Clean Coal in a post-COP21 era

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Key points of orientation

- The energy sector is key to sustainable economic growth
  - Largest source of GHG emissions today, around two-thirds of global total
  - Largest source of air pollution, linked to 6.5 million premature deaths per year
  - Billions remain without basic energy services
- The global energy transition gained momentum in 2016
  - Global energy intensity fell by 2.1% in 2016; fossil-fuel subsidy reform efforts are spreading
  - Renewables supplied half of global electricity demand growth in 2016, and nuclear net capacity reached highest level since 1993
  - After a decade of growth, global coal use halted in 2014 and declined in 2015
- There is no single story about the future of global energy
  - Fast-paced technological progress and changing energy business models

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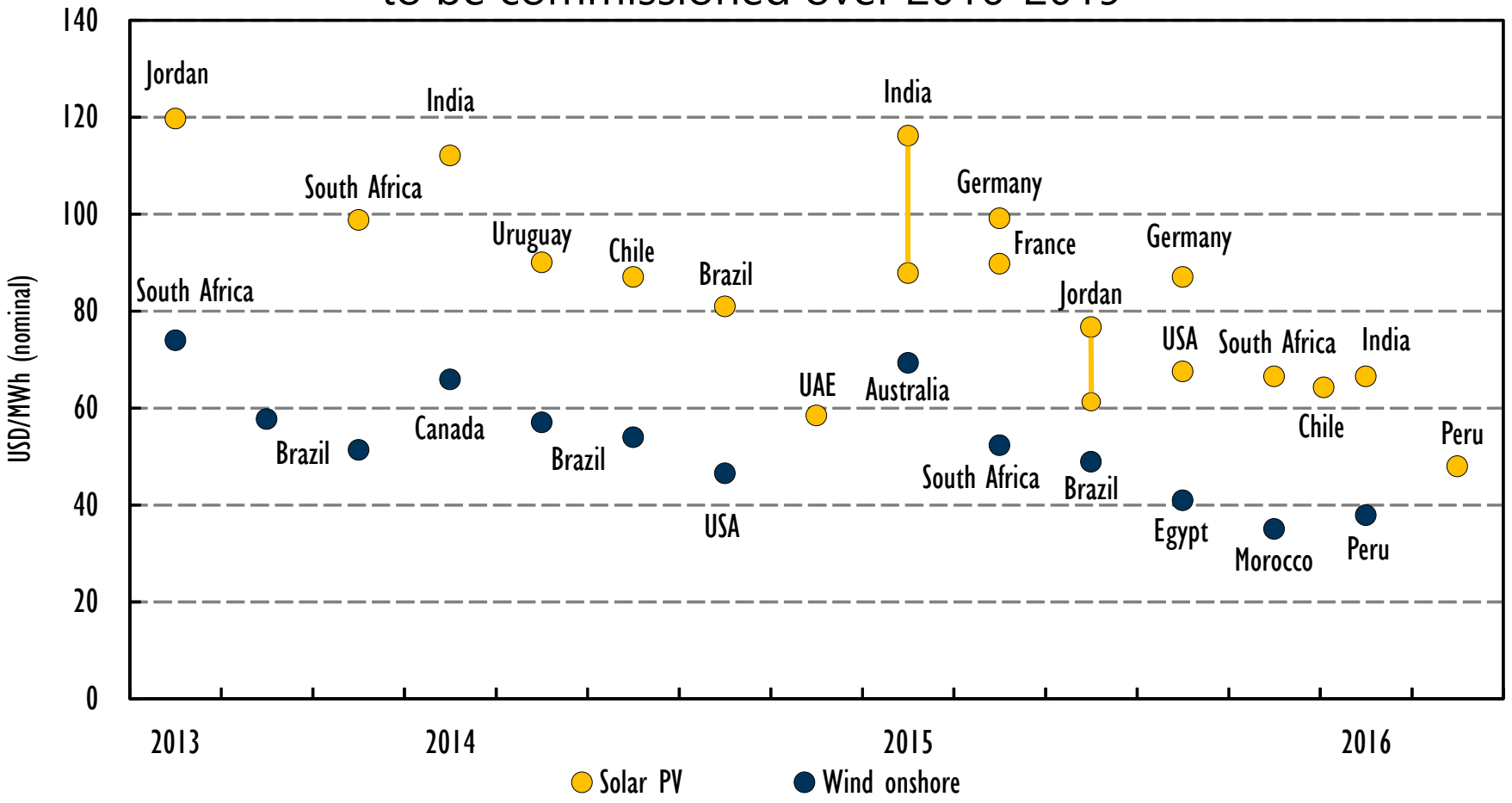
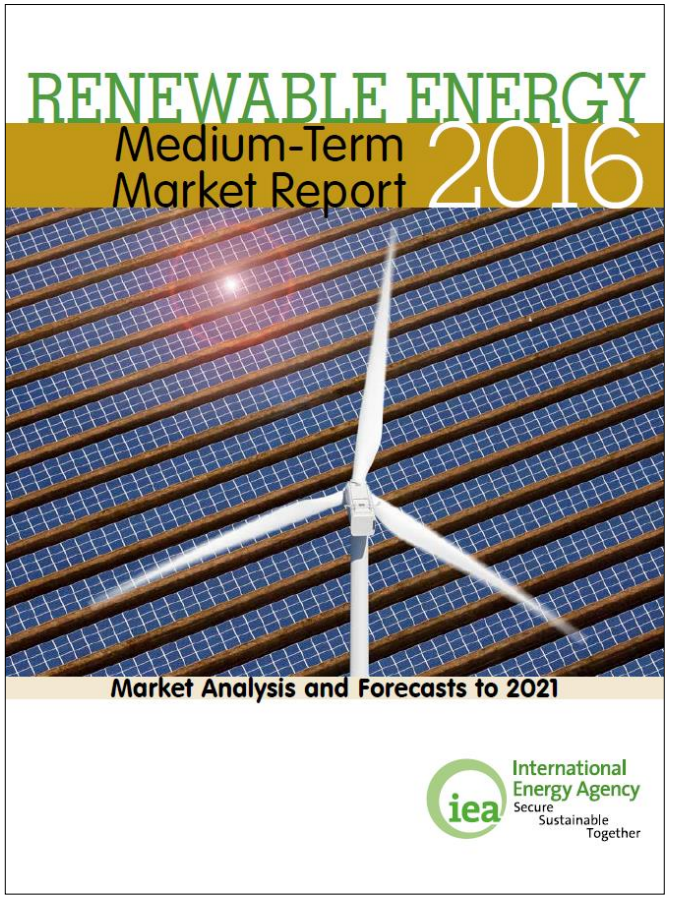
Wind and PV downward price trends continuing rapidly

Recent announced long-term contract prices for new renewable power to be commissioned over 2016-2019





Best results occur where price competition, long-term contracts and good resource availability are combined

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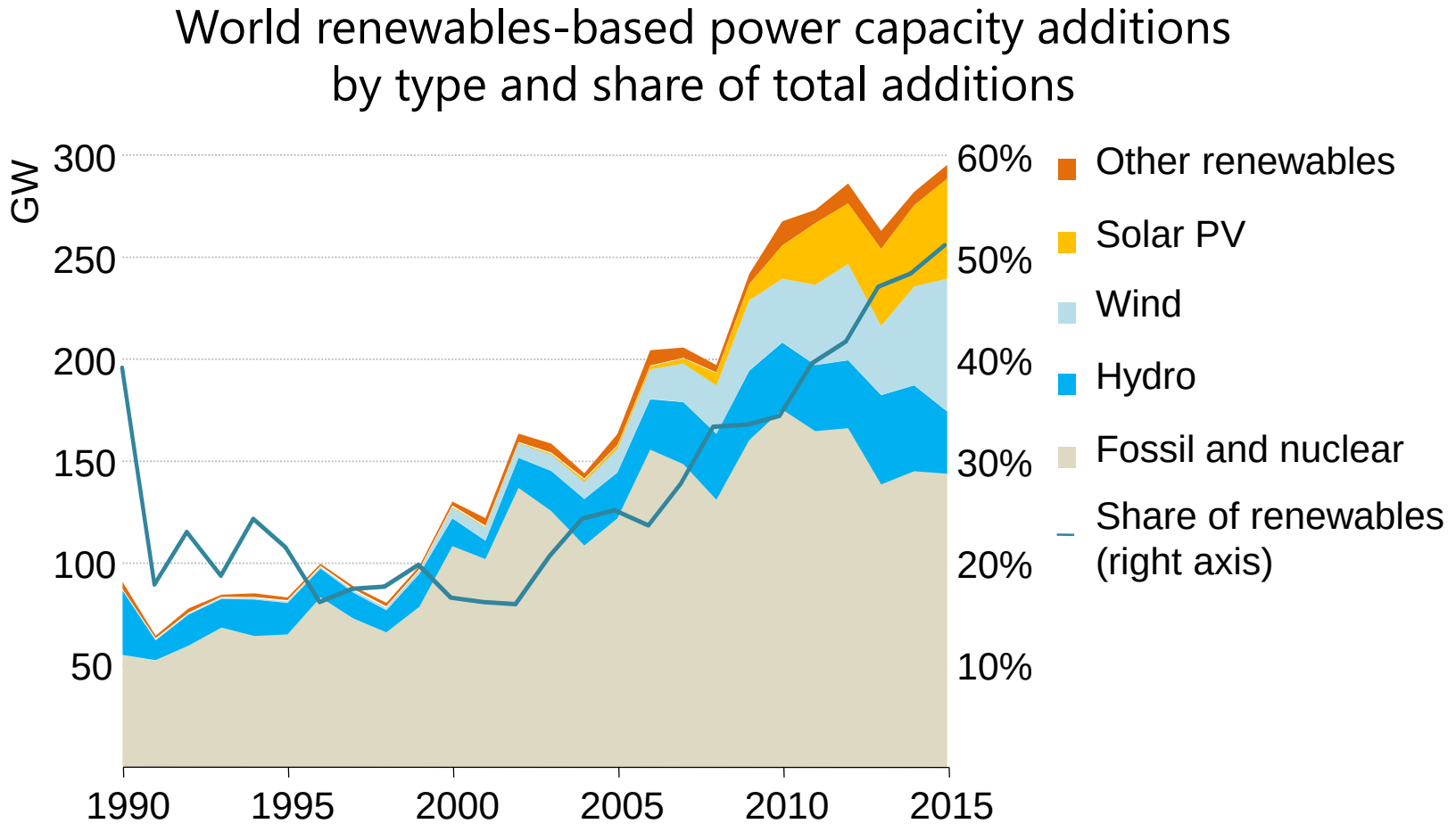
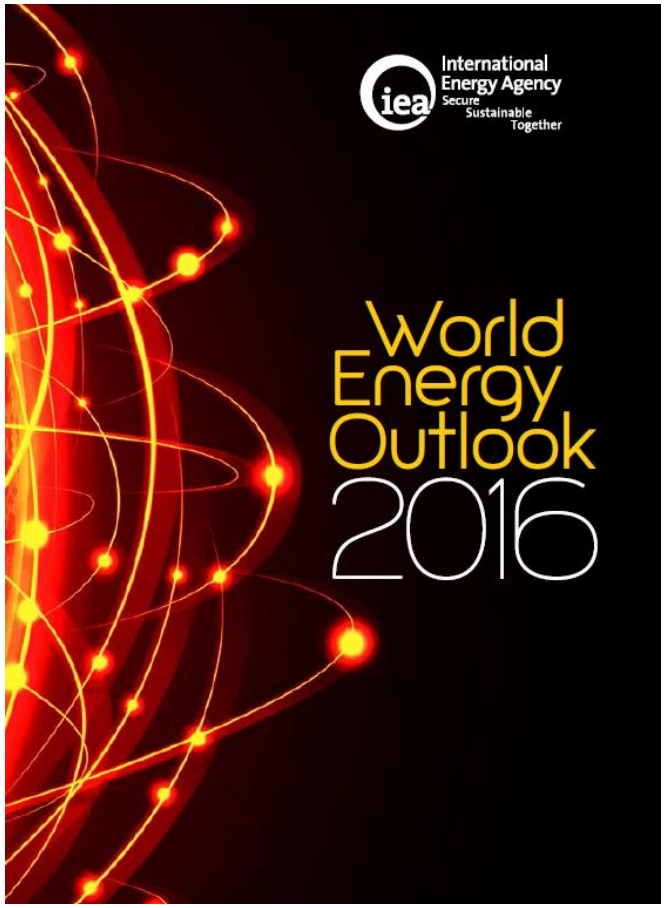
Low-carbon sources are powering up





Renewables-based power capacity additions set a new record in 2015 and exceeded those of all other fuels for the first time

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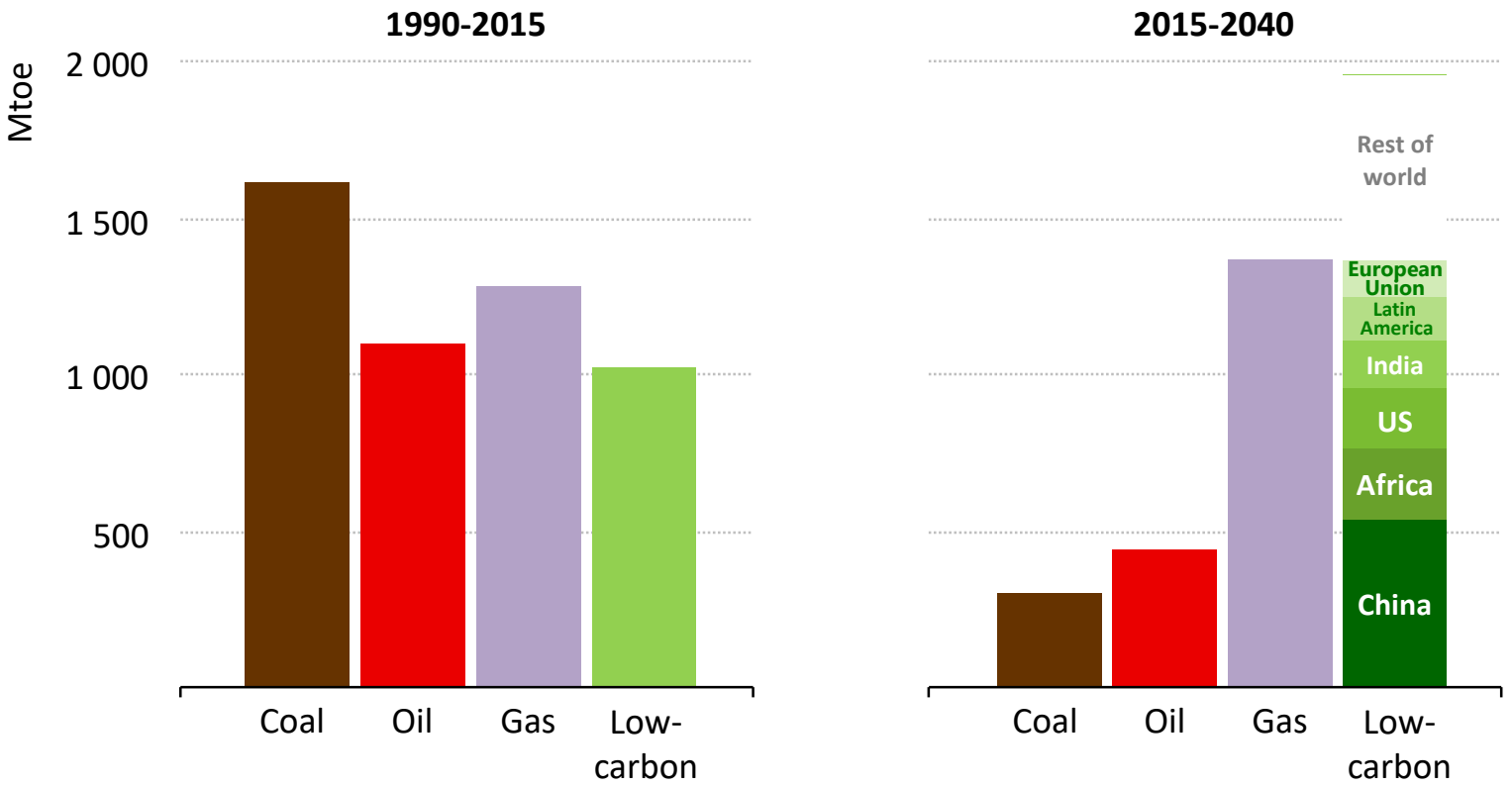
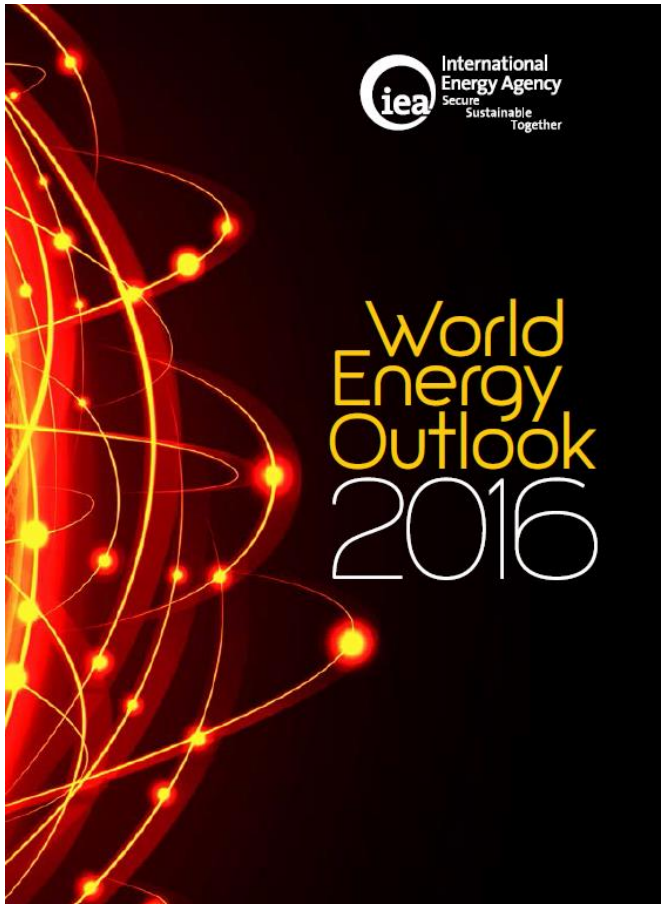
A new ‘fuel’ in pole position

Change in total primary energy demand





Low-carbon fuels & technologies, mostly renewables, supply nearly half of the increase in energy demand to 2040

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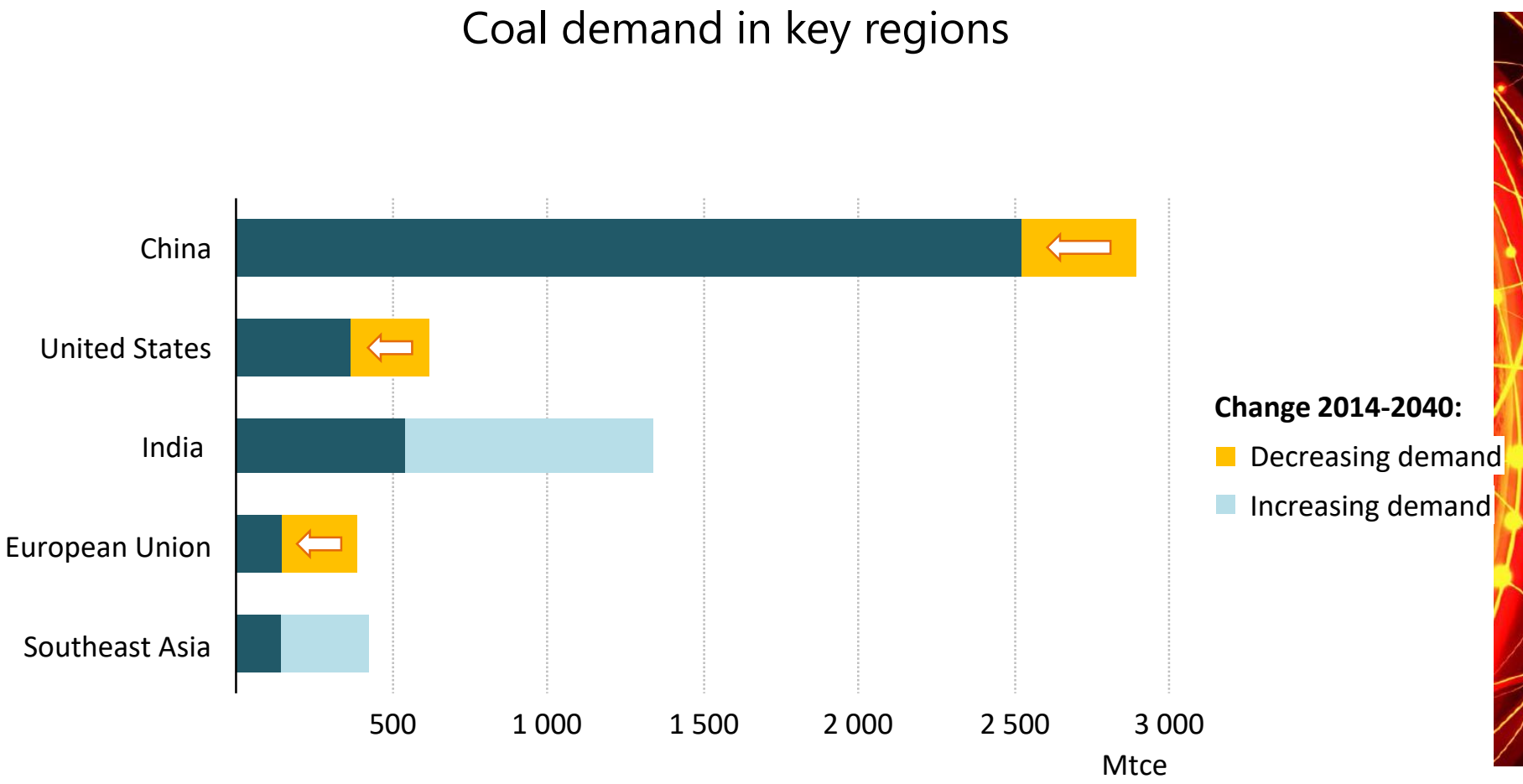
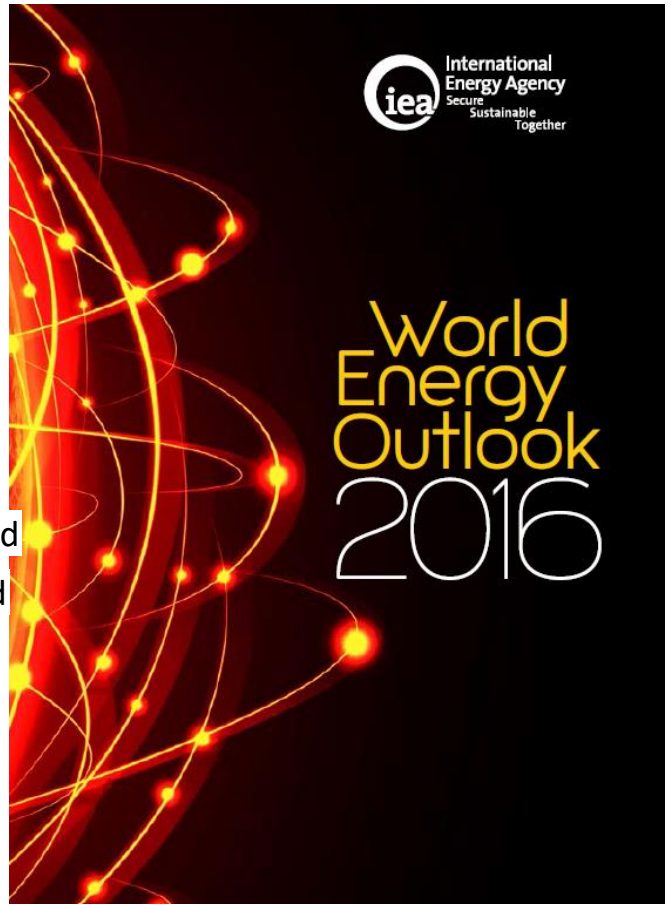
Coal: a rock in a hard place





The peak in Chinese demand is an inflexion point for coal; held back by concerns over air pollution & carbon emissions, global coal use is overtaken by gas in the 2030s

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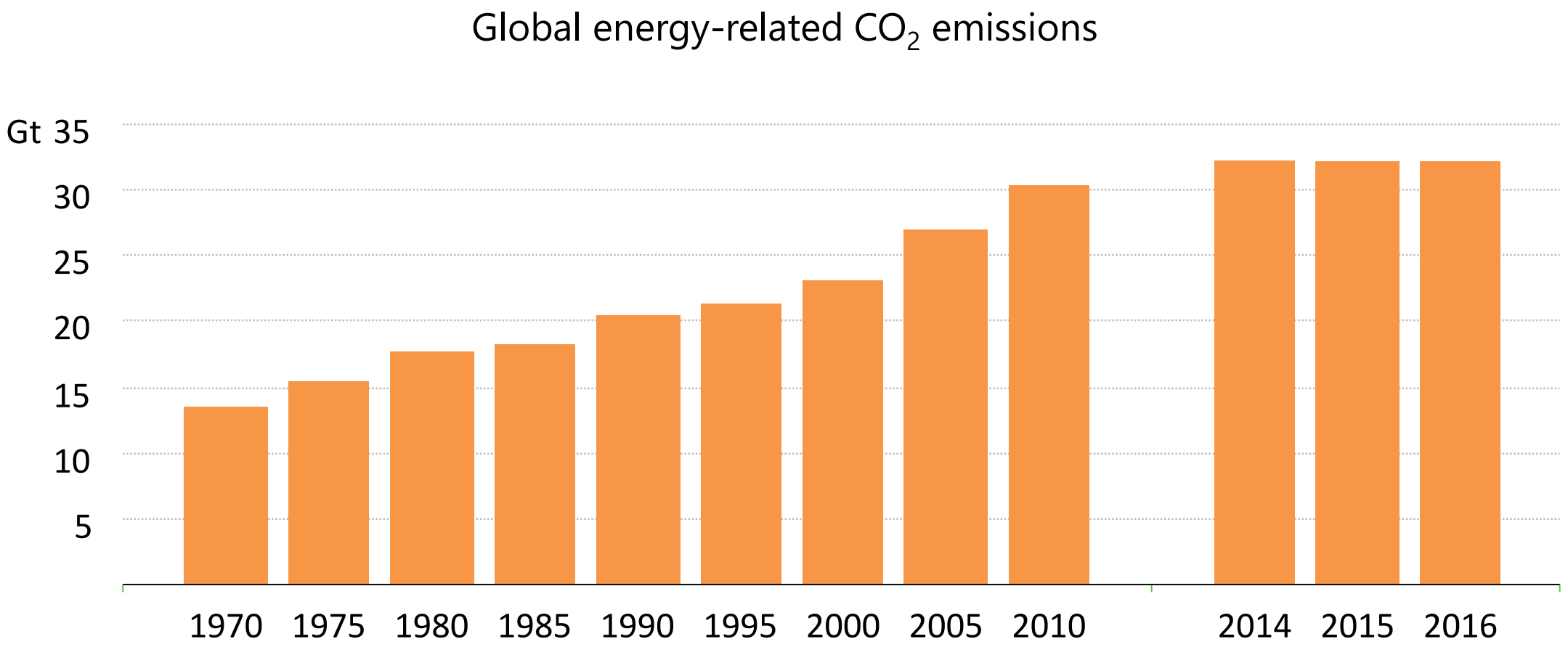
Global CO_2 emissions flat for 3 years – an emerging trend?



IEA analysis for 2016 shows that global CO_2 emissions did not increase for the third consecutive year in a row, even though the global economy grew.

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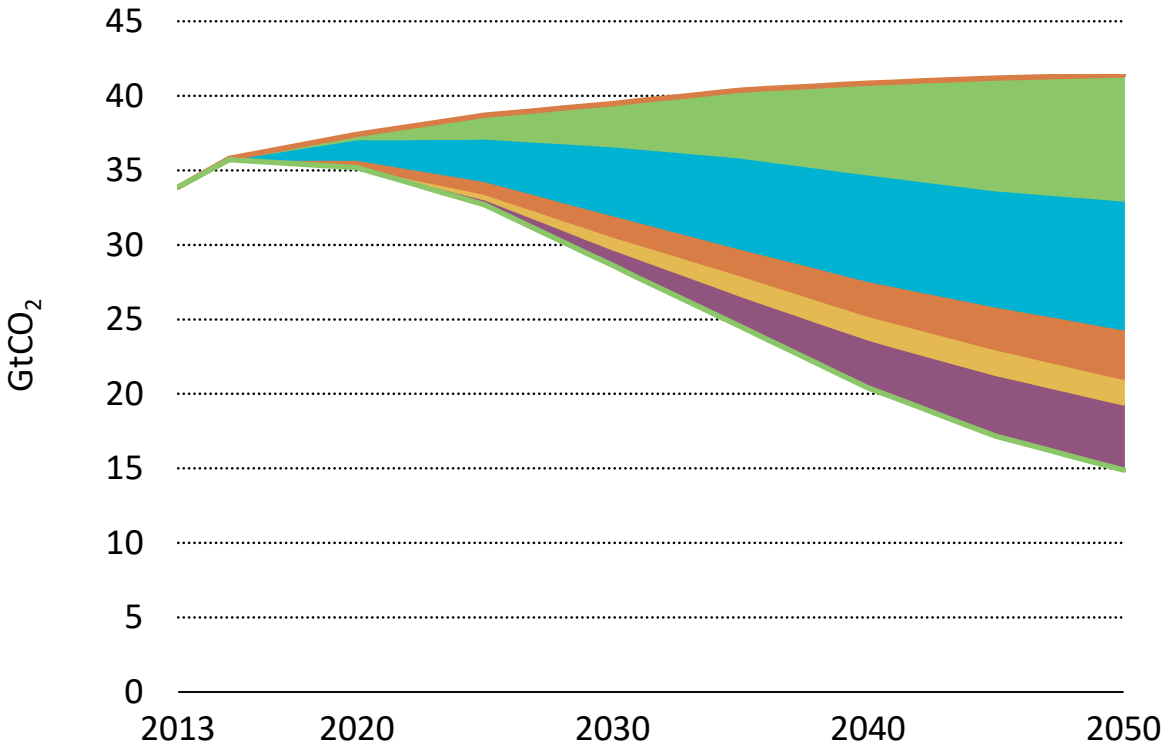
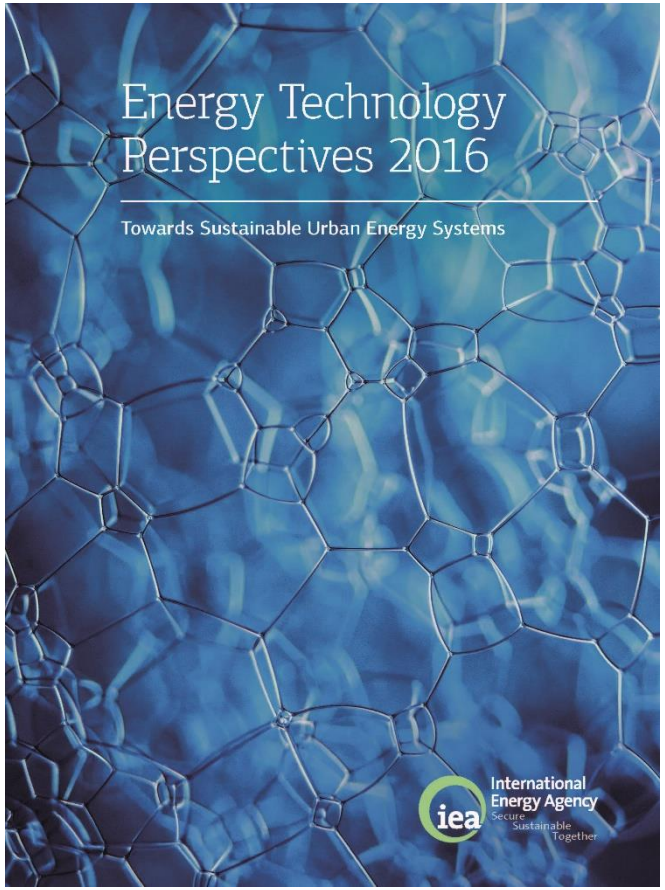
Energy Innovation can expand current momentum

Technology contribution to global cumulative CO_2 reductions





The carbon intensity of the global economy can be cut by two-thirds through a diversified energy technology mix

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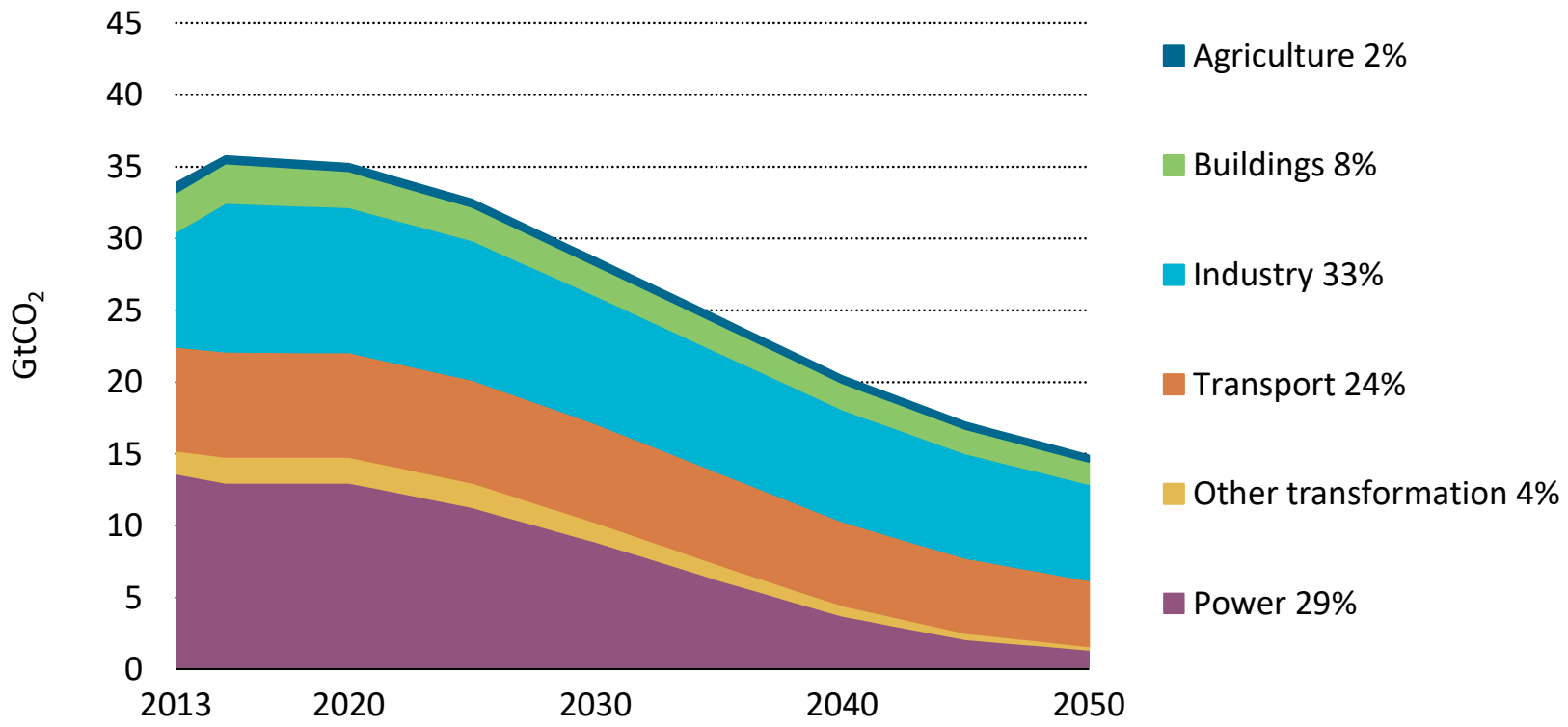
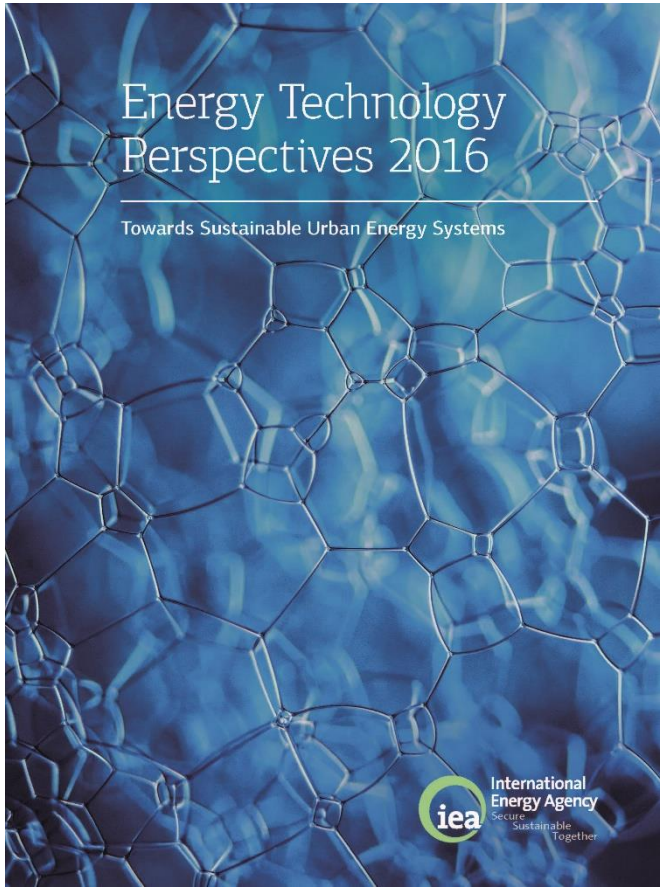
But the challenge increases to get from 2 degrees to "well below"

Energy- and process-related CO_2 emissions by sector in the 2DS





Industry and transport account for 57% of the cumulative remaining emissions in the 2DS to 2050.

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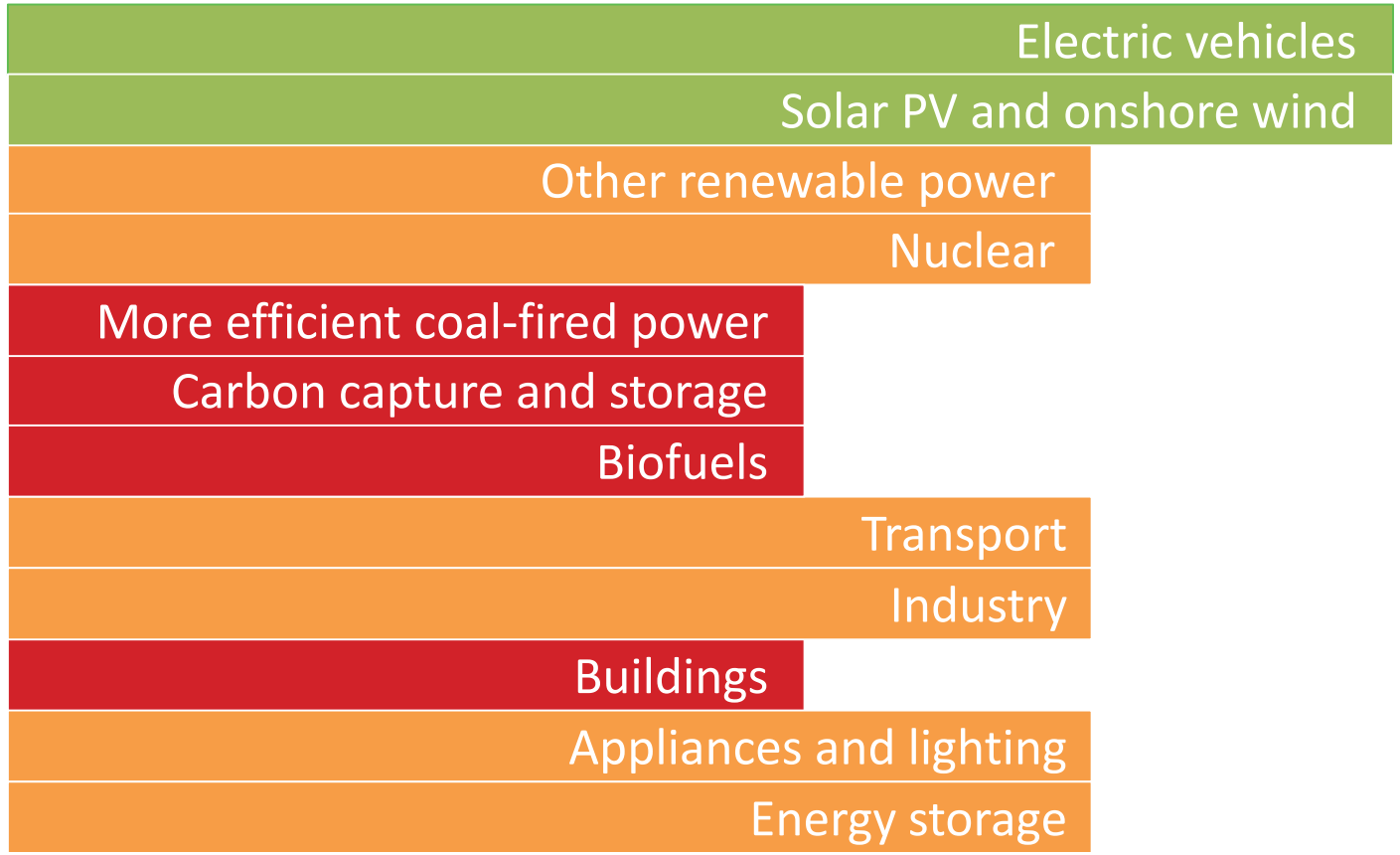
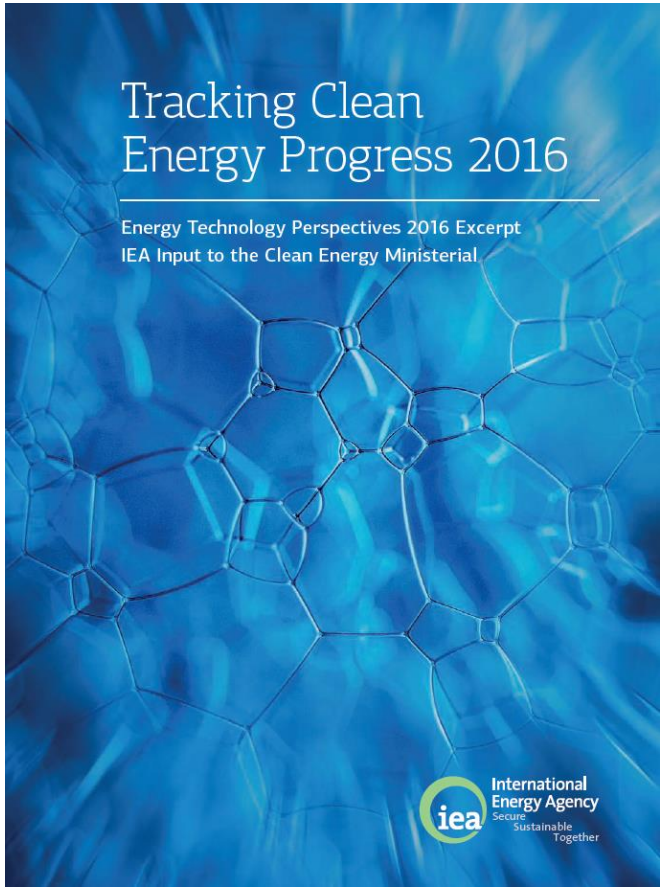
Progress in clean energy needs to accelerate

Technology Status today against 2DS targets





Clean energy deployment is still overall behind what is required to meet the 2°C goal, but recent progress on electric vehicles, solar PV and wind is promising

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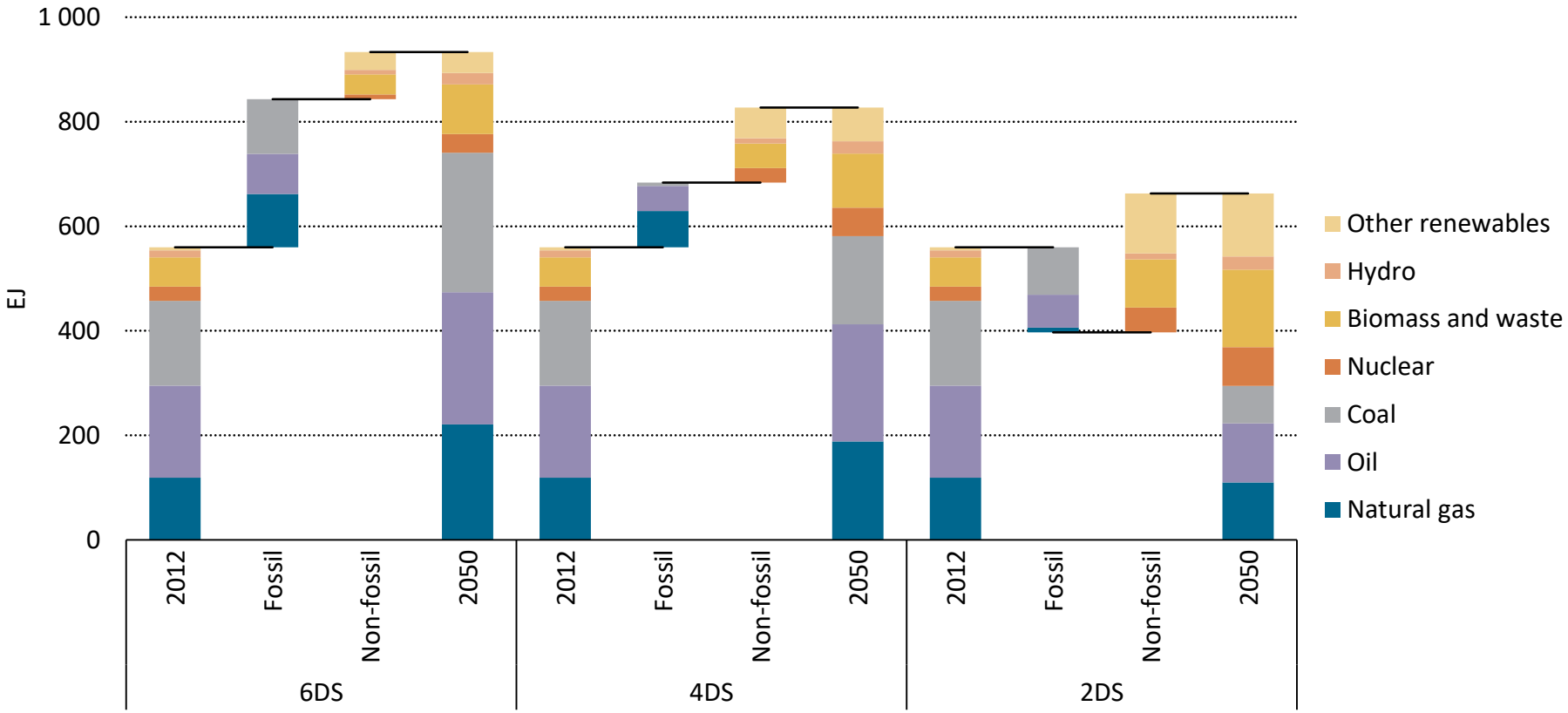
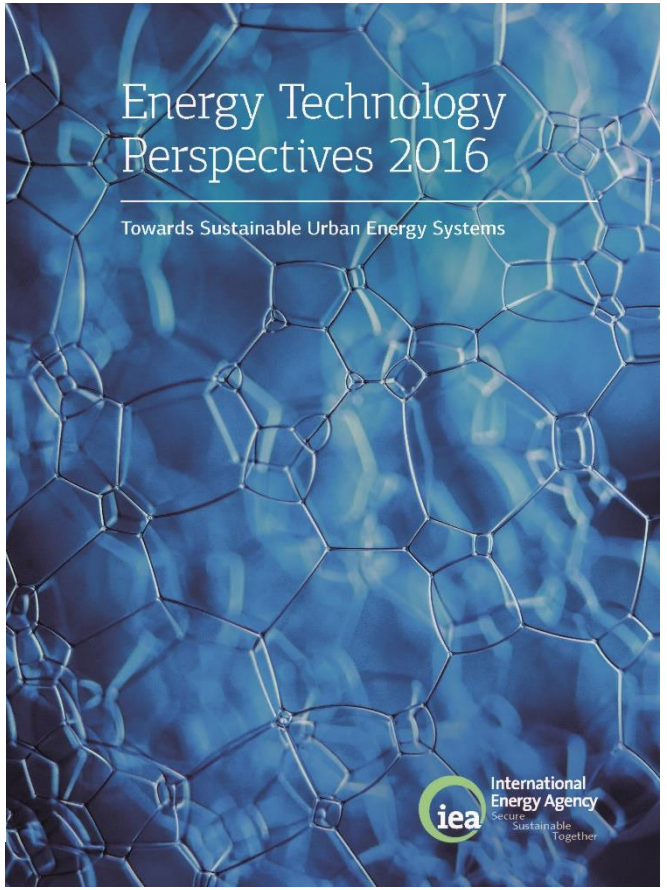
Innovation can support a multitude of sustainable energy solutions

Primary energy mix in the ETP scenarios





Fossil fuels remain an important part of global energy supply in the 2DS with a 45% share in 2050

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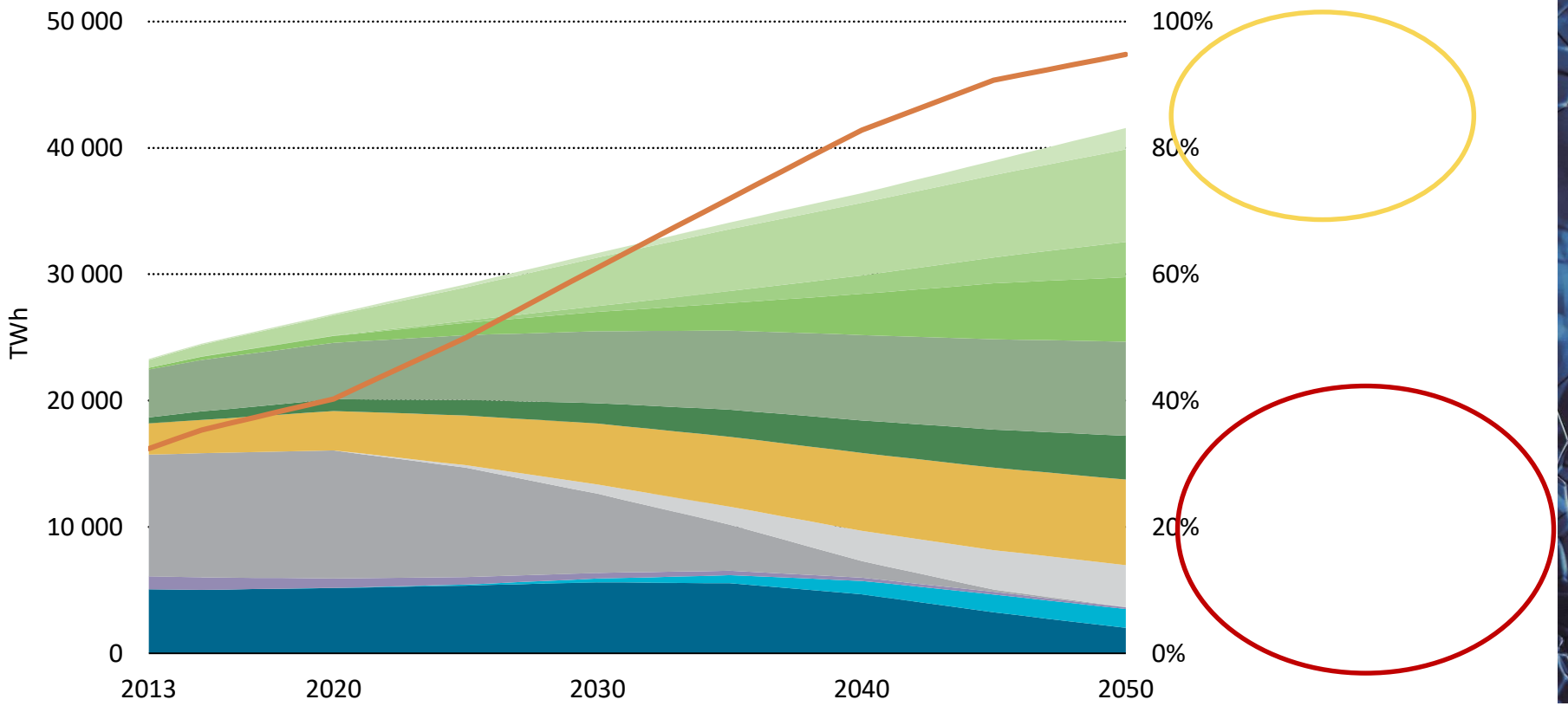
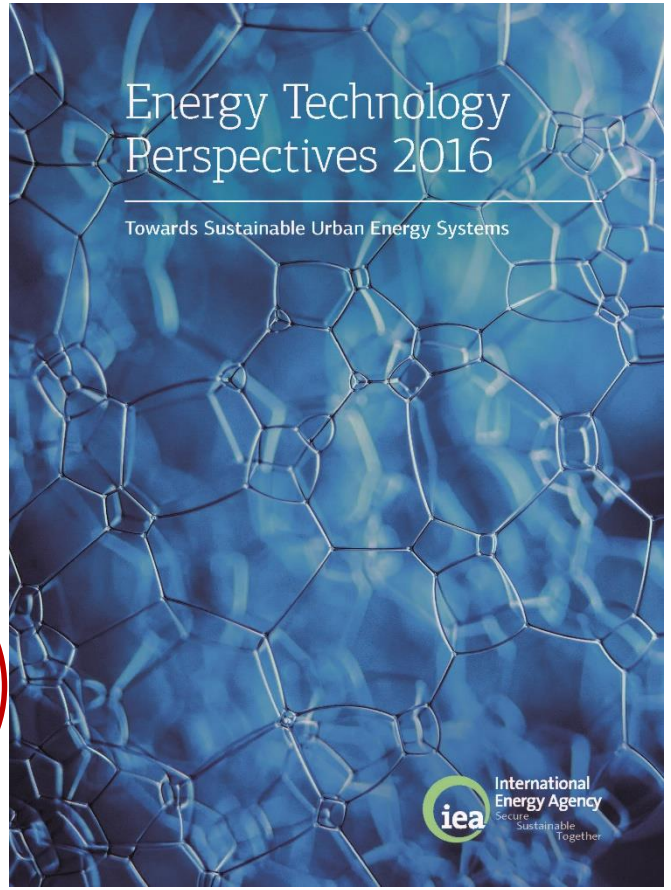
Re-thinking electricity supply

Global electricity generation capacity by technology, and share of low-carbon generation





Generation today:
- Fossil fuels: 68%
- Renewables: 22%

Generation 2DS 2050
- Renewables: 67%
- Fossil fuels: 17%

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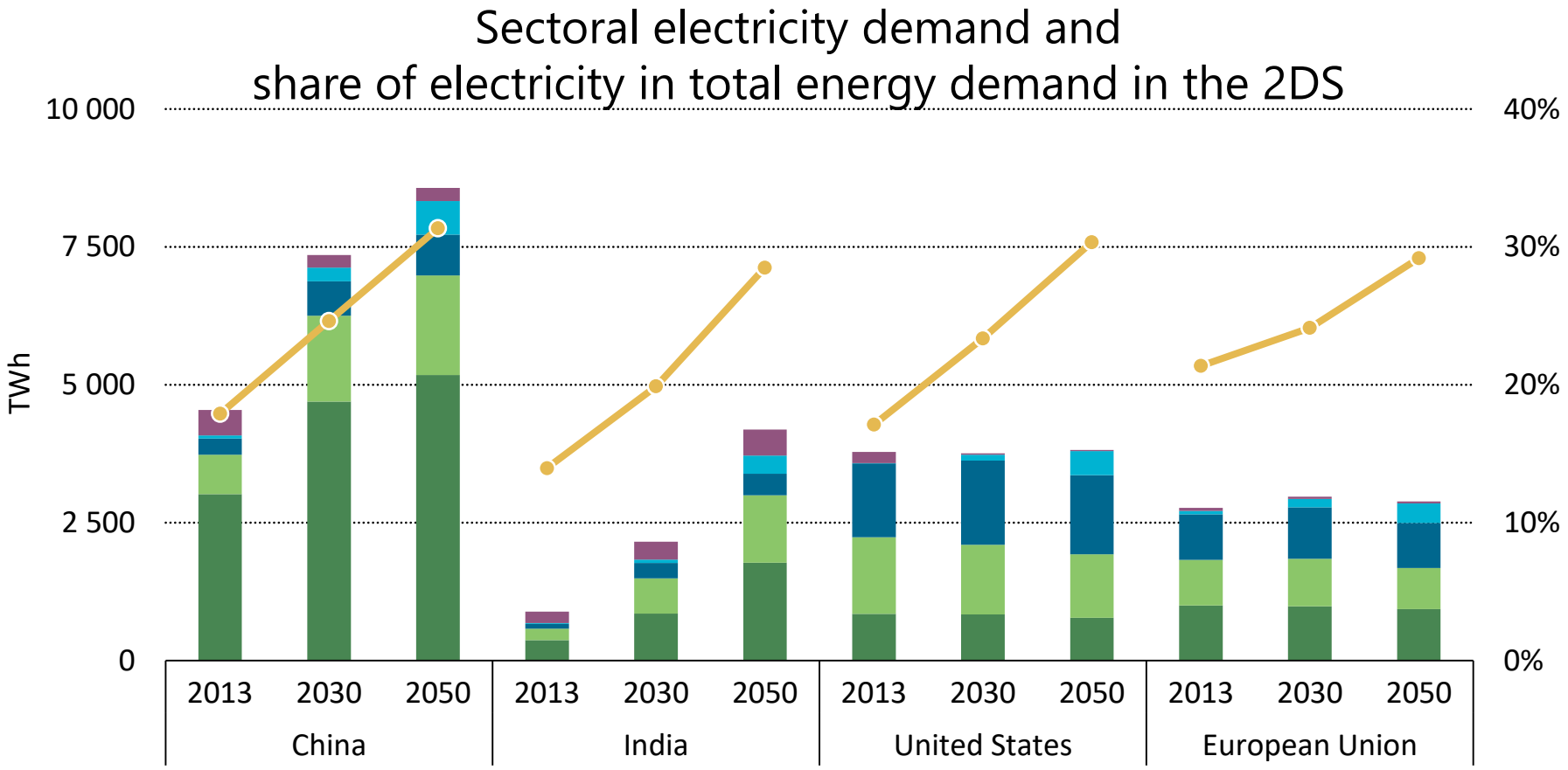
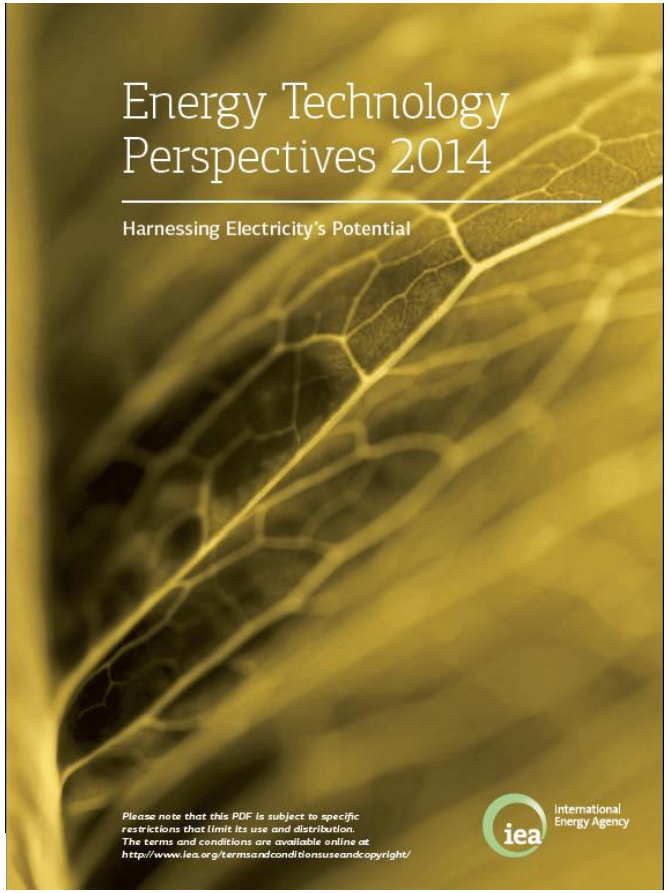
The regional context matters





Differences in growth of *electricity* demand and sectoral distribution require targeted systems development plans. All regions show high growth in VRE deployment

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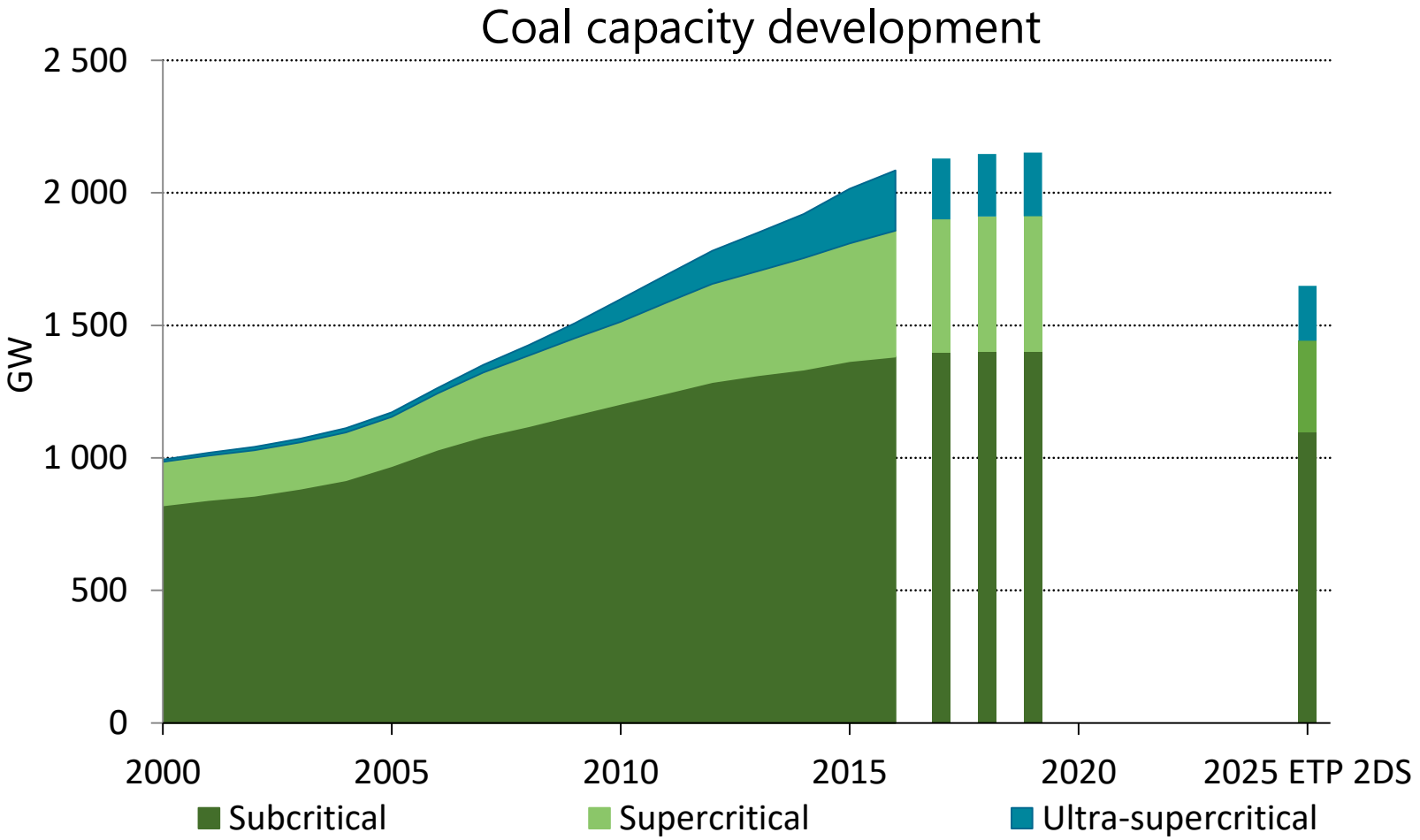
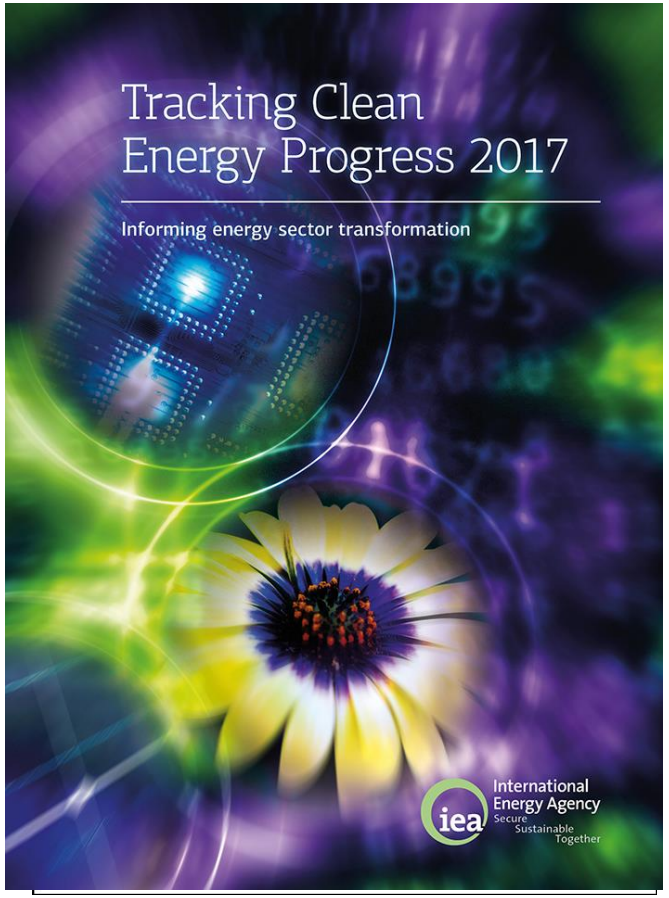
Coal trends are slowing, but need to be reversed





The past trends of increased subcritical technology deployment seem to be slowing, but new additions need to stop to be in line with 2DS objectives

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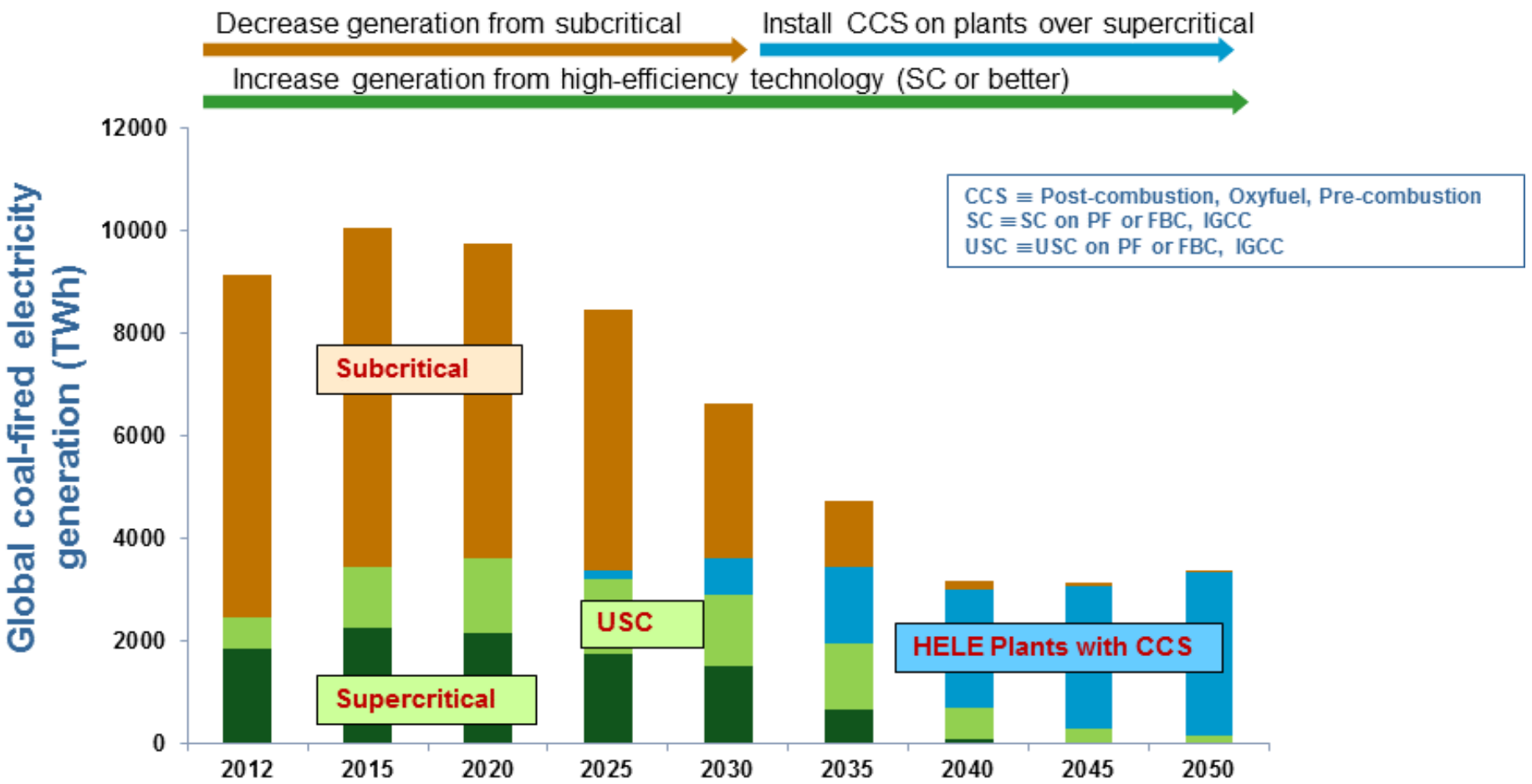
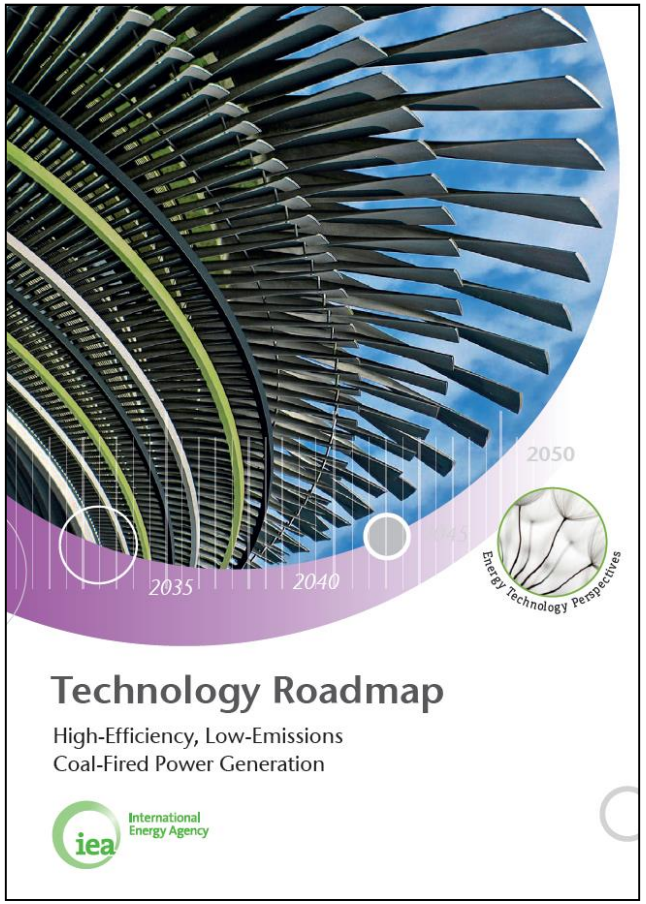
Coal: to avoid carbon lock-in, Improve efficiency, then deploy CCS





To meet the 2DS, generation from subcritical plants need to cease before their technical lifetimes end

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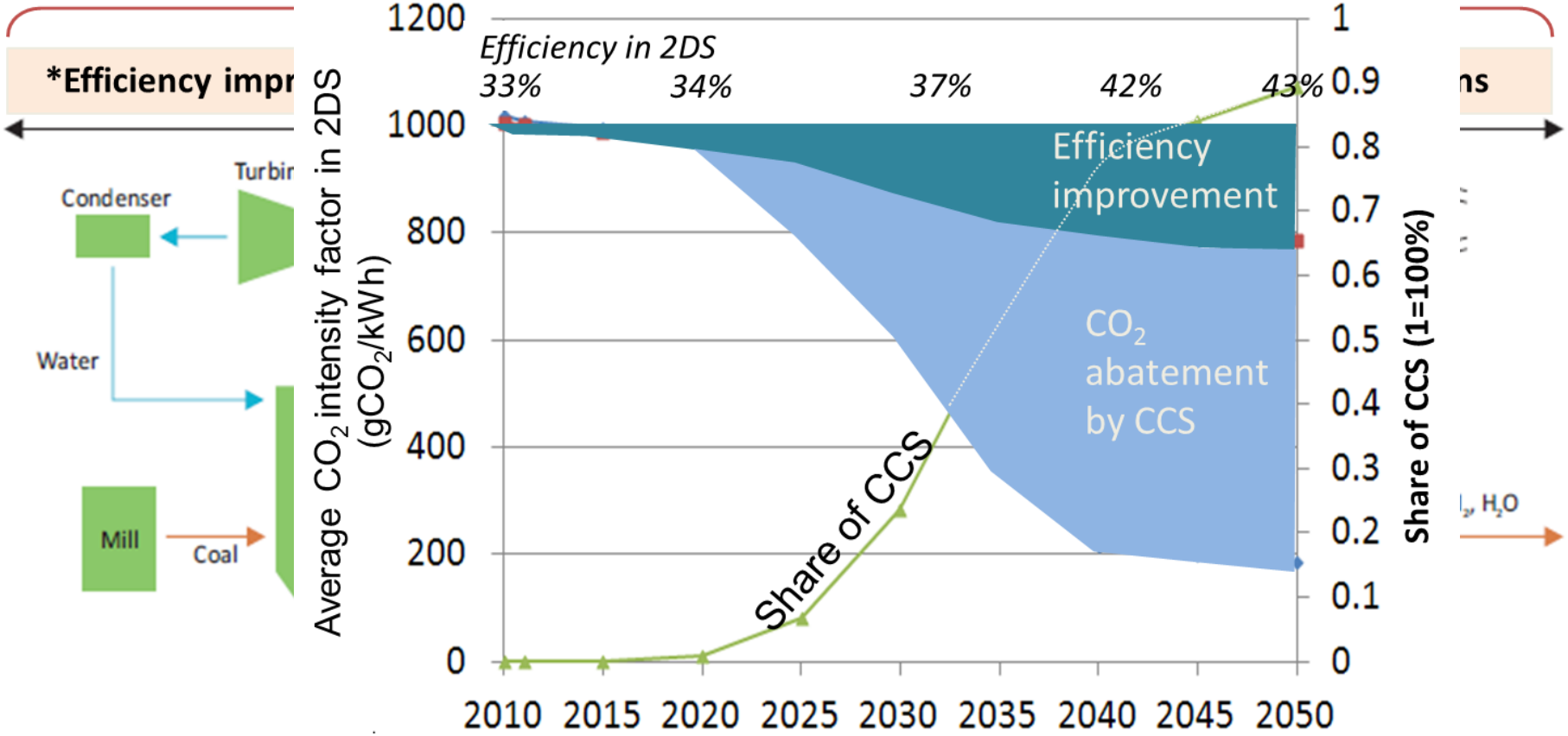
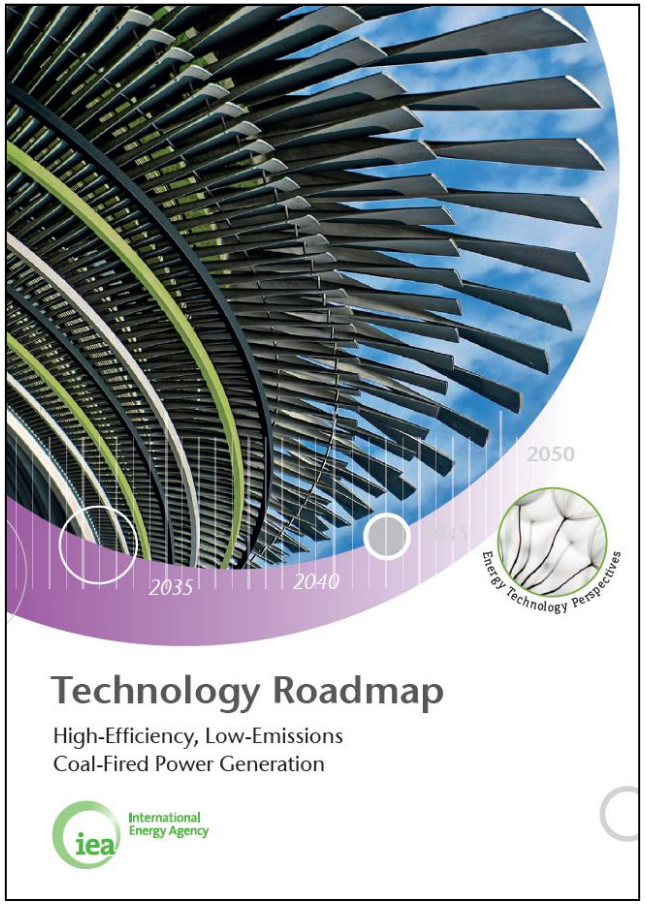
Power generation efficiency: Reducing the cost of CO_2 abatement





Raising efficiency significantly reduces the CO_2/kWh emitted

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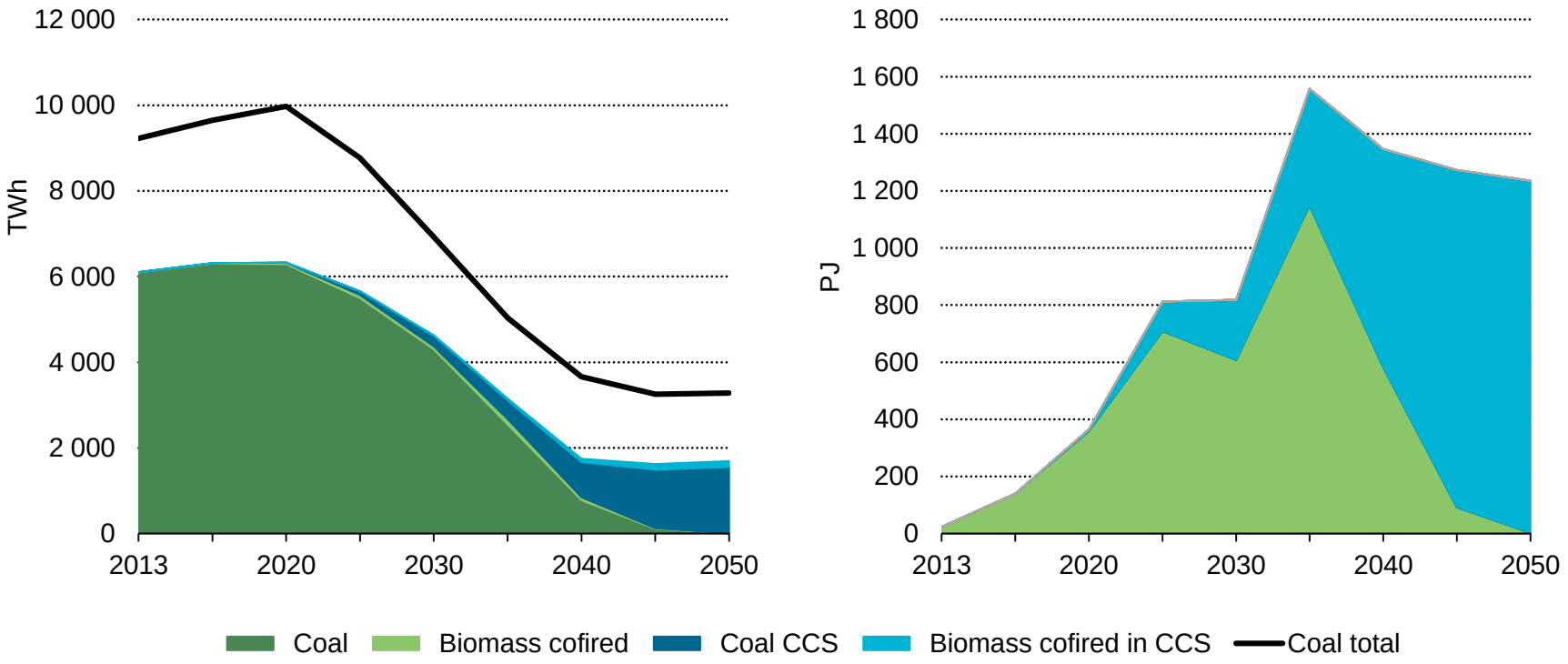
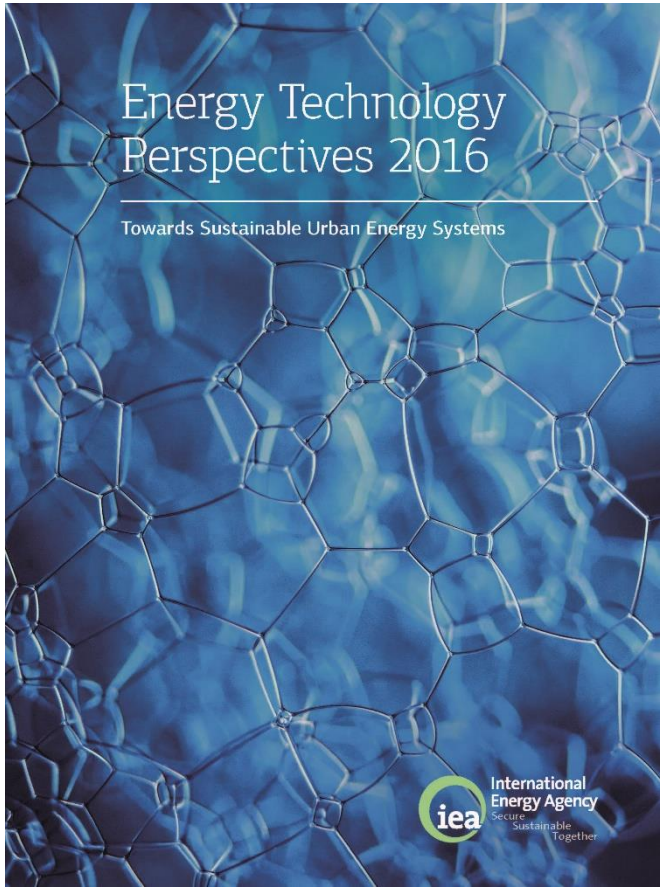
Increasing use of biomass co-firing to offset remaining emissions





Biomass co-firing and CCS play crucial role in reducing carbon intensity of the coal fleet in the 2DS.

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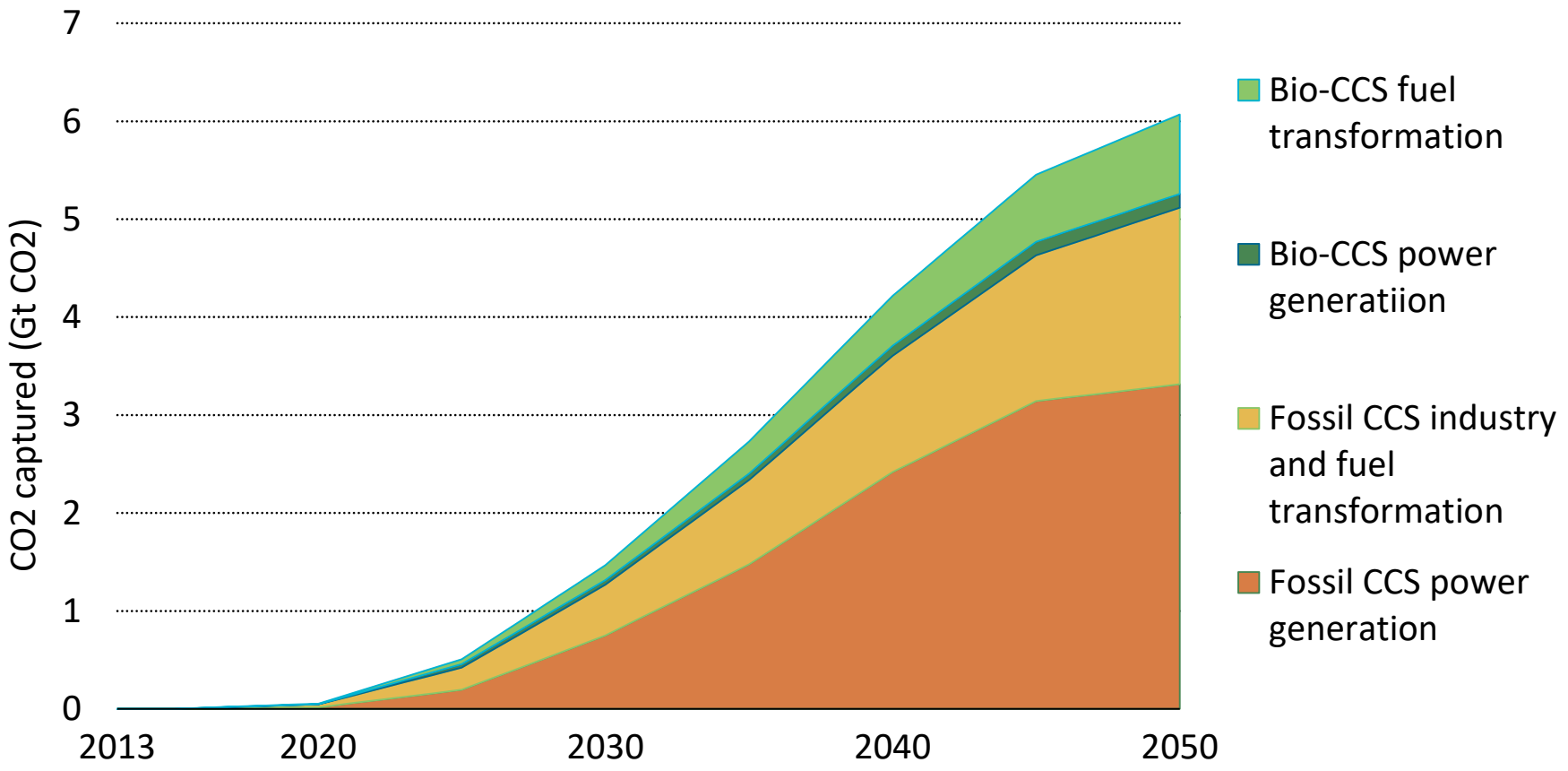
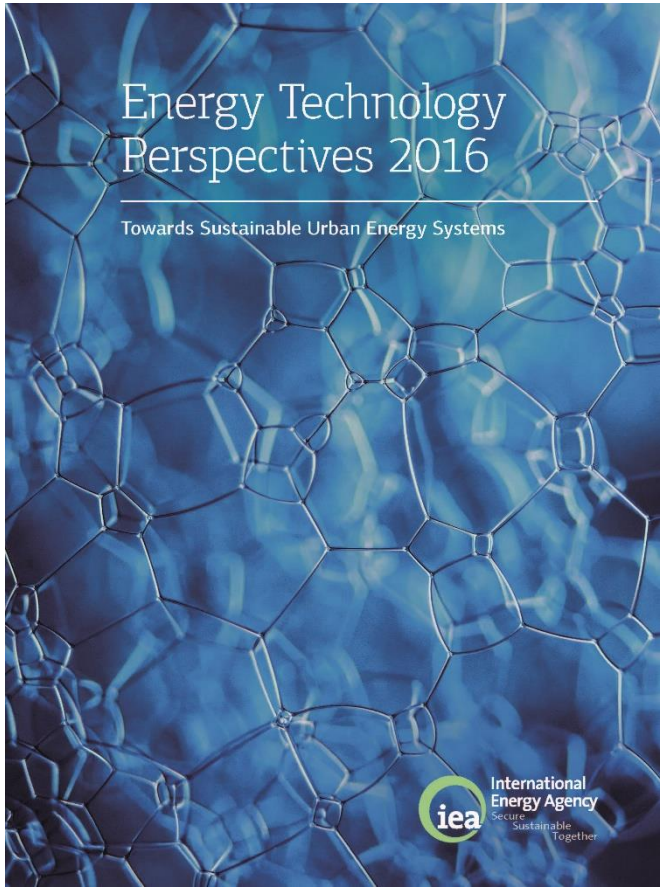
Role of biomass with CCS in the 2DS





Almost 1.1 Gt of CO2 captured in 2050 is linked to biomass with CCS, corresponding to 16% of total CO2 captured globally, around 0.7 Gt of total capture from coal plants with cofiring.

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Role of CCS in the 2DS

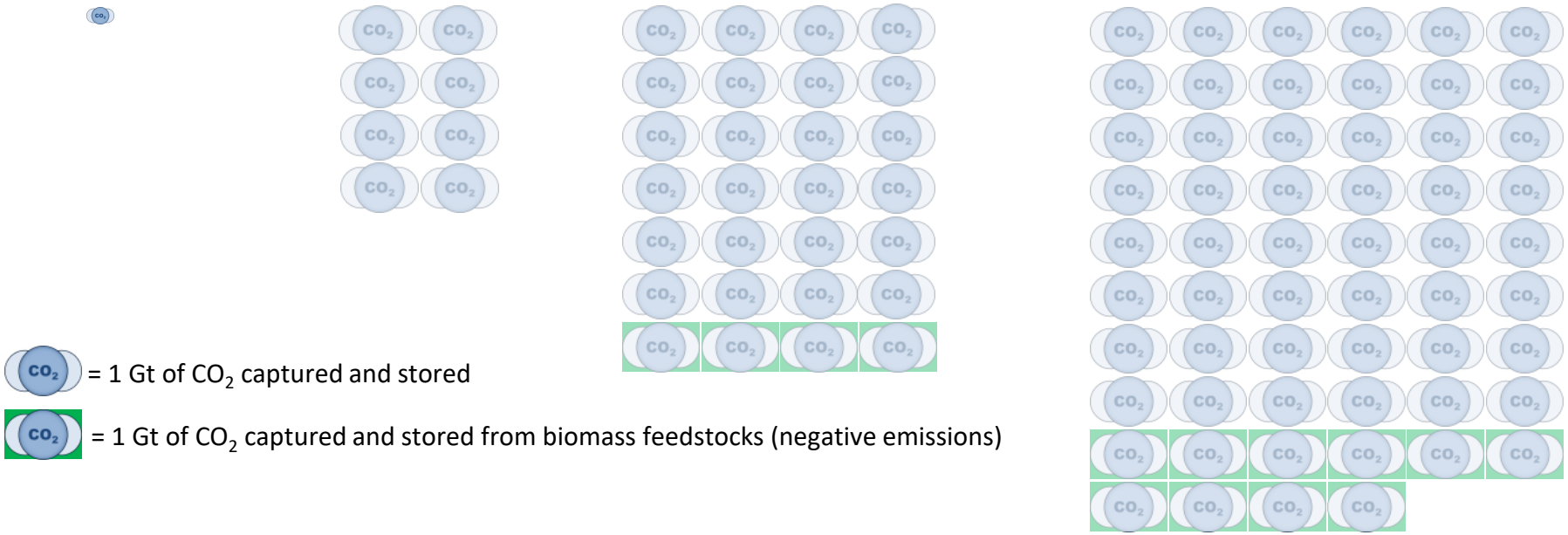
- A total of 94Gt captured and stored through 2050 in IEA 2DS

1996-2016:
0.04 Gt
Verified stored

2017-2030:
8 Gt

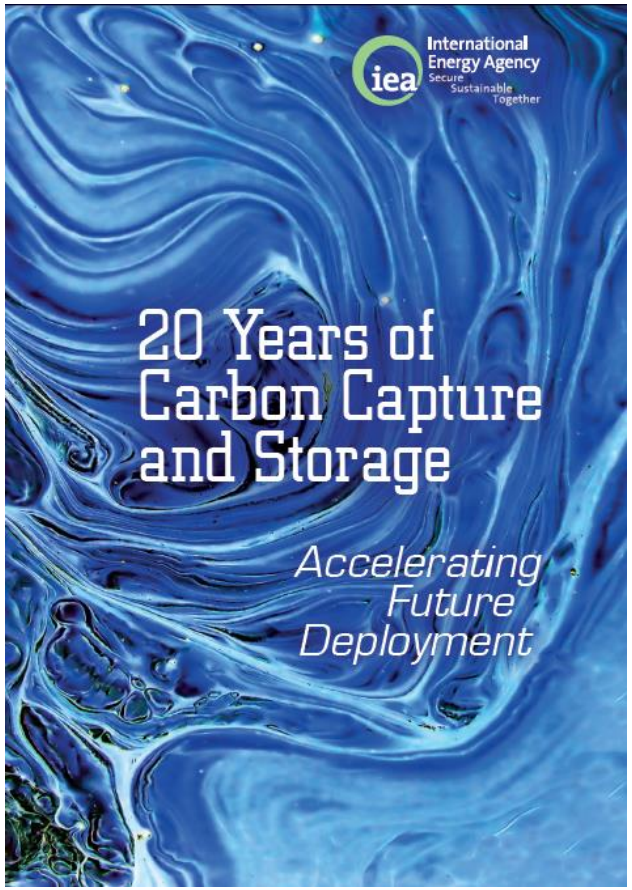
2031-2040:
28 Gt

2041-2050:
58 Gt



= 1 Gt of CO_2 captured and stored

= 1 Gt of CO_2 captured and stored from biomass feedstocks (negative emissions)



Almost 1.1 Gt of CO_2 captured in 2050 is linked to biomass with CCS, corresponding to 16% of total CO_2 captured globally, around 0.7 Gt of total capture from coal plants with cofiring.

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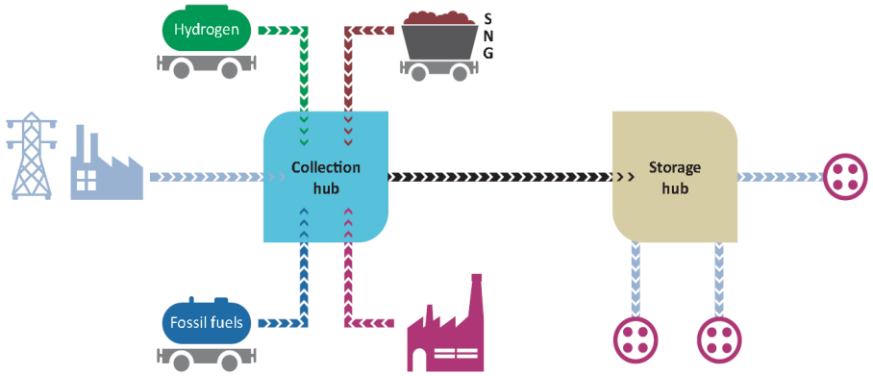
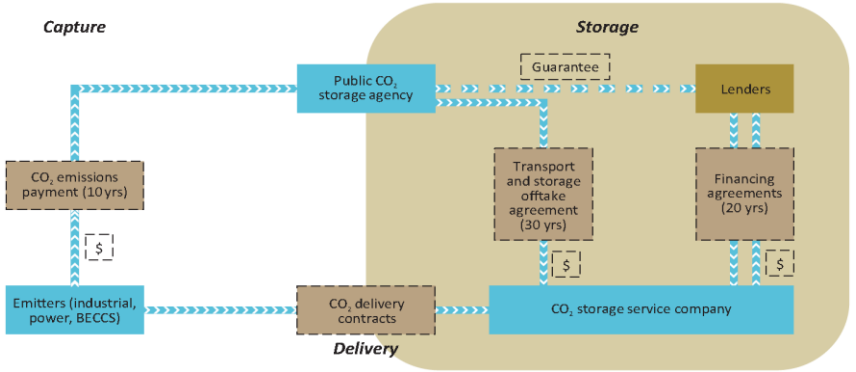
New approach on transport and storage infrastructure

- For CCS to play its role, significant investment in transport and storage is required
- Capture, transport and storage are different businesses with different challenges → hence separate business models needed
- Many (most?) capture plant operators have no skills, nor interest, in owning and operating transport and storage
- "Disaggregation" can help simplify project organisation and financing
- Governments can play a key role in transport and storage infrastructure development





The role of CCS will only be realised if the infrastructure to transport and store CO_2 is available.

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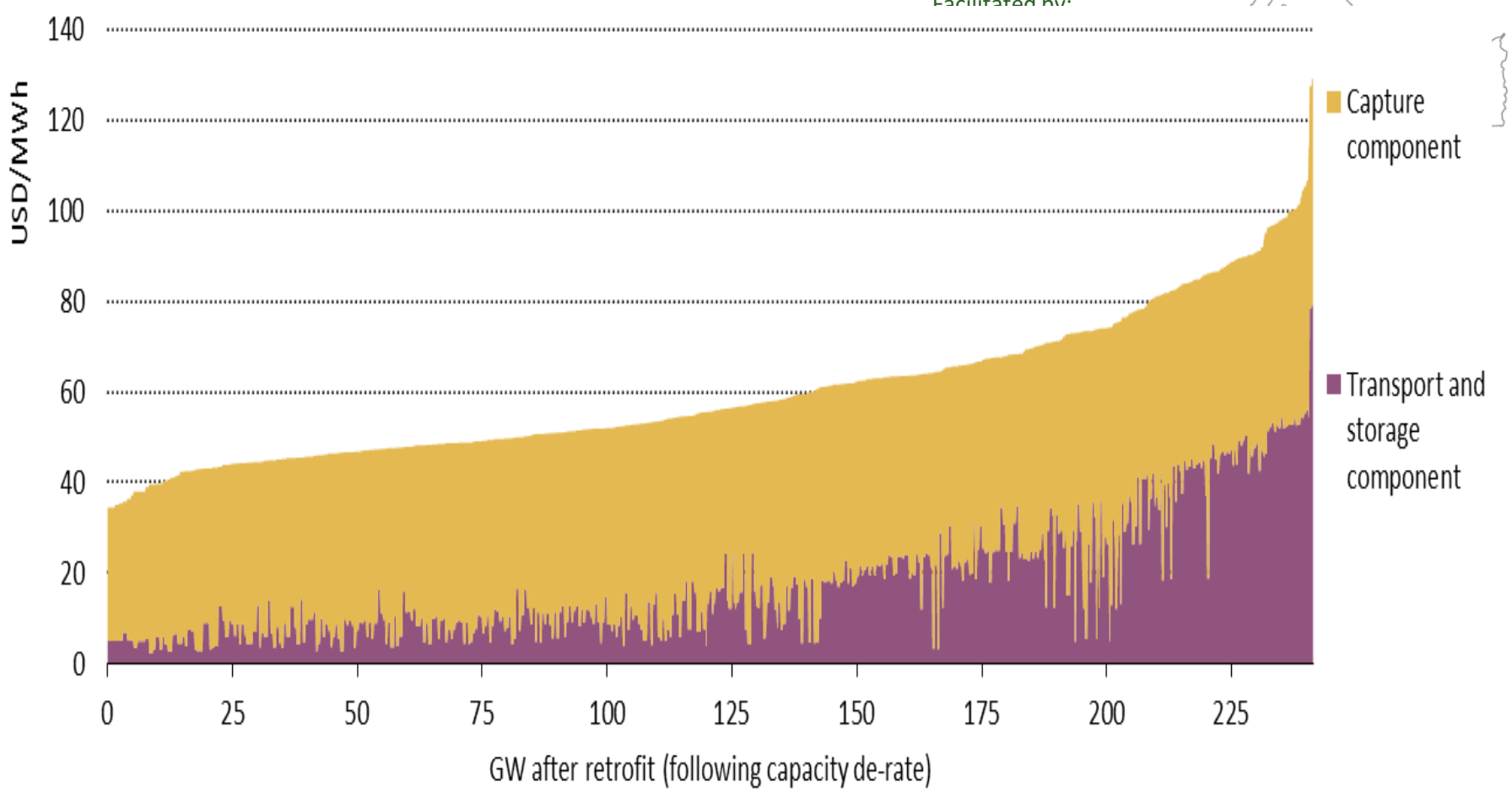
Coal 'Unlocking' in China: CCS retrofits



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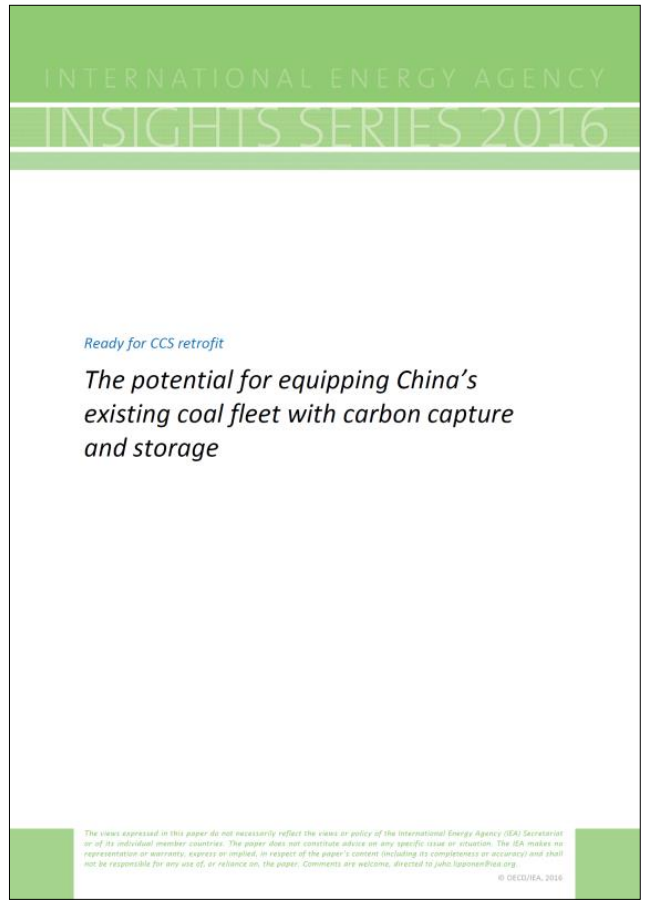

A large potential exists to retrofit CCS on China's existing coal-fired power fleet

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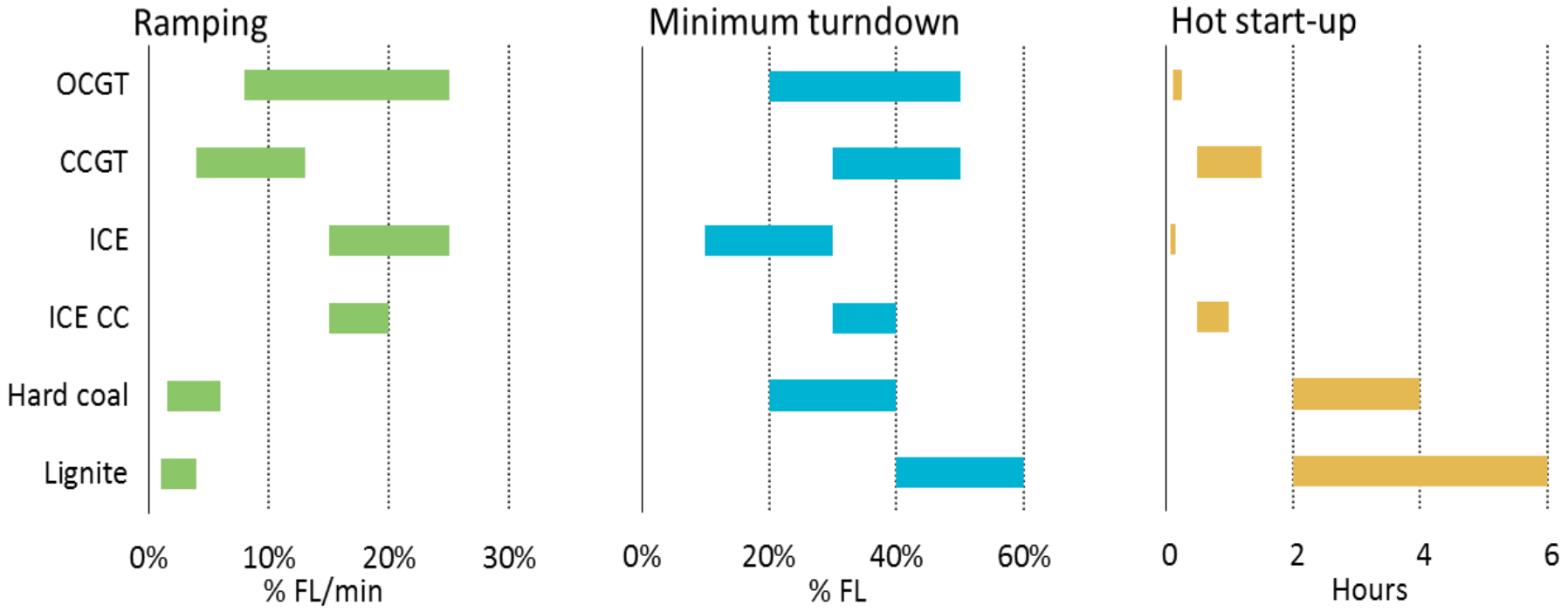
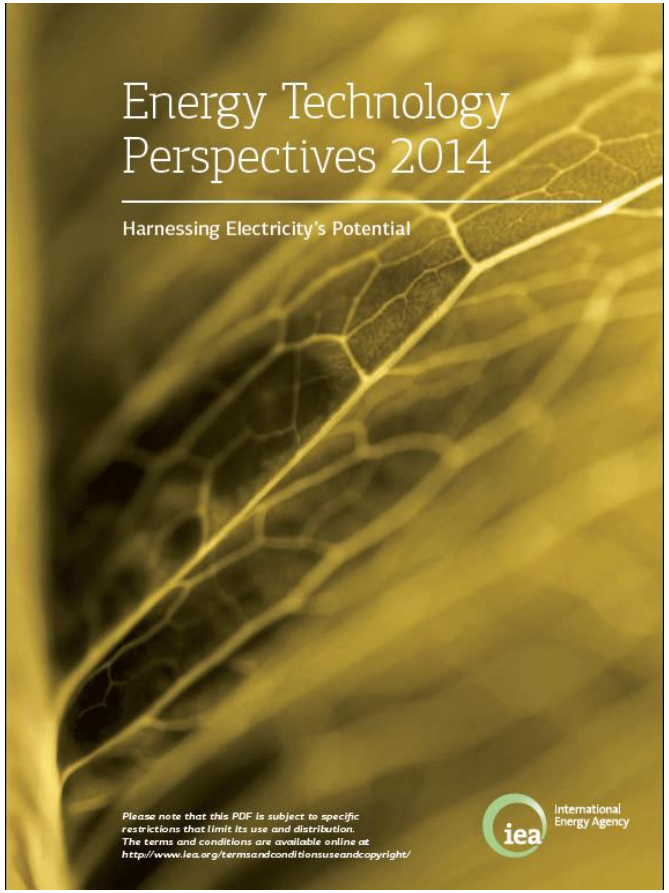
The changing role of power plants

Ranges of flexibility parameters for thermal electricity generation technologies





Thermal power plants' role will vary with electricity markets evolution.
Shifting from base-load operation towards flexibility may change generation technology choices.

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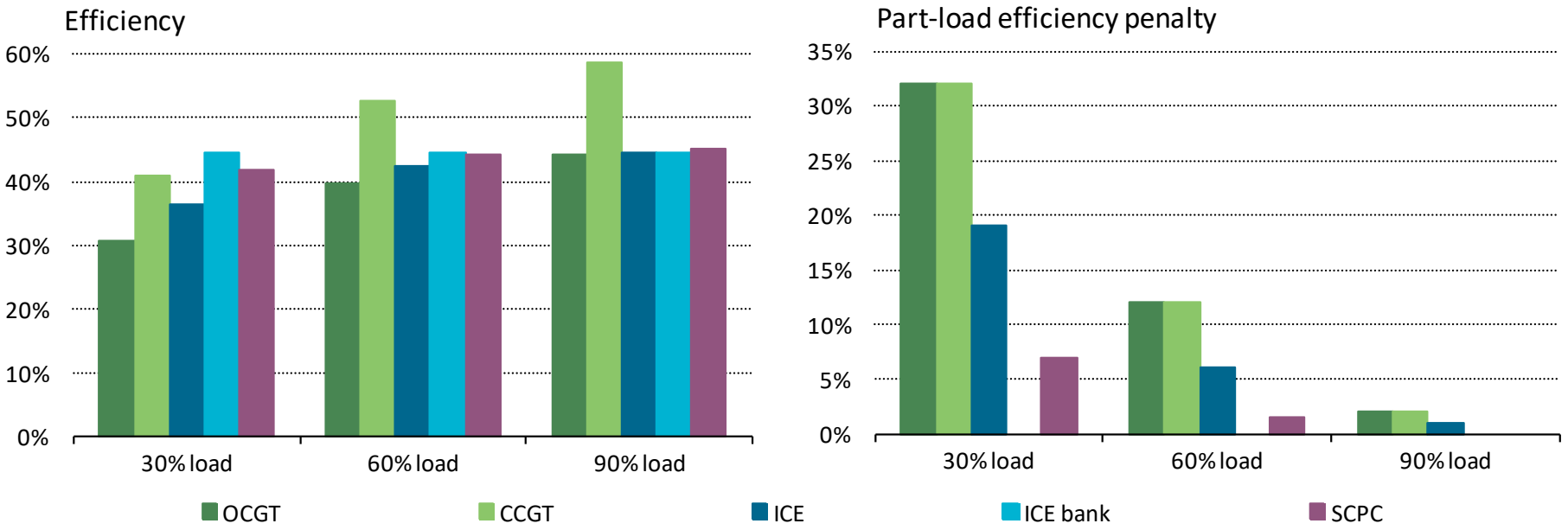
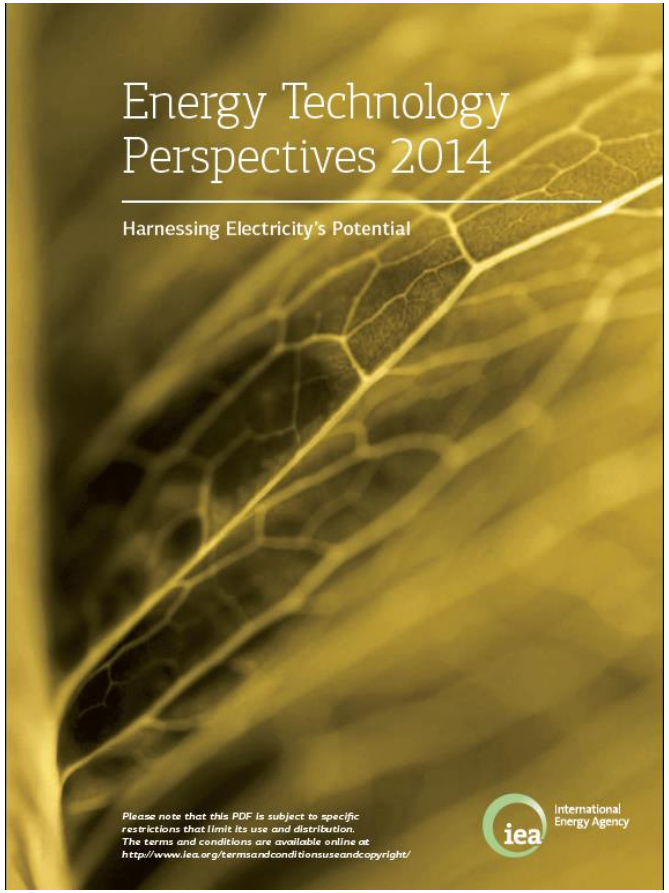
May need to trade efficiency for flexibility





Technology choices should consider all operating modes to assess the most efficient power plant design

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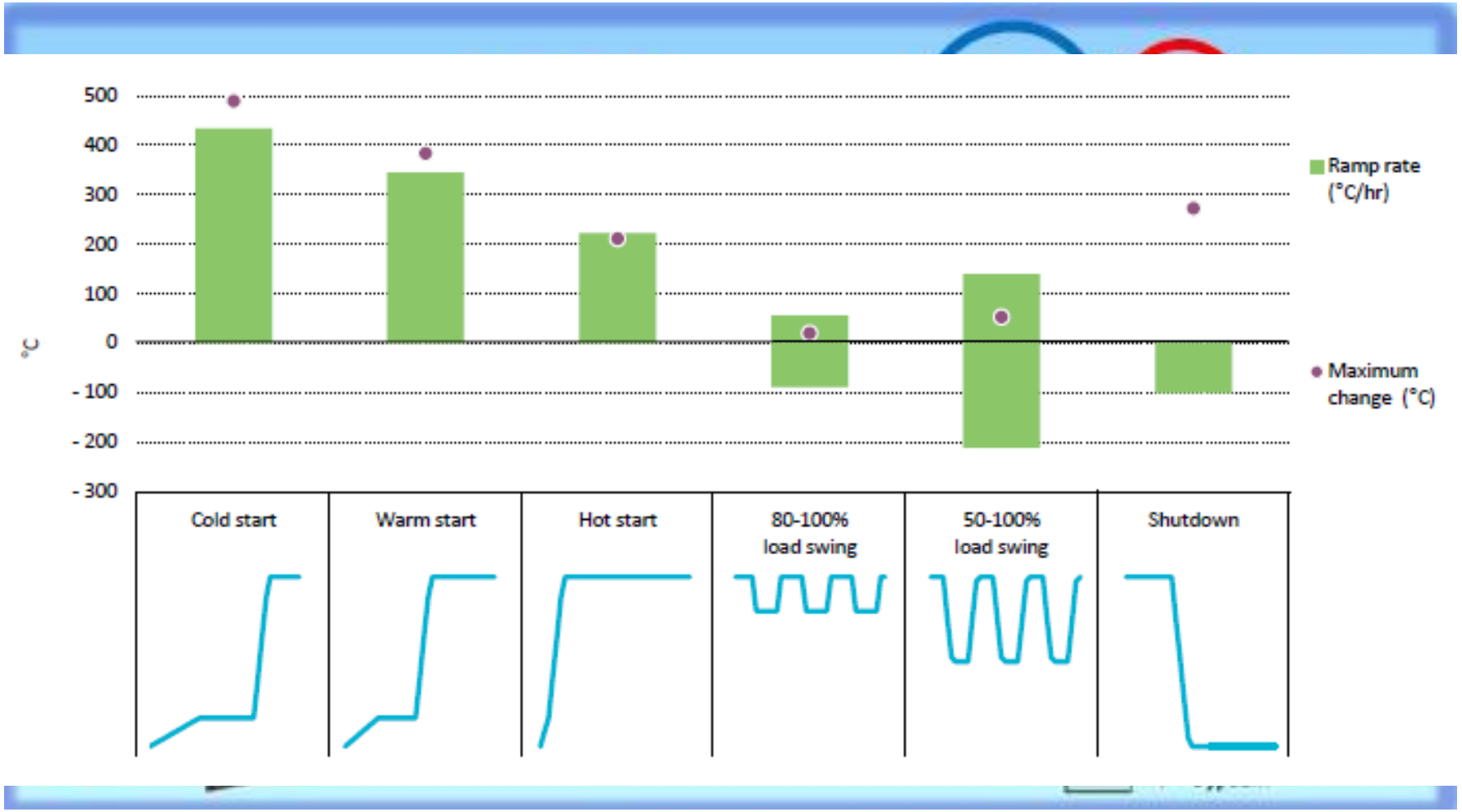
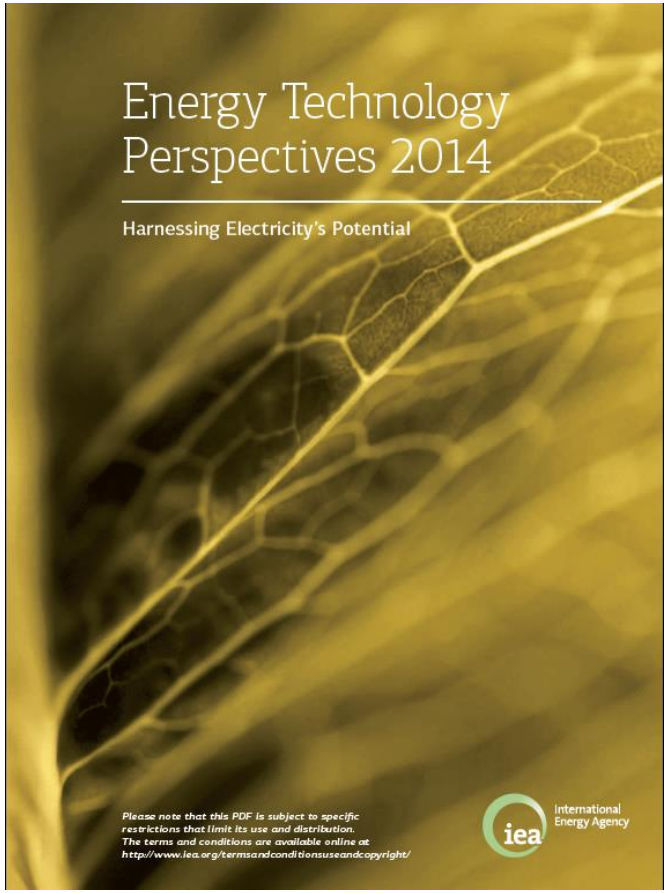
Cycling impacts on existing coal assets





Source: IEA Clean Coal Centre

Cold start is the most damaging operating condition due to large temperature changes imposed on equipment and materials

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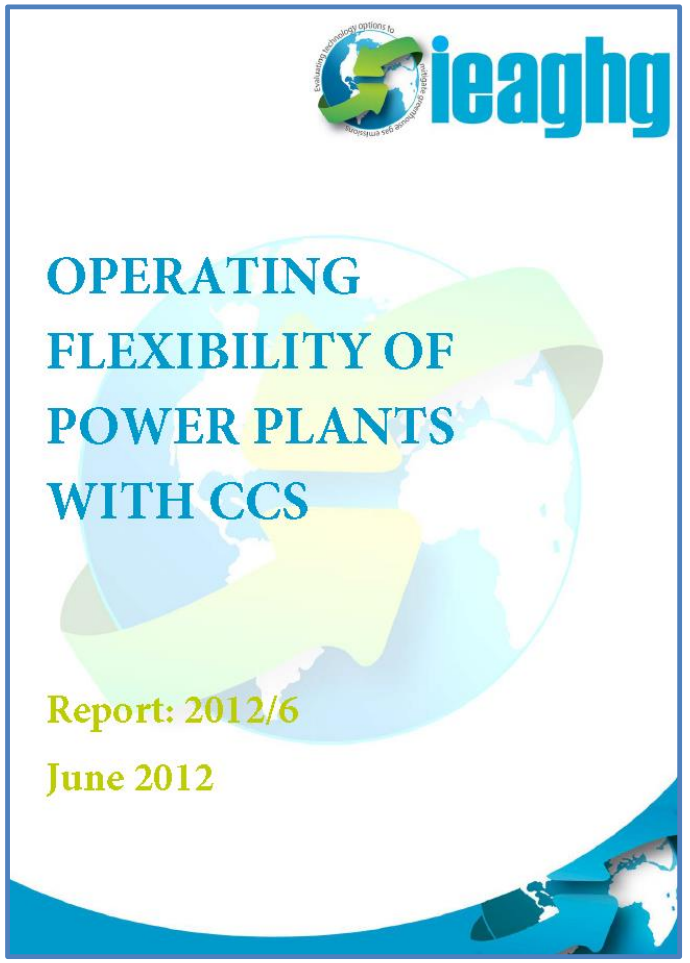
Can CCS be flexible?

- Modern NGCC and PC (USC) plant have good operational flexibility, IGCC somewhat less
- Flexible capture operation possible, but part-load efficiency penalty for plants with capture marginally greater than for plants without capture
- CO_2 compression and air separation limiting factors
- Ways to improve CCS operational flexibility, e.g.
  - By-passing capture
  - Storage of CO_2-rich solvent
  - Storage of captured CO_2
- However, experience to date is limited



Flexibility options exist, but require further development and practical experience.

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Collaboration is key to accelerating innovation

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Accelerating results for 40 years

- Close to 6,000 experts
- 39 TCPs
- More than 1,900 topics to date
- 52 countries
- About 300 public or private entities
- 4 regional or international organisations

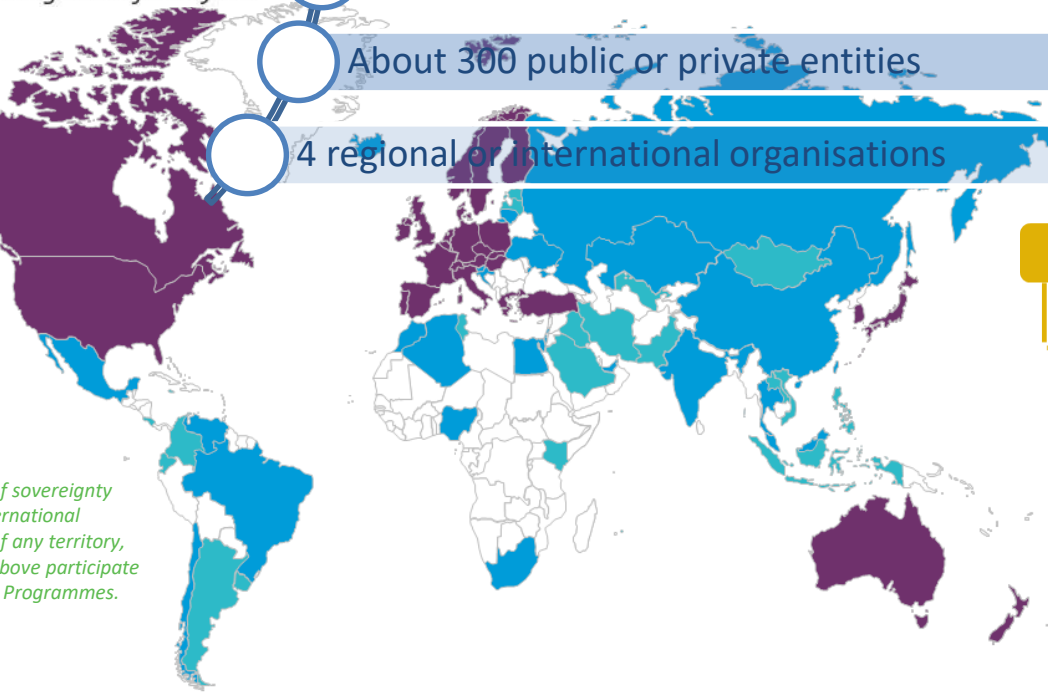
CLEAN ENERGY MINISTERIAL
Accelerating the Global Clean Energy Transition

Energy Demand
- Appliances (SEAD)
- Buildings and Industry (EMWG)
- Electric Vehicles (EVI)

Energy Systems & Integration
- 21st Century Power (21CPP)
- Energy Access (Global LEAP)
- Smart Grids (ISGAN)
- Smart Cities (GSCN)

Energy Supply
- Solar and Wind
- Bioenergy
- Hydropower

Cross-Cutting Support
- Women in Clean Energy (C3E)
- Clean Energy Solutions Center



This map is without prejudice to the status of sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area. Experts from countries shown above participate in activities of the Technology Collaboration Programmes.

Entities participating From IEA countries
Entities participating from partner countries
Entities from countries considering participation

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