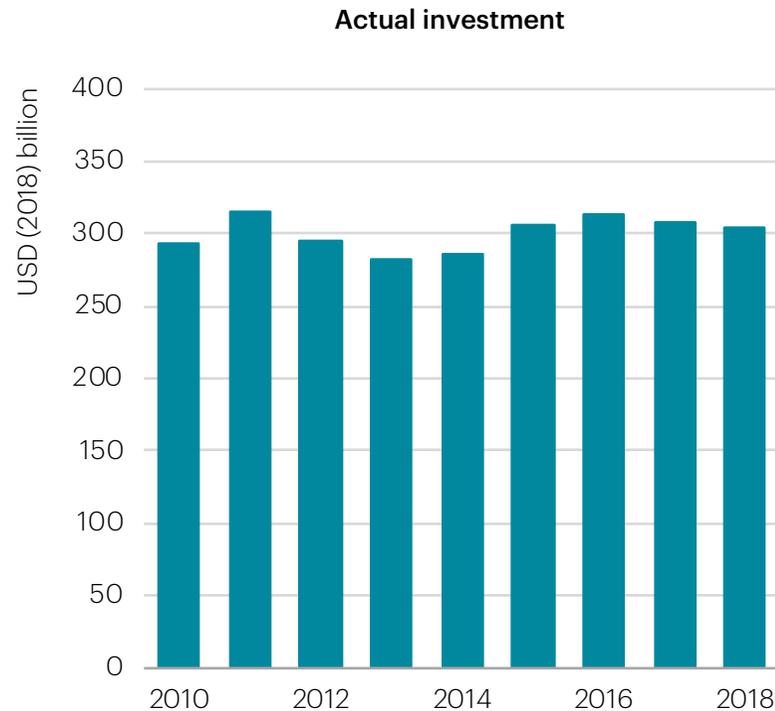
# Lower costs dampened the impact of less upstream spending since 2014...

Investment in upstream oil and gas – actual spend vs implied investment at constant 2018 cost levels



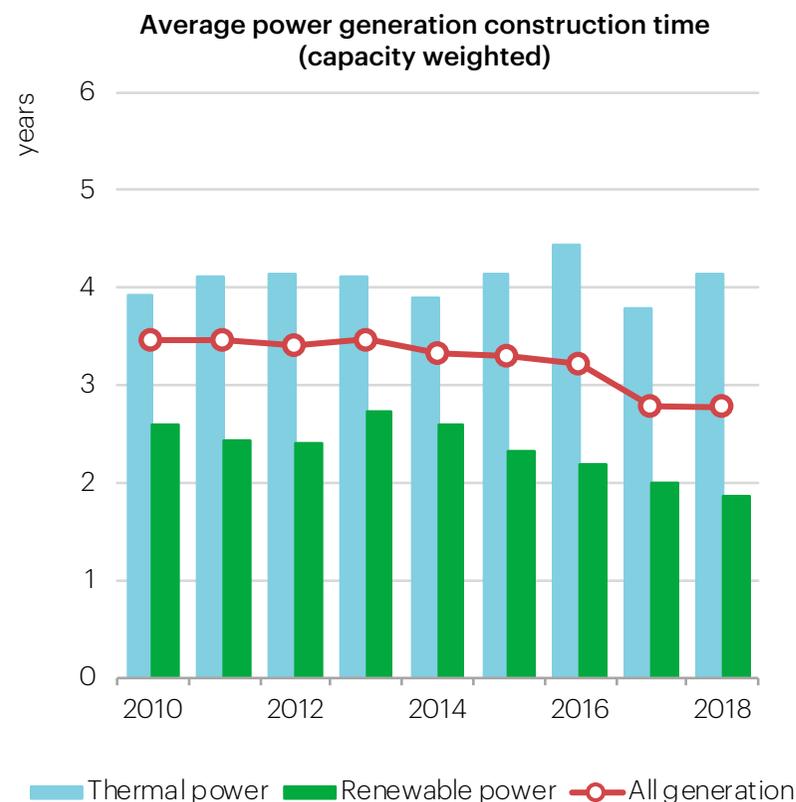
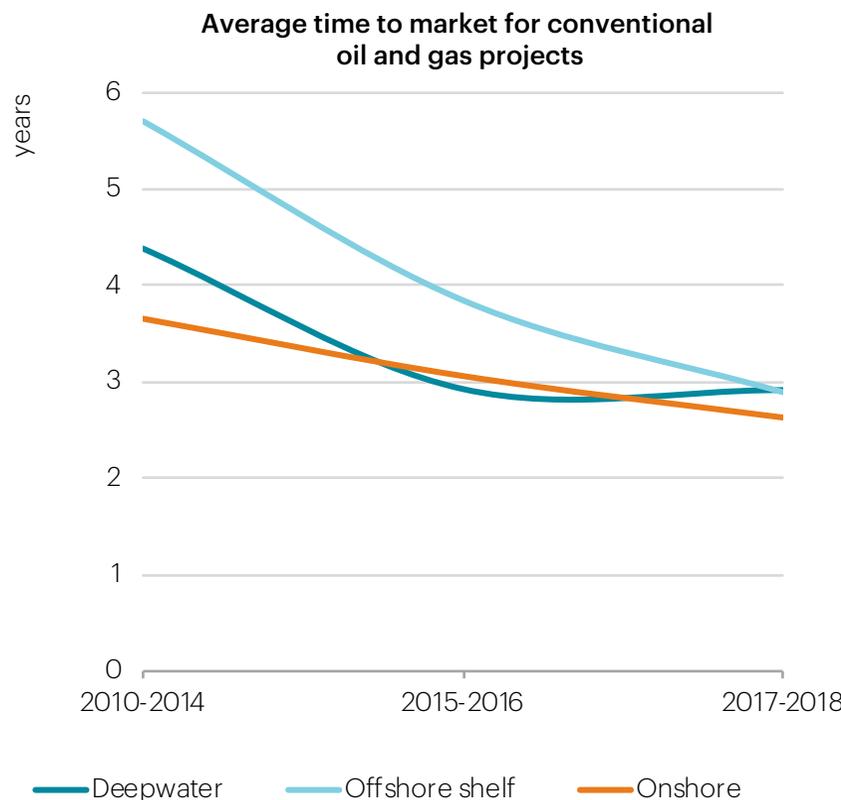
## ...while adjusted for costs, renewables investment is up 55% since 2010

Investment in renewable power – actual spend vs implied investment at constant 2018 cost levels



# There has been a broad a shift towards projects with shorter lead times...

Trends in project development and investment timelines for oil and gas supply and power generation



## ...as industry seeks to limit long-term risks in a changing energy system

In recent years there has been a broad shift in favour of projects with shorter construction times that limit capital at risk. For upstream oil and gas and power generation, the industry is bringing capacity to market on average more than 20% faster than at the start of the decade. This reflects better project management and improved economics for shorter cycle technologies as well as industry competition.

In power, capital cost declines – reflecting technology progress and deployment location – have been most evident in solar PV (-75% since 2010), onshore wind (-20%) and battery storage (-50%). In offshore wind, capital cost declines for commissioned projects have been less dramatic, but rising utilisation rates and lower financing costs have driven prices in auctions to new lows.

After declining 30% over 2014-16, a slight rebound in upstream oil and gas costs in the last two years was lower than the increase in oil prices. With more spending on shale and faster time to market for conventional projects, the industry is now better able to react to changing market conditions.

In oil and gas and renewables, a dollar of investment buys more than in the past. Adjusting investment to 2018 cost levels shows a rising trend in spending activity for renewable power, up around 55% since 2010. For oil and gas, cost reductions have damped the impact of falling investment since 2014.

Prices for some efficient goods, e.g. LEDs and electric vehicles, have continued to fall, and many energy efficient investments are already cost-effective with relatively short payback periods. Still, policy, market, and financing-related challenges have acted as barriers to increased spending on efficiency.

Changes are not evident in all areas, with little recent progress in improving costs or project cycles for nuclear; carbon capture, utilisation, and storage; building retrofits; and some large-scale grid projects.

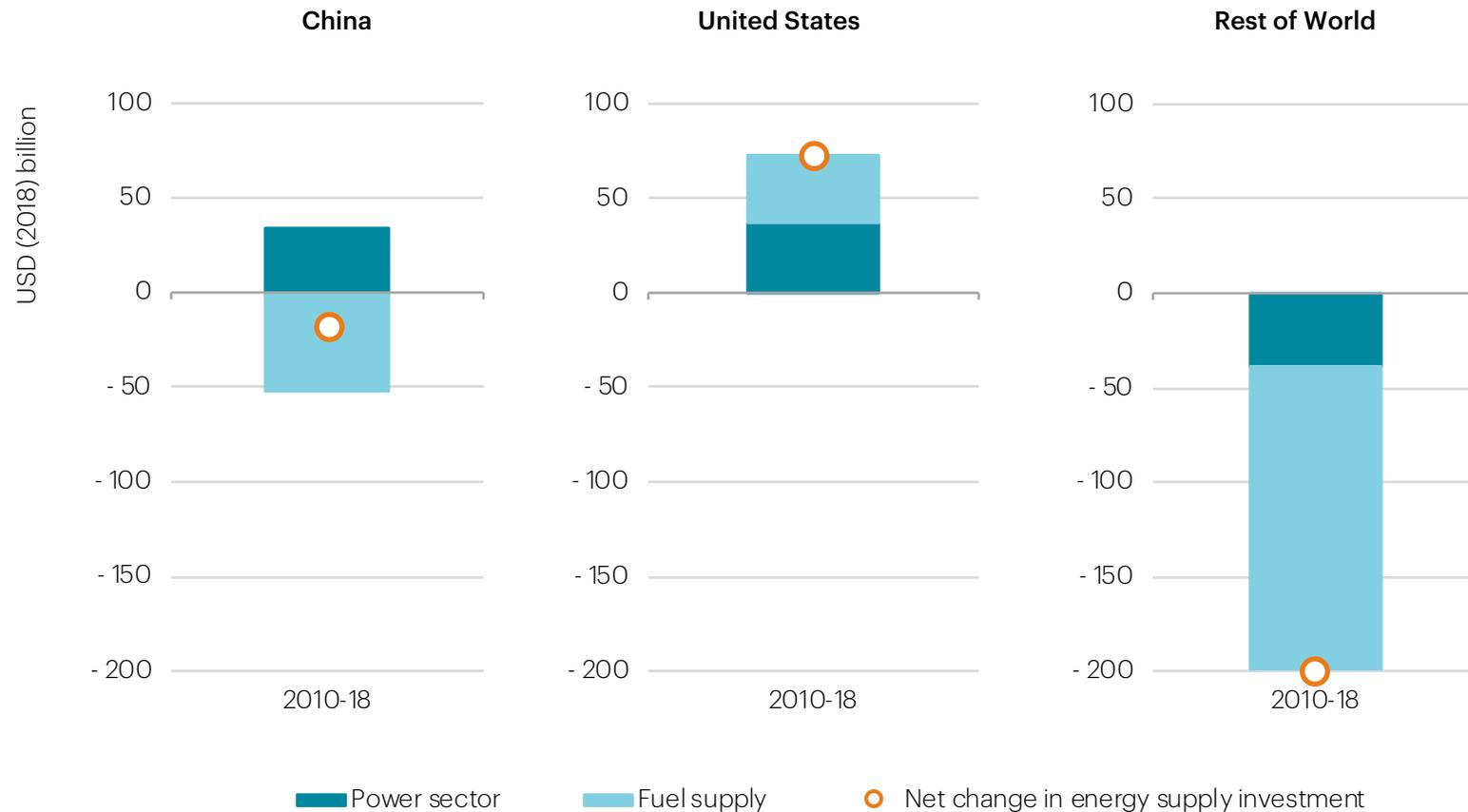
# Energy investment by geography

Country and regional trends (18-22)

Energy investment by income segment and population (23-24)

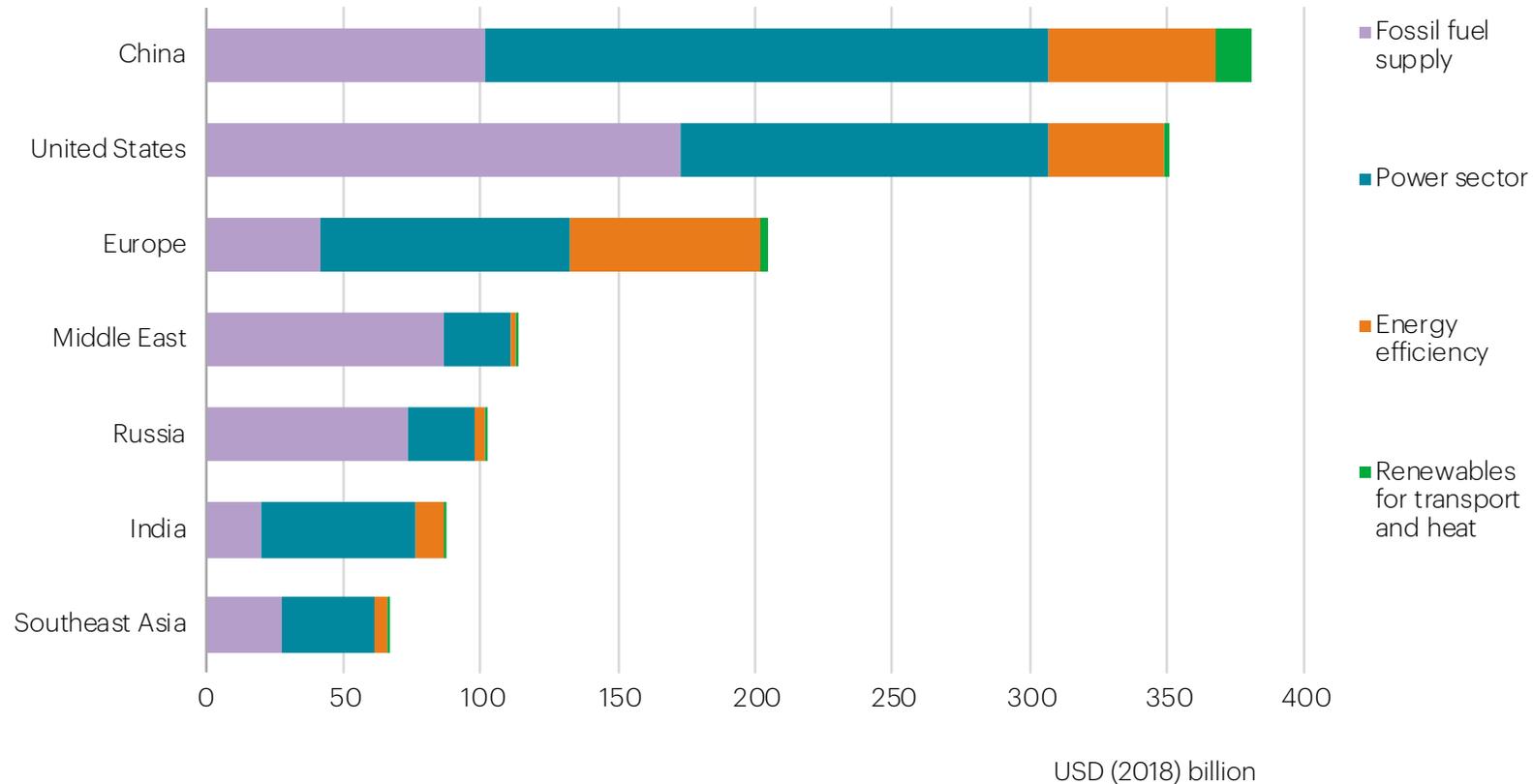
# The United States accounted for most growth in energy supply investment this decade

Changes in energy supply investment, 2010-18



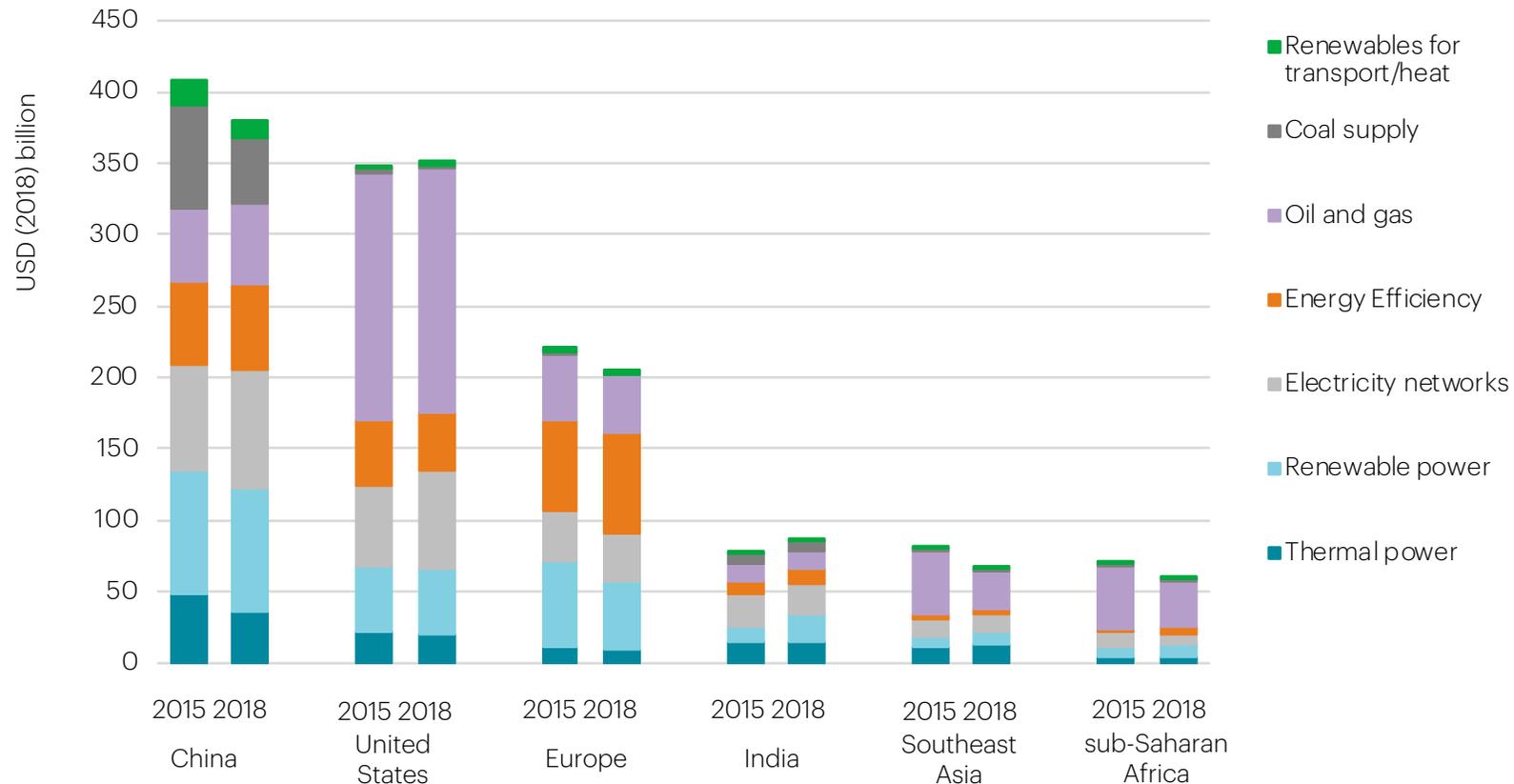
# China remained the largest market for total energy investment in 2018

Energy investment by sector in selected markets in 2018



# Investment in India has grown the most over the past three years

Energy investment by sector in selected markets, 2015 and 2018



## China, the United States & India are driving some key investment trends...

More than two dollars in every ten invested in energy goes to powering Asian economies; another two dollars divides between oil and gas and power in North America. These shares have grown in recent years.

The United States has been responsible for most of the growth in energy supply investment this decade, with increases in both oil and gas, supported by more spending on shale, and in the power sector. While oil and gas spend has moderated somewhat in the past three years (even as it grew strongly from 2017 to 2018), that for electricity networks rose. Compared to 2015, investment in renewable power and gas power remained relatively stable, but at high levels. Meanwhile, investment in energy efficiency has declined over the period.

China remained the largest market for energy investment in 2018, but its lead narrowed. While spending is increasingly driven by low-carbon electricity supply and networks, total investment declined by 7% over the past three years due to lower spend on new coal-fired plants, down over 60%, outweighing relatively

high investment in renewable power and nuclear. Energy efficiency spending has risen by over 6% the past three years.

Among major areas, energy investment has risen mostly rapidly in India the past three years, up 12%. In 2018, renewable spending continued to exceed that for fossil fuel-based power, supported by tendering for solar PV, and from 2017 wind, amid uncertain financial attractiveness of new coal power, though spending in coal supply rose somewhat. While transmission spending is expanding, investment in distribution has not grown.

## ...but each region has its own story, often one of lower spending

Investment growth was stable or declined in other major regions during the past three years. In some areas this reflects a response to lower oil prices (e.g. Middle East), an ongoing rebalancing between old and new parts of the system (e.g. Europe) as well as persistent financing risks that have held back more robust levels of spending to address strong demand growth (e.g. sub-Saharan Africa, Southeast Asia).

Energy investment in the European Union has declined by 7% over the past three years, but the share of spending going towards low-carbon energy has risen to nearly 60%. Energy efficiency has been the lone growth area for spending. Renewable power spending has slowed, in part from falling costs, but accounts for over 80% of generation spending.

Investment in the Middle East is down by one-fifth over the past three years, one of the largest declines globally, led by a retrenchment in oil and gas spending, which outweighed higher spending on power, particularly in solar PV and gas generation. Some rebound may be on

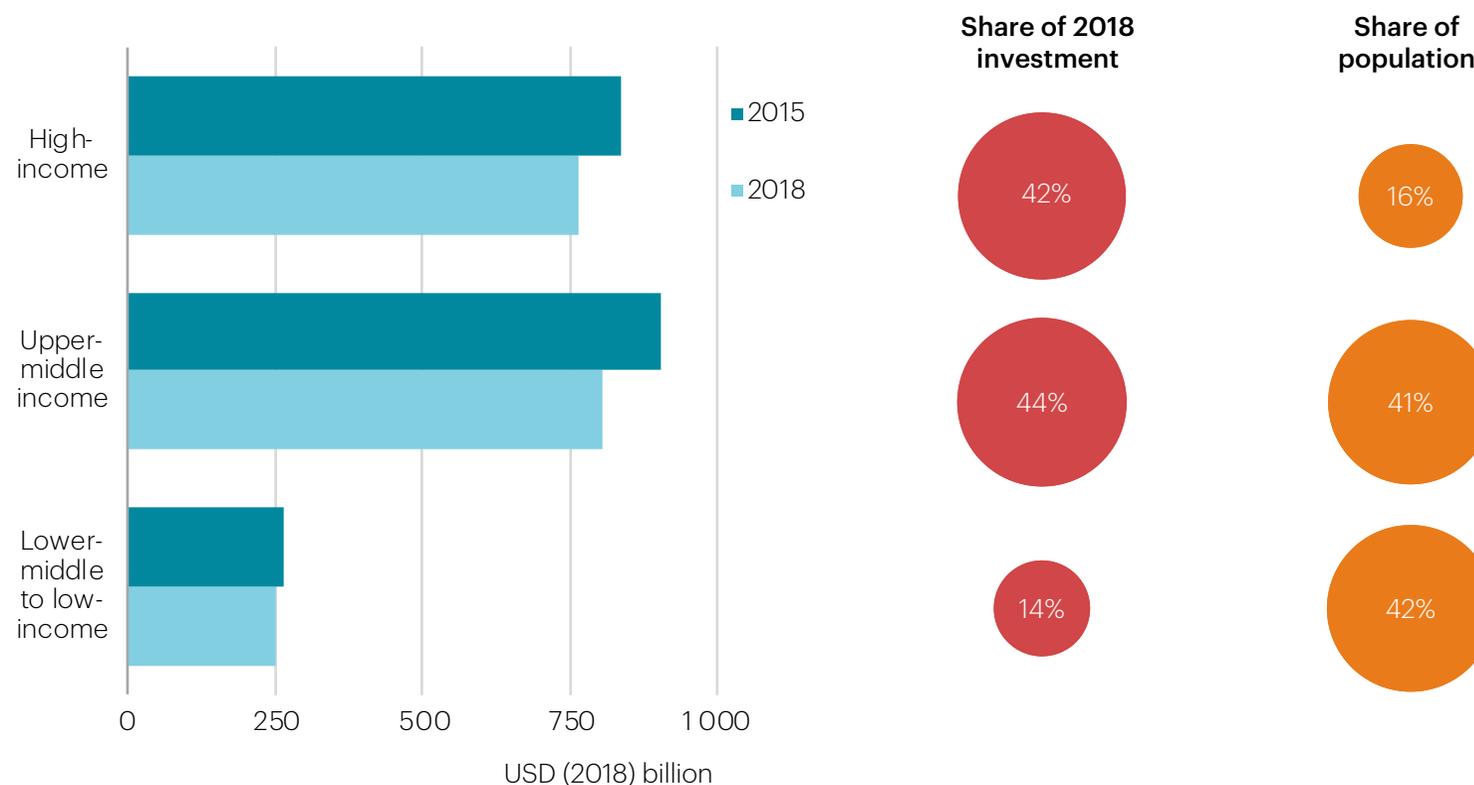
the horizon, with some of the largest national oil companies announcing higher capital budgets for 2019 (see Fuel Supply).

Southeast Asia energy investment is down almost one-fifth since 2015. Most of the fall stemmed from lower oil and gas supply spending while that for renewables and coal power registered increases. Energy efficiency accounts for only around 5% of investment and has not grown significantly.

In sub-Saharan Africa, investment has declined 15% compared with three years ago, with less oil and gas spending offsetting a small increase in renewables. Investment in capital intensive low-carbon technologies remains hampered by insufficient regulatory framework, challenging project development, persistent financial strain for utilities and a limited pool of public finance.

## Energy investment was mostly in high and upper-middle income regions...

Energy investment and population by region, classified by current income level



Note: Income categories are defined on the basis of gross national income/capita (current USD) thresholds from World Bank (2019). High-income = > USD 12 055; Upper-middle income = USD 3 896-12 055; Lower-middle to low-income = < USD 3 895.

Source: IEA analysis with calculations for income and population are based on World Bank (2019).

## ...but a shift towards lower income segments is needed

There is a strong link between income levels and energy investment. Nearly 90% of energy investment in 2018 was concentrated in high- and upper-middle income countries and regions. These areas also tend to benefit from relatively well-developed financial systems (see Financing and funding trends).

High-income countries, with just over 15% of the global population, accounted for over 40% of energy investment in 2018. Investment in this group is down somewhat from five years ago, largely due to lower spending in Europe and Japan, but rose in 2018 with stronger spending in fuel supply and the power sector predominantly in the United States.

Energy investment in recent years has also declined in upper-middle income countries and regions, with an increase in Mexico outweighed by falls in China, the Middle East, Brazil, the Russian Federation, and some Southeast Asia countries. Three years ago, this group comprised over 45% of energy investment.

Lower-middle and low-income countries accounted for less than 15% of energy investment in 2018 despite containing well over 40% of the world's population. In recent years, the fastest investment growth within this group has come from India with rising power sector spending, while spending in sub-Saharan Africa has declined, mostly due to less investment in fuel supply.

Looking ahead, the largest investment needs remain concentrated in currently high- and upper-middle income countries and regions, in part reflecting continued investment to replace and upgrade aging assets. However, to meet sustainable development goals, overall spending needs to grow from today's levels and to rebalance towards the fast-growing needs of lower-middle and low-income countries.

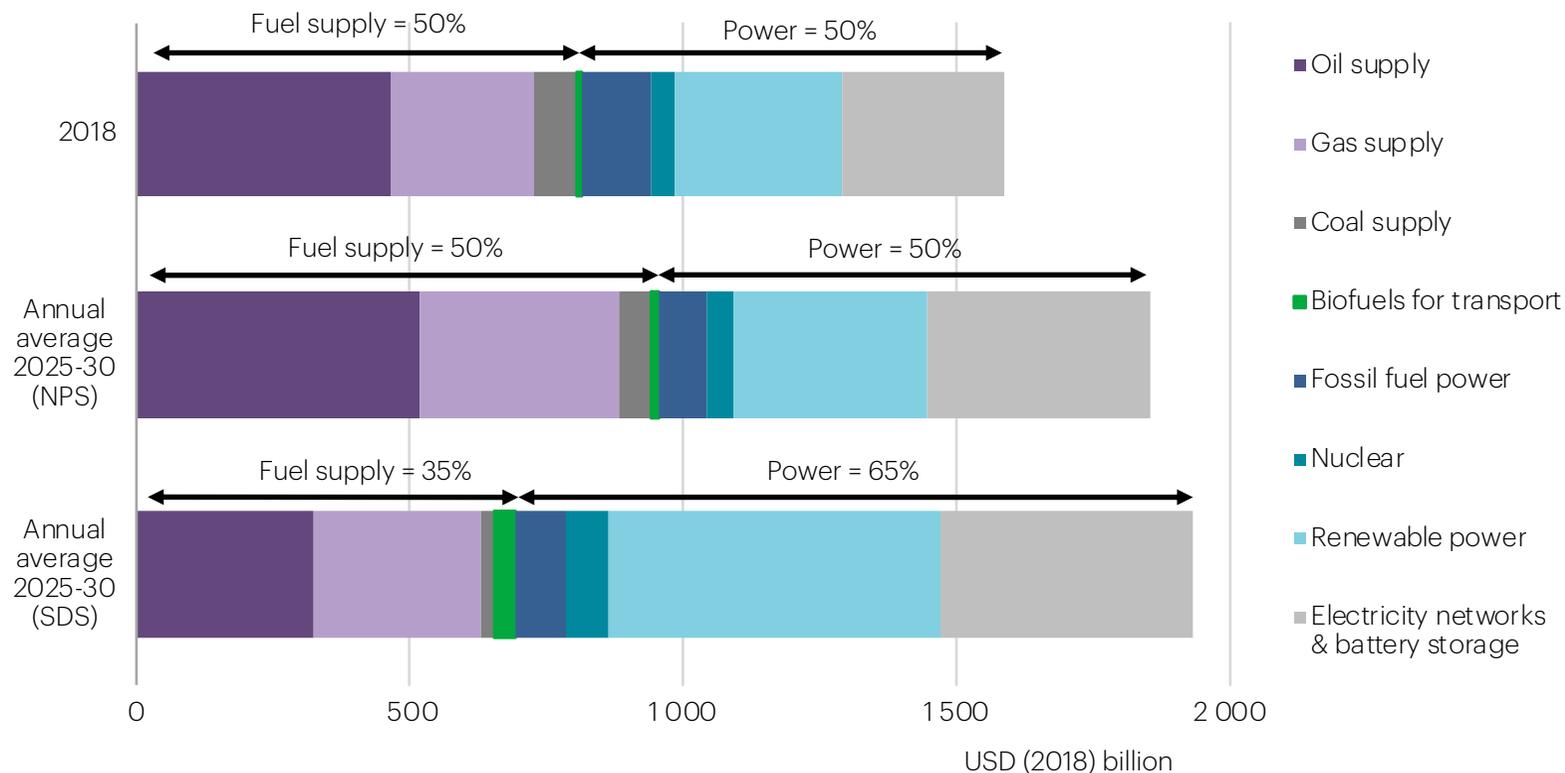
# Implications of today's energy investment trends

Is energy supply investment aligned with objectives for energy security and sustainability? (26-30)

Is investment in low-carbon energy enough to meet sustainability goals? (31-34)

# Energy supply investment needs to rise under any scenario, but major capital reallocation would be needed to meet sustainability goals

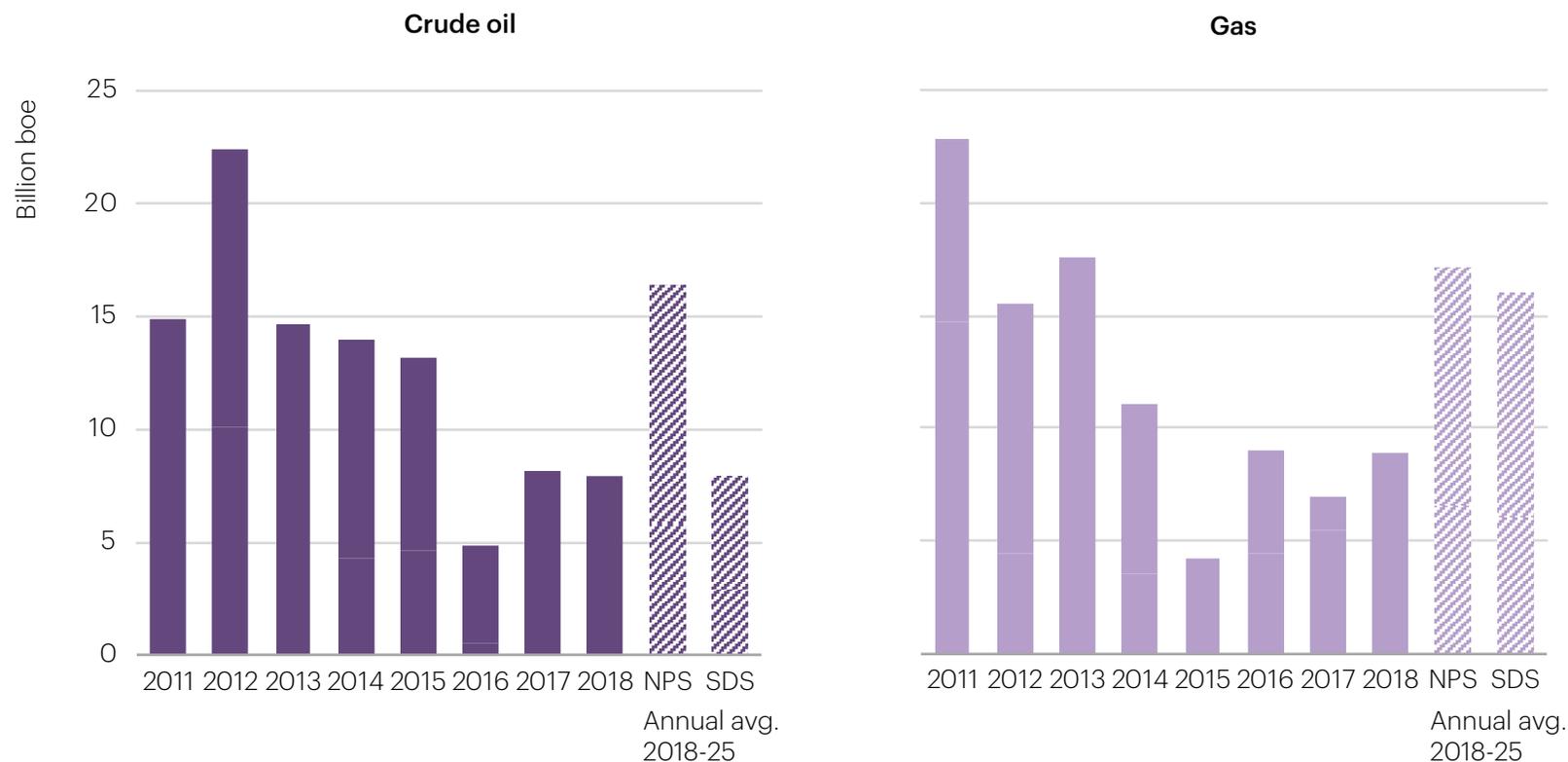
Global energy supply investment by sector in 2018 compared with annual average investment needs 2025-30 by scenario



Note: NPS = New Policies Scenario; SDS = Sustainable Development Scenario. Oil & gas supply includes upstream, midstream and downstream investment.

# Continued robust demand growth for oil and gas would require a sharp pick-up in approvals of new conventional upstream projects

Crude oil and gas conventional resources sanctioned

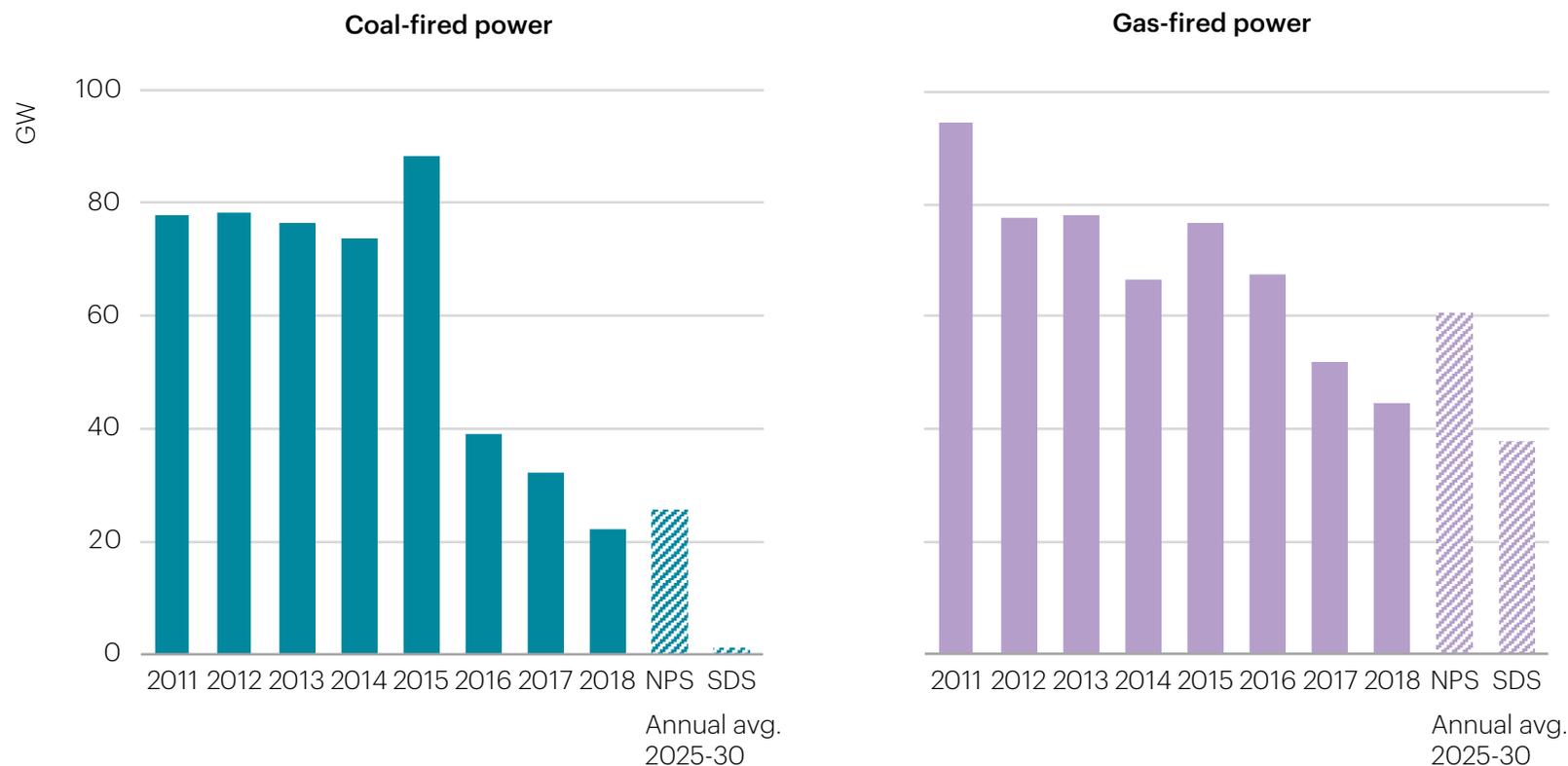


Note: NPS = New Policies Scenario; SDS = Sustainable Development Scenario.

Source: Historical sanctioned resources based on Rystad Energy (2019)

# Gas power remains in the mix; while the coal fleet continued to grow in 2018, sustainability goals point to a swift FID phase-out for unabated plants

Final investment decisions (FIDs) for coal-fired & gas-fired generation versus annual average needs 2025-30 by scenario

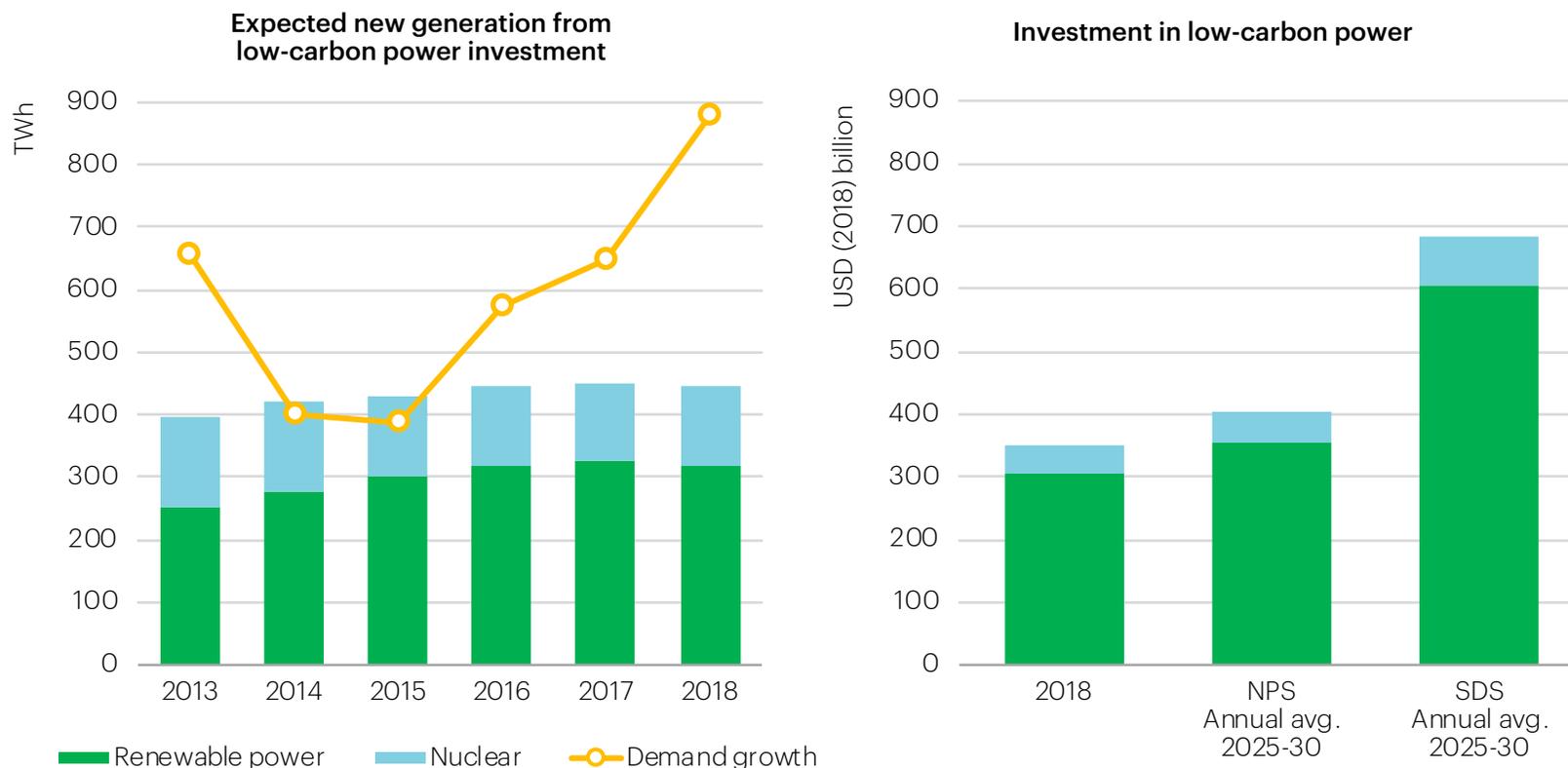


Note: NPS= New Policies Scenario, SDS=Sustainable Development Scenario. FIDs for coal-fired and gas-fired generation capacity in NPS and SDS does not include plants equipped with carbon capture.

Source: IEA analysis with historical FID data based on McCoy Power Reports (2019).

# Output from low-carbon power investment is not keeping pace with demand; a doubling of renewables spending is needed in the SDS

Expected generation from low-carbon power investments and annual investment needs by scenario



Note: Generation is based on the expected annualised output of the capacity associated with investment in a given year. TWh = terawatt hour. NPS = New Policies Scenario; SDS = Sustainable Development Scenario.

## Energy investment is misaligned with where the world appears to be heading, and also far out of step with where it needs to go

Compared with the annual average investment required for 2025-30 in IEA scenarios, total energy supply investment needs to step up significantly, even with changing costs. But the gaps differ starkly by sector and scenario, reflecting variations in the pathways for energy security and sustainability.

For fossil fuel supply, the lower levels of oil spending seen since 2014 would need to taper further to be consistent with the Sustainable Development Scenario (SDS), i.e. a trajectory consistent with the Paris Agreement. However, investment levels fall well short of what would be needed in a world of continued strong oil demand – as in the New Policies Scenario (NPS).

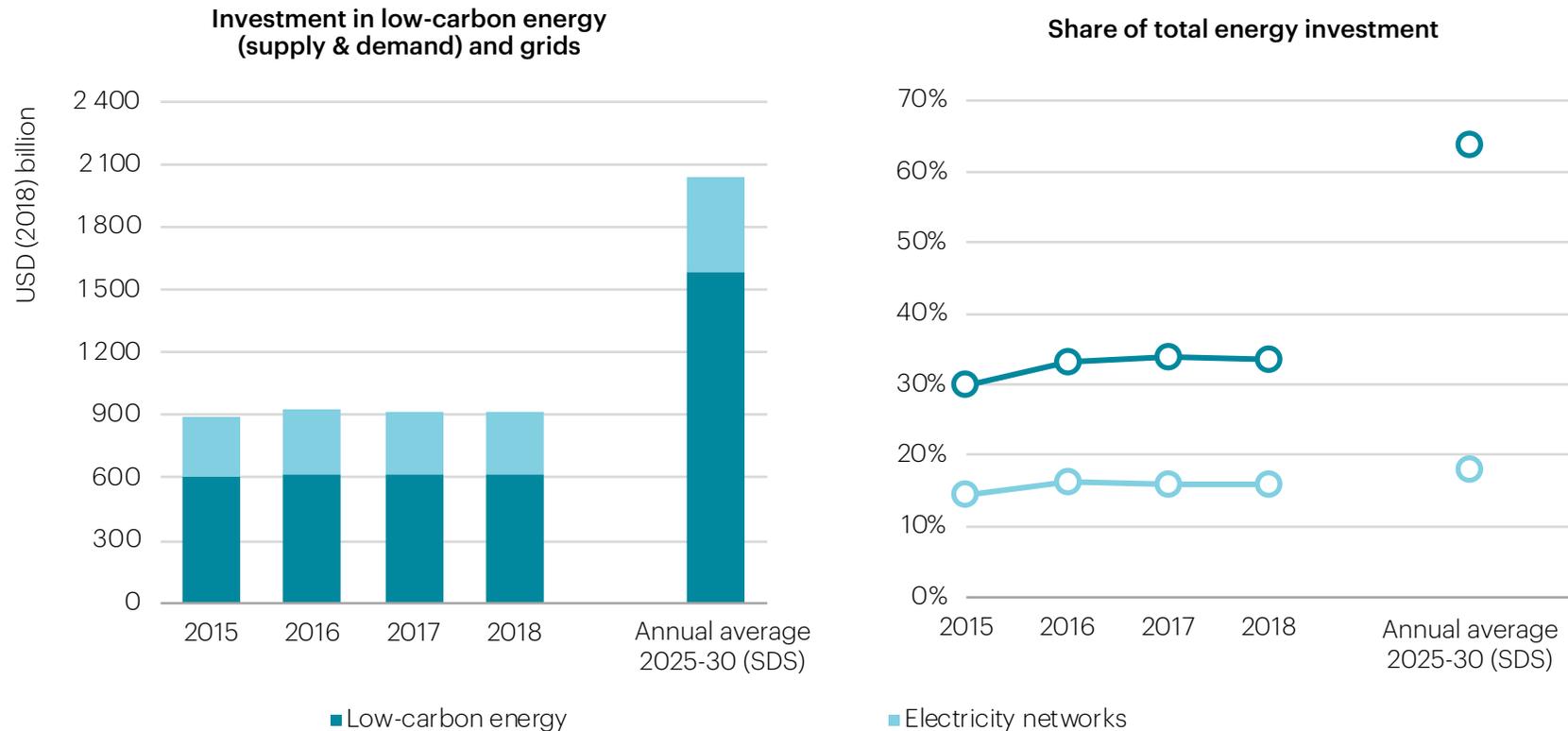
For gas supply, today's investment falls short of the levels projected in both the SDS and NPS, while for coal supply the opposite is true: current spending comfortably exceeds the levels required by the late 2020s in both scenarios. More spending on biofuels is needed in both scenarios.

For the power sector, the 2018 investment total is comparable to the projected needs in the NPS but more than one-third lower than required in the SDS. Both scenarios would require a sizeable reallocation of capital, especially in the accelerated decarbonisation and electrification that marks the SDS, which would require a doubling of renewable power spending, more investment in nuclear and a rising level of spending on electricity networks.

While a shift in spending is required in energy supply, investment needs also rise for demand. Energy efficiency and end-use play increasingly important roles in transport and heat – sectors responsible for over 70% of final energy consumption and over half of global carbon dioxide (CO<sub>2</sub>) emissions. The relative lack of policy attention given to these areas points to a broad need for more focus and activity.

# Total investment across low-carbon energy – including supply and efficiency – has stalled in recent years and needs a rapid boost to keep Paris in sight

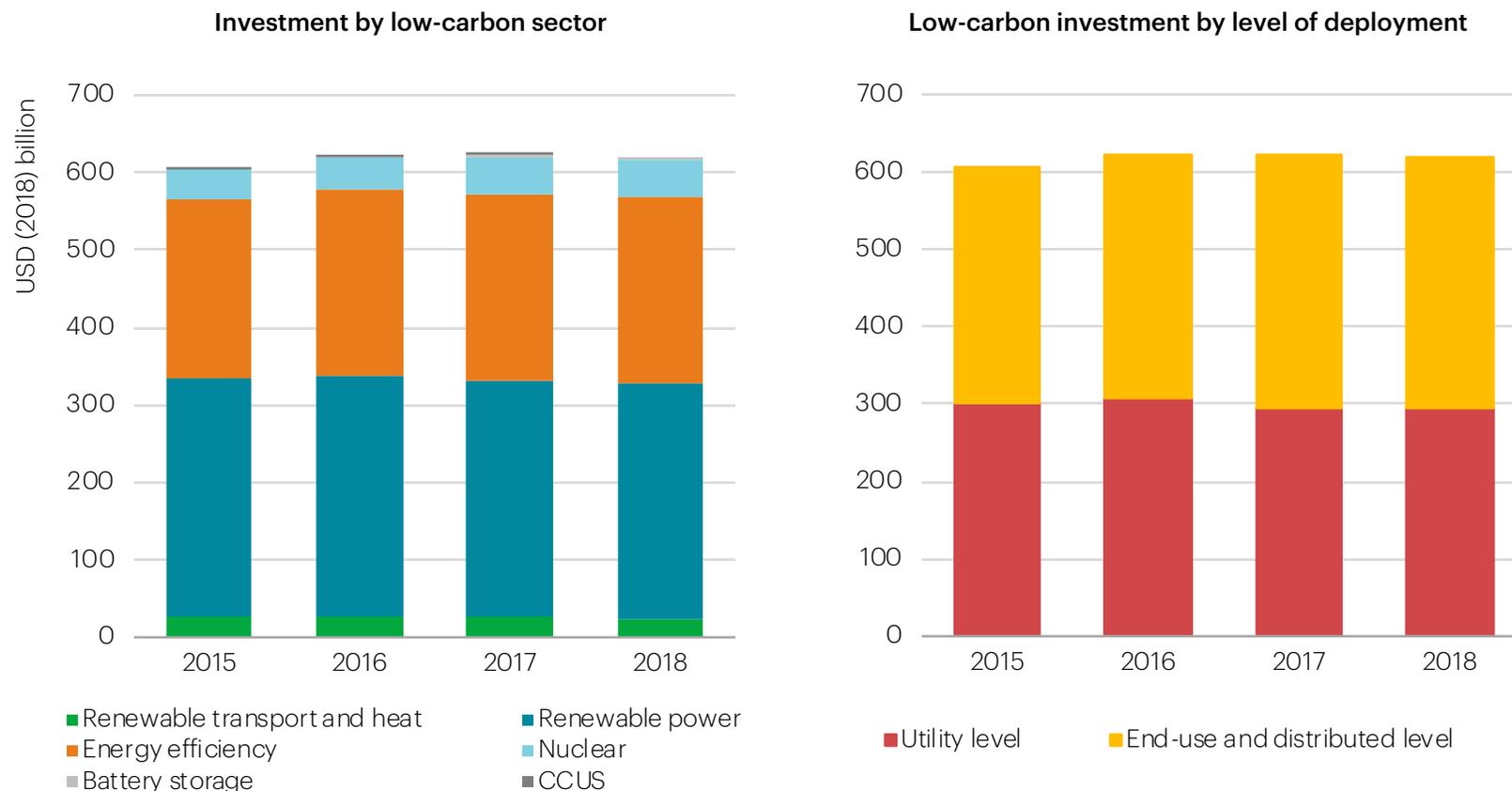
Global investment in low-carbon energy, including efficiency, and electricity networks compared with investment needs (SDS)



Note: Low-carbon energy investment includes energy efficiency, renewable power, renewables for transport and heat, nuclear, battery storage and carbon capture utilisation and storage. SDS = Sustainable Development Scenario.

# The role of efficiency and distributed resources highlight the importance of low-carbon financing solutions at both consumer and bulk power level

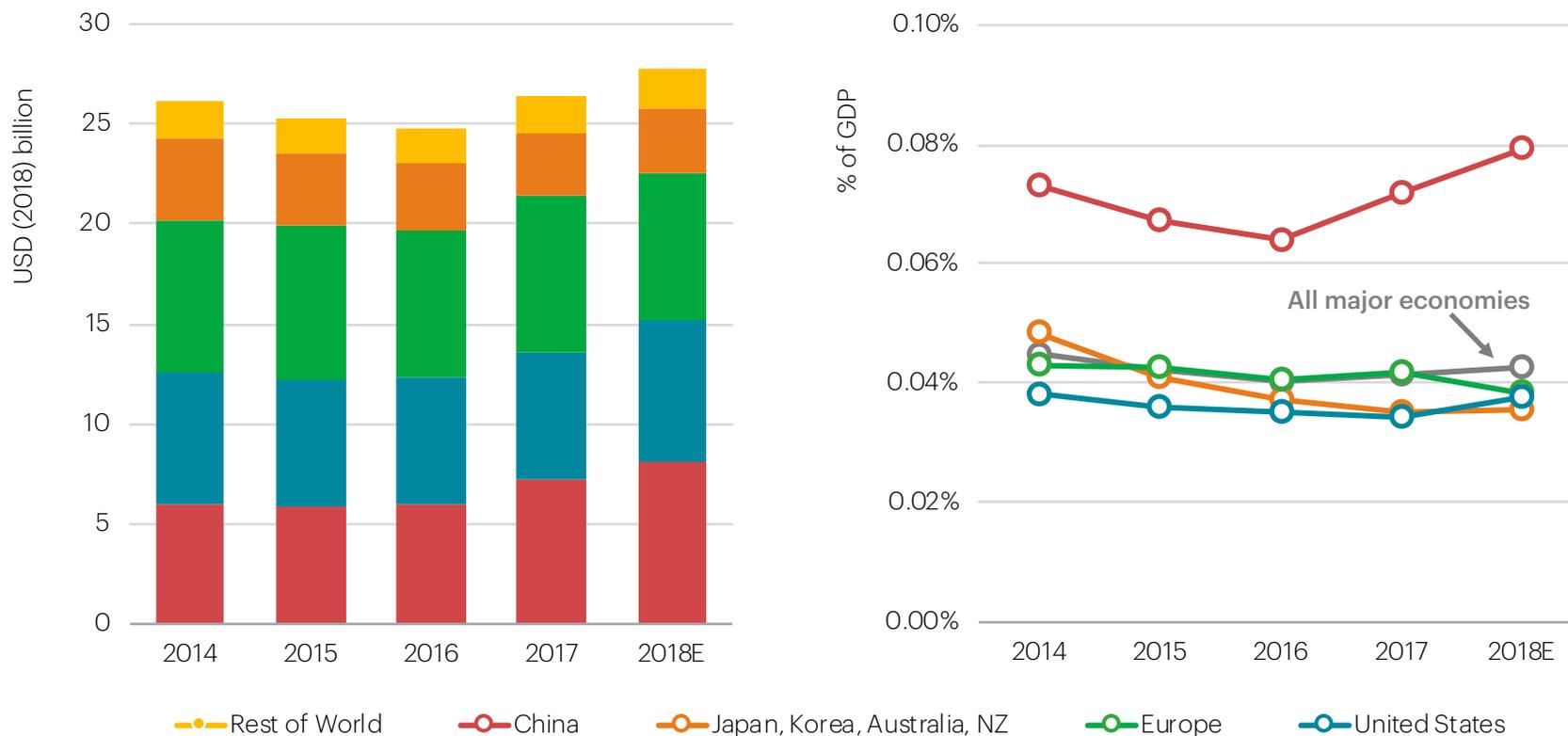
Global investment in low-carbon energy by sector and by level of deployment



Note: Utility-level assets include plants producing energy for commercial sale. End-user and distributed assets are those typically purchased or deployed at the consumer level. CCUS = carbon capture, usage, and storage.

# Government energy RD&D spending is rising, but not keeping up with GDP

Spending on energy RD&D by national governments, with preliminary 2018 data, and as a share of GDP



Note: RD&D = research, development and demonstration, as defined by the IEA Guide to Reporting Energy RD&D Budget/Expenditure Statistics, 2011.

## A step-change in policy focus, financing solutions and technology progress would be required to get investment onto a sustainable pathway

Investment in low-carbon energy – both in supply and demand – was relatively stable at around USD 620 billion in 2018. Spending growth has stagnated over the past two years, compared with 3% growth in 2016. The share of low-carbon in total energy investment stayed at near 35%. Investment in electricity grids – an enabler for clean energy transitions – has decreased modestly the past two years.

Low-carbon spending in 2018 was marked by unchanged investment in energy efficiency and nuclear, while that for renewable power edged downwards. Battery storage investments grew by almost half, but were the equivalent, in dollar terms, to just over 1% of total grid spending. Spending on renewables for transport and heat declined slightly, with more biofuels investment offset by lower spending on solar heating installations.

Just over half of low-carbon investment was in assets typically purchased or deployed at the end-user level – due to the role of energy efficiency but also distributed energy resources.

This raises a dichotomy in financing energy transitions. Utility-level assets tend to benefit from larger deal sizes and standard structures that attract interest from banks. Investments at end-user level tend to be much smaller and depend on the credit worthiness of consumers and small and medium-sized enterprises, with portfolio aggregation often needed to access larger pools of capital.

To meet long-term sustainability goals in the SDS, even with changing costs, low-carbon investment would need to grow two-and-a-half times by 2030, with its share rising to 65%. Although the needs in networks are comparatively less, the regulated nature of grids points to a need for sustained policy commitment for appropriate levels of investments that supports growing shares of variable renewables.