



2017 Energy Technology Perspectives...

... and the Role of CCS

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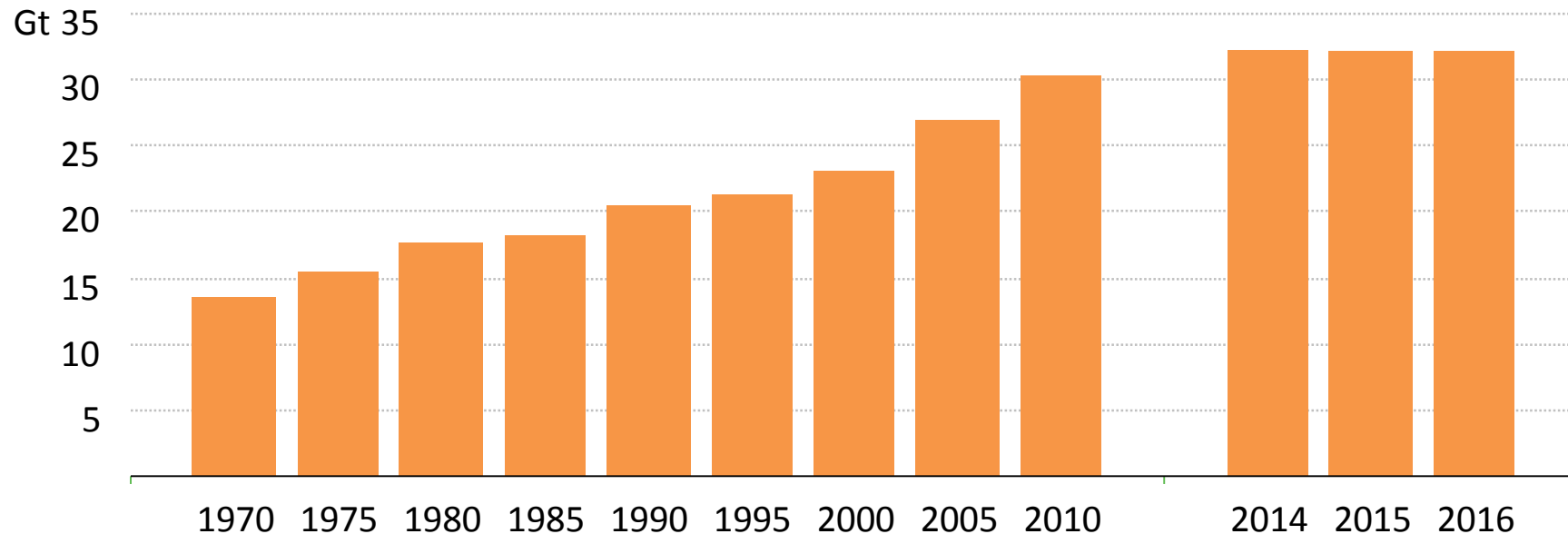
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- Global energy markets are changing rapidly
 - *Renewables supplied half of global electricity demand growth in 2016, and increase in nuclear capacity reached highest level since 1993*
 - *Global energy intensity improved by 2.1% in 2016*
 - *Electric car sales were up 40% in 2016, a new record year*
- The energy sector remains key to sustainable economic growth
 - *1.2B people lack access to electricity; 2.7B people lack access to clean cooking*
 - *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*
- There is no single story about the future of global energy
 - *Fast-paced technological progress and changing energy business models*

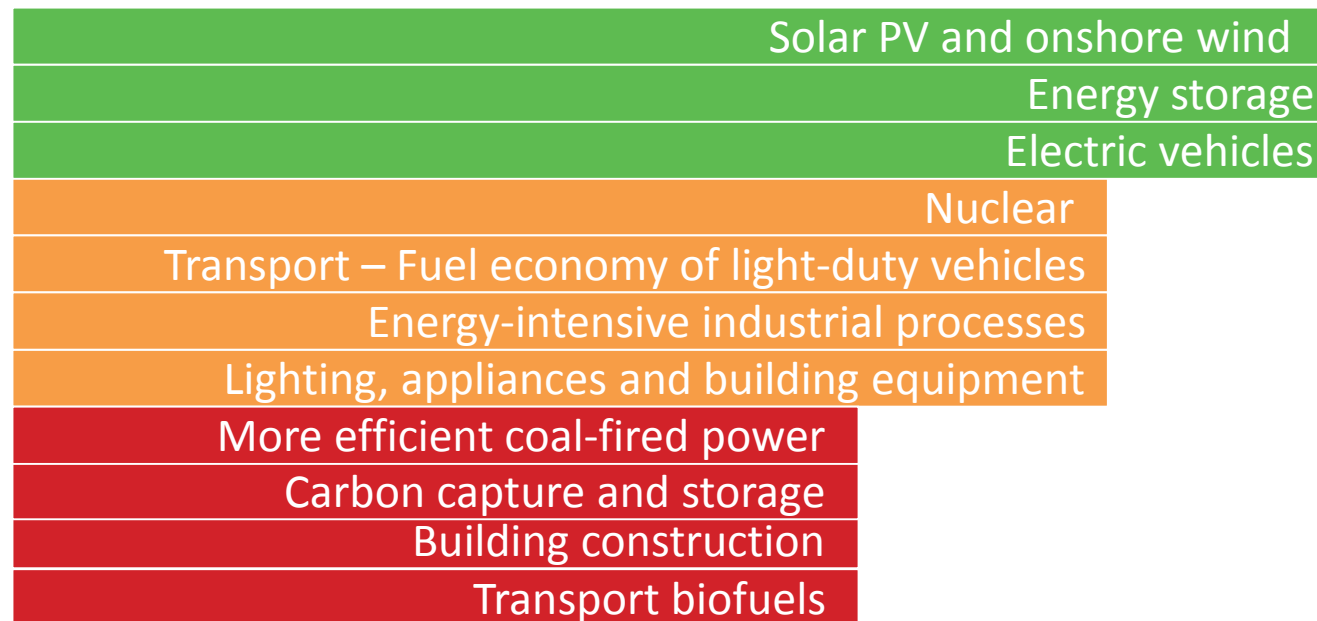
Global CO₂ emissions flat for 3 years – an emerging trend?

Global energy-related CO₂ emissions



IEA analysis shows that global CO₂ emissions remained flat in 2016 for the third year in a row, even though the global economy grew, led by emission declines in the US and China.

The potential of clean energy technology remains under-utilised

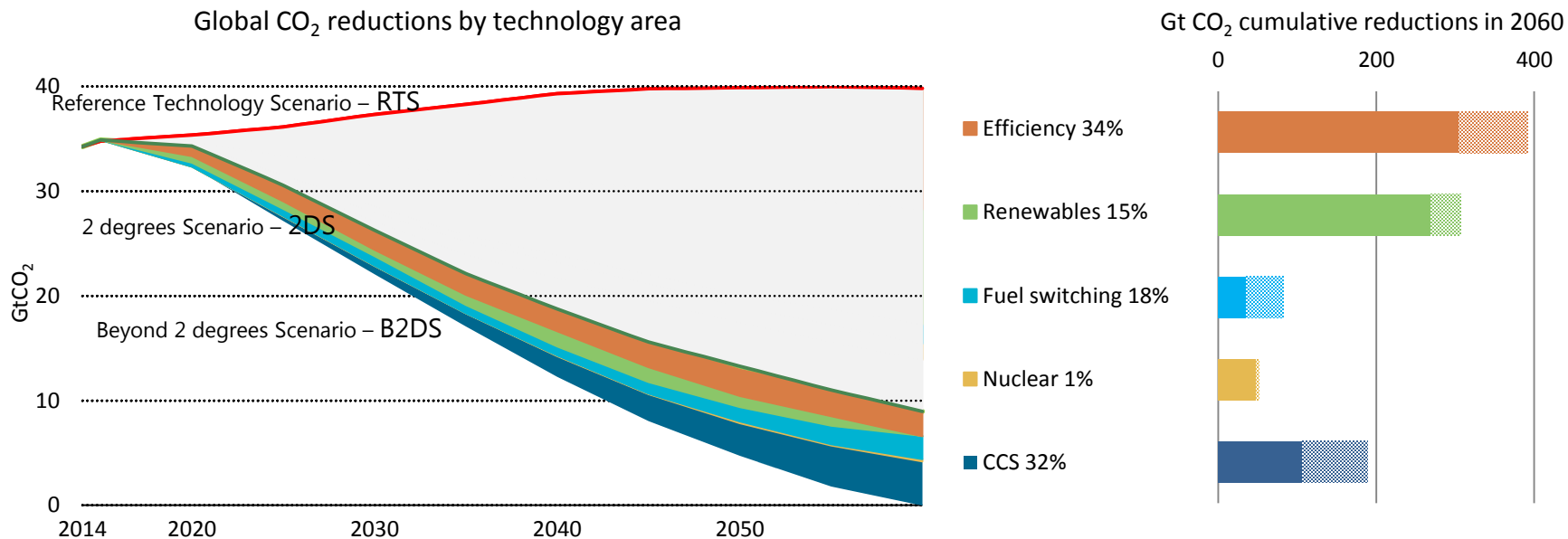


● Not on track ● Accelerated improvement needed ● On track

Recent progress in some clean energy areas is promising, but many technologies still need a strong push to achieve their full potential and deliver a sustainable energy future

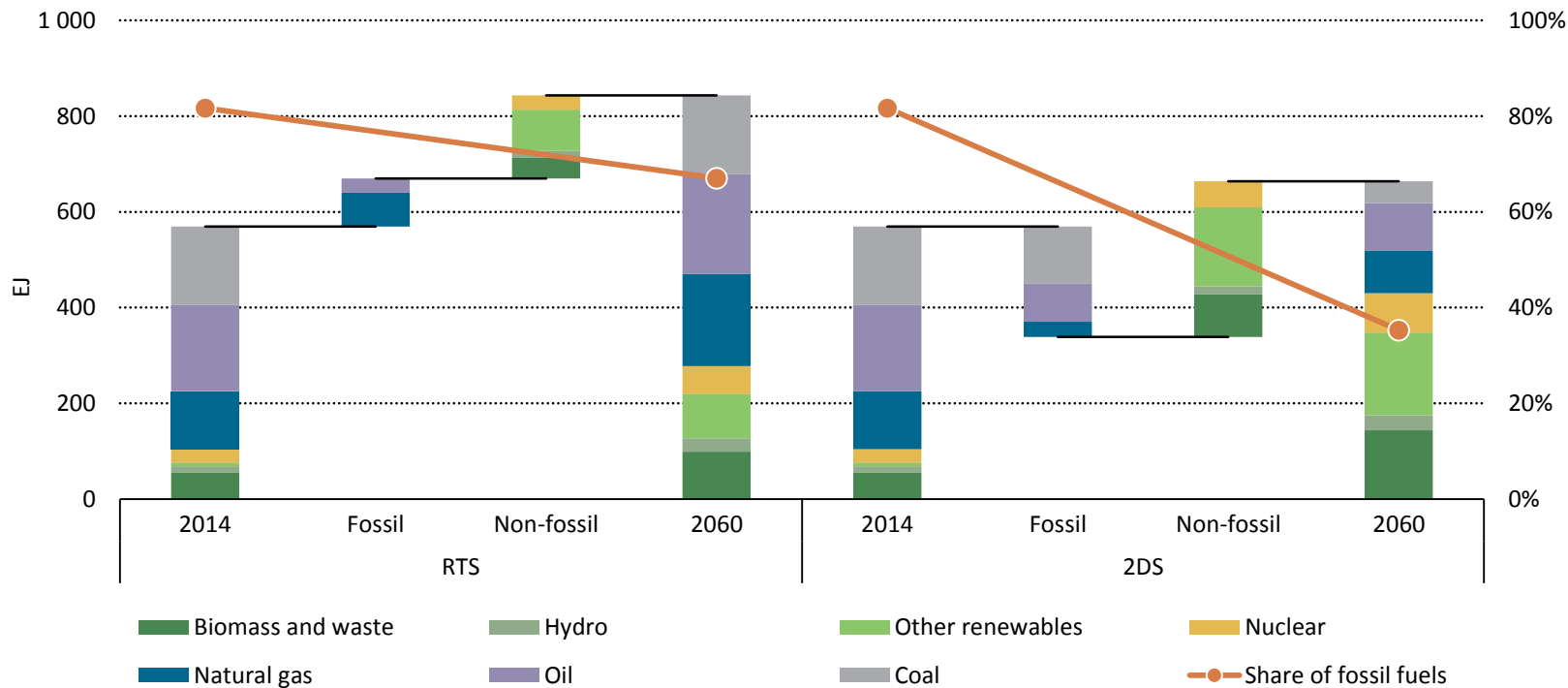
How far can technology take us?

Technology area contribution to global cumulative CO₂ reductions



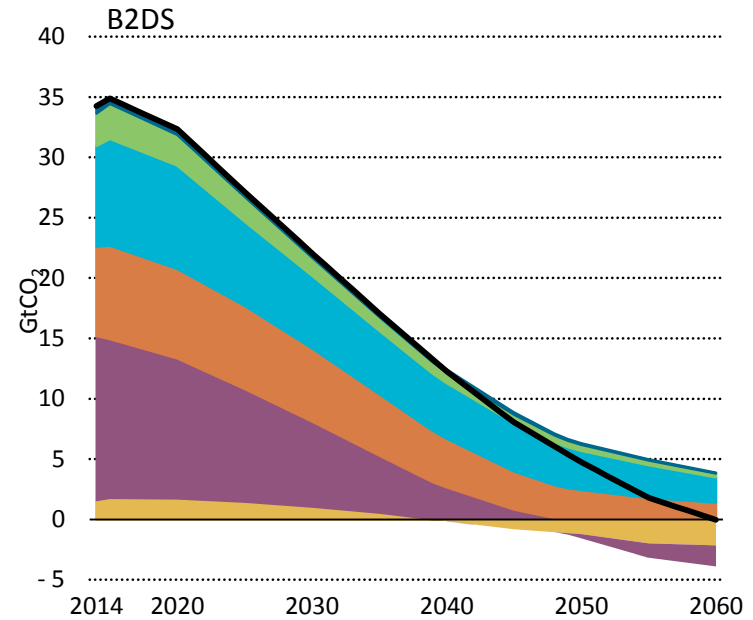
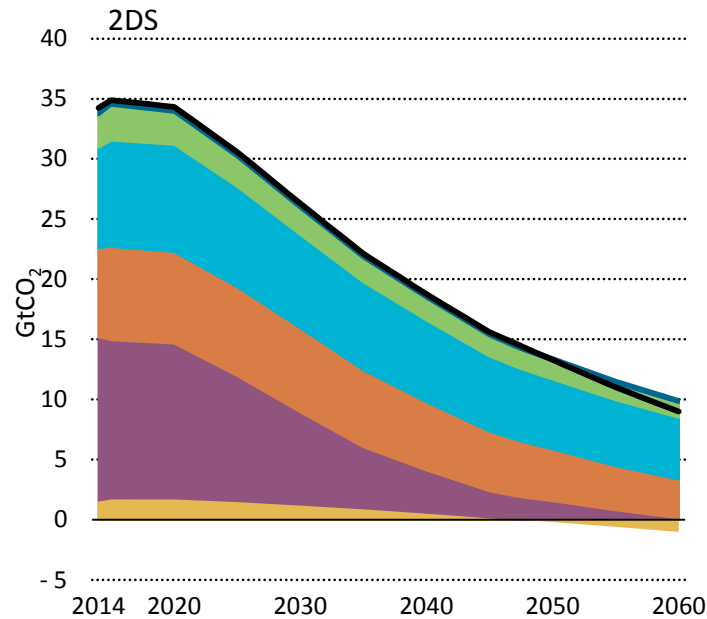
Pushing energy technology to achieve carbon neutrality by 2060 could meet the mid-point of the range of ambitions expressed in Paris.

Primary energy demand in the RTS and 2DS



More than half of primary energy demand is from renewables in the 2DS
The share of fossil fuels falls from 81% today to 35% in 2060 in the 2DS

Remaining CO₂ emissions in the 2DS and B2DS

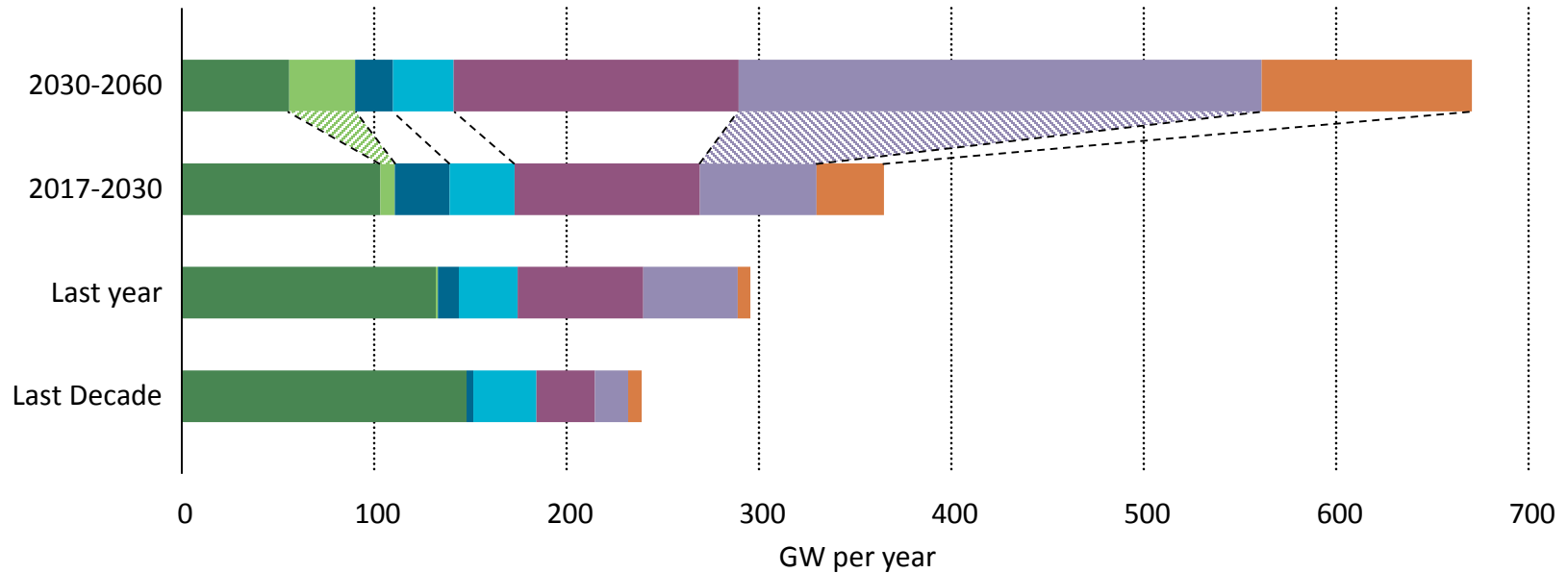


Other transformation Power Transport Industry Buildings Agriculture

The remaining CO₂ emissions in industry and power must be targeted for the B2DS
Negative emissions are necessary to achieve net-zero emissions in 2060

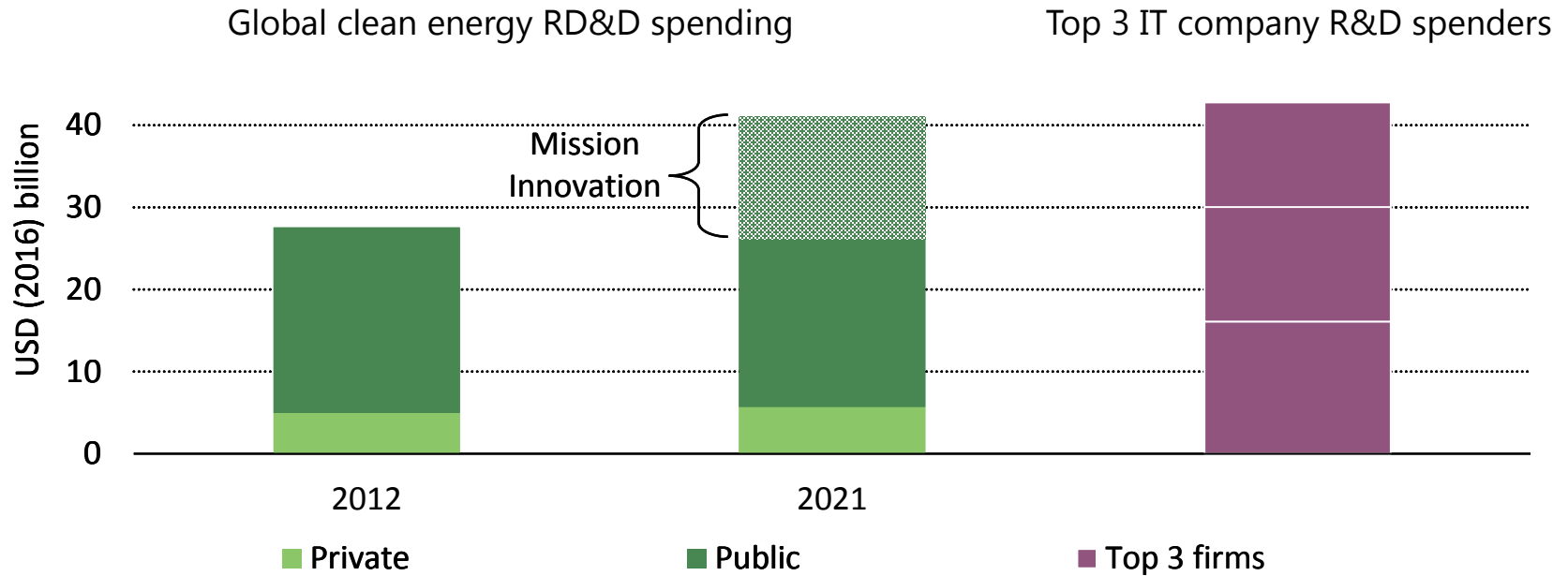
Can we push up the low-carbon power deployment pace?

Average capacity additions in different periods in the B2DS



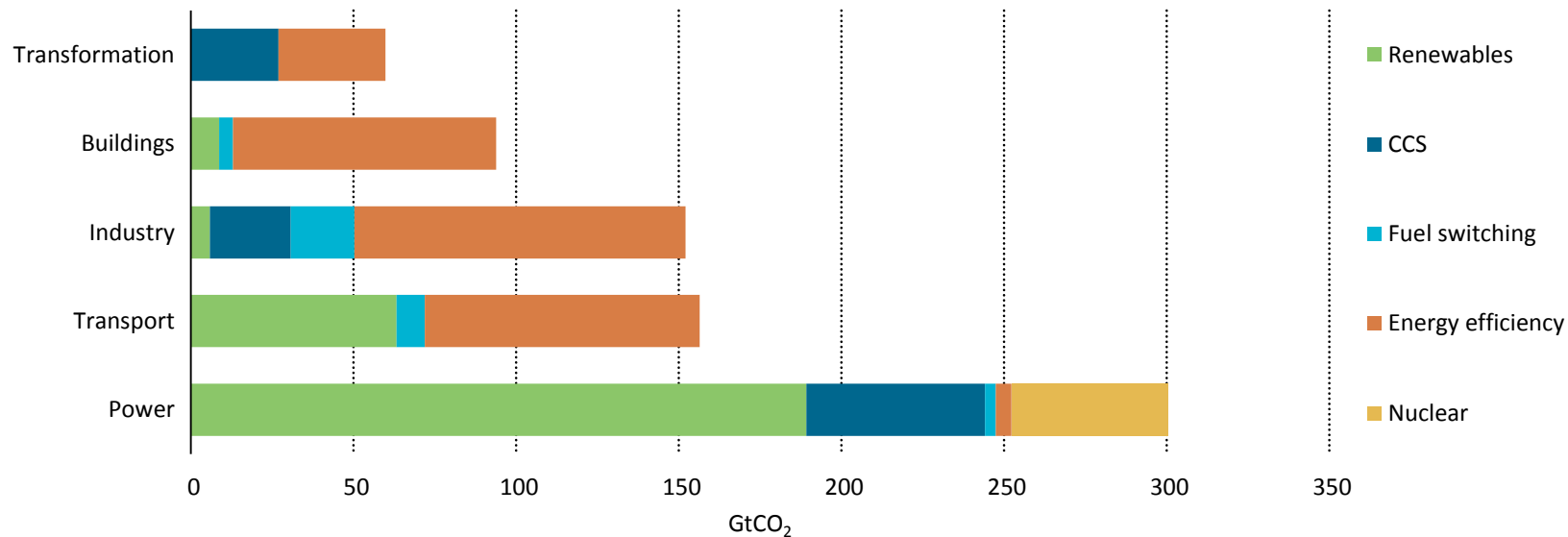
Recent successes in solar and wind will have to be extended to all low-carbon solutions, and brought to a scale never experienced before.

Global clean energy RD&D spending needs a strong boost



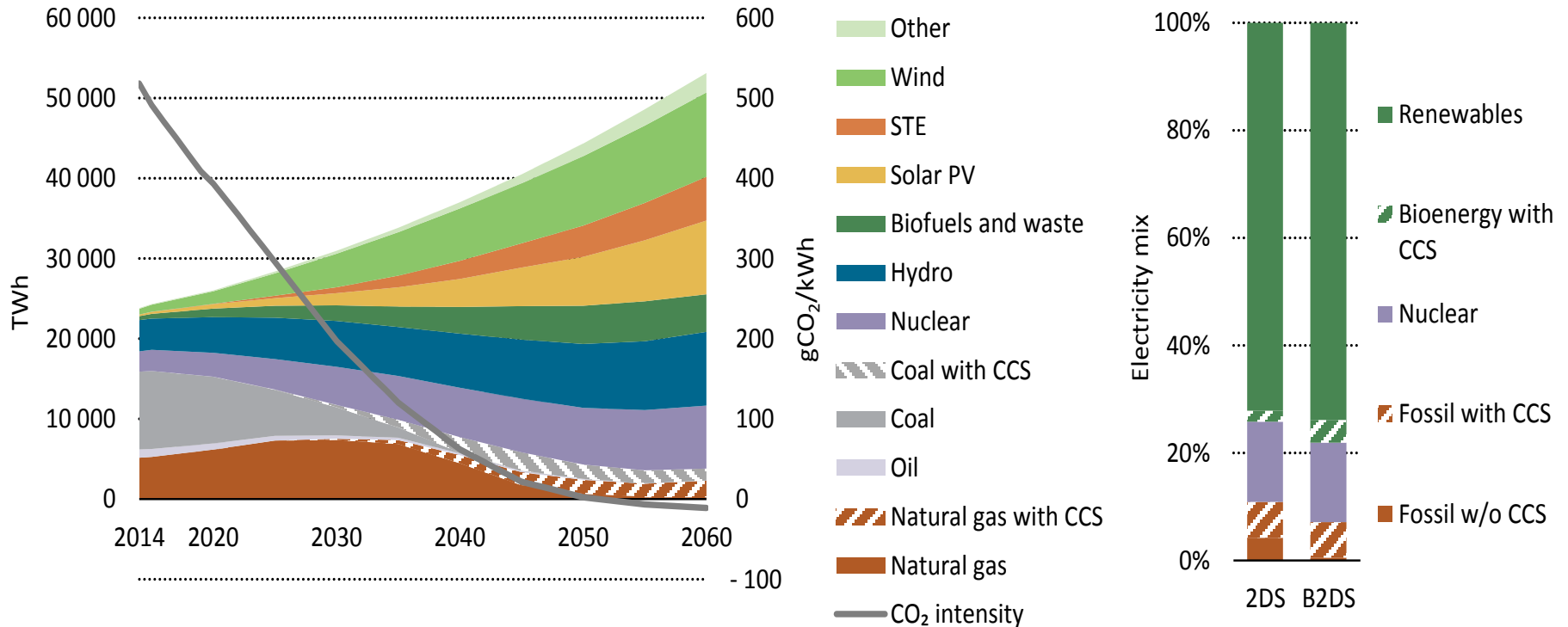
Global RD&D spending in efficiency, renewables, nuclear and CCS plateaued at \$26 billion annually, coming mostly from governments. Mission Innovation could provide a much needed boost.

Cumulative CO₂ emissions reductions by sector and technology: RTS to 2DS



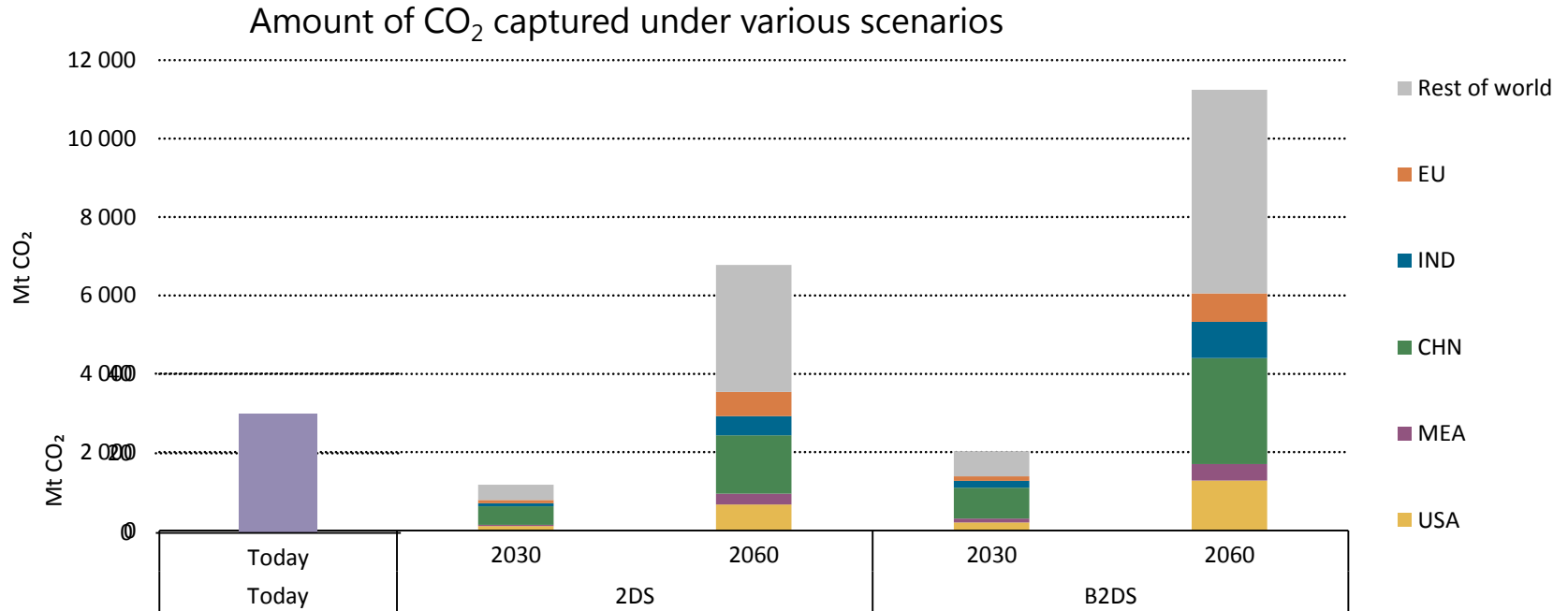
Action is required across all energy supply and demand sectors

Global electricity generation in the B2DS



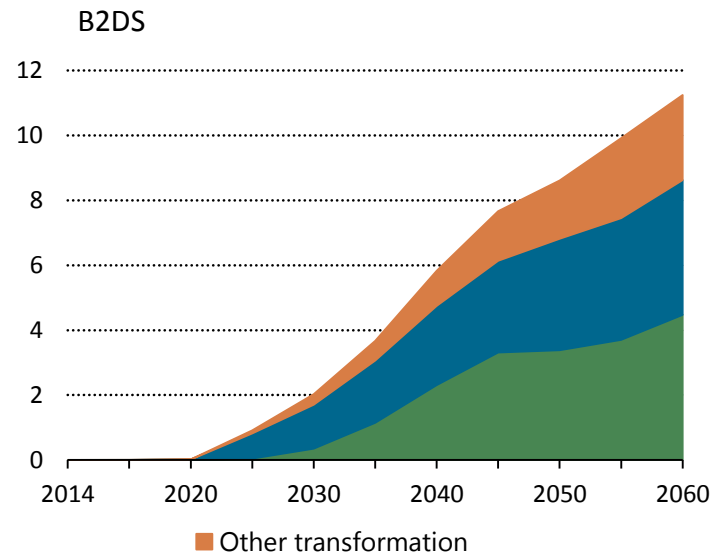
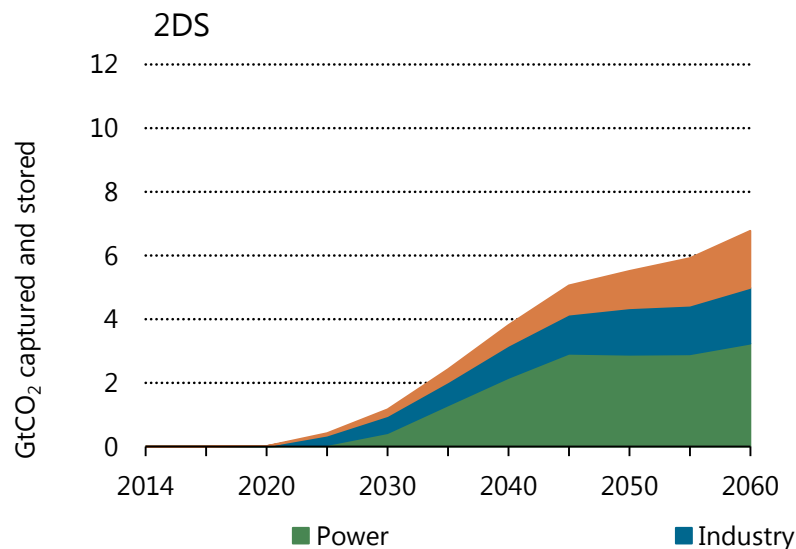
Global electricity generation is decarbonized by 2050 in the B2DS and becomes a source of negative emissions

A challenging task ahead for CCS

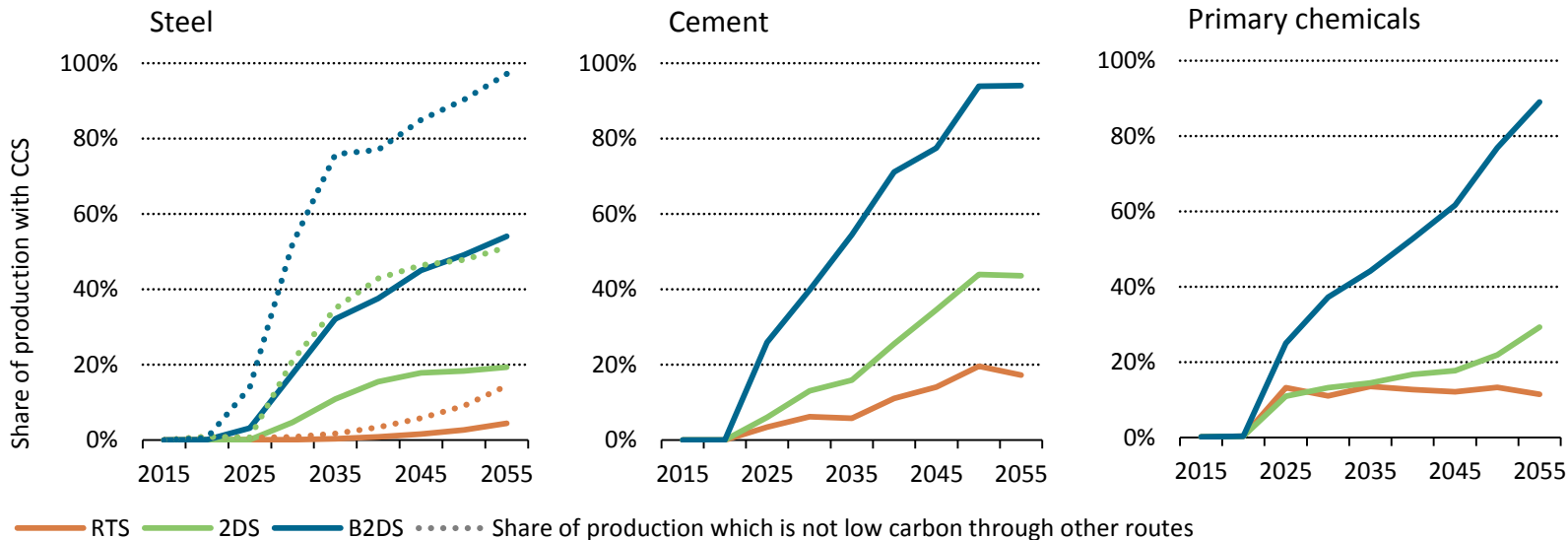


CCS is happening today, but needs to be ramped up hundreds of times to achieve long-term goals. The role for CCS varies based on local circumstances.

CCS deployment rates – 2DS and B2DS

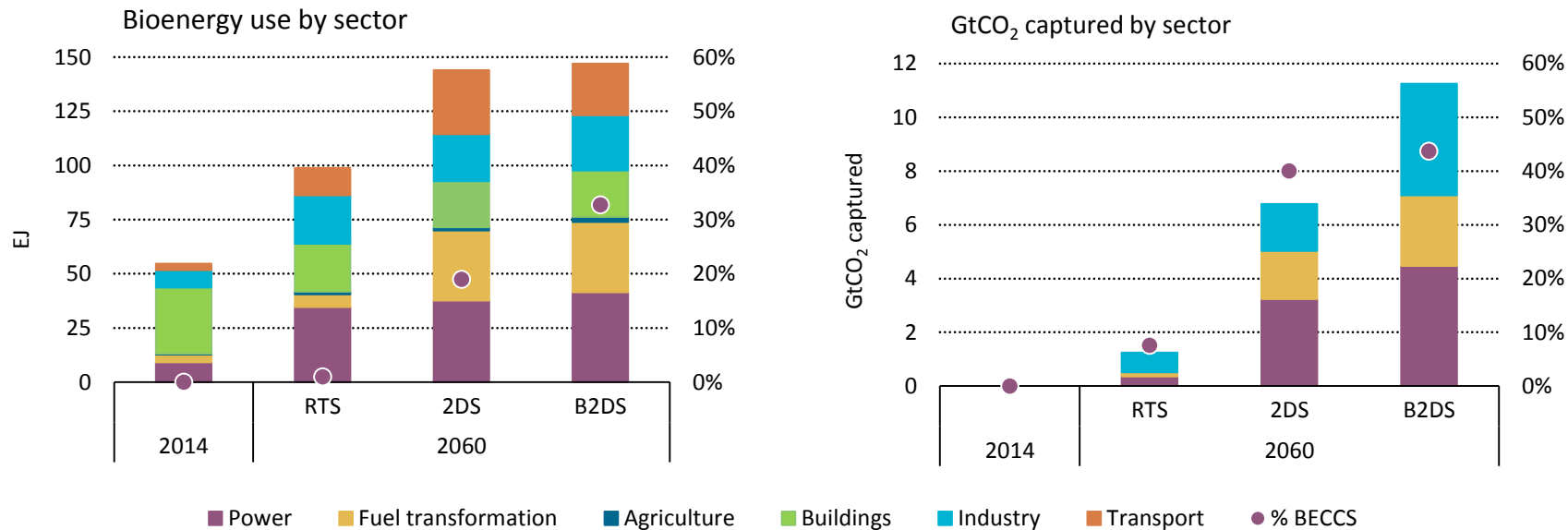


Deployment of CCS increases significantly in the B2DS, with over 11 Gt captured and stored in 2060



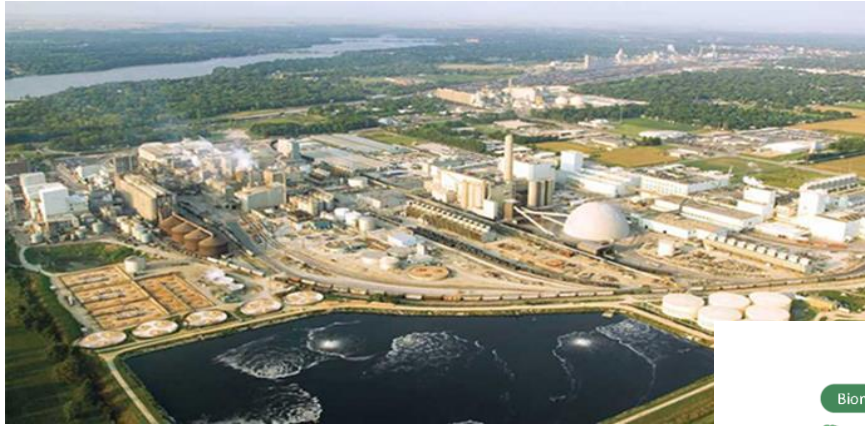
CCS is applied to a much greater proportion of industrial production by 2060 in the B2DS

Bioenergy use and CO₂ capture in the RTS, 2DS and B2DS

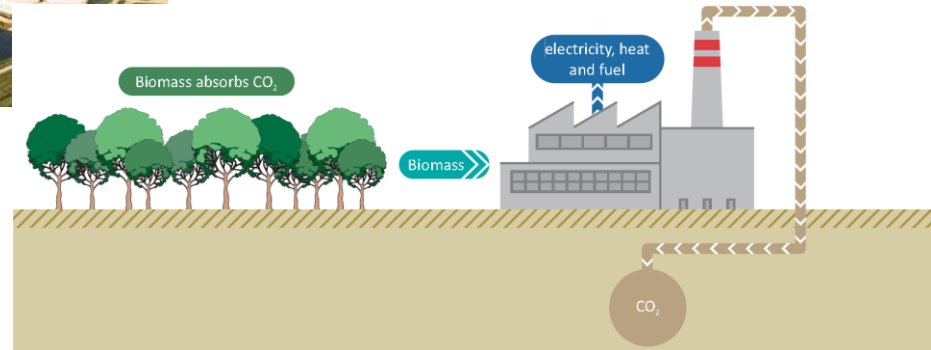


A growing percentage of bioenergy use will need to have CO₂ capture in the 2DS and B2DS

Large-scale BECCS is now a reality



ADM's Illinois Industrial CCS Project



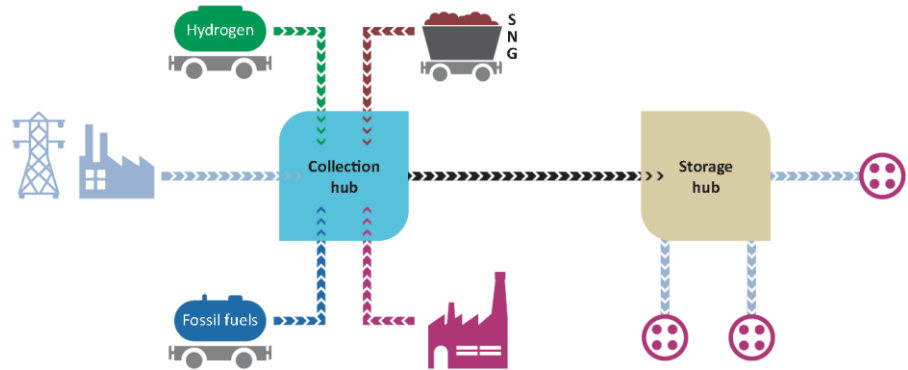
The world's first large-scale bio-CCS facility commenced operation in April 2017.

CCS at the rate of the 2DS and B2DS involves managing vast quantities of CO₂

Logistical challenge of the CO₂ volume can only be addressed through CO₂ transport and storage infrastructure and with strong support from the public sector

Investment in CO₂ transport and storage infrastructure can leverage investment in CO₂ capture in different industries

- Self-build model
- Joint venture model
- Pay-at-the-gate model



- Early signs point to changes in energy trajectories, helped by policies and technologies, but progress is too slow
- An integrated systems approach considering all technology options must be implemented now to accelerate progress
- Each country should define its own transition path and scale-up its RD&D and deployment support accordingly
- Achieving carbon neutrality by 2060 would require unprecedented technology policies and investments
- Innovation can deliver, but policies must consider the full technology cycle, and collaborative approaches can help

- The role of CCS in any cost-effective energy scenario is vital
- Strong public-sector leadership in developing CO₂ transport and storage infrastructure will be needed
- Carbon pricing can provide a helpful signal, but CCS deployment requires additional policy support and comprehensive policy packages
- B2DS calls for 60% more CO₂ captured and stored by 2060 compared with 2DS – going beyond a 2-degree scenario is extremely challenging

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