



A sustainable & secure transition to a low carbon future

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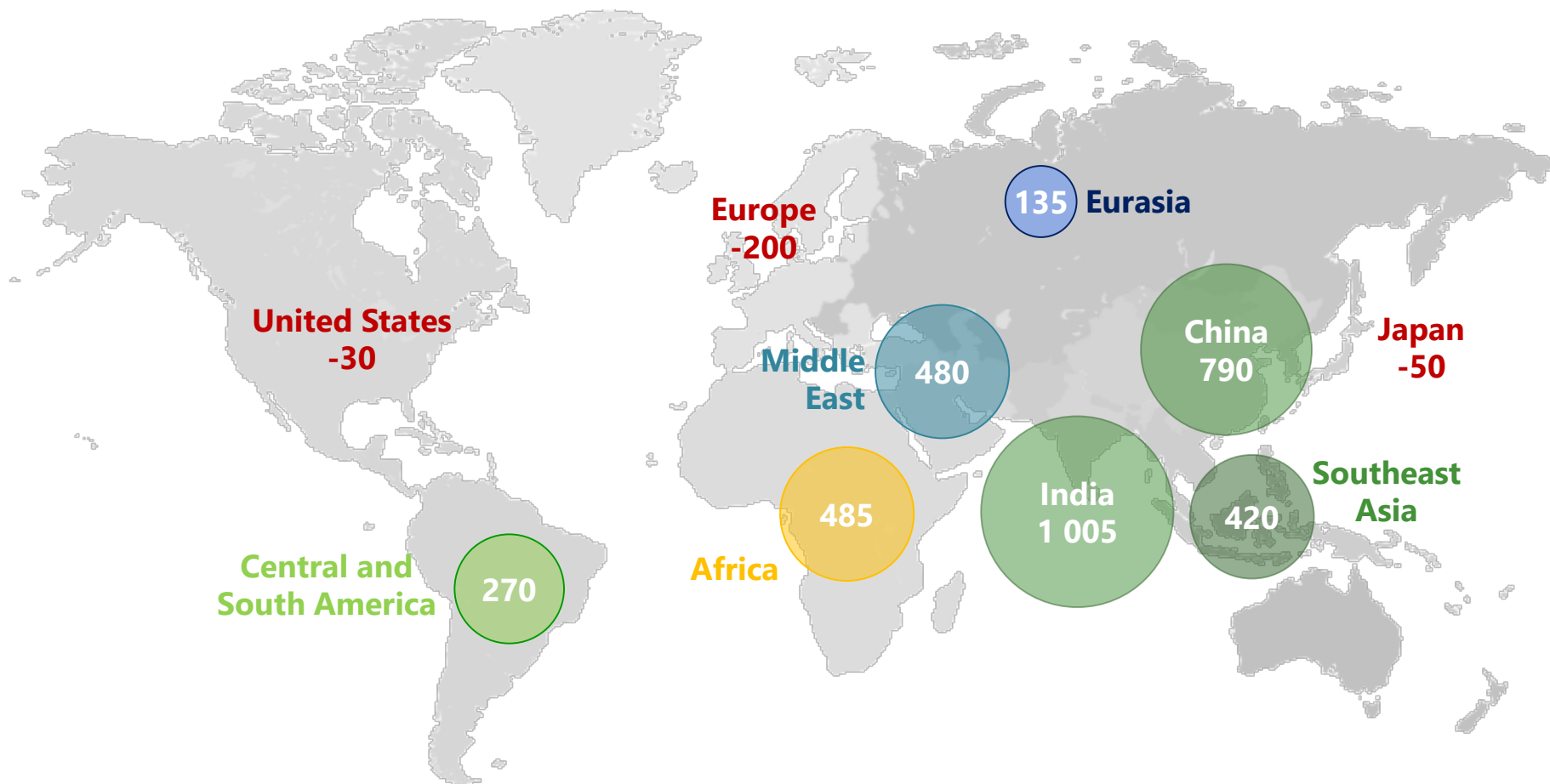


Tipping the energy world off its axis

- Four large-scale upheavals in global energy :
 - *The **United States** is turning into the undisputed global leader for oil & gas*
 - ***Solar PV** is on track to be the cheapest source of new electricity in many countries*
 - ***China's** new drive to "make the skies blue again" is recasting its role in energy*
 - *The future is **electrifying**, spurred by cooling, electric vehicles & digitalisation*
- These changes brighten the prospects for affordable, sustainable energy & require a reappraisal of approaches to energy security
- There are many possible pathways ahead & many potential pitfalls if governments or industry misread the signs of change

India takes the lead, as China energy growth slows

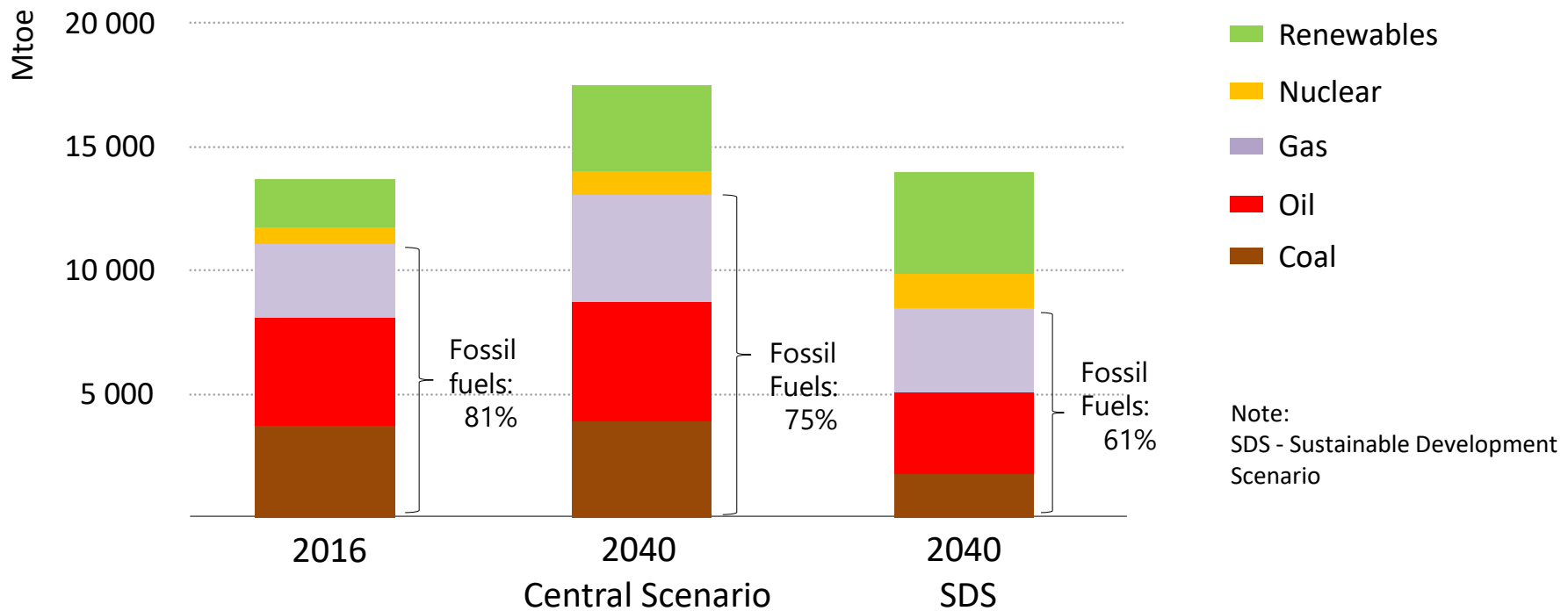
Change in energy demand, 2016-40 (Mtoe)



India, China and other developing Asia will be critical in determining the future trajectory of global energy demand & CO₂ emissions

Government policy choices will shape the global energy mix

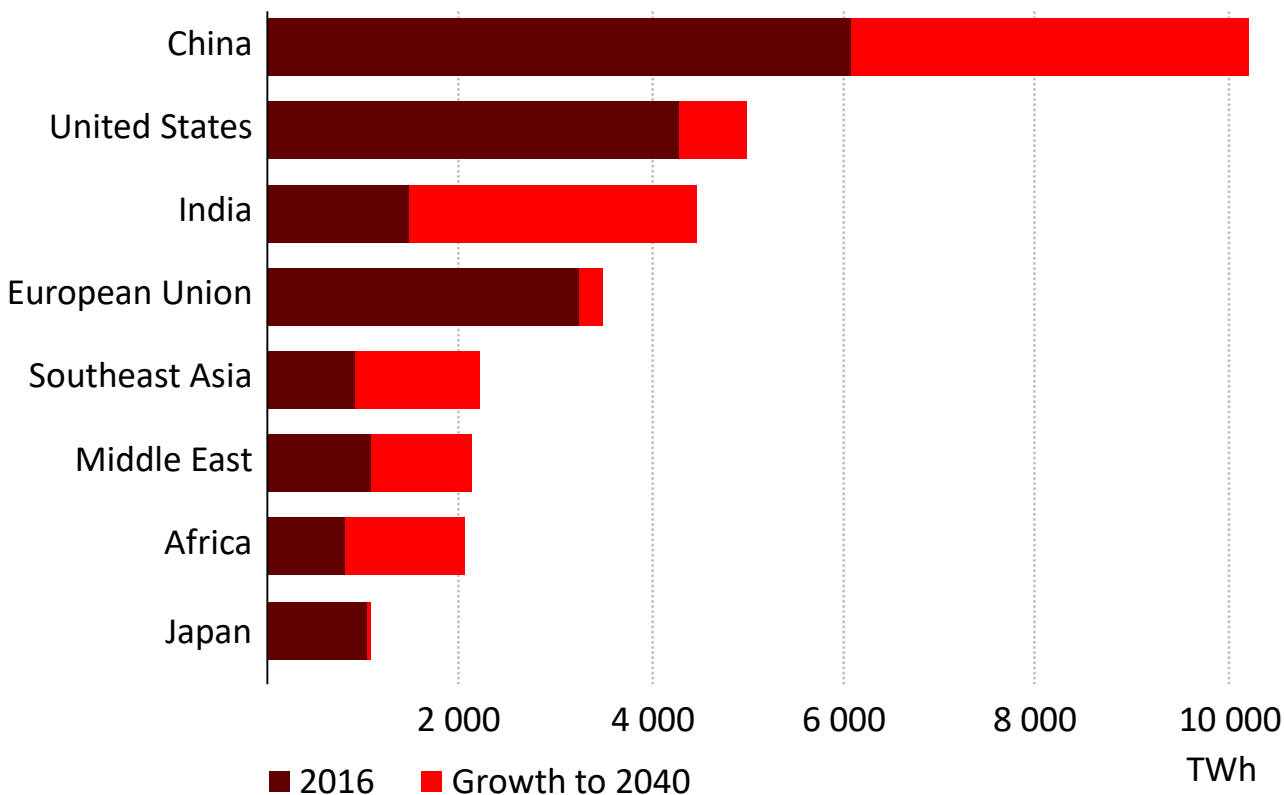
Total primary energy demand in the world by fuel and scenario



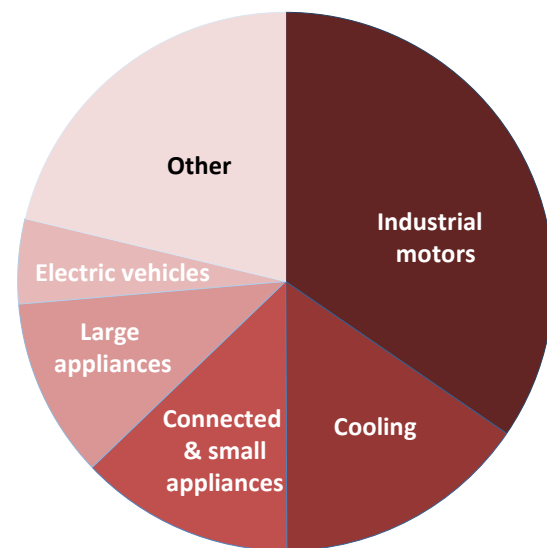
Even in a low-carbon energy future, there is still an important role for natural gas, oil and coal ; Efficiency, renewables, nuclear and CCUS are critical for a sustainable energy path

The future is electrifying

Electricity generation by selected region



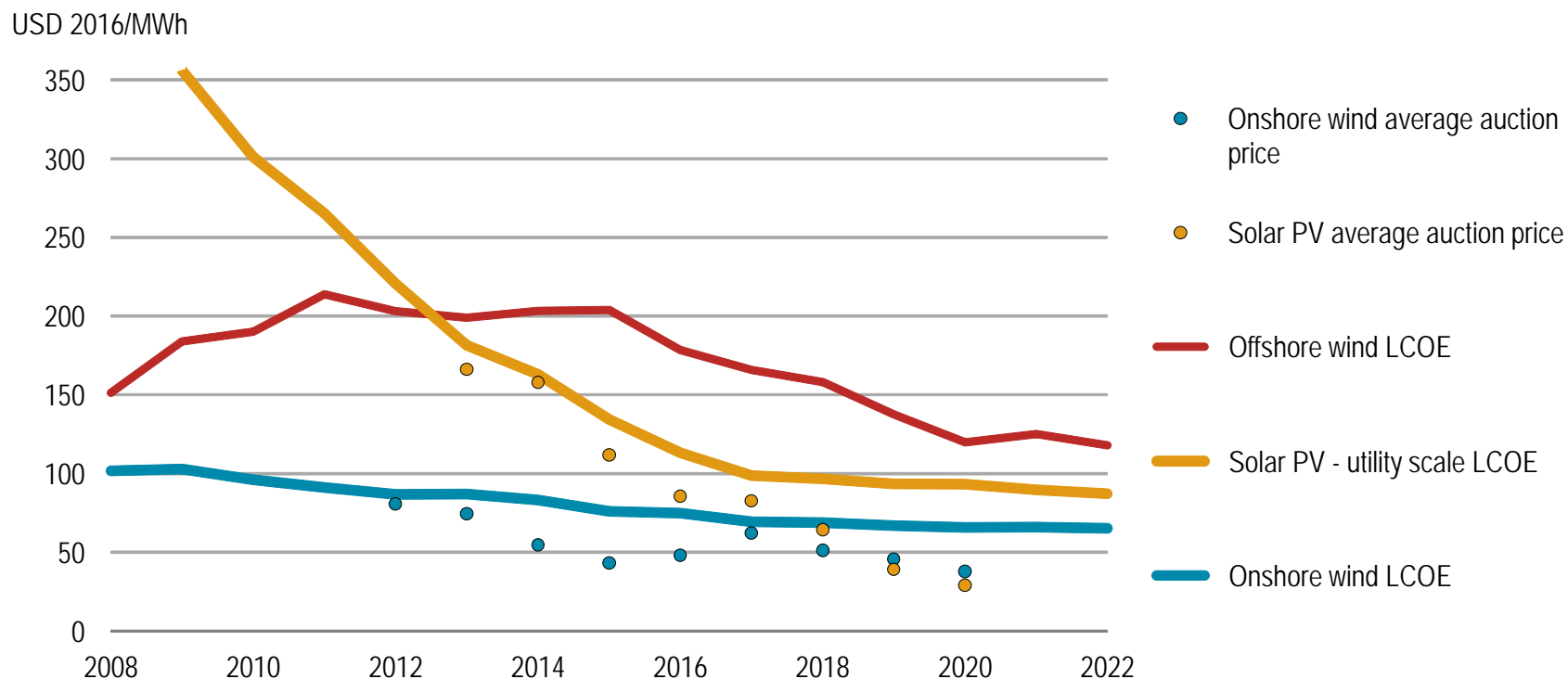
Sources of global electricity demand growth



India adds the equivalent of today's European Union to its electricity generation by 2040, while China adds the equivalent of today's United States

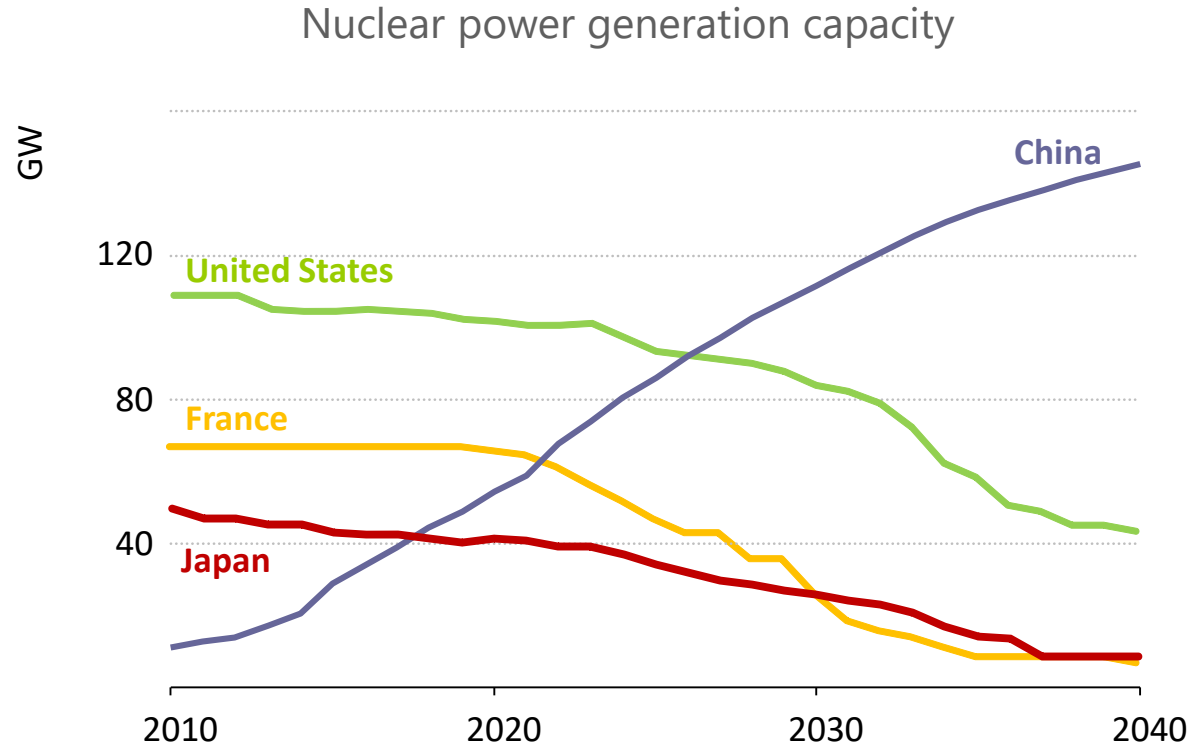
Wind and solar PV costs being driven down by competition

Wind and solar PV average LCOEs and auction results by commissioning date



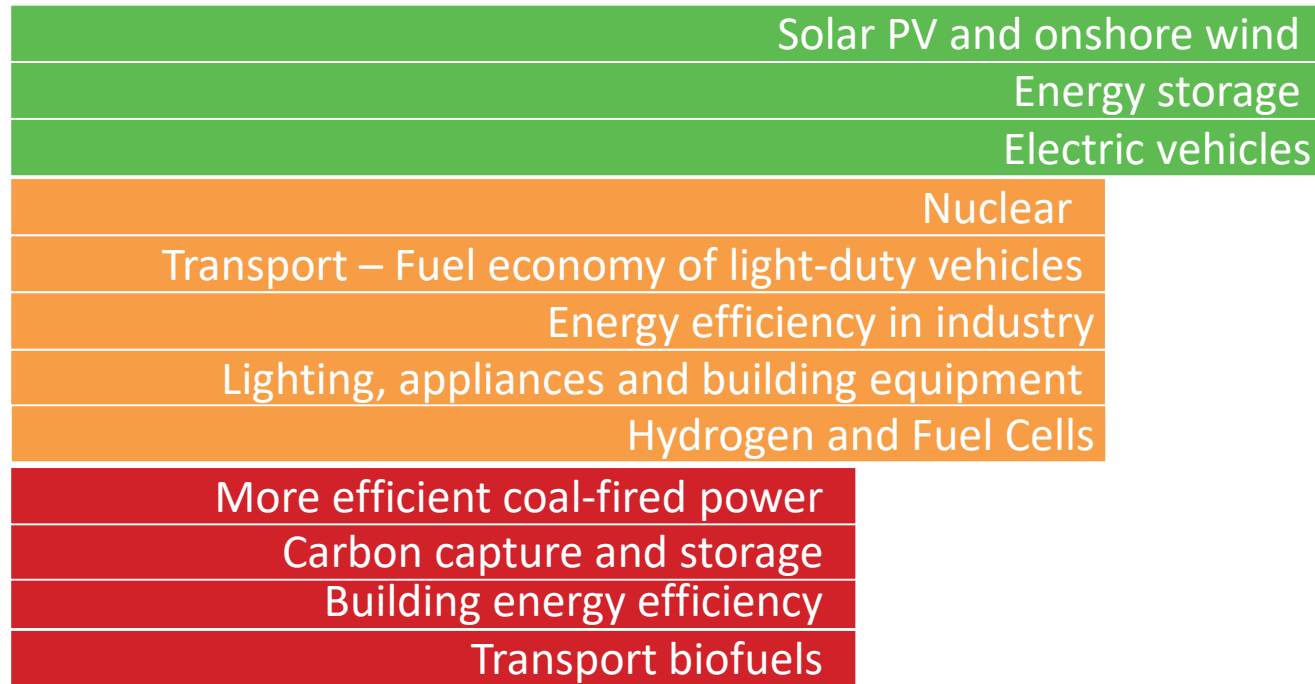
**The cost of wind and solar PV have fallen sharply, with further reductions expected;
Cost-optimal integration requires interconnections, flexible generation, storage & demand response**

A new leader emerging on nuclear



Without additional lifetime extensions, the largest nuclear fleets face significant declines, while China is soon set to overtake the United States as the global leader

The potential of clean energy technology remains under-utilised

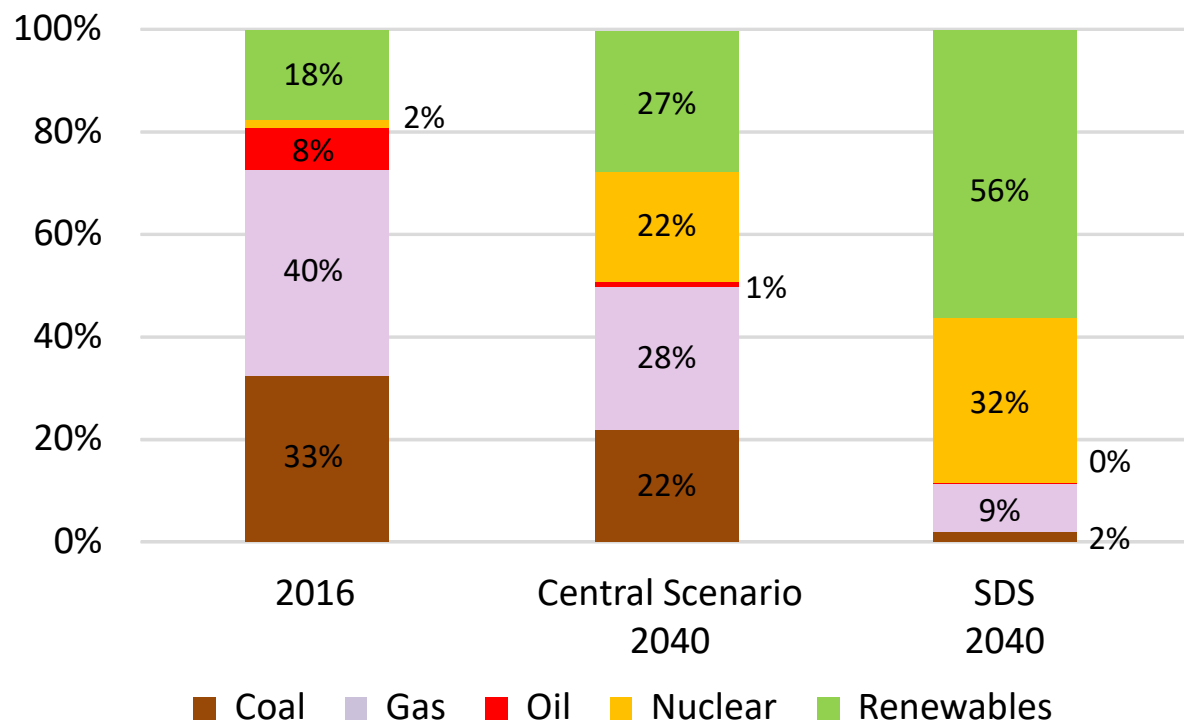


● Not on track ● Accelerated improvement needed ● On track

Despite good progress in some areas, many technologies still need a strong push to achieve their full potential and deliver a sustainable energy future

Japan's Power Mix: Policy determines uptake of low-carbon sources

Power generation mix in Japan by fuel and scenario



Decarbonisation of Japan's power sector can be achieved through the uptake of variable renewables and the restart of nuclear plants while ensuring their safety

Recommendations for Japan

- Enhance energy security and resilience by taking an “all fuel” and “all technology” approach to energy policy
- Continue to adjust renewable support policies in line with falling costs & ensure there is adequate system flexibility including interconnections
- Pursue all low carbon options, including efficiency, renewables, nuclear (with maximum safety), to decrease emissions in a cost-optimal way
- Continue to be a leader in global energy technology R&D and innovation
- Take advantage of the opportunities that digitalization is creating in the energy sector, while being mindful of the associated risks
- The IEA stands ready to support the clean and secure energy transition in providing cutting-edge technical advice to governments



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