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The Global Energy Transition: Challenges and Opportunities for Europe and the Netherlands

Noé van Hulst

27 June 2019, TU Delft

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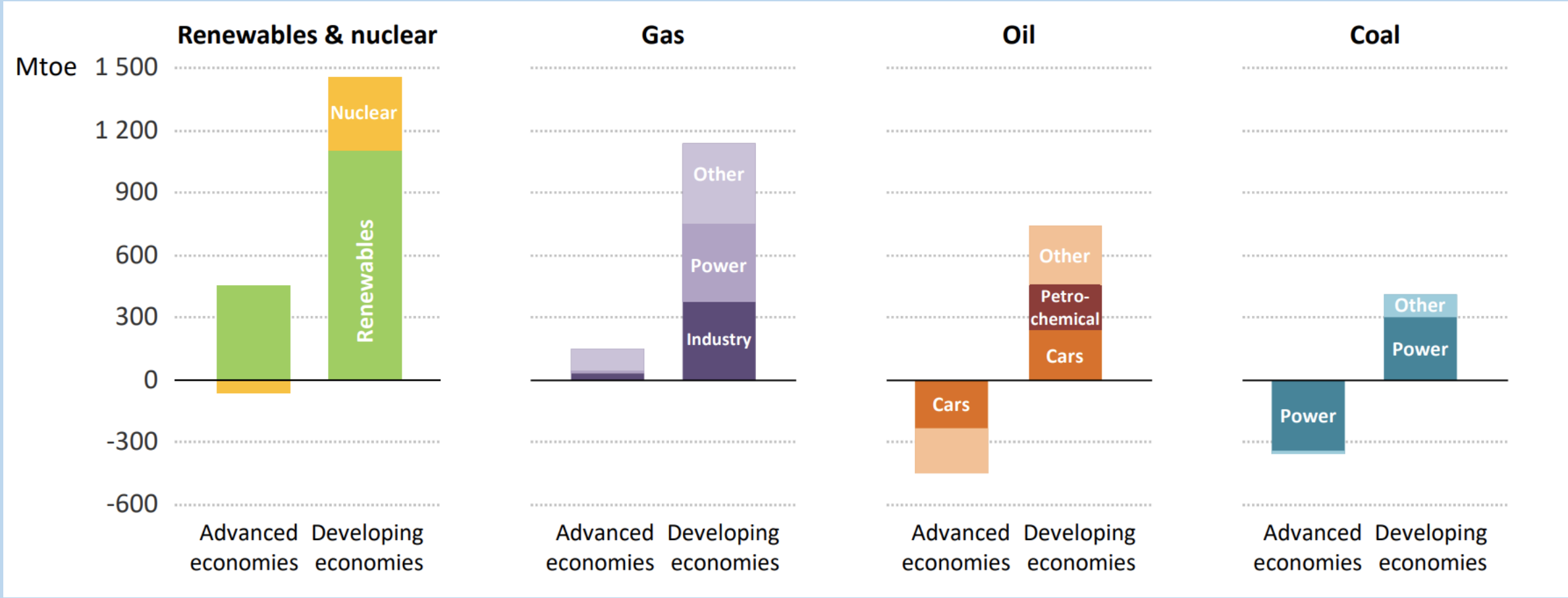
Fueling the Demand for Energy

Change in global energy demand, 2017-2040



The increase in demand would be twice as large without continued improvements in energy efficiency, a powerful tool to address energy security and sustainability concerns.

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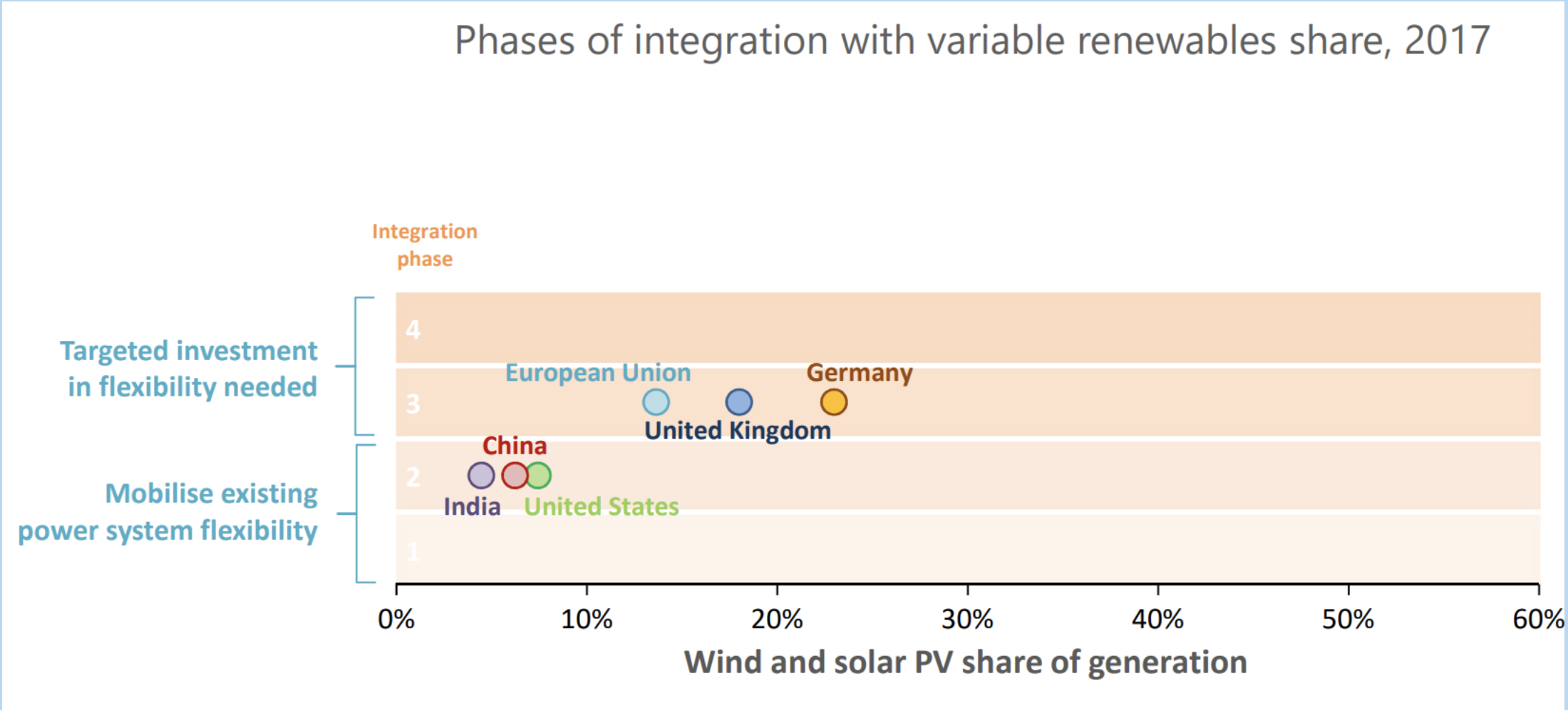
Flexibility: the Cornerstone of Tomorrow's Power Systems



Higher shares of variable renewables raise flexibility needs and call for reforms to deliver investment in power plants, grids, and energy storage, and unlock demand-side response

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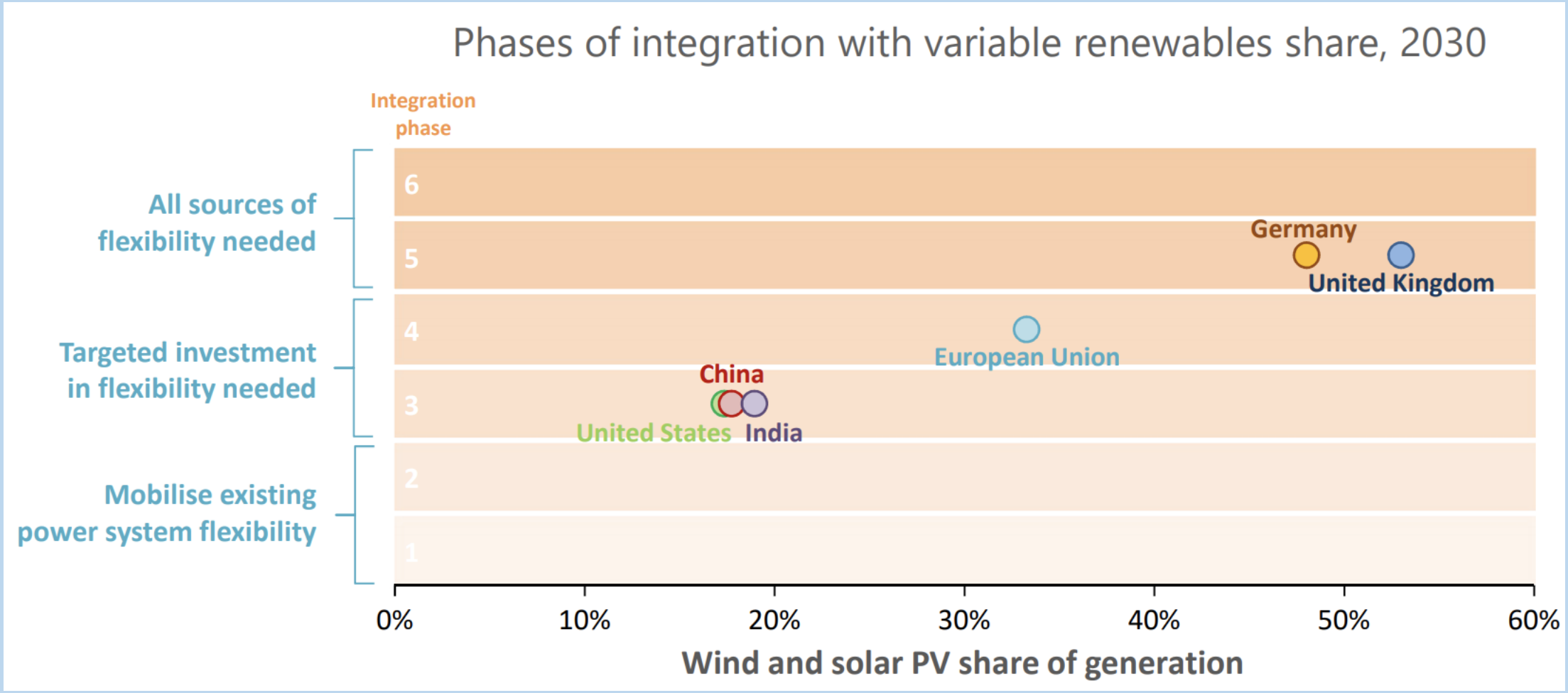

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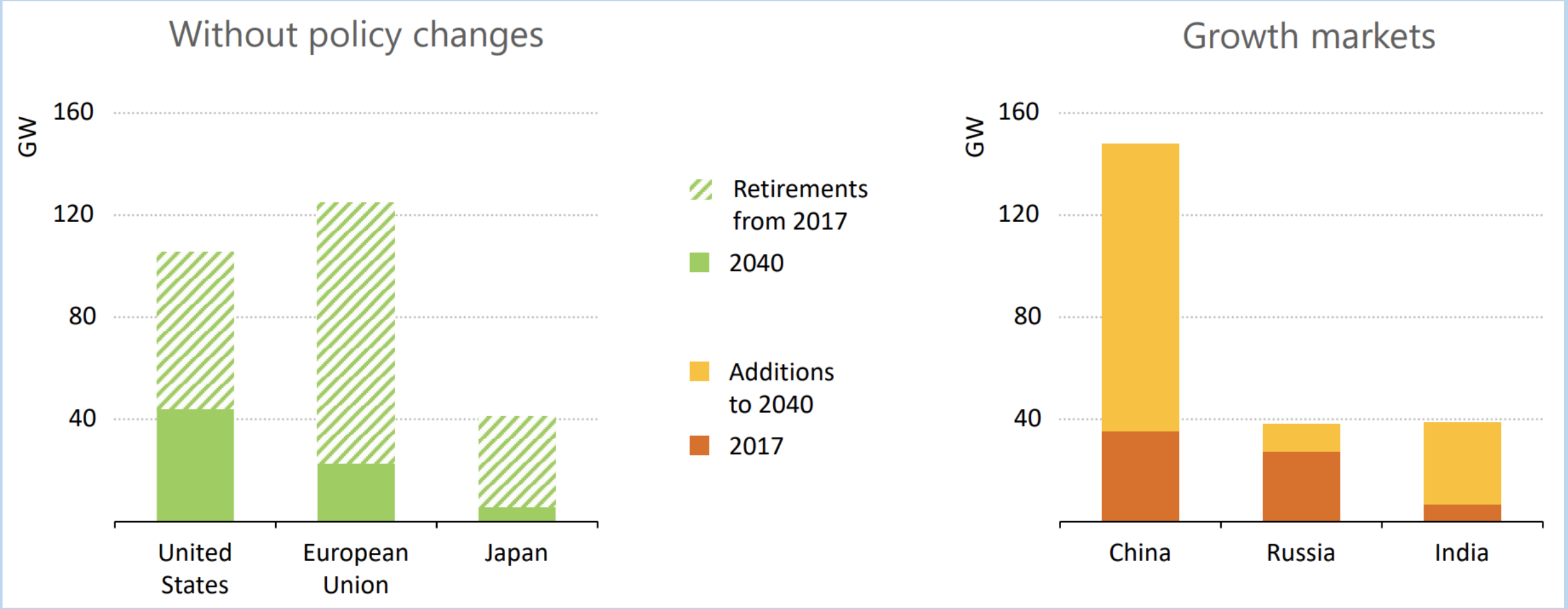
Two Directions for Nuclear Power



The contribution of nuclear power could decline substantially in leading markets, while large growth is coming, as China takes first position within a decade

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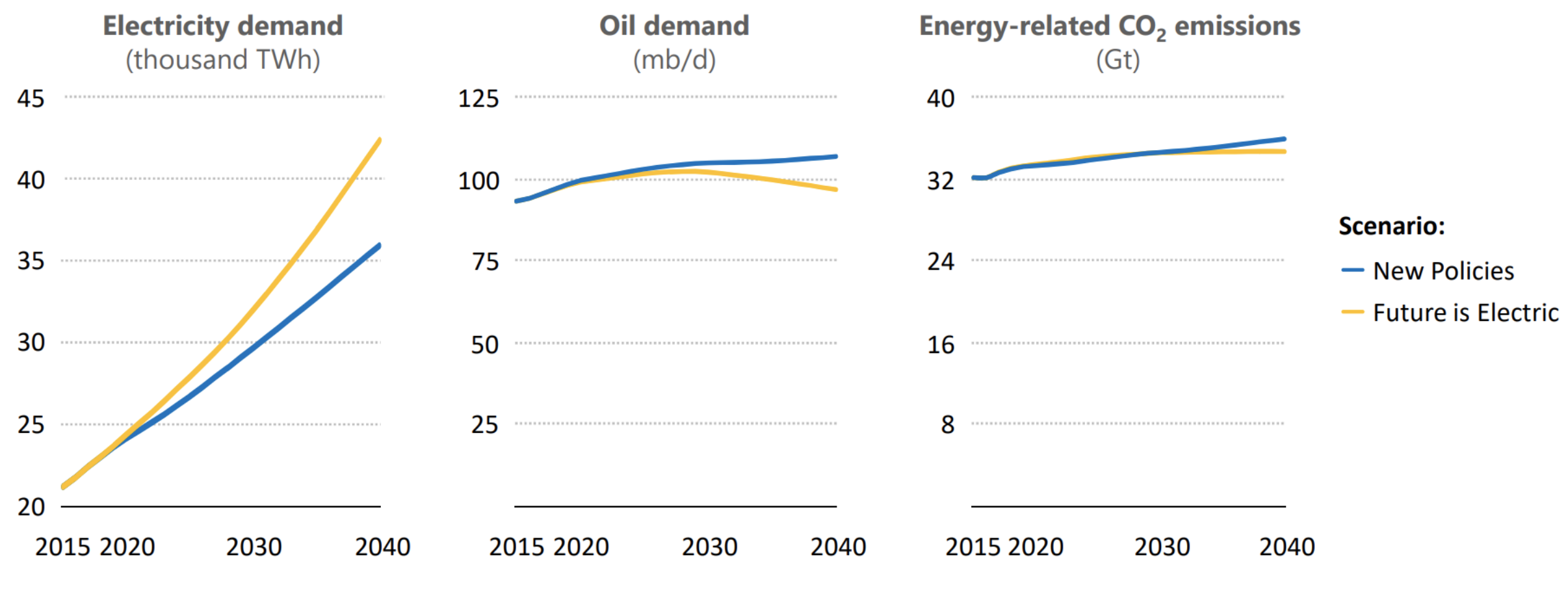
What if the future is electric?



Increased electrification leads to a peak in oil demand, avoids 2 million air pollution-related premature deaths, but does not necessarily lead to large CO_2 emissions reductions

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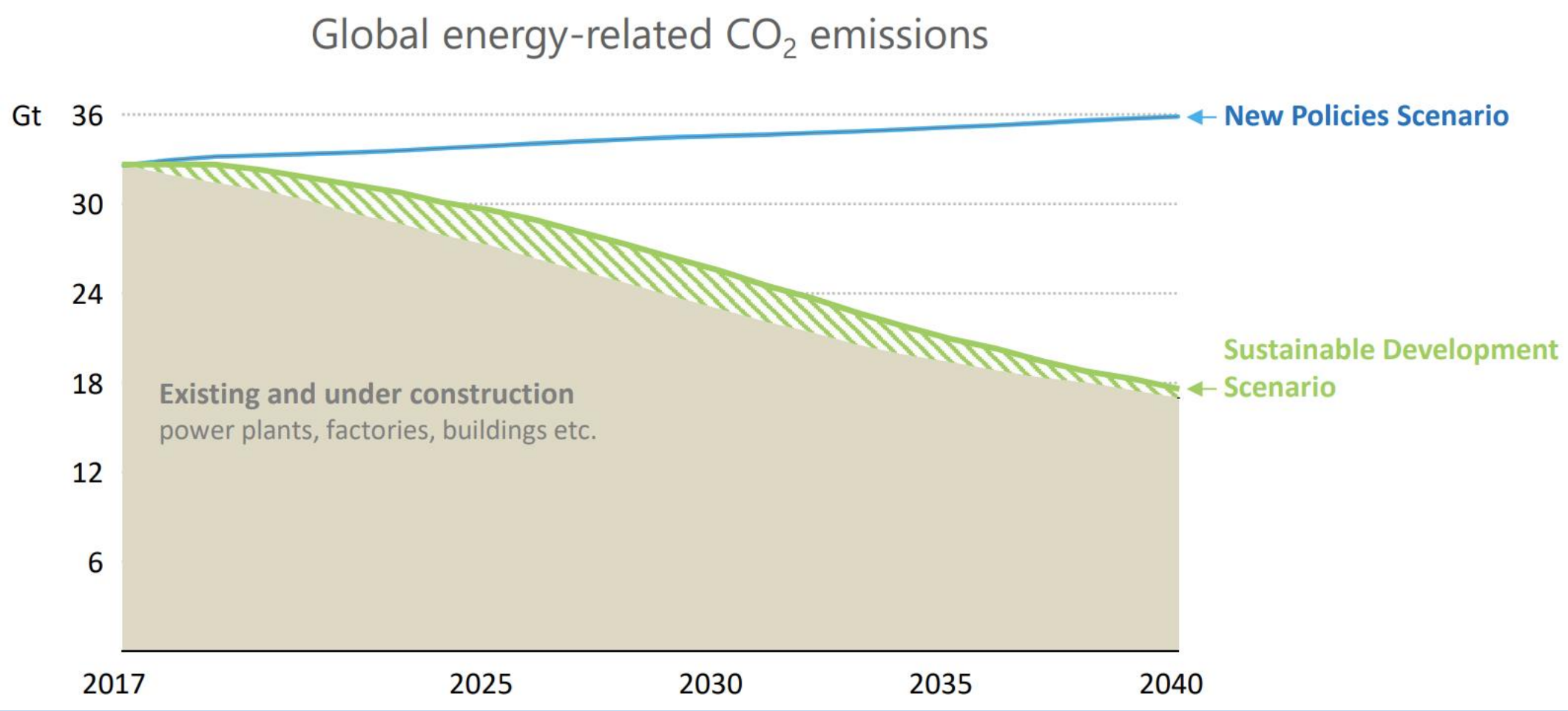
Can we Unlock a Different Energy Future?



Coal plants make up one-third of CO_2 emissions today and half are less than 15 years old; policies are needed to support CCUS, efficient operations and technology innovation

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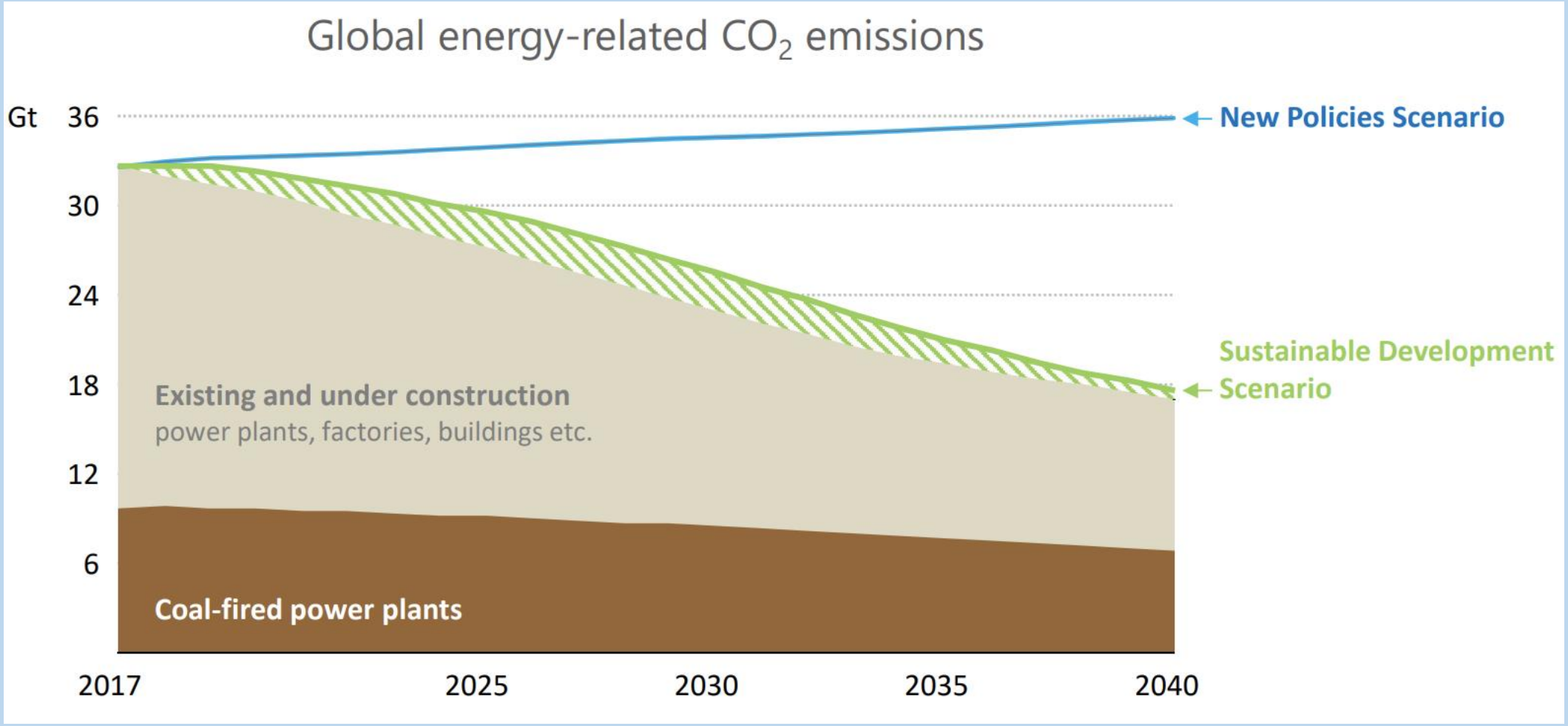

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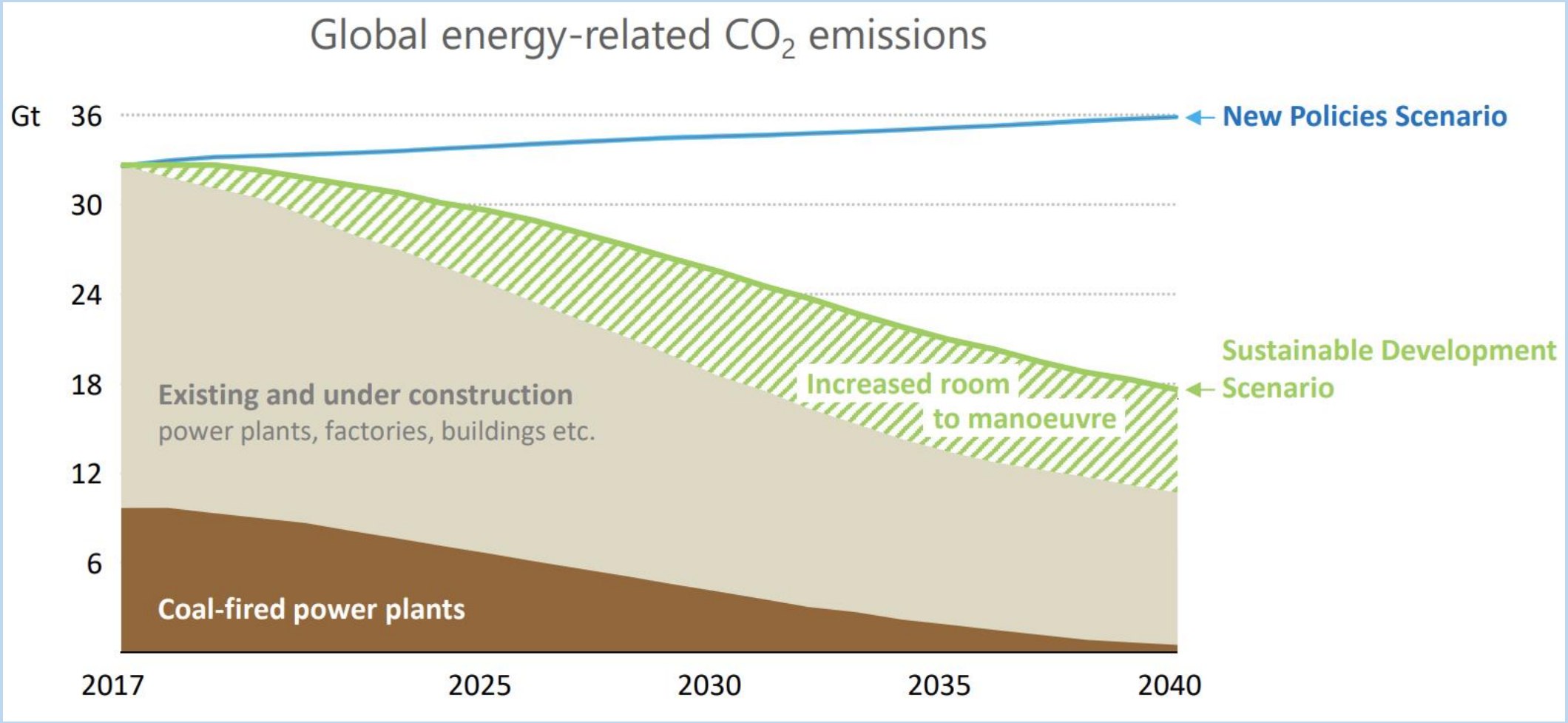

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Conclusions

- The links between energy & geopolitics are strengthening & becoming more complex, a major factor in the outlook for energy security
- A mismatch between robust oil demand in the near term & a shortfall in new projects risks a sharp tightening of oil markets in the 2020s
- The rapid growth of electricity brings huge opportunities; but market designs need to deliver both electricity and flexibility to keep the lights on
- There is no single solution to turn emissions around: renewables, efficiency & a host of innovative technologies, including storage, CCUS & hydrogen, are all required
- The future pathway for energy is open: governments will determine where our energy destiny lies

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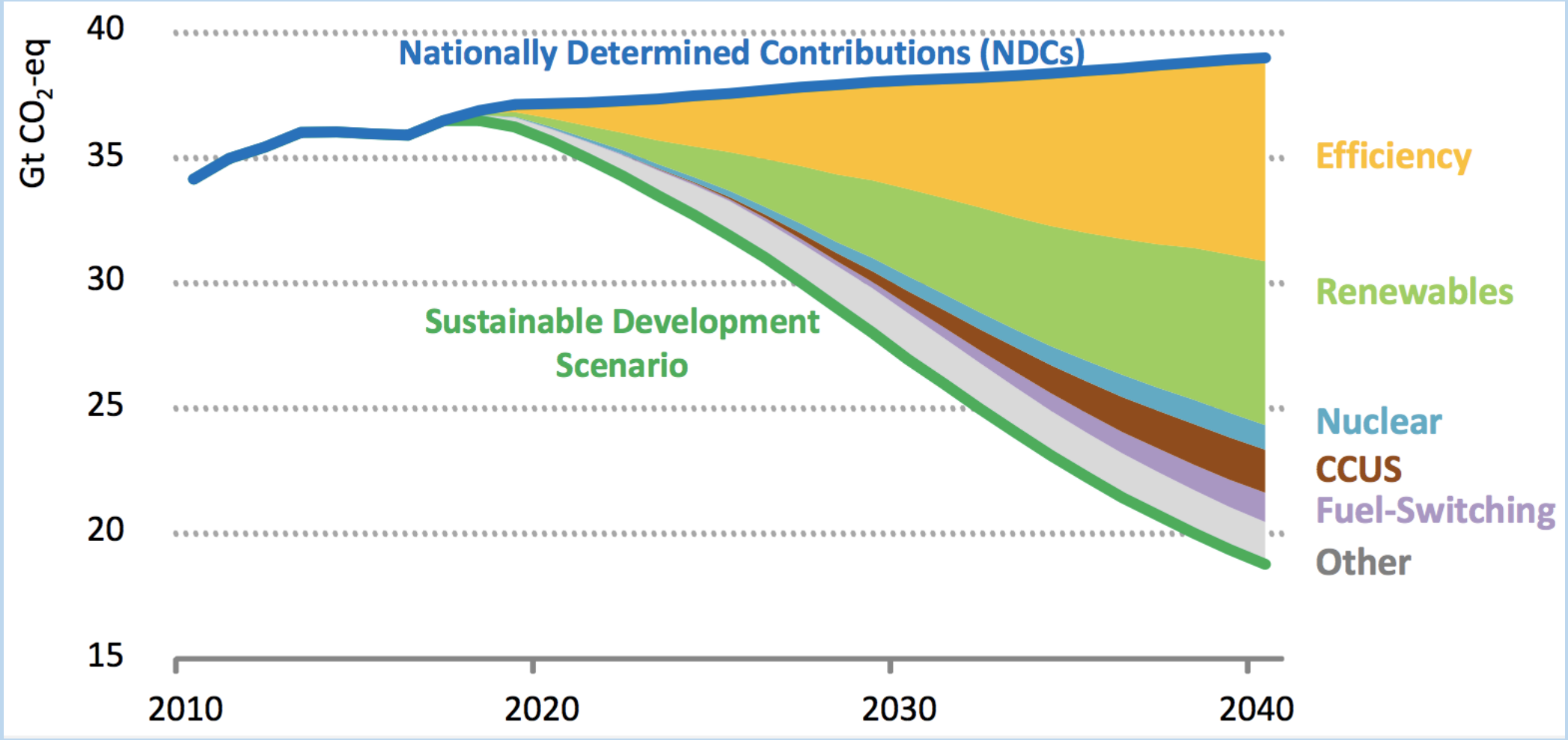
Transitioning Towards a Cleaner and More Secure Energy System



There is no single solution to our energy challenges: while efficiency and renewables account for the bulk of abatement, a host of other technologies including nuclear, CCUS, hydrogen and storage are also required

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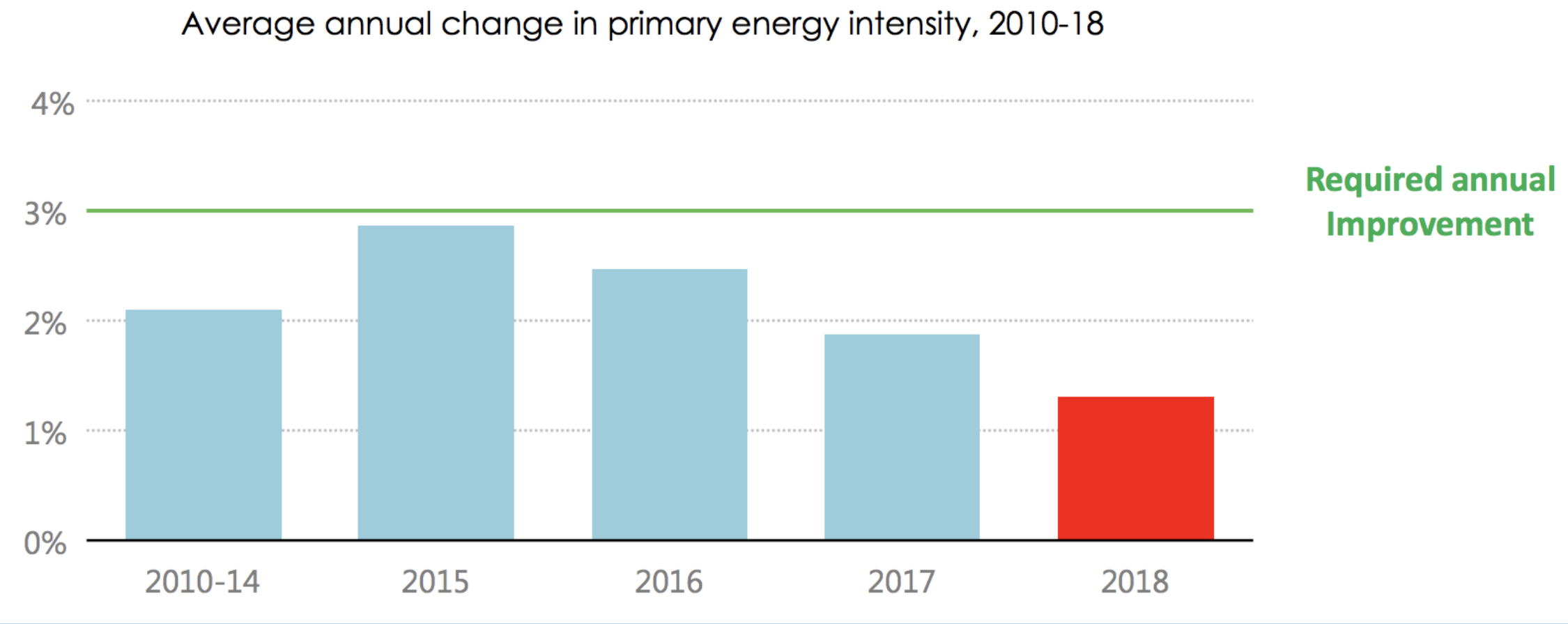
World Energy Efficiency Improvements are Slowing



2018 saw a worrying slowdown in energy efficiency progress despite IEA analysis showing huge untapped potential remaining in all sectors. Stronger action on efficiency is imperative.

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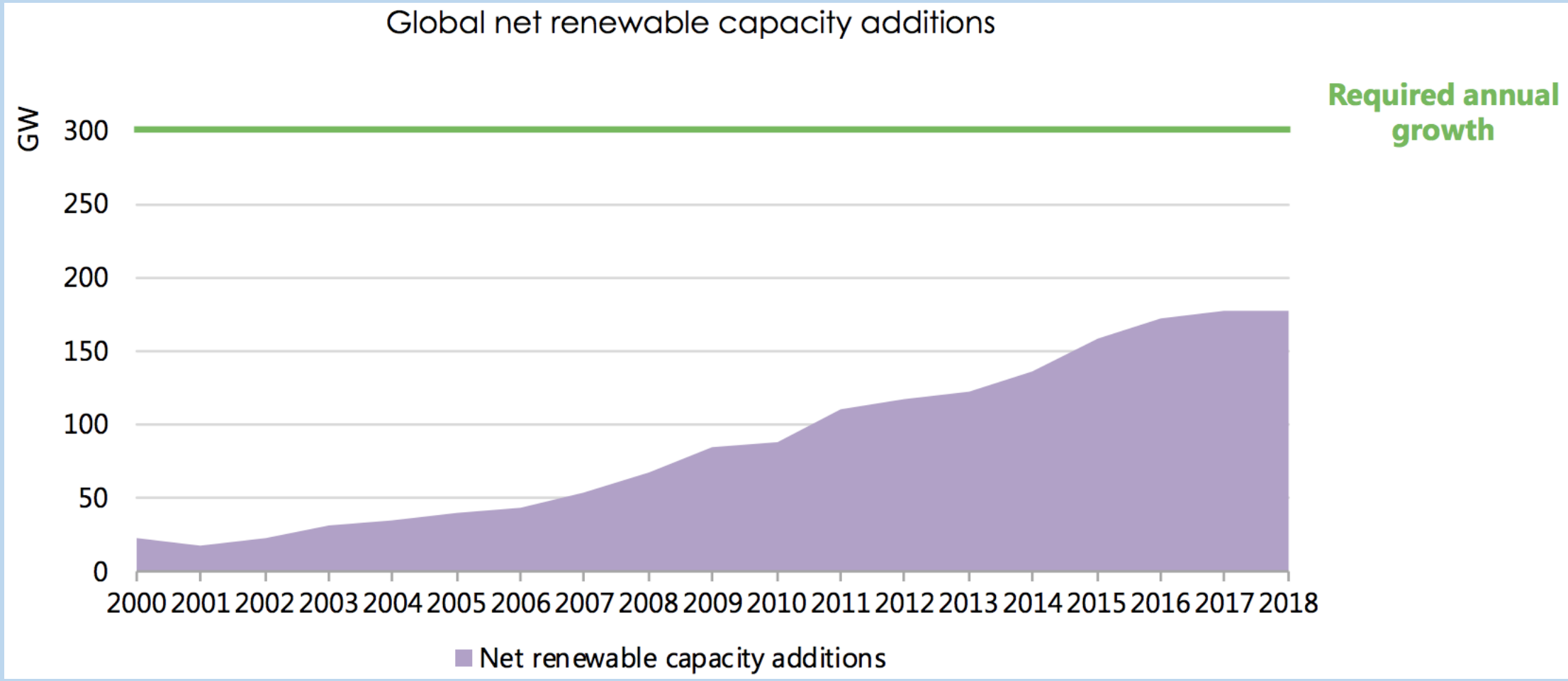
2018 Renewable Capacity Growth Stalled



Some 300 GW of renewable capacity additions are needed each year to be on track for a sustainable energy future; achieving this requires increased policy certainty to reduce investment risk and a strong focus on system integration.

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Tracking Clean Energy Progress 2019

Solar PV	Bioenergy for power	EVs	Rail	Lighting
Data centres	Energy storage	Renewable power	Onshore wind	Offshore wind
Hydropower	Nuclear power	Natural gas-fired power	Industry	Chemicals
Iron & steel	Cement	Pulp & paper	Aluminium	Transport
Trucks & buses	Transport biofuels	Aviation	International shipping	Cooling
Appliances & equipment	Energy integration	Hydrogen	Smart grids	Demand response
Power	Geothermal	CSP	Ocean	Coal-fired power
CCUS in power	Other supply	Methane from oil & gas	Flaring emissions	CCUS in industry and transformation
Fuel economy	Buildings	Building envelopes	Heating	Heat pumps

IEA's latest tracking of clean energy technologies show **7 are on track**, **23 need improvement**, and **15 are off track**

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Conclusions

- There is a growing disconnect between climate ambitions and real-world energy trends
- Only 7 of 45 clean energy technologies are on track for what is required to reach a sustainable energy future
- Governments have a key role to play in shaping investment decisions necessary for clean energy transitions
- There is no single solution to our energy challenges: renewables, nuclear, efficiency, and host of innovative technologies, including storage, CCUS, and hydrogen are all required
- The IEA will continue to focus on “all fuels and all technologies” to provide CEM stakeholders with the world’s best energy data, independent and rigorous analysis and real-world solutions

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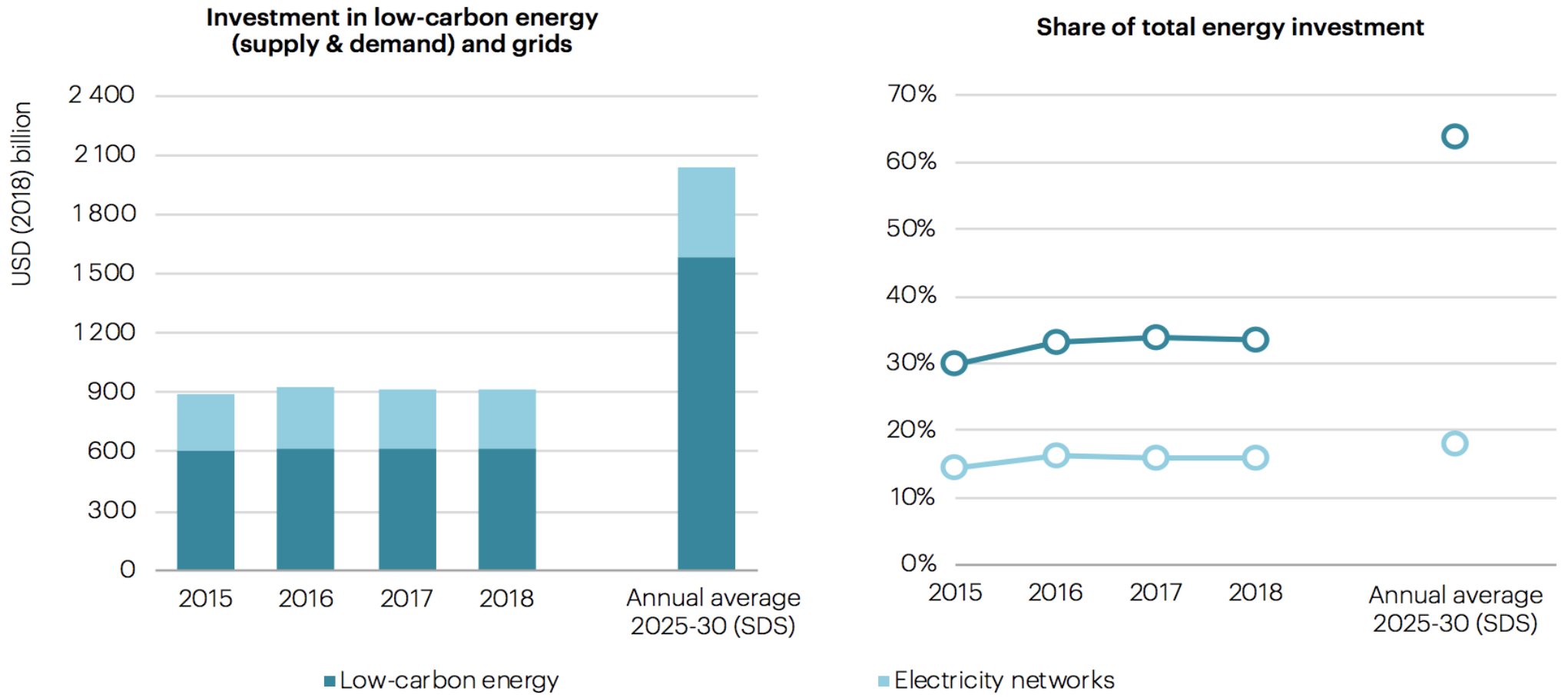
Total investment across low-carbon energy – including supply and efficiency – has stalled in recent years and need a rapid boost to keep Paris in sight

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.

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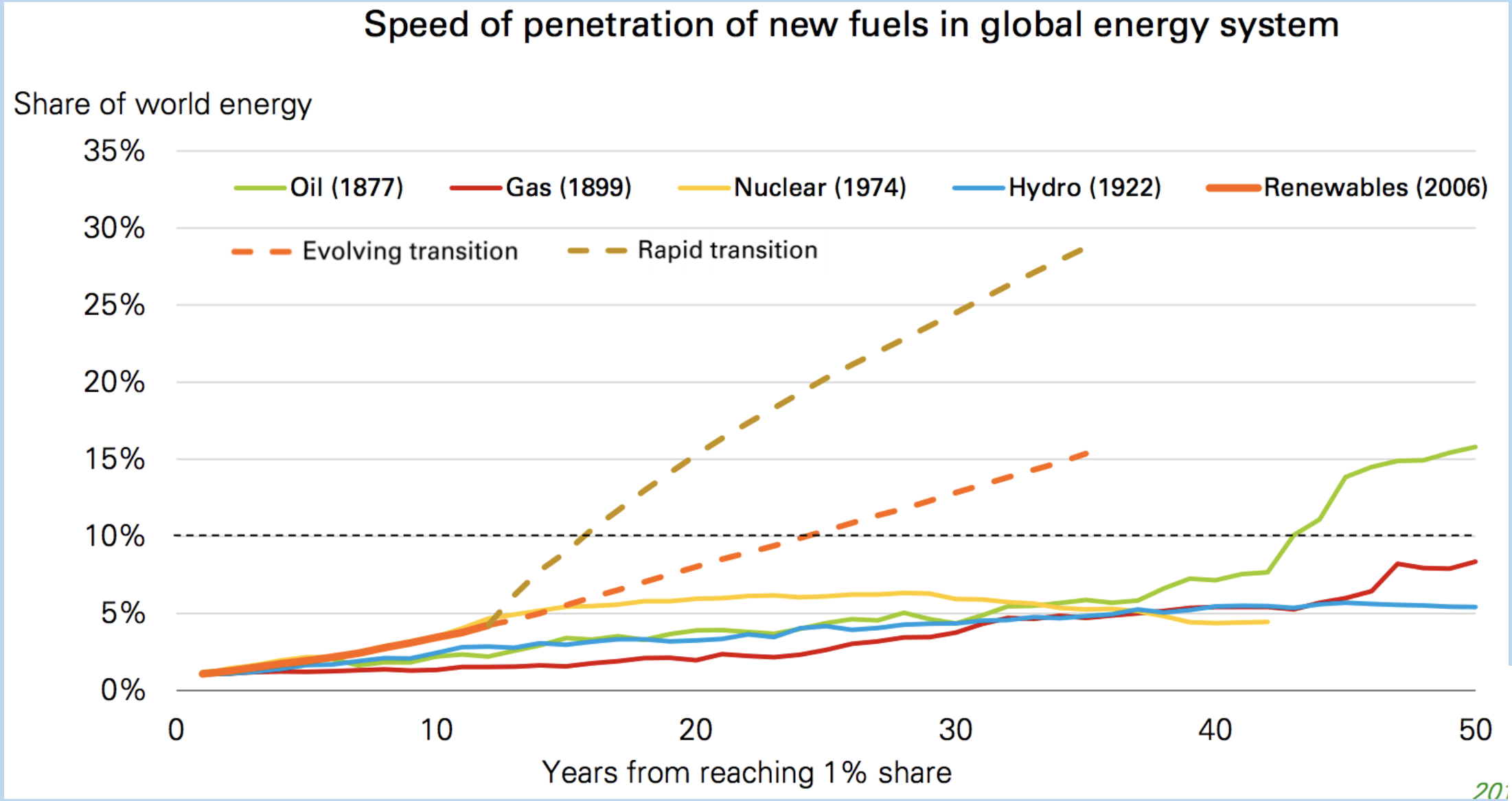
Speed of Energy Transition



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Hydrogen – A common *element* of our energy future?

- Momentum currently behind hydrogen is unprecedented, with more and more policies, projects, and plans by governments and companies in all parts of the world
- Hydrogen can help overcome many difficult energy challenges
  - ***Integrate more renewables***, including by enhancing storage options and tapping their full potential
  - ***Decarbonise hard-to-abate sectors*** – steel, chemicals, trucks, ships, and planes
  - ***Enhance energy security*** by diversifying the fuel mix and providing flexibility to balance grids
- But there are challenges: ***costs*** need to fall; ***infrastructure*** needs to be developed; ***cleaner hydrogen*** is needed; and ***regulatory barriers*** persist.

Source: IEA

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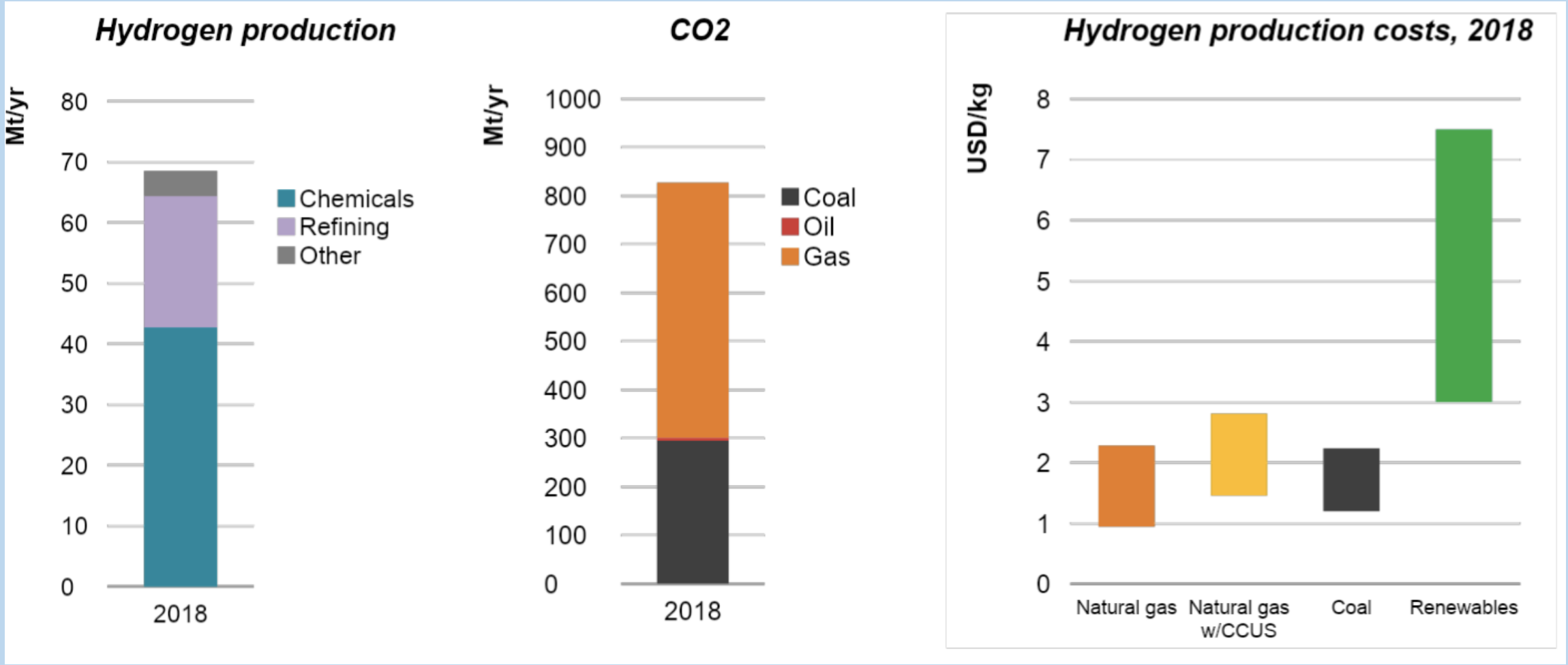
Hydrogen is Already Part of the Energy Mix



Dedicated hydrogen production is concentrated in very few sectors today, and virtually all of it is produced using fossil fuels, as a result of favourable economics.

Source: IEA

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Hydrogen Production with CO_2 Capture is Coming Online

Low-carbon hydrogen from fossil fuels is produced at commercial scale today, with more plants planned. It is an opportunity to reduce emissions from refining and industry.

Source: IEA

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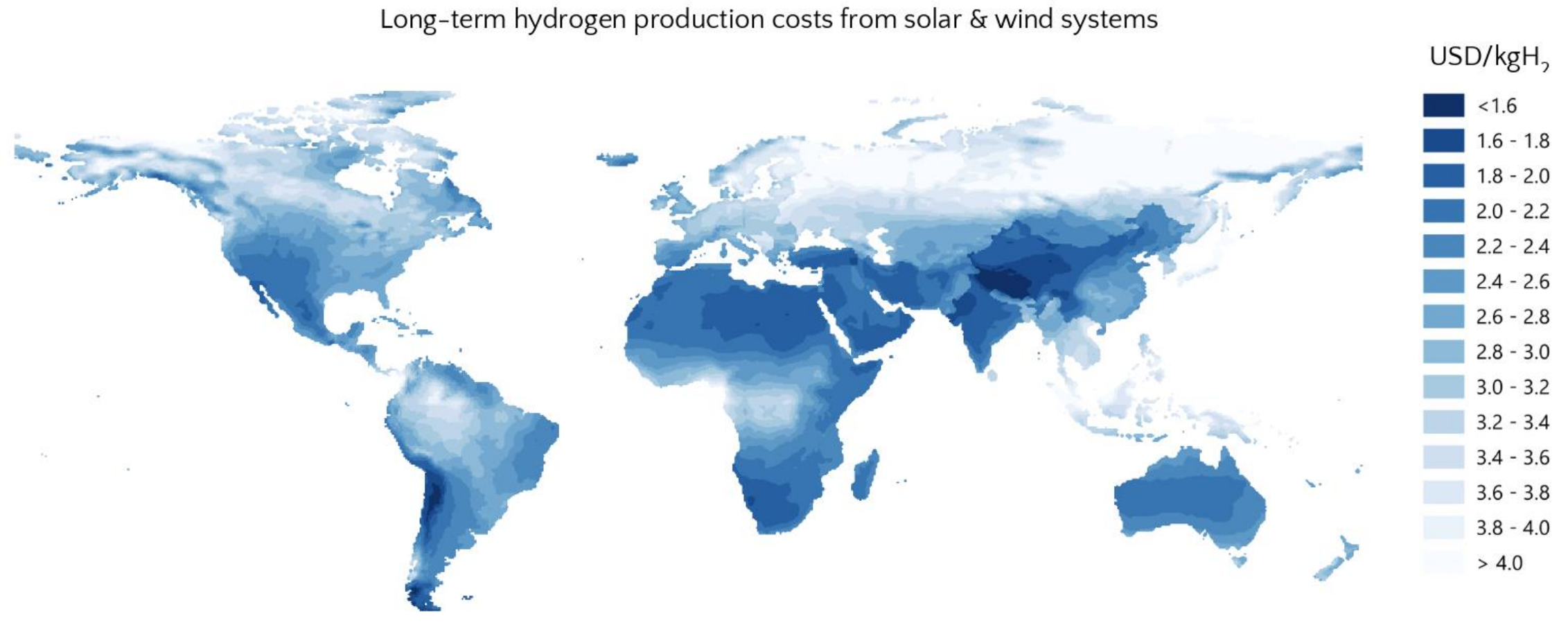
Renewables Hydrogen Costs are Set to Decline



The declining costs of solar PV and wind could make them a low-cost source for hydrogen production in regions with favourable resource conditions.

Source: IEA

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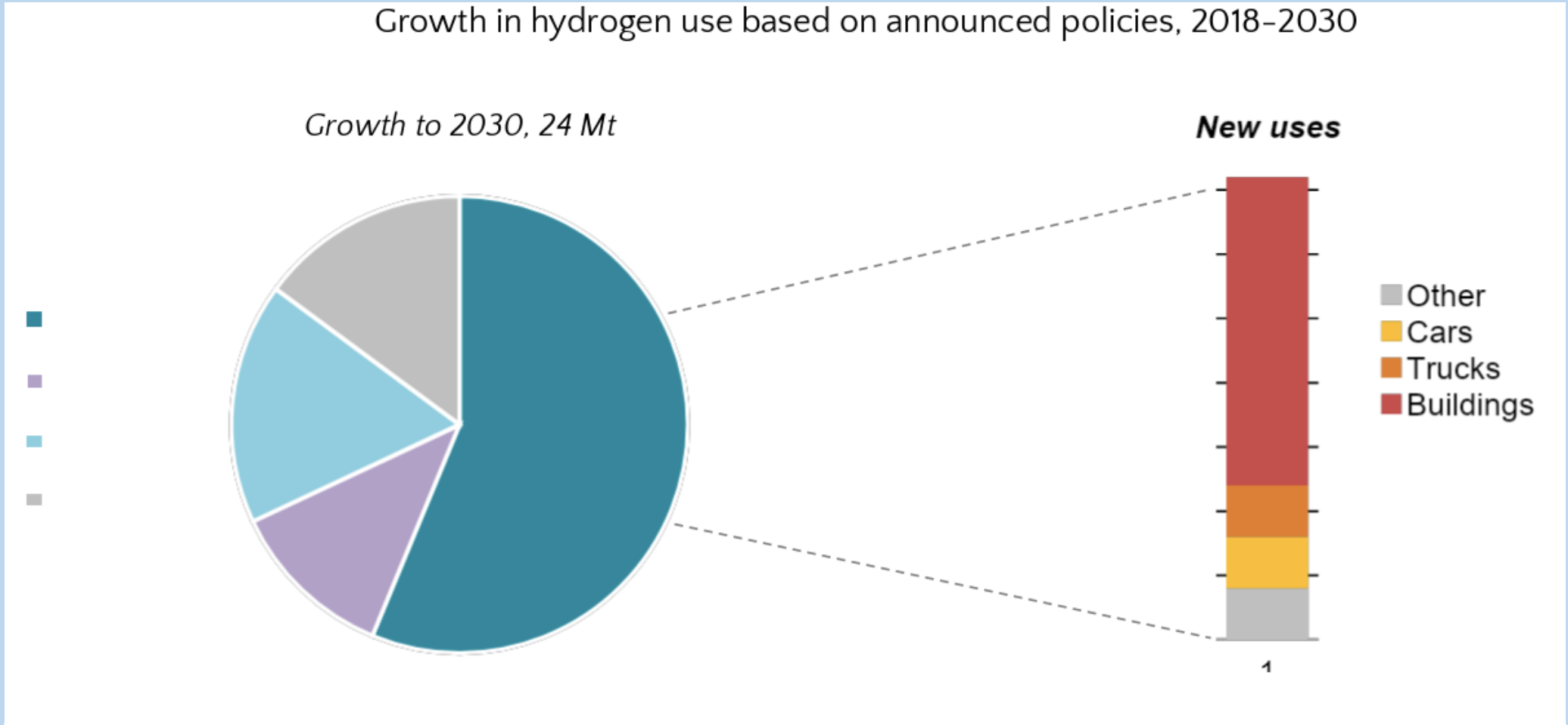
The Challenge to 2030: Expand Hydrogen Beyond Existing Applications



Dependable demand from current industrial applications can be used to boost clean hydrogen production; policies and industry targets suggest increasing use in other sectors, but ambition needs to increase.

Source: IEA

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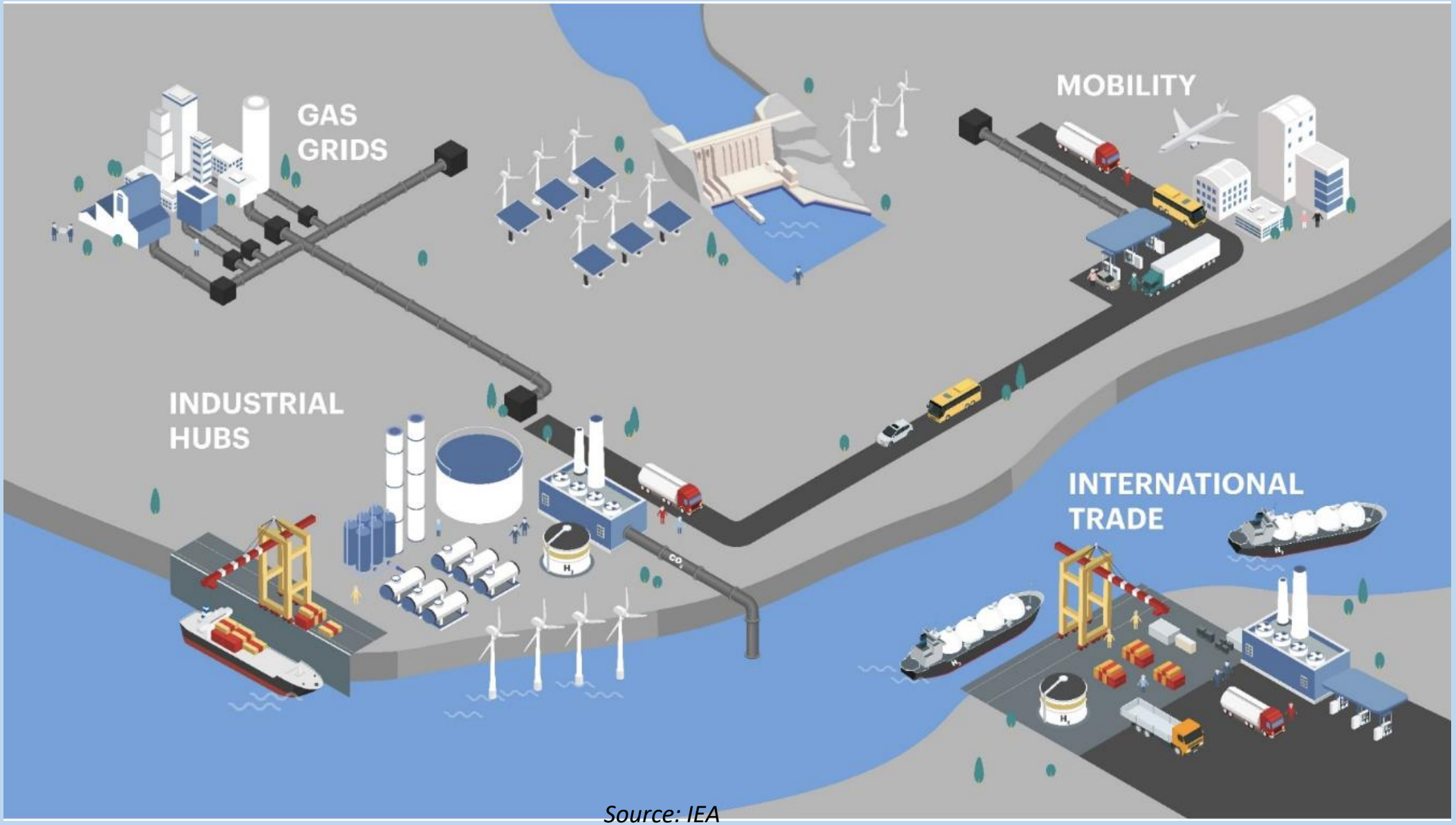
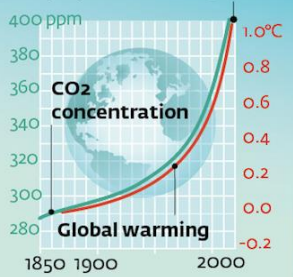
Four Key Opportunities for Scaling up Hydrogen to 2030



Source: IEA

Moving towards 2030 and 2050 with hydrogen

The earth has warmed up by 1.1°C since 1850



If we do nothing the global temperature will rise by another 4° C by 2100

22 April 2016
Paris Agreement
Global warming set at a max. 2° C. This requires **CO2-reductions** in the Netherlands of:
- **40-50%** by 2030
- **85-100%** by 2050

Hydrogen as a fuel and as a raw material can help to achieve CO2-reduction targets

Hydrogen pipeline
Linking hydrogen industries in Zeeland and the Delta region

Pilot project HyStock
Converting solar energy into hydrogen in Zuidwending

The energy transition requires new forms of infrastructure and intelligent use of existing networks. Gasunie wants to invest in new infrastructure for renewable gases such as hydrogen.

Hydrogen is a clean energy carrier: H_2 combustion yields only water vapour.

19 North Sea Wind Power Hub
An island where power from offshore wind farms is partially converted into hydrogen that is piped onshore

18 National hydrogen transport network
H2-pipeline network links major industrial areas Eemshaven, IJmuiden, Rotterdam, Chemelot, Zeeland and the Ruhr area

17 Further deployment H2 - and CO2 network Zeeland

3 Wind turbine generating hydrogen

4 ISPT Hydrohub 1 MW test centre

5 Hydrogen refuelling station network North of the Netherlands

6 20 H2 buses Province of Groningen

7 GZI Next Hydrogen plant including a hydrogen fuel station

8 20-40 MW Electrolyser Green power into H2. 100 MW in 2024

9 Element 1 Gasunie / TenneT / Thyssengas power-to-gas pilot

10 Green hydrogen value chain with Engie: towards a 100 MW electrolyser

11 Hydrogen storage in salt caverns

12 Magnum power station First turbine on hydrogen (± 700,000 households)

13 100 MW Electrolyser

14 IJmuiden Ver Wind farm, possible onshore electrolysis

15 h-vision Large-scale switch to hydrogen for power stations and chemical processes. Capture and storage of CO2

16 Magnum power station All three turbines on hydrogen: > 2 million homes supplied with power

gasunie

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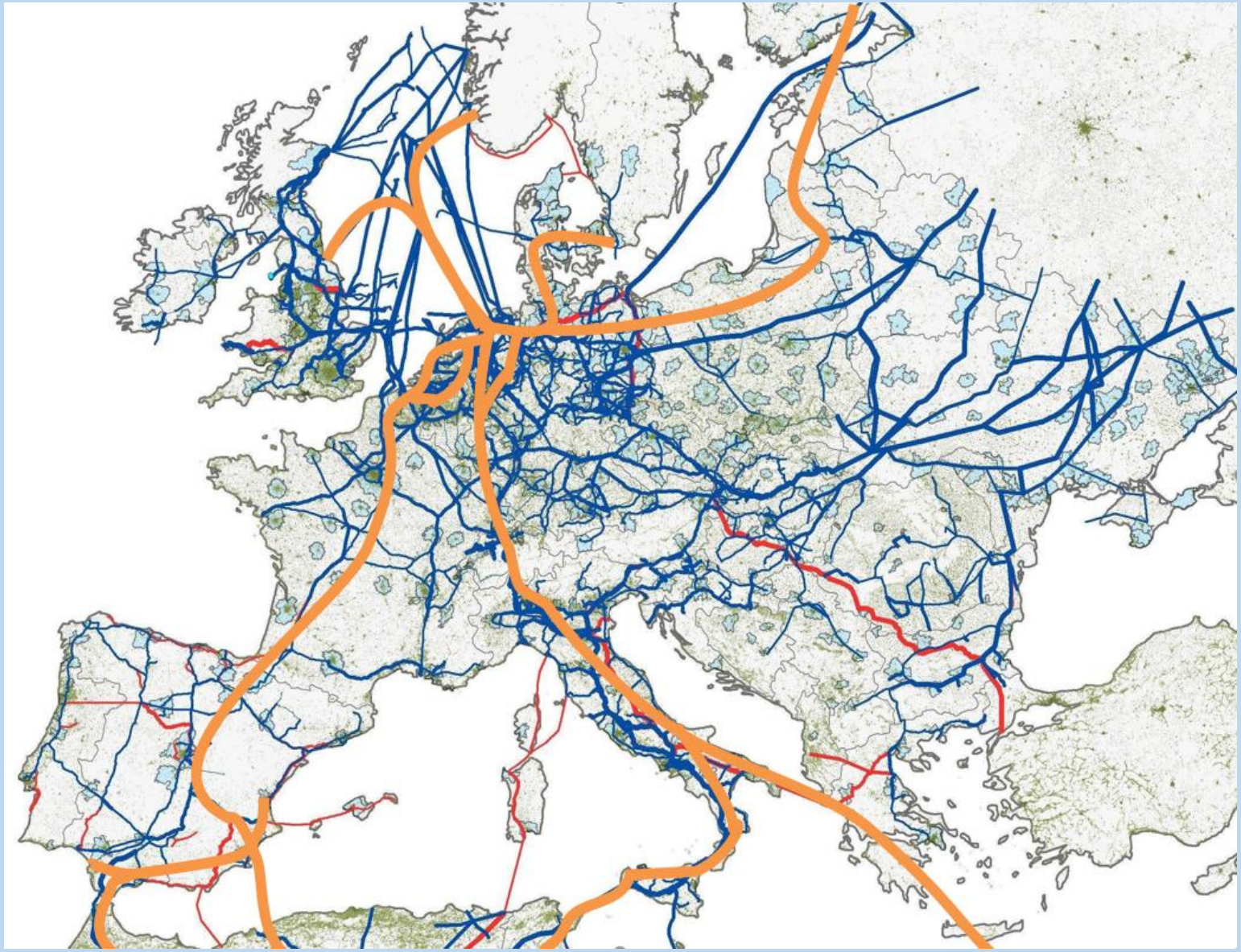
European Hydrogen Backbone



TU Delft Delft University of Technology

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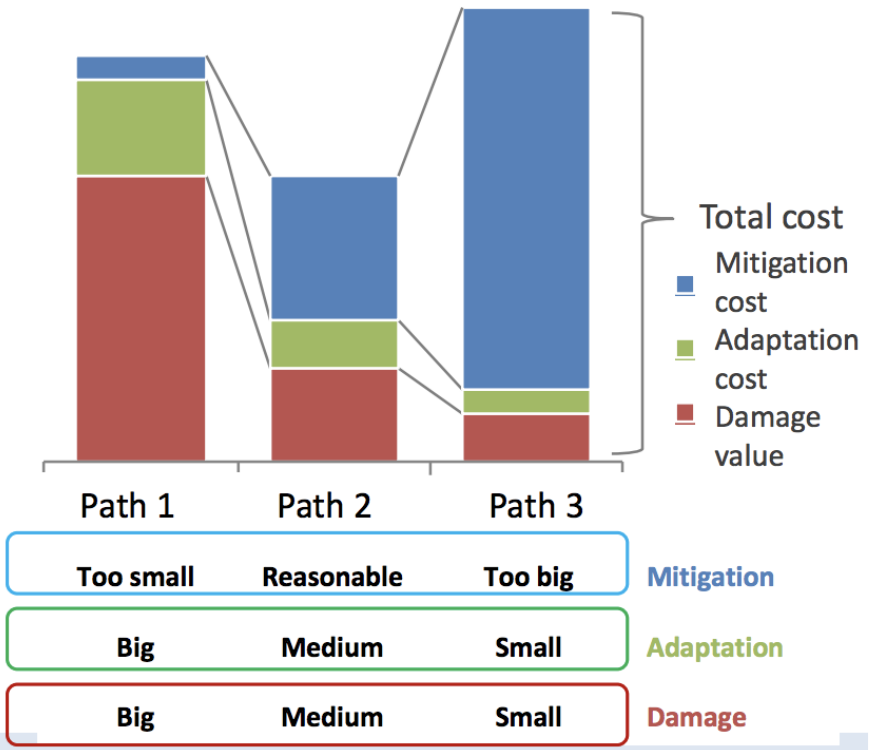
Rule for ultra long-term: Reduce the total cost

❖ Mitigation + Adaptation + Damage = Total cost

Mitigation	Typical measures are GHG emissions reduction via energy efficiency and non-fossil energy use. Includes reduction of GHG release to the atmosphere via CCS These measures **mitigate** climate change.
Adaptation	Temperature rise may cause sea-level rise, agricultural crop drought, disease pandemic, etc. **Adaptation** includes counter measures such as building banks/reservoir, agricultural research and disease preventive actions.
Damage	If mitigation and adaptation cannot reduce the climate change effects enough to stop sea-level rise, draught and pandemics, **damage** will take place.

❖ Illustration of total cost for each path



Without measures against climate change, the mitigation cost is small, while the adaptation and damage costs become substantial. Aggressive mitigation measures on the other hand, would reduce the adaptation and damage costs but the mitigation costs would be notably colossal.

The climate change issue is a long-term challenge influencing vast activities over many generations. As such, and from a sustainability point of view, the combination (or the mix) of different approaches to reduce the total cost of mitigation, adaptation and damage is important.

Source: "IEEJ Outlook 2019" (IEEJ, October 2018)