



Tracking clean energy transitions

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Where do we need to go?

The global challenge: Climbing down the mountain



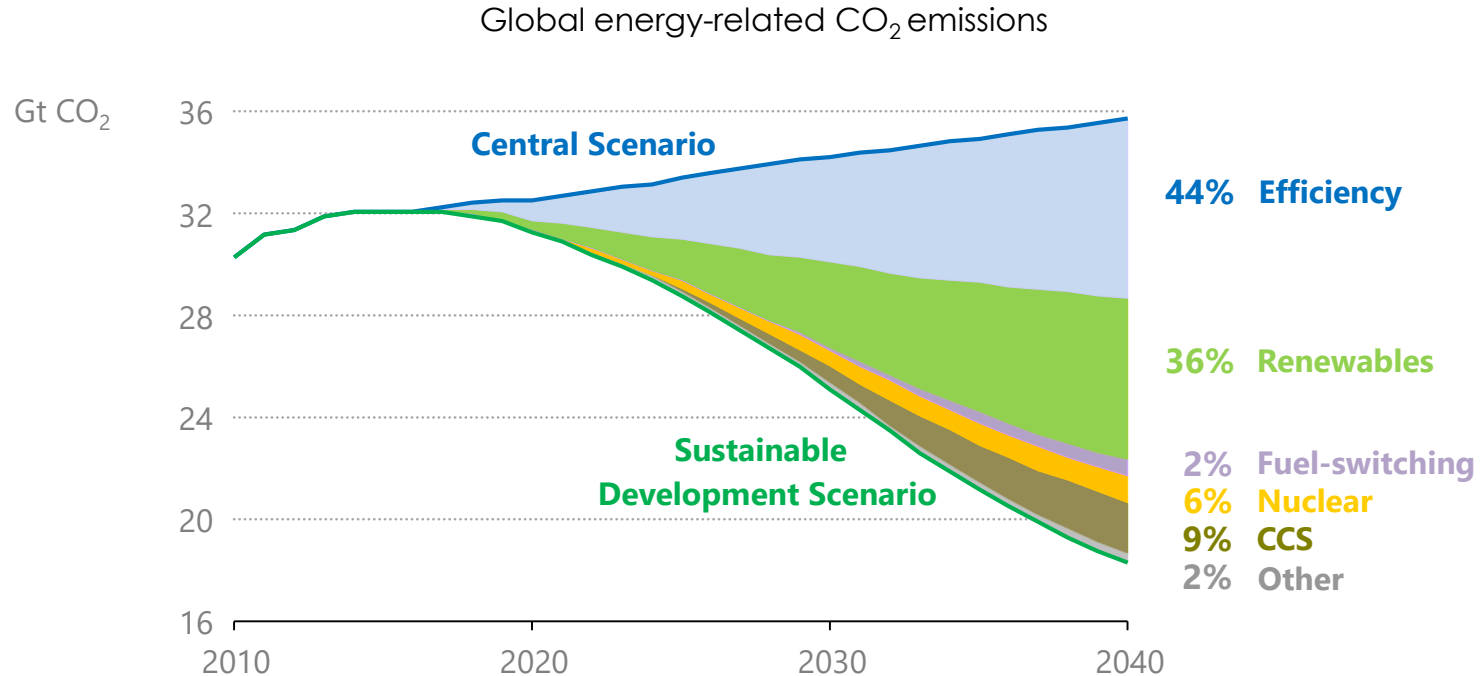
“Getting to the top is optional.

Getting down is mandatory.”

- Ed Viesturs

— SDS

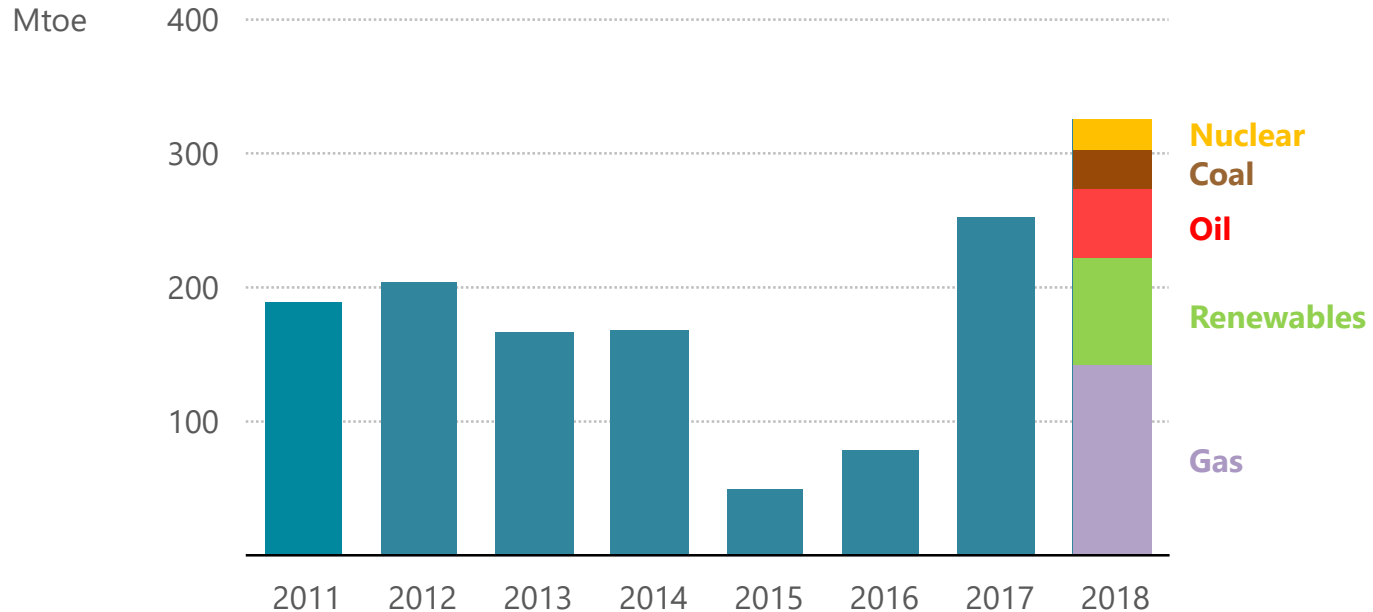
Where we need to be in 2040 to reach sustainable goals



A wide variety of technologies are necessary to meet sustainability goals, notably energy efficiency, renewables, CCUS and nuclear

2018 – a remarkable year for energy

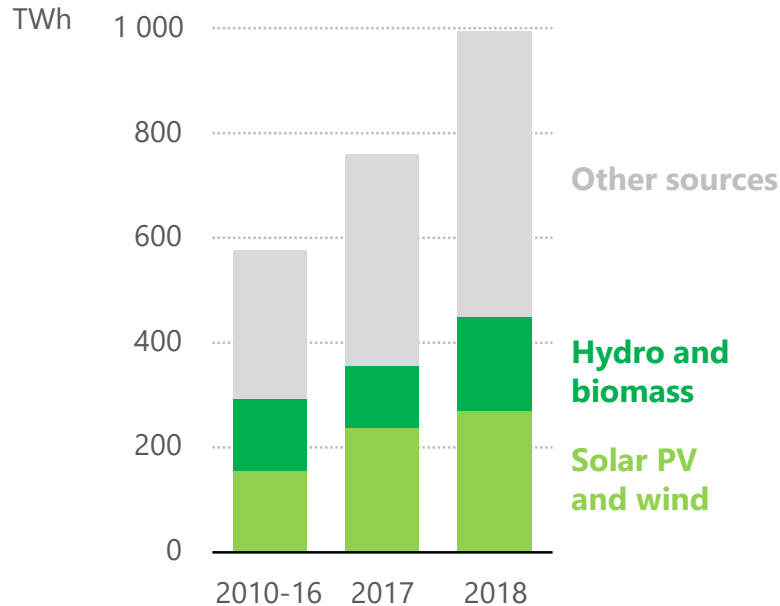
Annual change in global primary energy demand, 2011-18



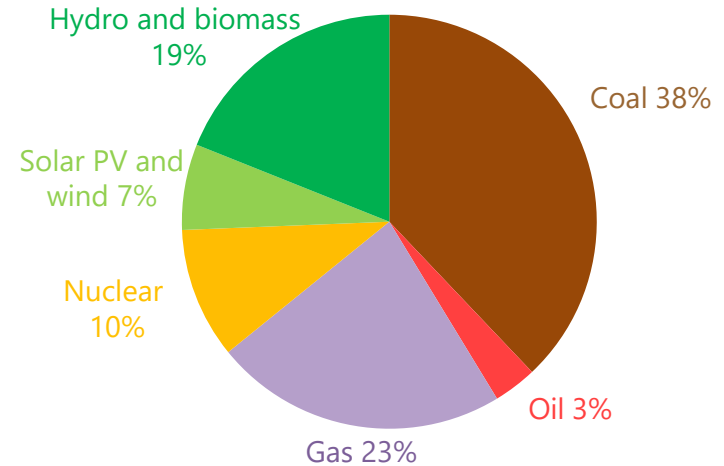
Global energy demand last year grew by 2.3%, the fastest pace this decade, an exceptional performance driven by a robust global economy, weather conditions and moderate energy prices.

Electricity growth outpaces renewables acceleration

Average annual change in electricity generation, 2010-18



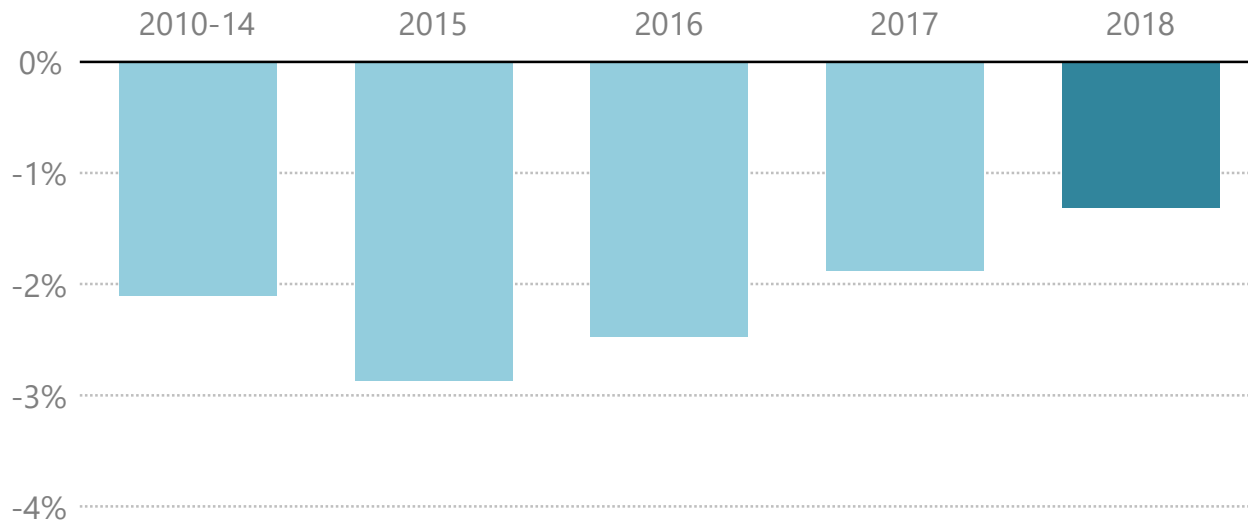
Electricity generation mix in 2018



Renewables accounted for the largest growth in electricity demand, led by growth in solar, wind and hydro. However, this growth was not fast enough to bend power sector emissions.

Efficiency improvements slowed again in 2018

Average annual change in primary energy intensity, 2010-18

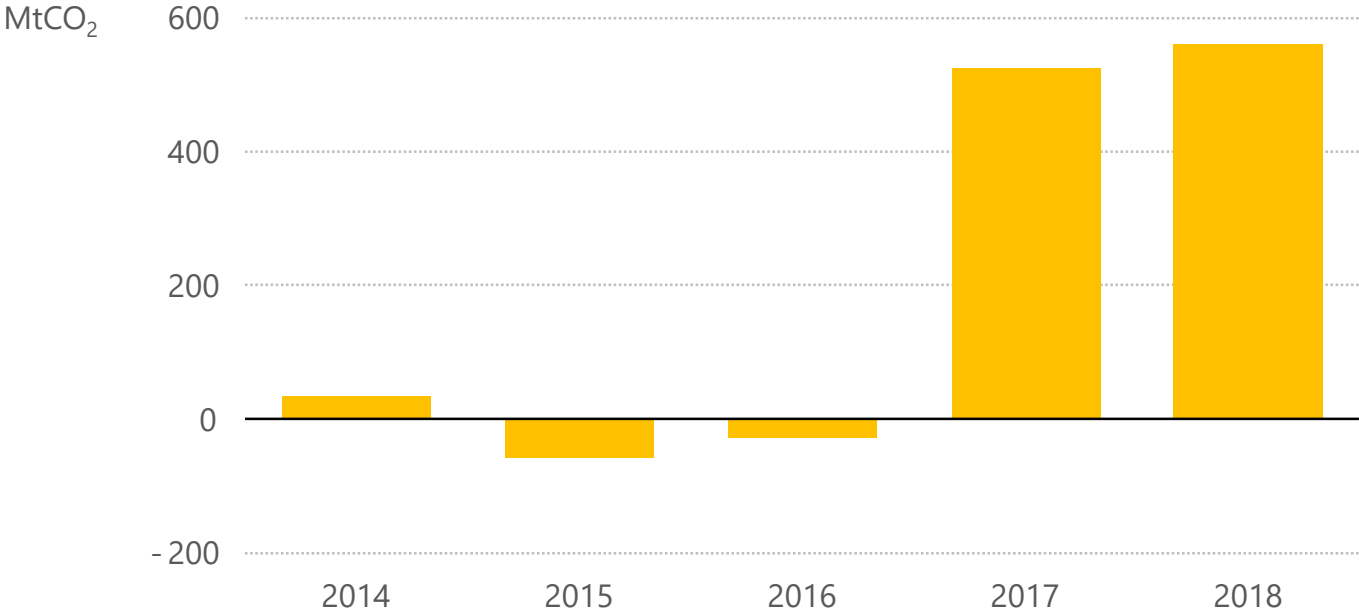


In 2018 energy intensity improved by 1.3%, half the rate of the period 2014-2017. Weaker energy efficiency policy implementation and strong demand growth in more energy intensive economies contributed to this slowdown.

Energy-related CO₂ emissions hit a record high...



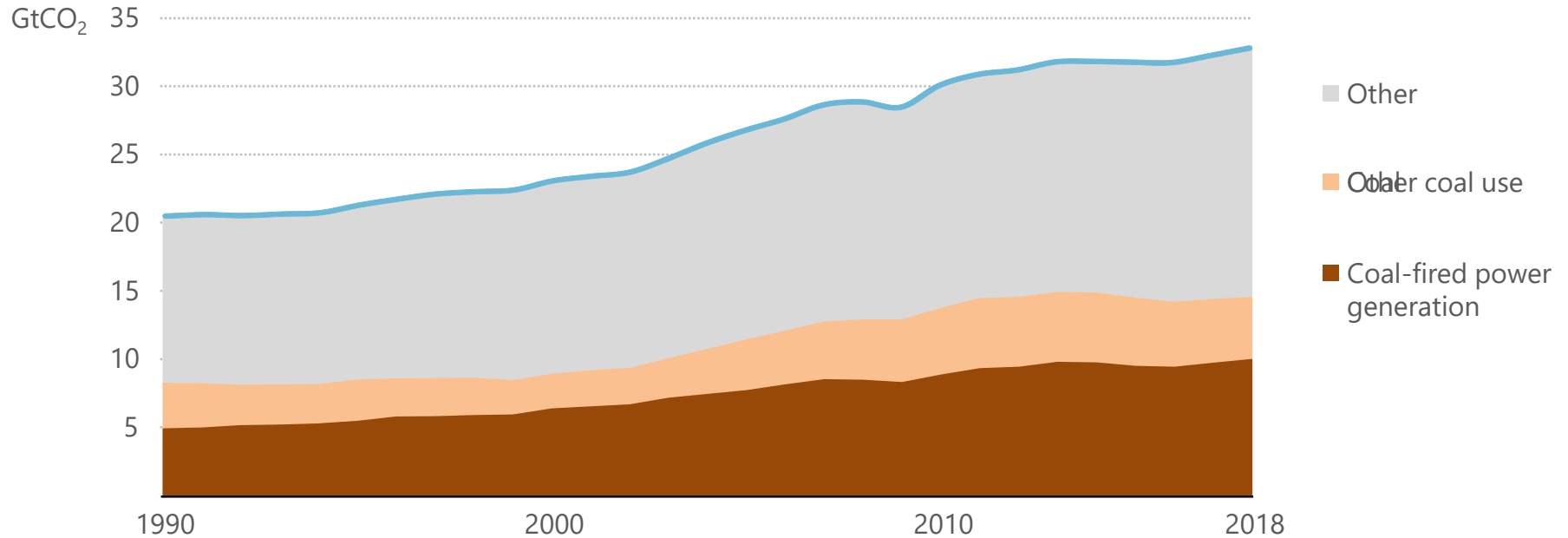
Annual change in global energy-related CO₂ emissions, 2014-2018



Higher demand for fossil fuels drove up global CO₂ emissions for a second year after a brief hiatus. Increases in efficiency, renewables, coal-to-gas switching and nuclear avoided 640 Mt of CO₂ emissions.

..led by coal in power generation in Asia

Global energy-related CO₂ emissions, 1990-2018



Emissions from coal continue to rise, driven by increasing coal use mostly for power generation in Asia. Coal is the largest source of emissions, and associated with around one-third of the warming to date.

Power

- Renewable power
 - Solar PV
 - Onshore wind
 - Offshore wind
 - Hydropower
 - Bioenergy
 - Geothermal
 - Concentrating solar power
 - Ocean
- Nuclear power
 - Natural gas-fired power
 - Coal-fired power
 - CCUS in power

Industry

- Chemicals
- Iron and steel
- Cement
- Pulp and paper
- Aluminium
- CCUS in industry & transformation

Transport

- Electric vehicles
- Fuel economy
- Trucks & buses
- Transport biofuels
- Aviation
- International shipping
- Rail

Buildings

- Building envelopes
- Heating
- Heat pumps
- Cooling
- Lighting
- Appliances & equipment
- Data centres and networks

Other supply

- Methane emissions from oil and gas
- Flaring emissions

Energy integration

- Energy storage
- Hydrogen
- Smart grids
- Demand response

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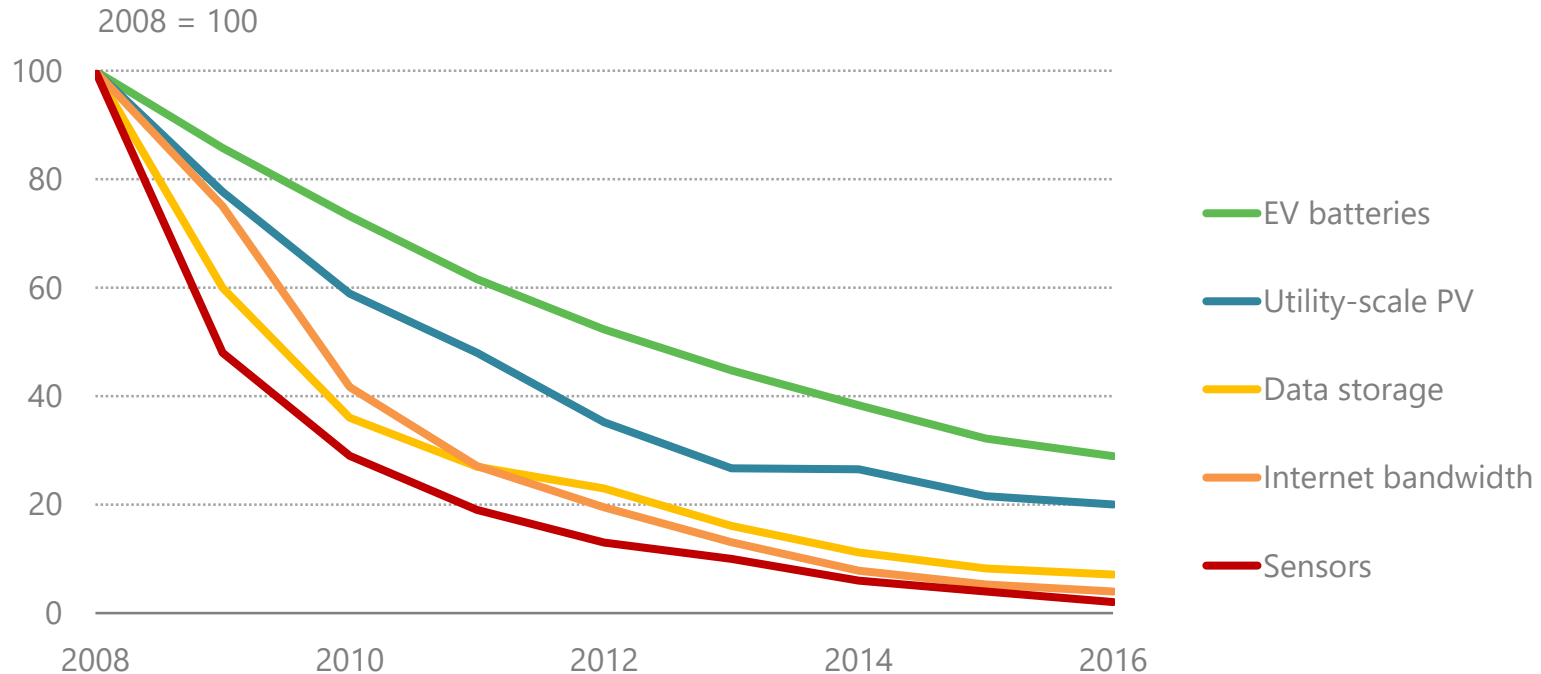
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Technology progress in the energy is slow compared to other sectors

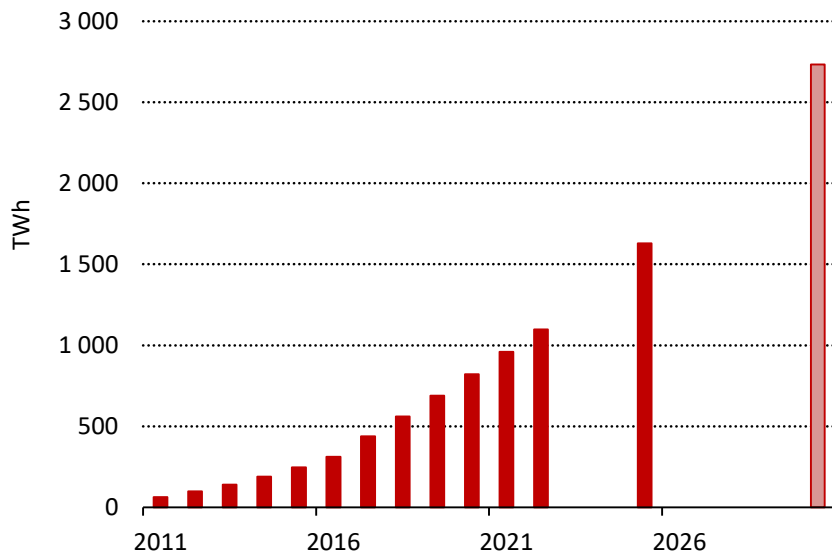


Sources: Based on BNEF (2017), Utilities, Smart Thermostats and the Connected Home Opportunity; Holdowsky et al. (2015), Inside the Internet of Things; IEA (2017), Renewables; Tracking Clean Energy Progress; World Energy Investment; Navigant Research (2017), Market data: Demand Response. Global Capacity, Sites, Spending and Revenue Forecasts.

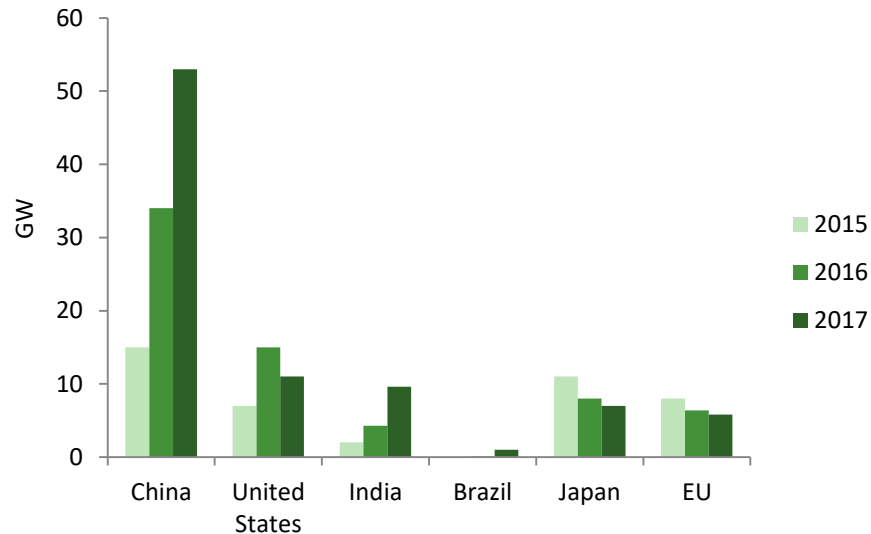
The energy sector is among the most regulated and shielded from change - Transitions typically take 30-40 years

Solar PV is the only renewable technology on track

Solar PV



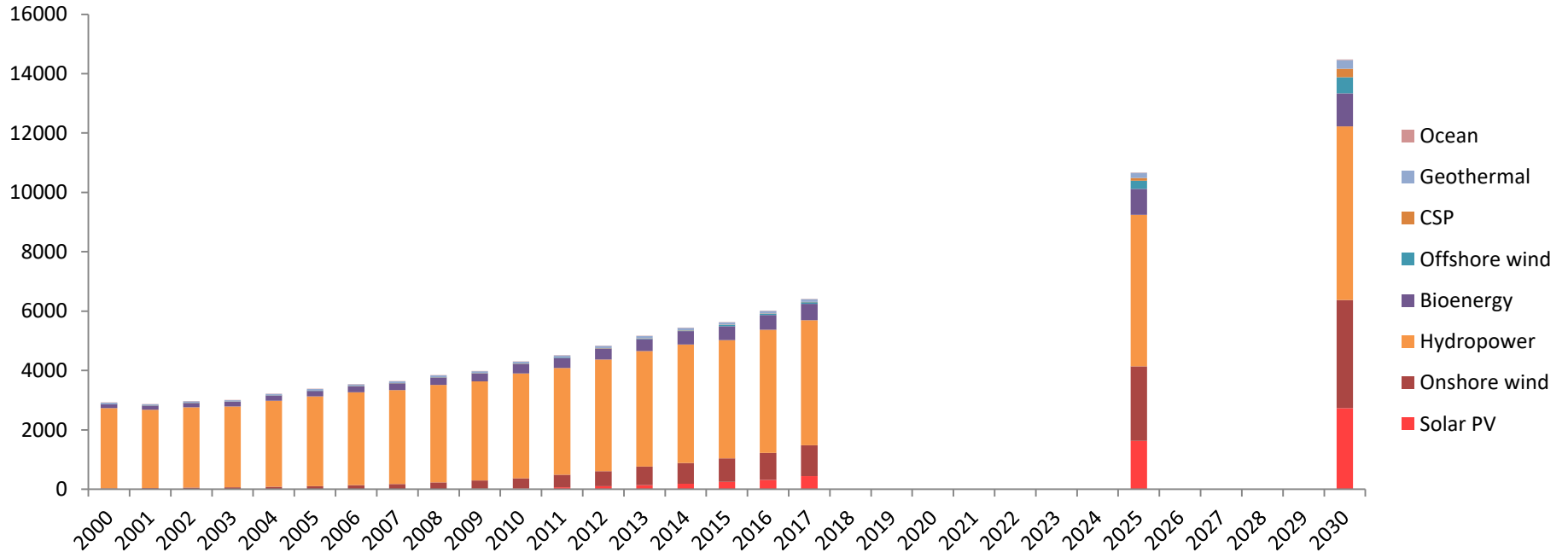
Solar PV deployment



Solar PV has shown record growth in 2017; it is well on track to meet its SDS target

So despite progress in solar PV, renewables growth is not fully on track

Renewables generation by technology

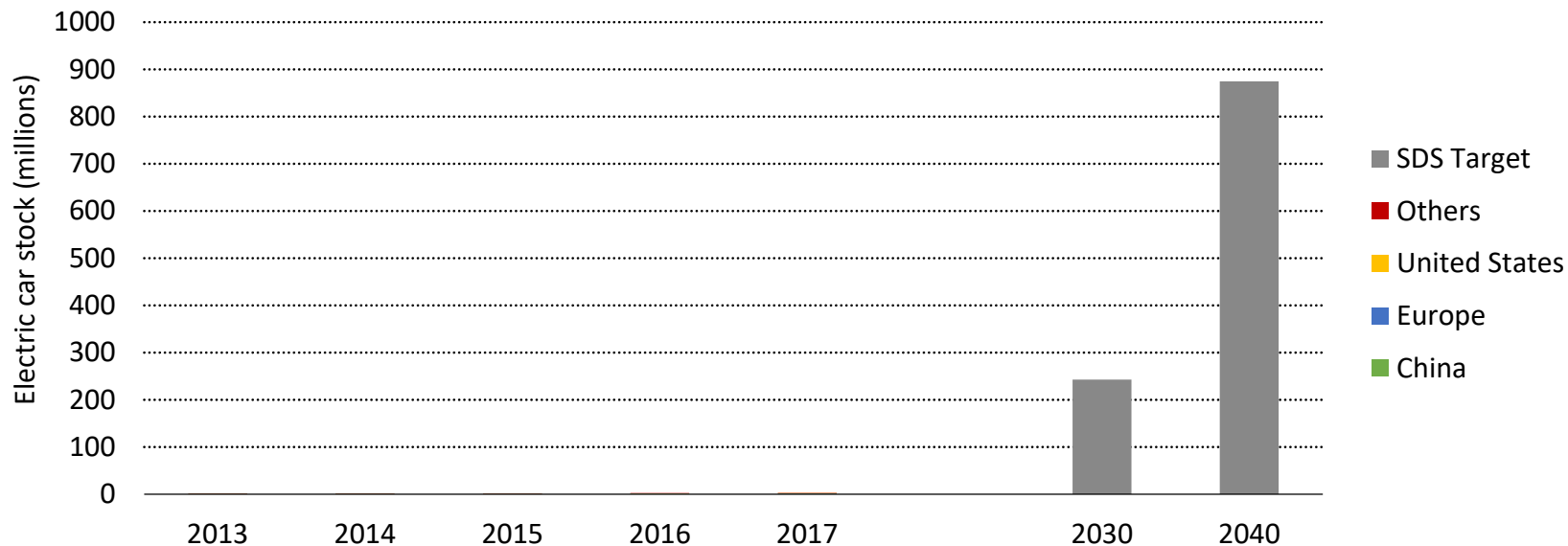


Renewables saw the highest rate of generation growth among all energy sources in 2017, but overall deployment must speed up to meet the renewables SDS target by 2030

EV growth has grown rapidly; strong momentum needs to continue

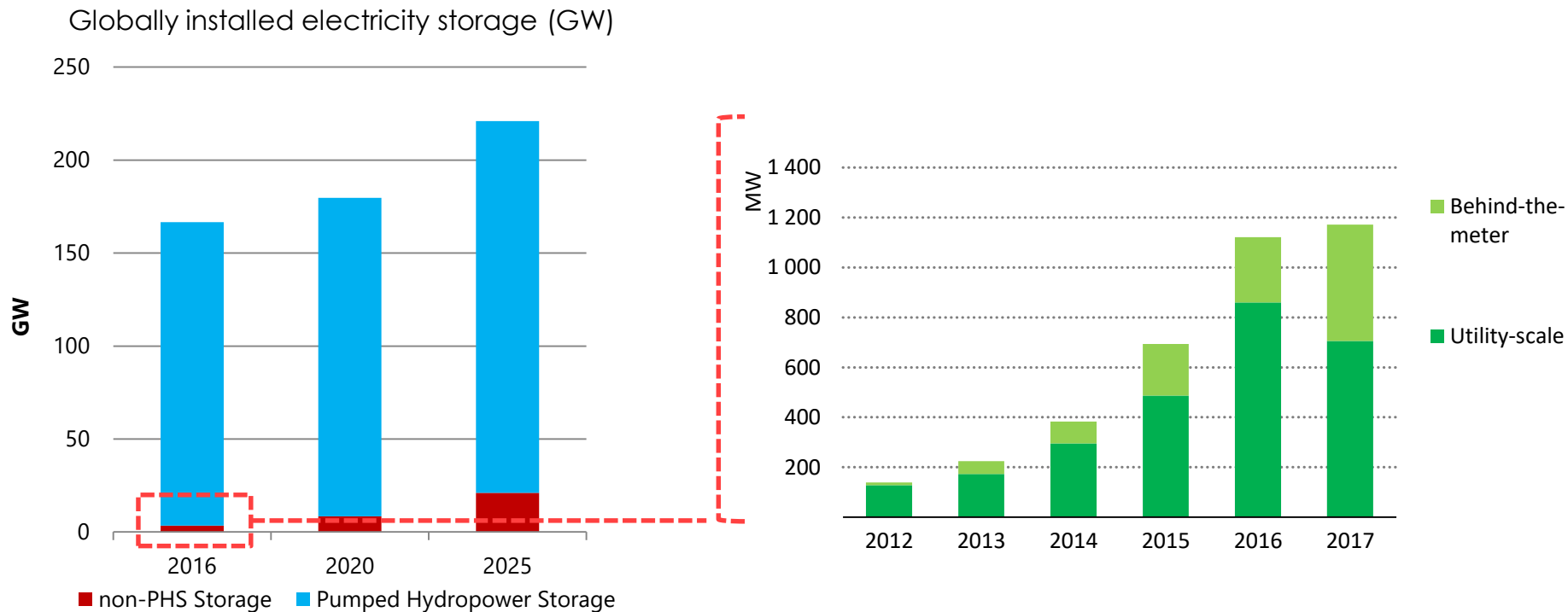


Global electric car stock



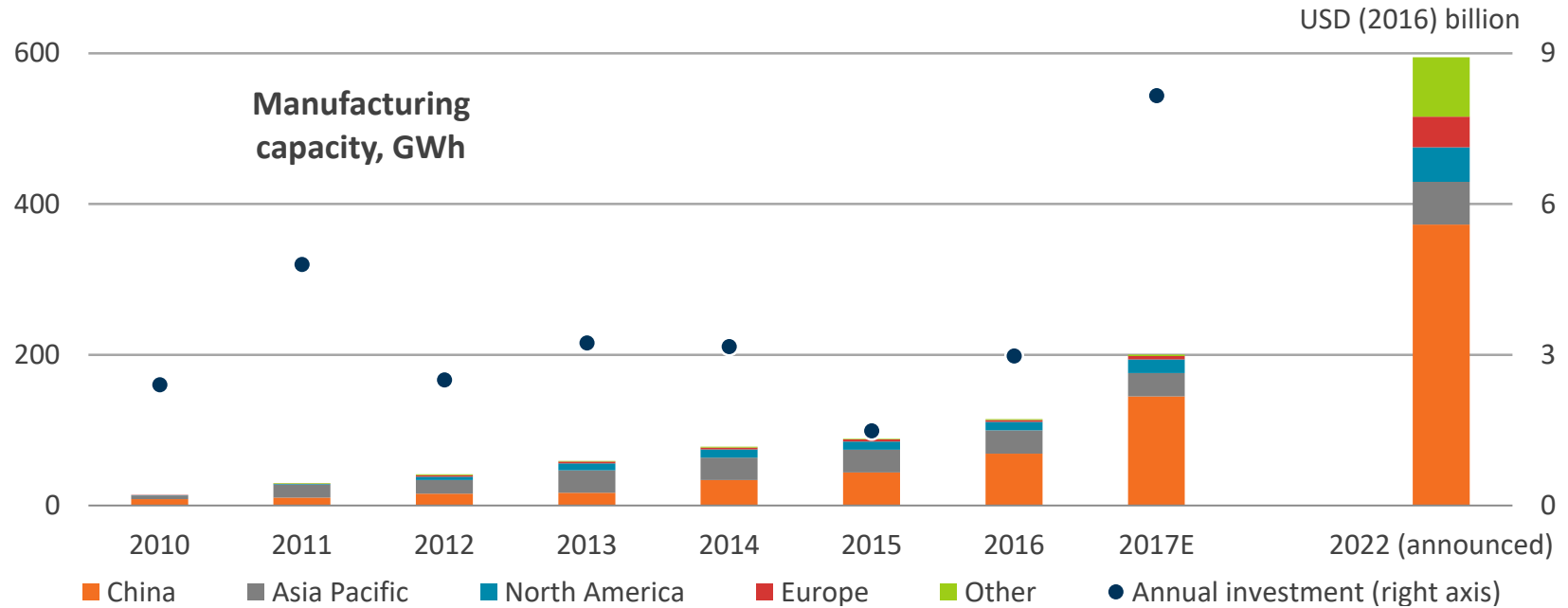
The number of passenger electric cars on the road passed 3 million in 2017, but it needs to grow to 240 million by 2030 in the SDS

Battery storage also needs to prove stable growth, and policy support is key



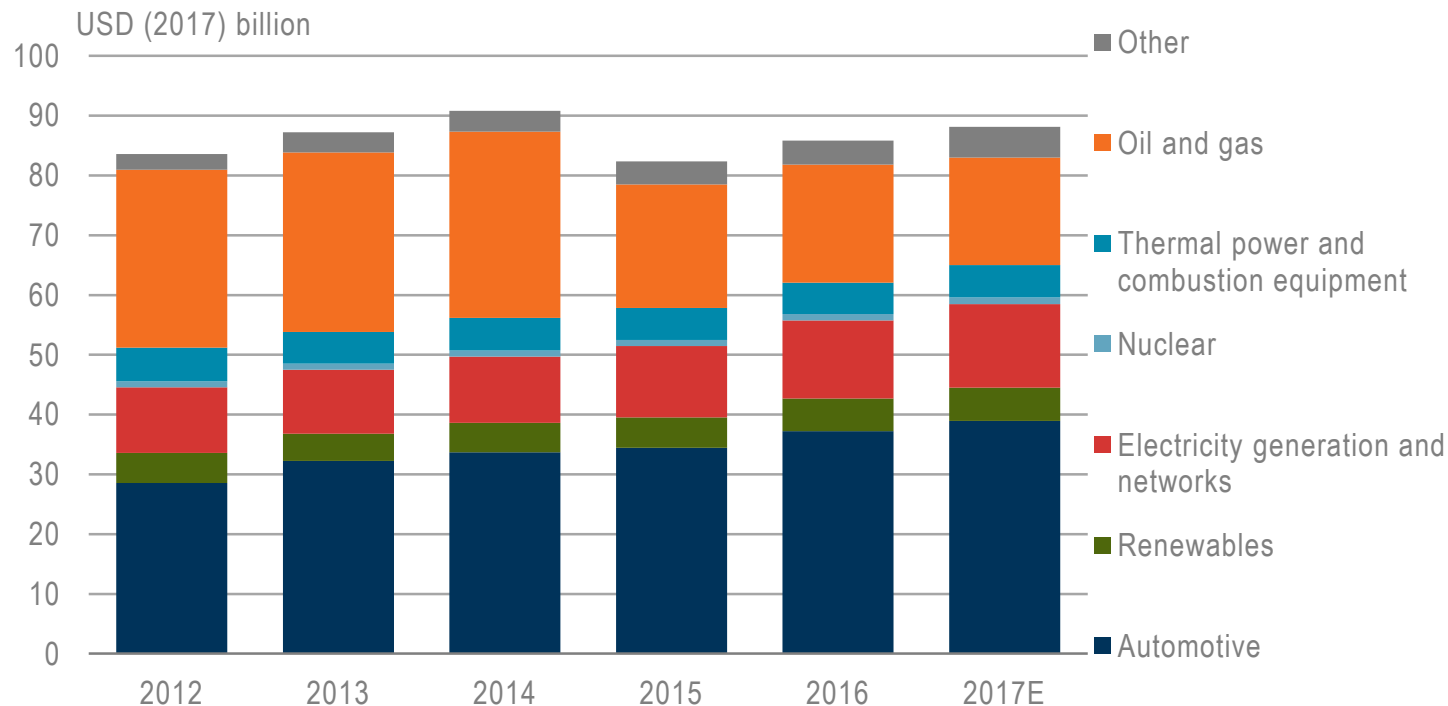
The expansion of grid-scale batteries, which are used mainly for frequency regulation and demand shifting, will hinge on policies to reward additional capacity, flexibility and avoided grid cost services.

A huge scale-up in batteries coming – high profile announcements only part of the story



With China particularly taking big leaps in manufacturing output, the PV story could be repeated for storage

Corporate energy R&D spending is recovering slowly

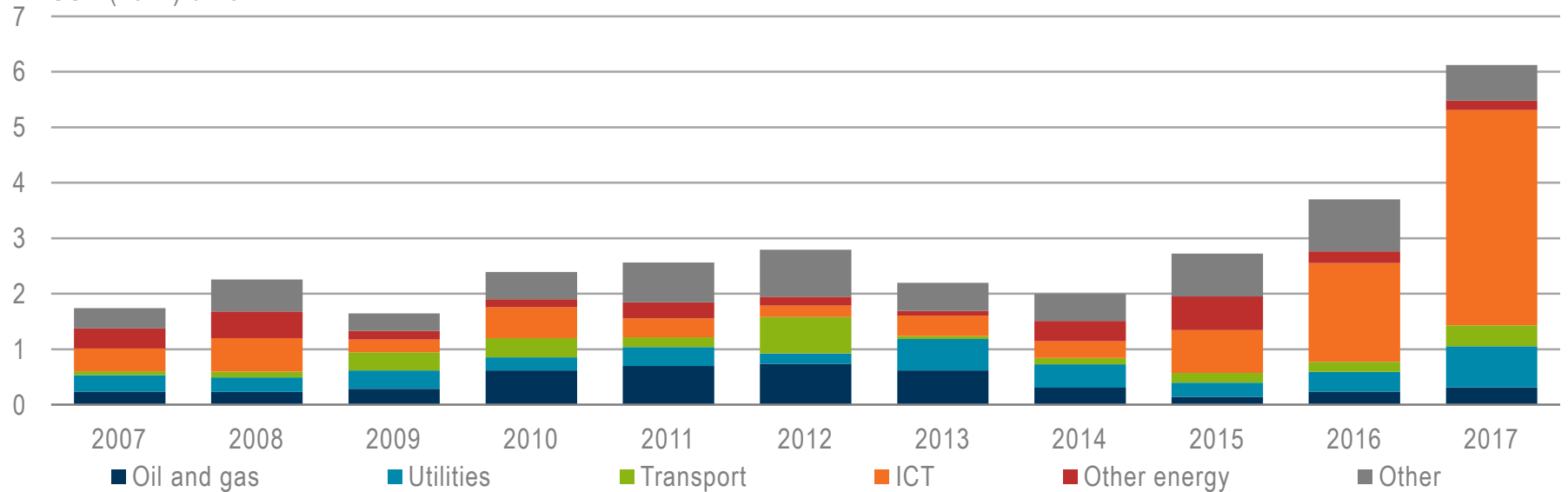


The private sector remains the largest single source of funding for energy R&D, despite lower spending in recent years

The energy innovation system is changing

Corporate investments in new energy technology companies, by sector of investing company

USD (2017) billion



Corporate venture capital and growth equity for energy tech startups reached USD 6 billion in 2017; companies are taking strategic positions in a changing energy system, digital firms above all others.

- Of 38 clean-energy technologies **4 are on track**, **23 need improvement** & **11 are off track**
- Need to focus on all technologies; lack of progress on some puts even more pressure on others
- Government policy & market design will be instrumental in spurring innovation, deployment and private investment
- Faster technological innovation can spur economic growth, while also improving energy security & sustainability



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