Energy Technology Perspectives 2017

Catalysing Energy Technology Transformations

Juho Lipponen, Head of CCS Unit, Acting Head of ETP Division

Luis Munuera, Energy Analyst, ETP Division

IEA

Spanish Energy Club, Madrid, 14 September 2017

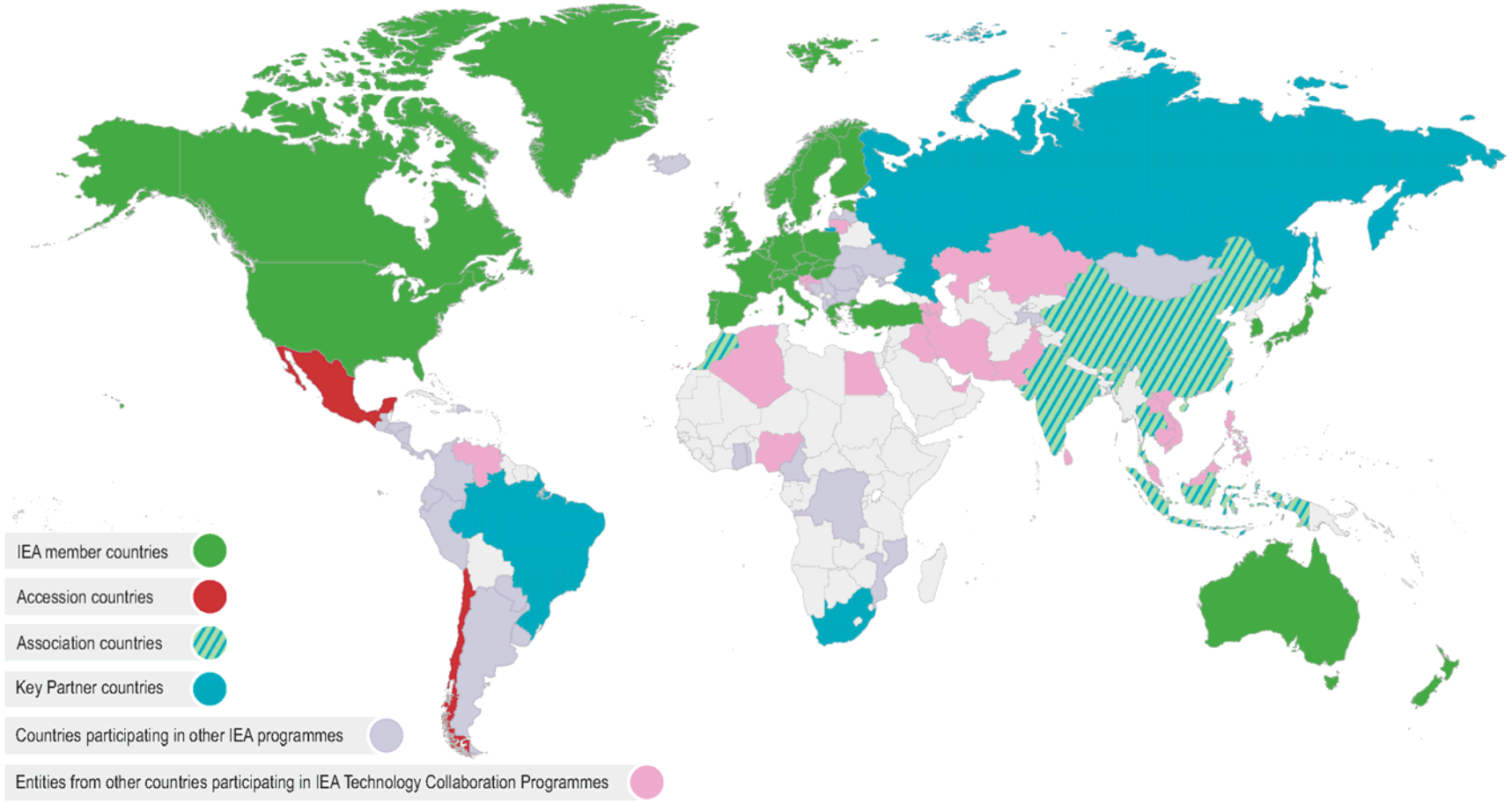
Outline

1. IEA & some key energy trends
2. ETP energy modelling
3. Energy Technology Perspectives 2017

The International Energy Agency (IEA)

- Founded by 17 OECD countries, including Spain, in wake of 1974 oil crisis to promote energy security, cooperation & stable markets
- Leading energy market and technology analysis & data, to help governments & industry make good energy choices
- Increased industry involvement, led by CEO-level Energy Business Council
- Management focused on a 3-pillar modernisation programme
  - *"Opening the doors" of the IEA*
  - *Broadened approach to energy security*
  - *A global hub for clean energy technologies & energy efficiency*

IEA global engagement

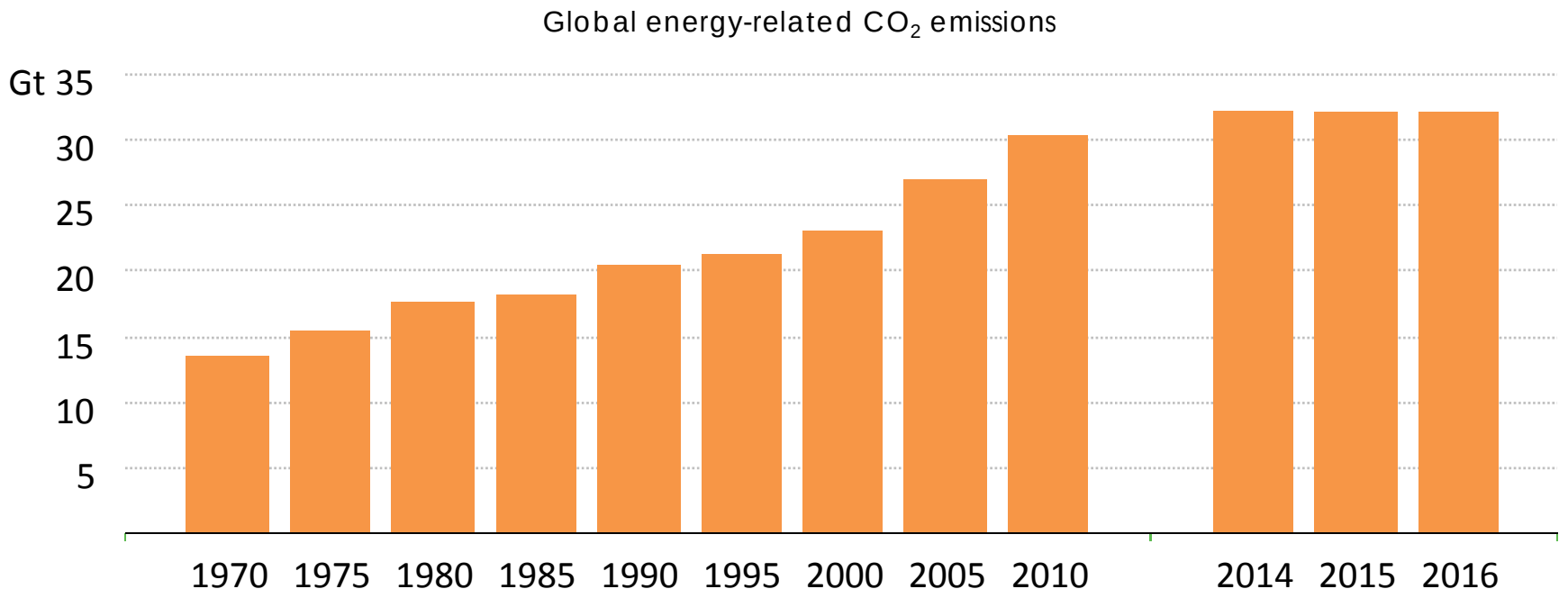


This map is without prejudice to the status of sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Key trends and starting points

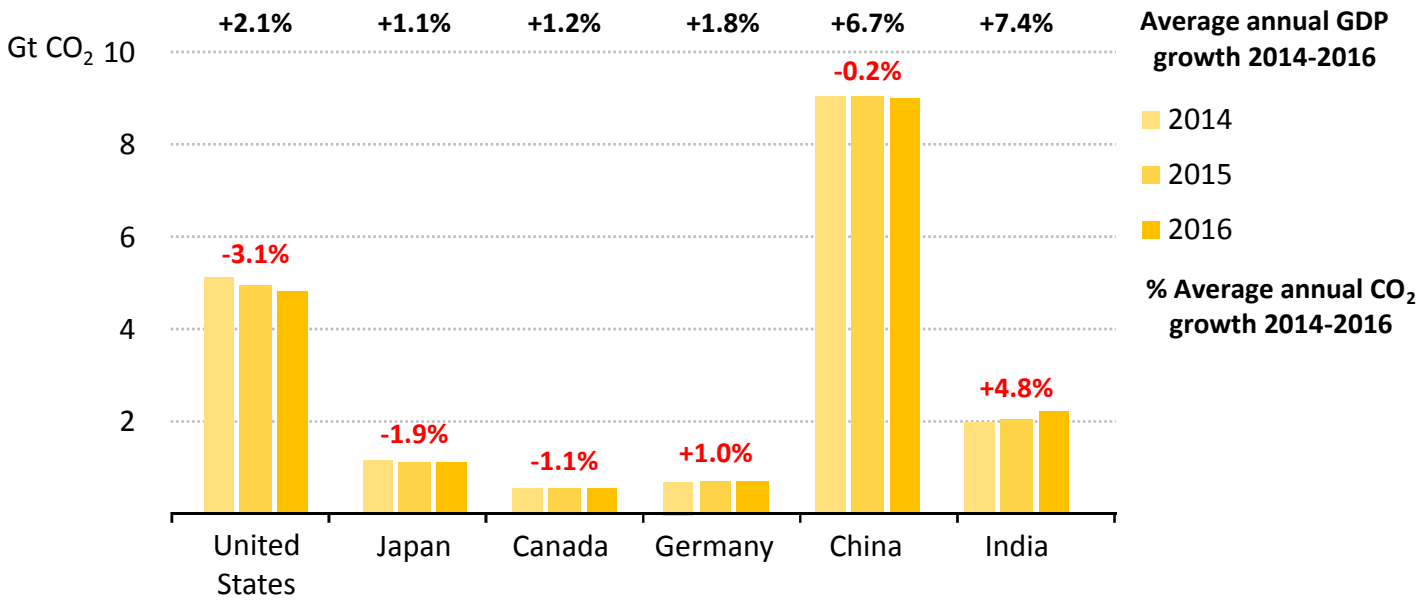
- Global energy markets are changing rapidly
  - *Renewables supplied half of global electricity demand growth in 2016, and increase in nuclear capacity reached highest level since 1993*
  - *Global energy intensity improved by 2.1% in 2016*
  - *Electric car sales were up 40% in 2016, a new record year*
- 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 CO_2 emissions flat for 3 years – an emerging trend?



IEA analysis shows that global CO_2 emissions remained flat in 2016 for the third year in a row, even though the global economy grew.

Global CO_2 emissions flat for 3 years

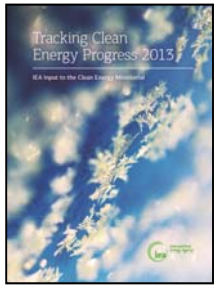


Two largest emitters, the US and China, have reduced emissions since 2014, with the main drivers being switching from coal to gas, renewables & nuclear in the power sector

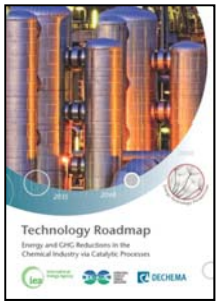
What the IEA does on energy technology

1. Where do we need to go?

2. Where are we today?

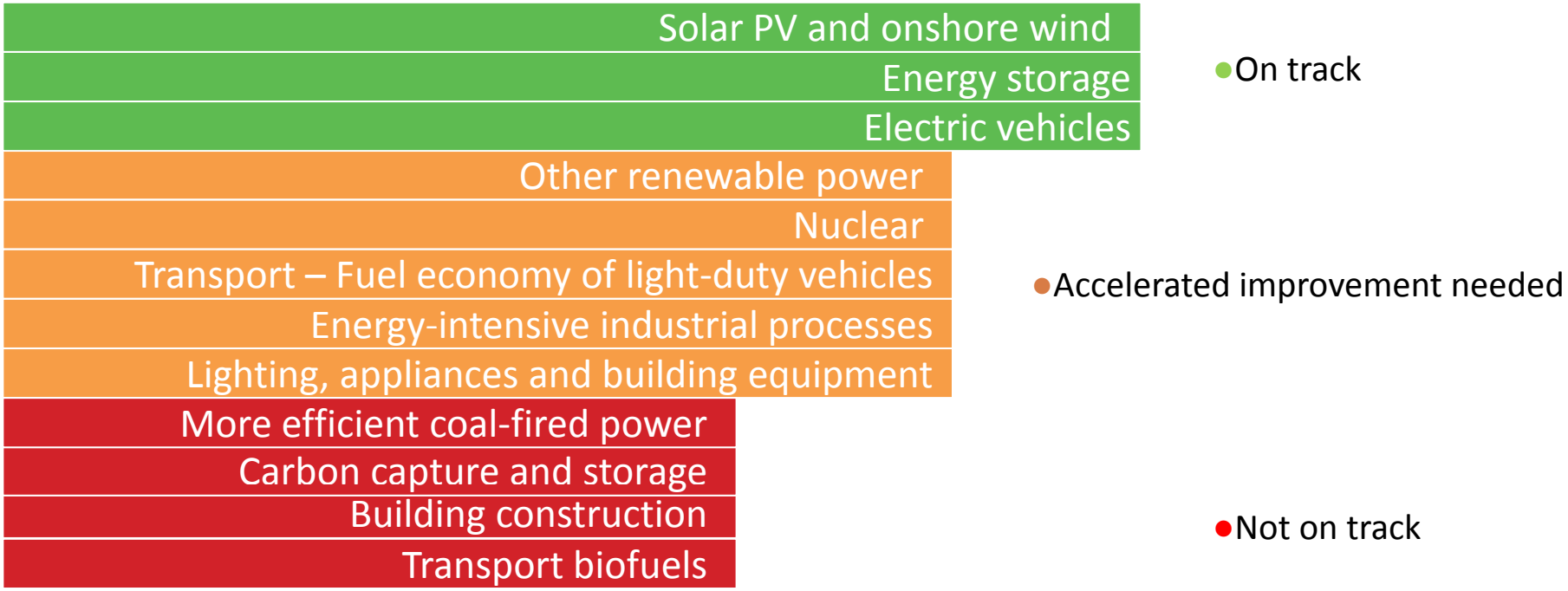


3. How do we get there?



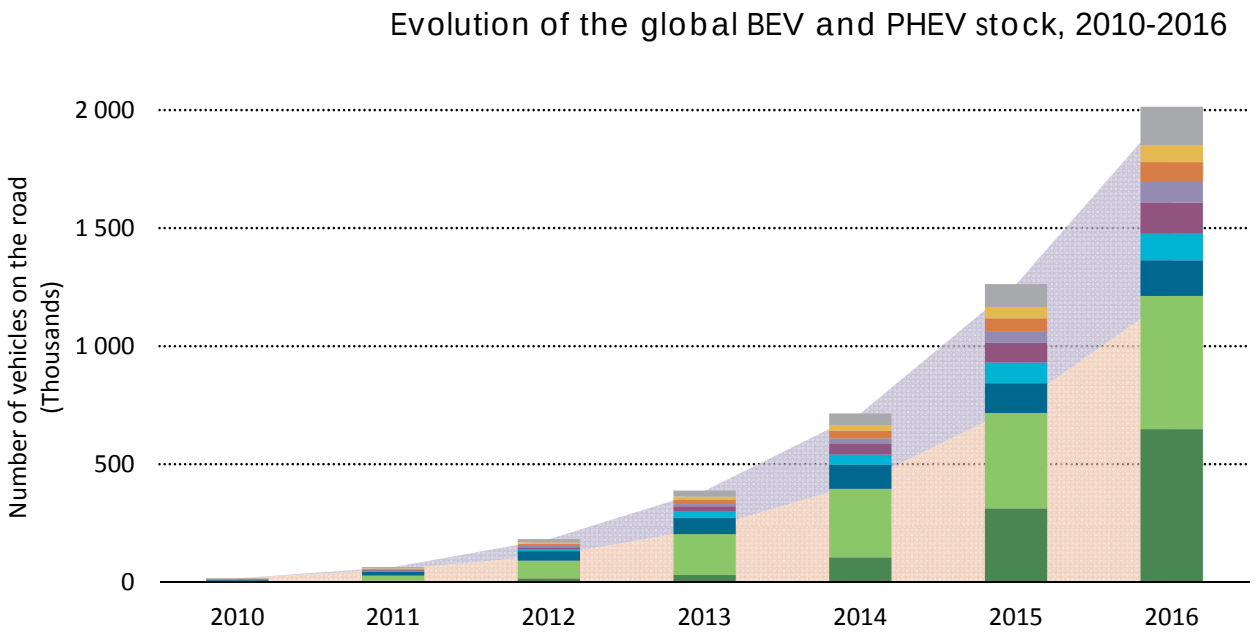
iea Energy Technology Network

The potential of clean energy technology remains underutilised



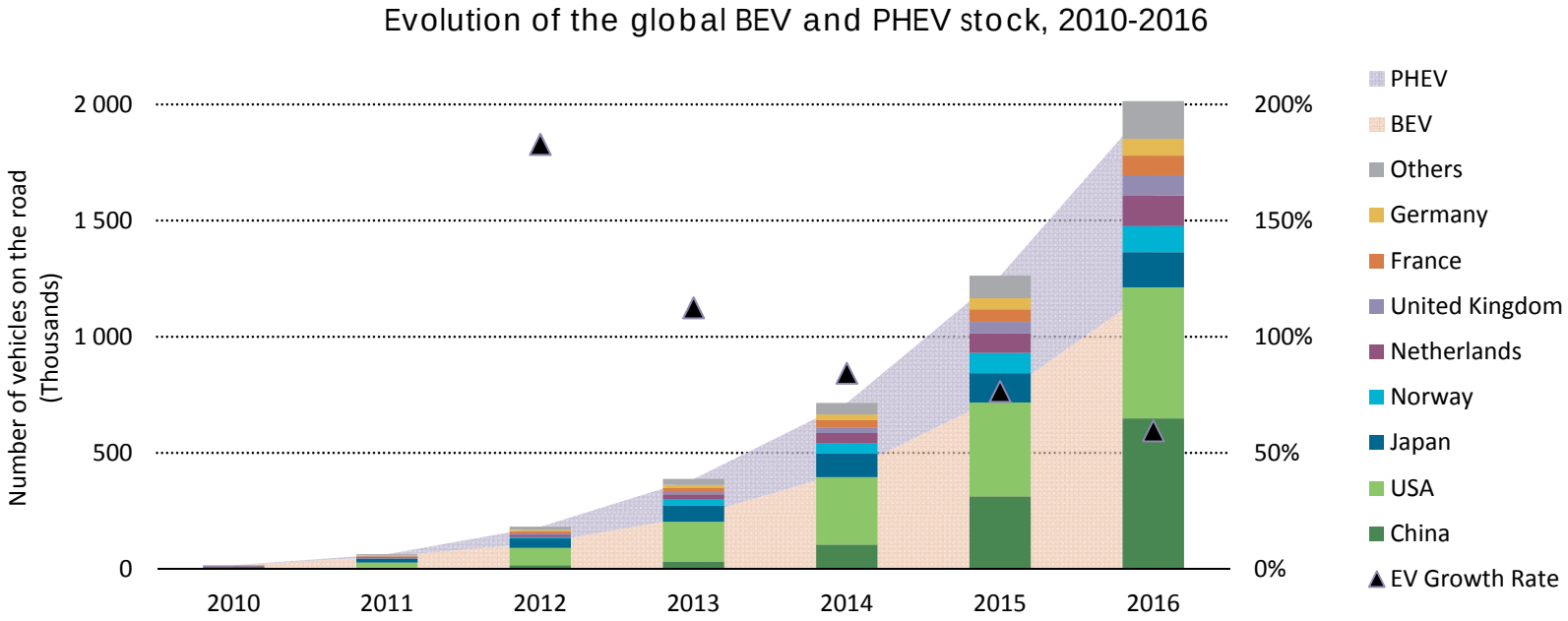
Recent progress in some clean energy areas is promising, but many technologies still need a strong push to achieve their full potential and deliver a sustainable energy future.

EVs are still on track,



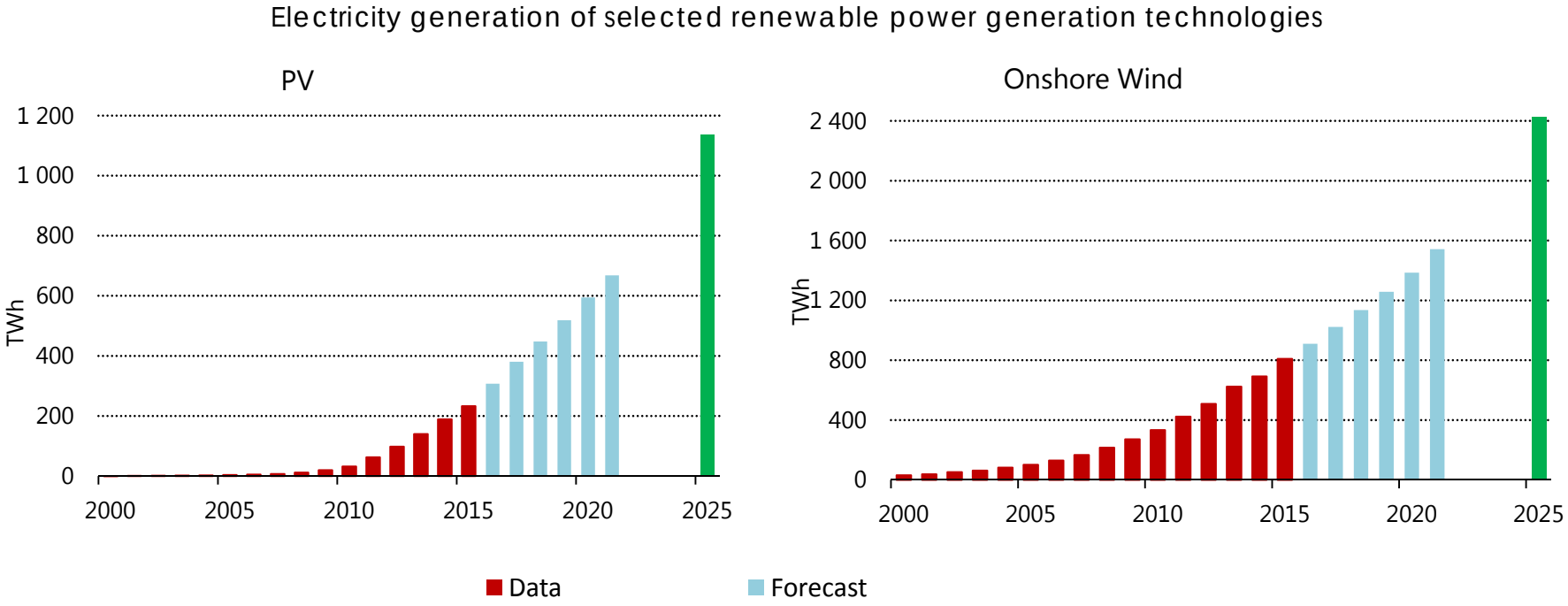
The global PEV car stock has reached 2 million units in circulation last year,

EVs are still on track, but need continued support



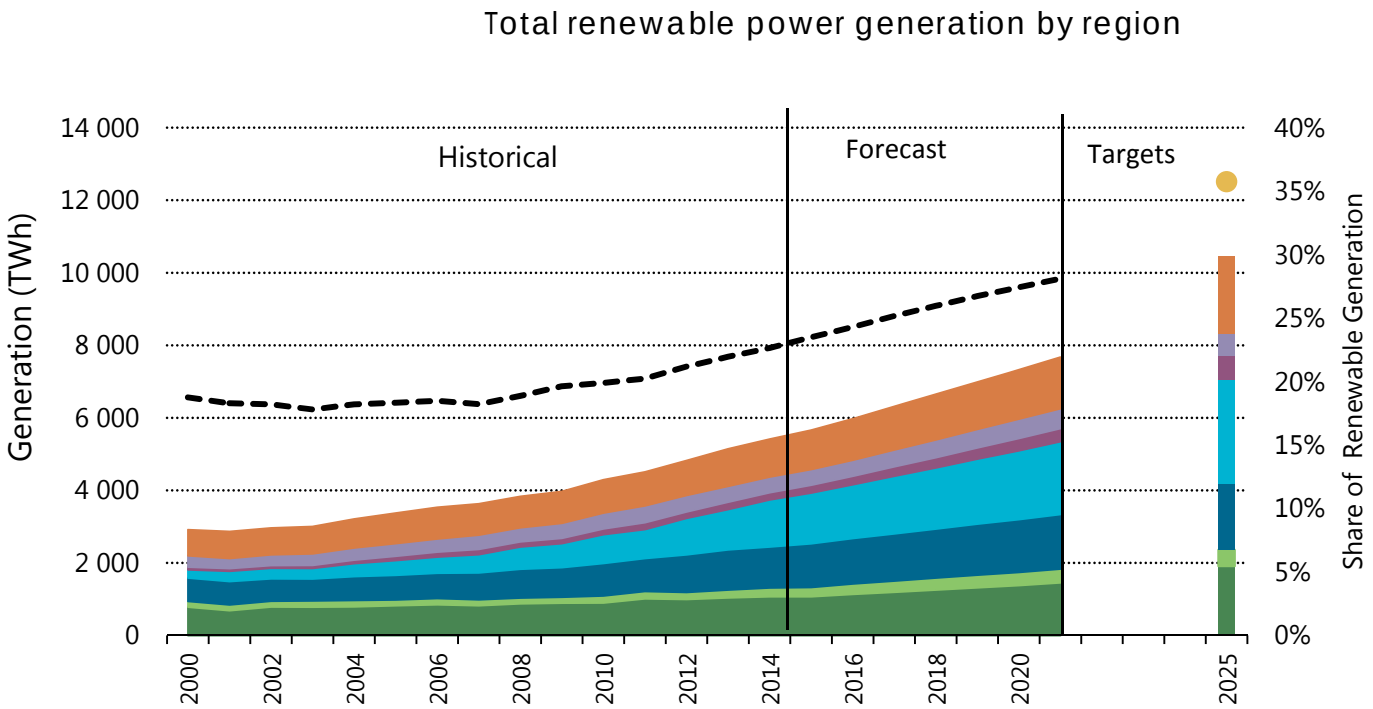
The global PEV car stock has reached 2 million units in circulation last year, but sales growth went from 70% last year to 40% this year, suggesting an increasing risk to start diverging from a 2DS trajectory.

Solar PV and Wind are still leading the transition…



Solar PV and onshore wind electricity generation are expected to grow by 2.5 times and by 1.7 times, respectively, over 2015-20.

… but can't make up for other low-carbon generation sources



While renewable power additions keep breaking records, they need to grow much faster to reach the 2DS electricity generation targets. Progress on early-stage technologies also needs to accelerate.

Outline

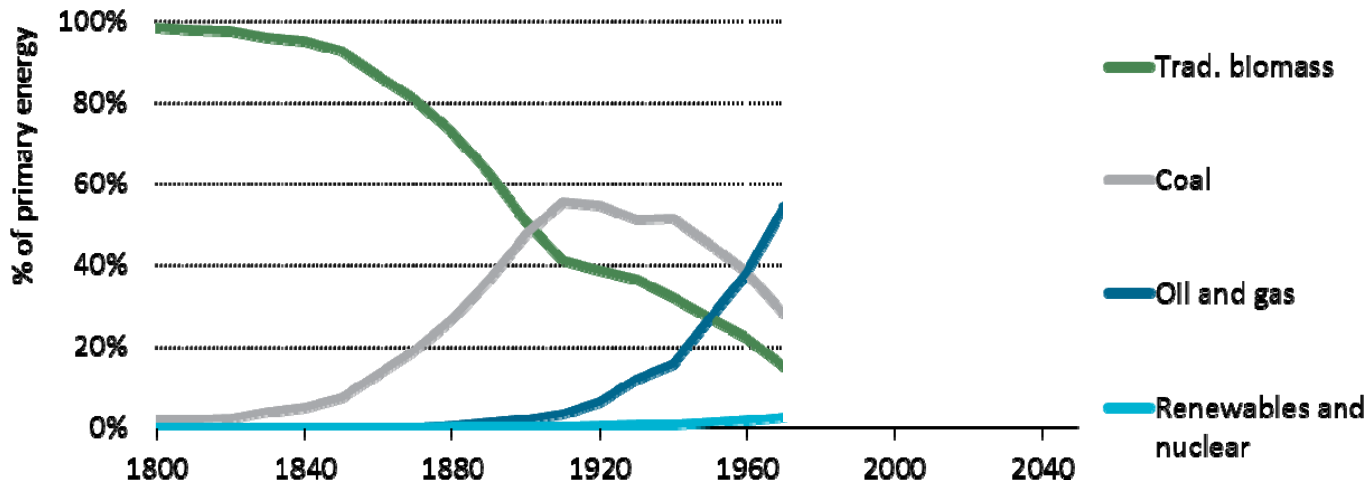
1. IEA & some key energy trends
2. ETP energy modelling
3. Energy Technology Perspectives 2017

Outline

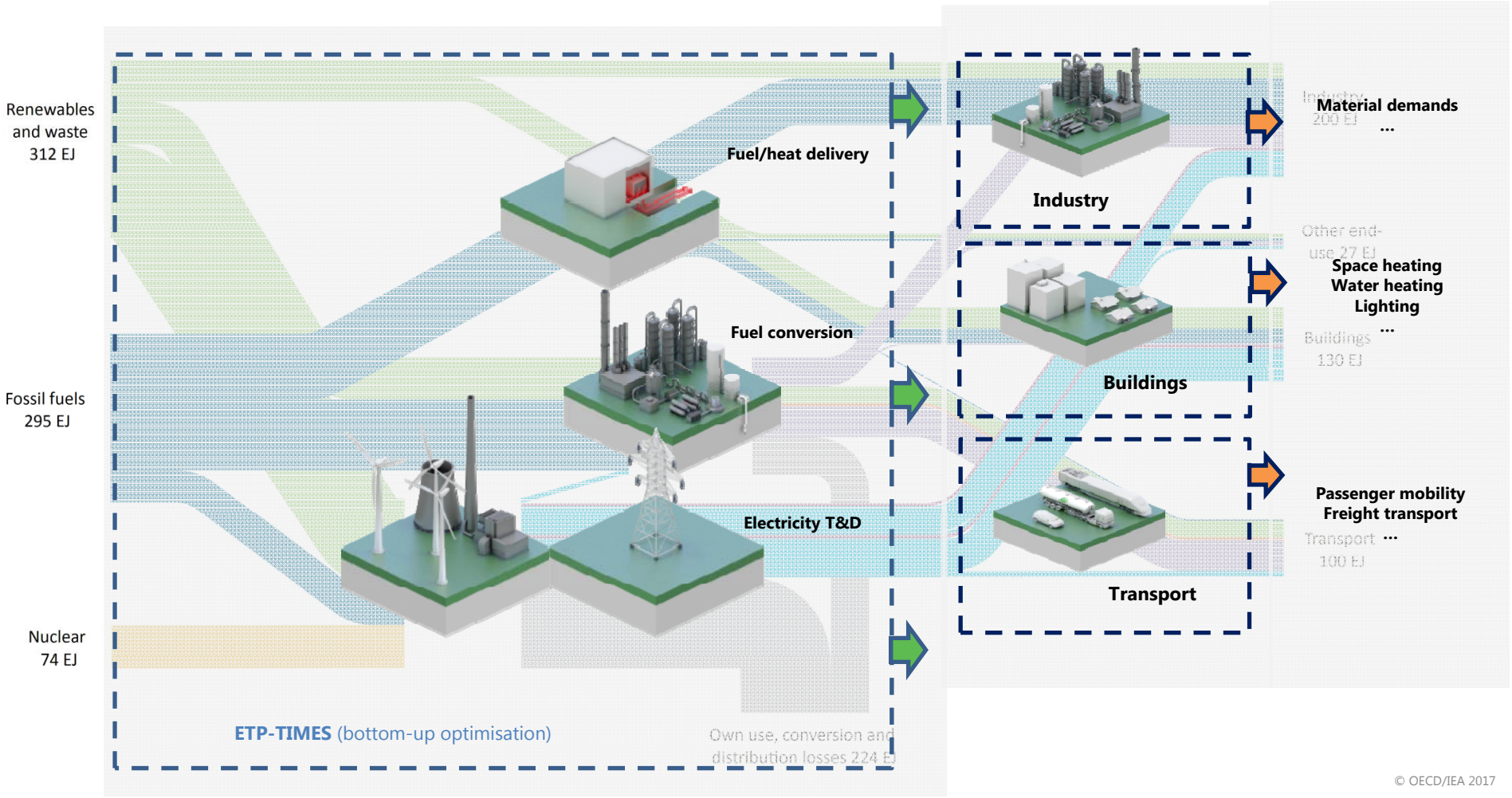
1. IEA & some key energy trends
2. ETP energy modelling
3. Energy Technology Perspectives 2017

The global challenge: Climbing down the mountain

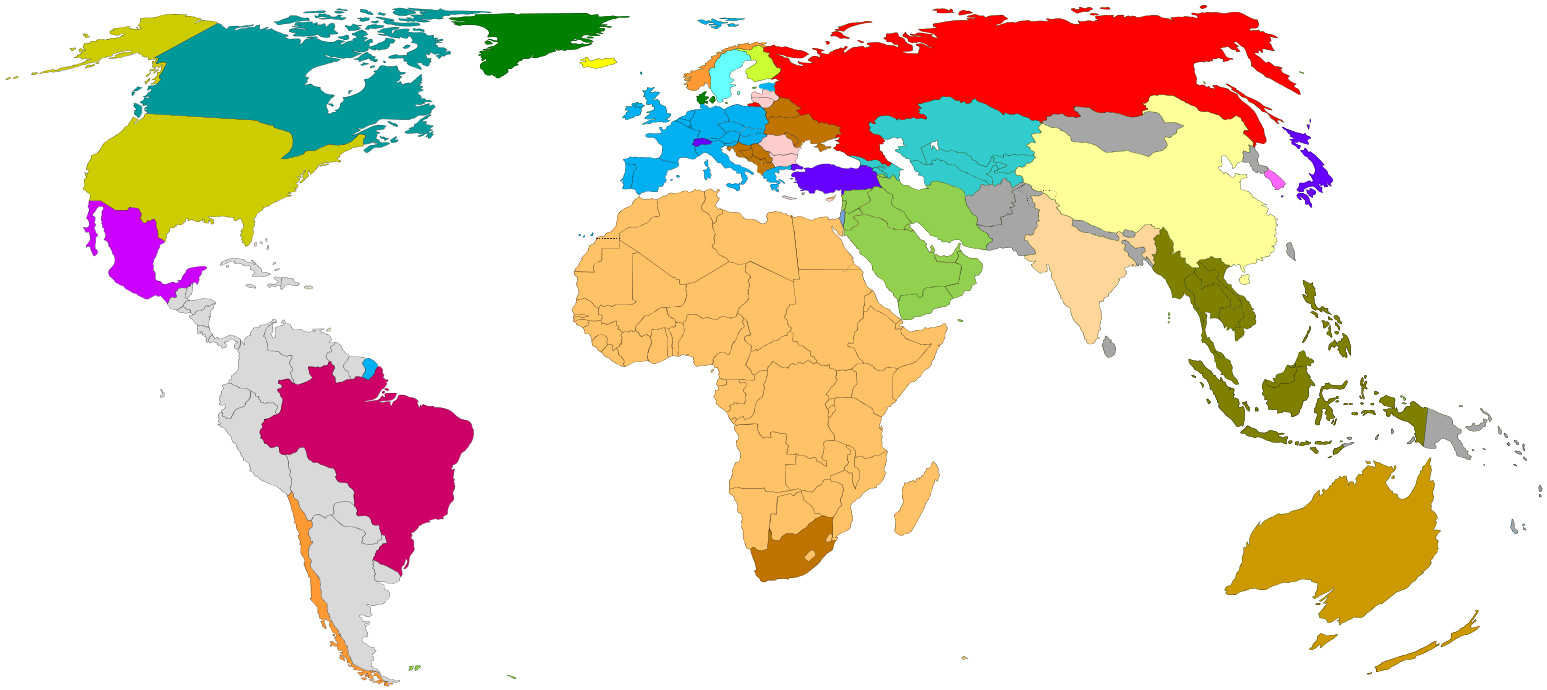
And technology transitions in the energy sector are slow



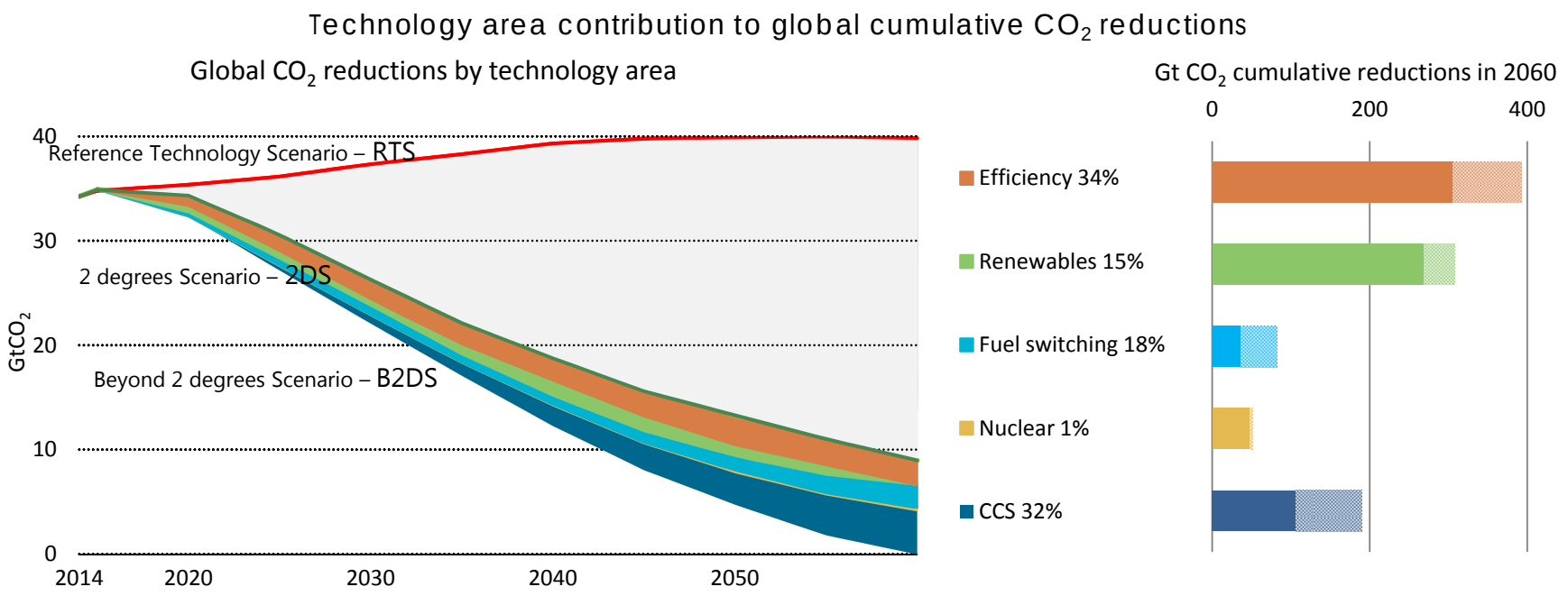
Data from Smil (2010) and IEA (2015), 2DS scenario



From now to 2060, in 28-36 regions around the world

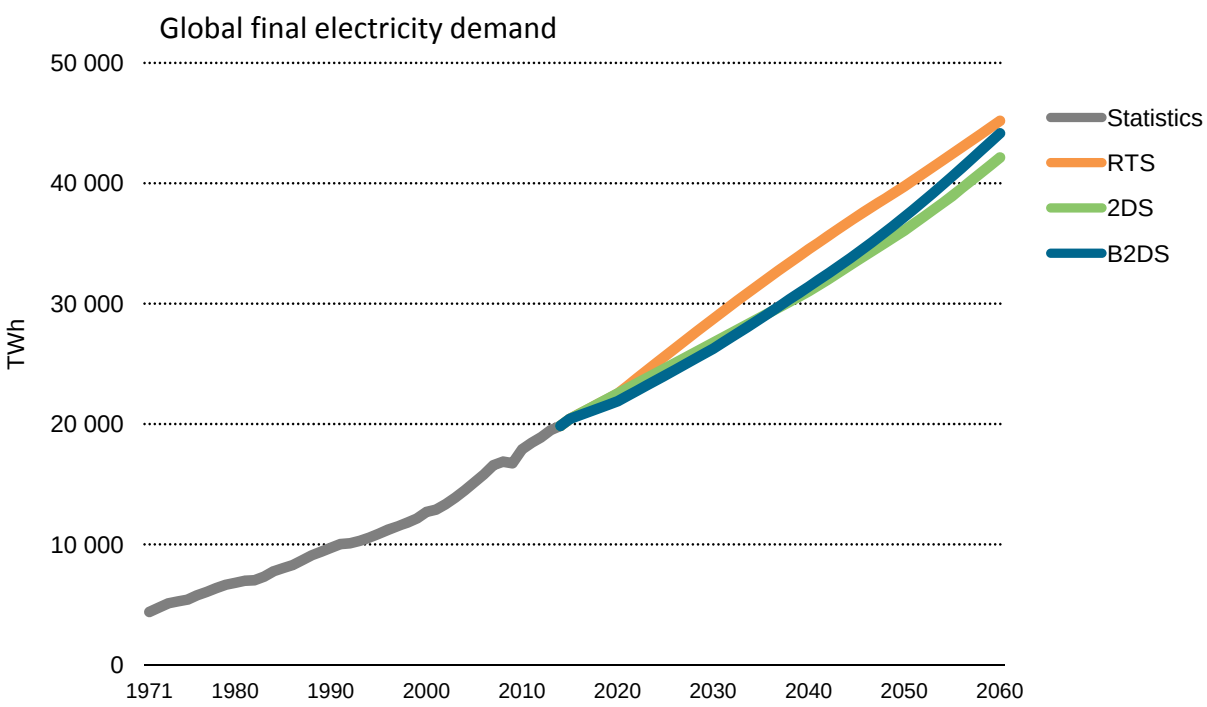


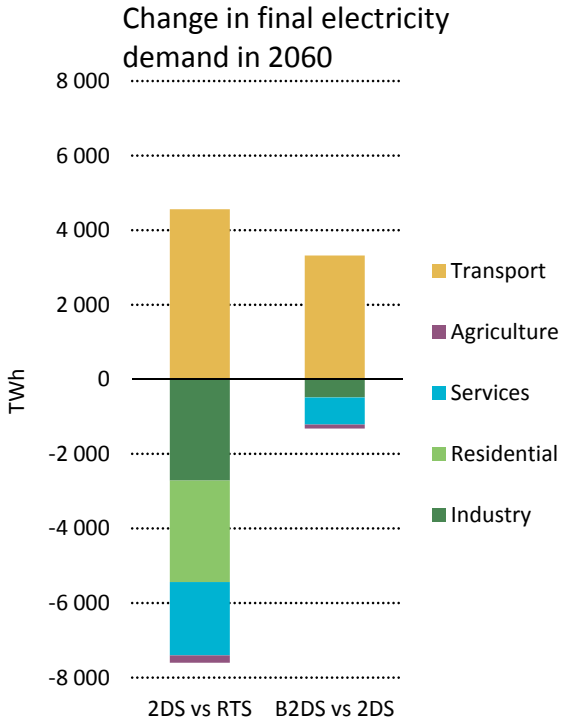
How far can technology take us?



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

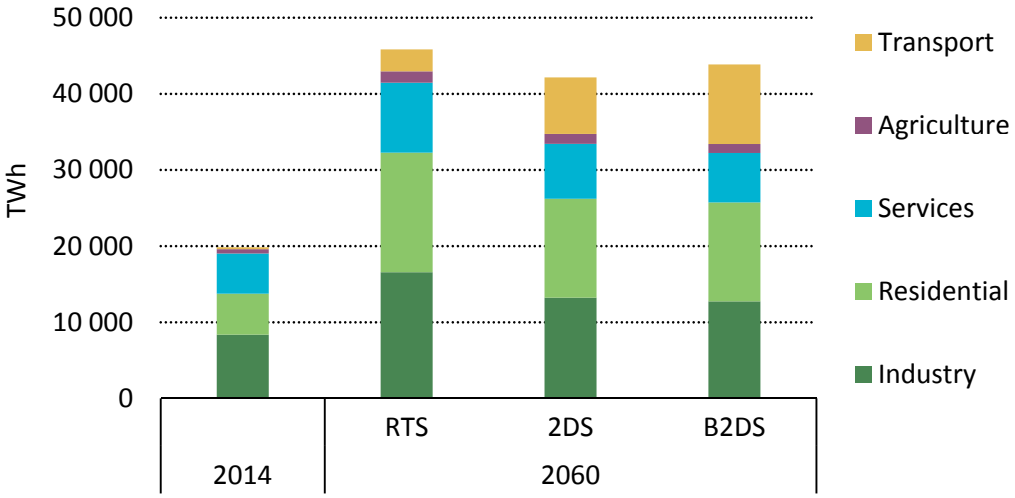
The future is electric

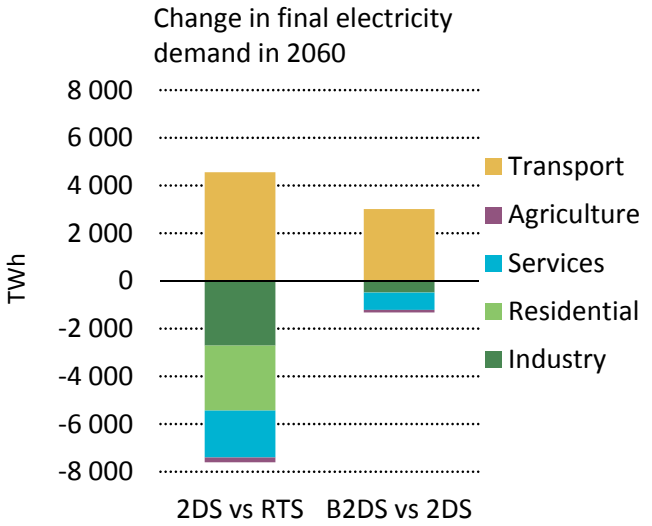




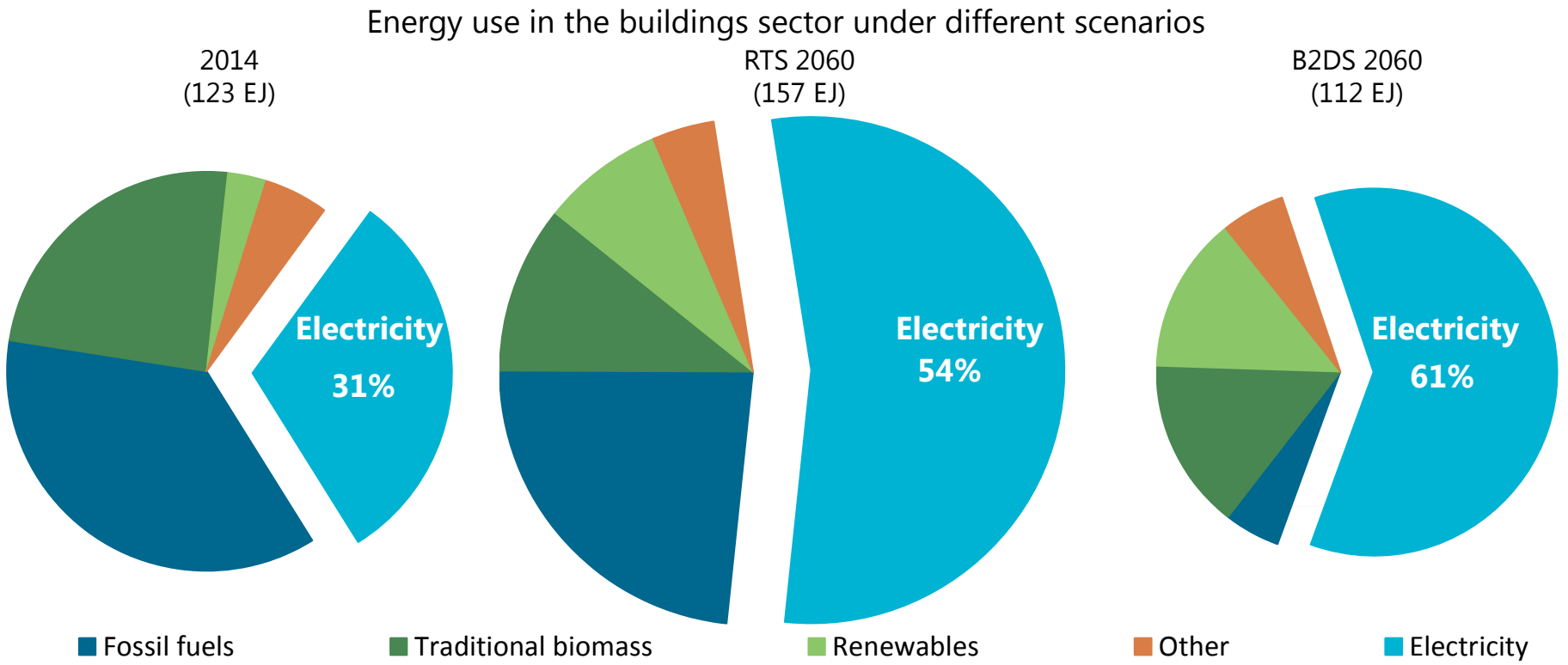
Electricity becomes on a global level the largest final energy carrier in the 2DS and B2DS, with the electricity share in final energy use more than doubling compared to today, up to 41% in the B2DS in 2060.

Electricity demand



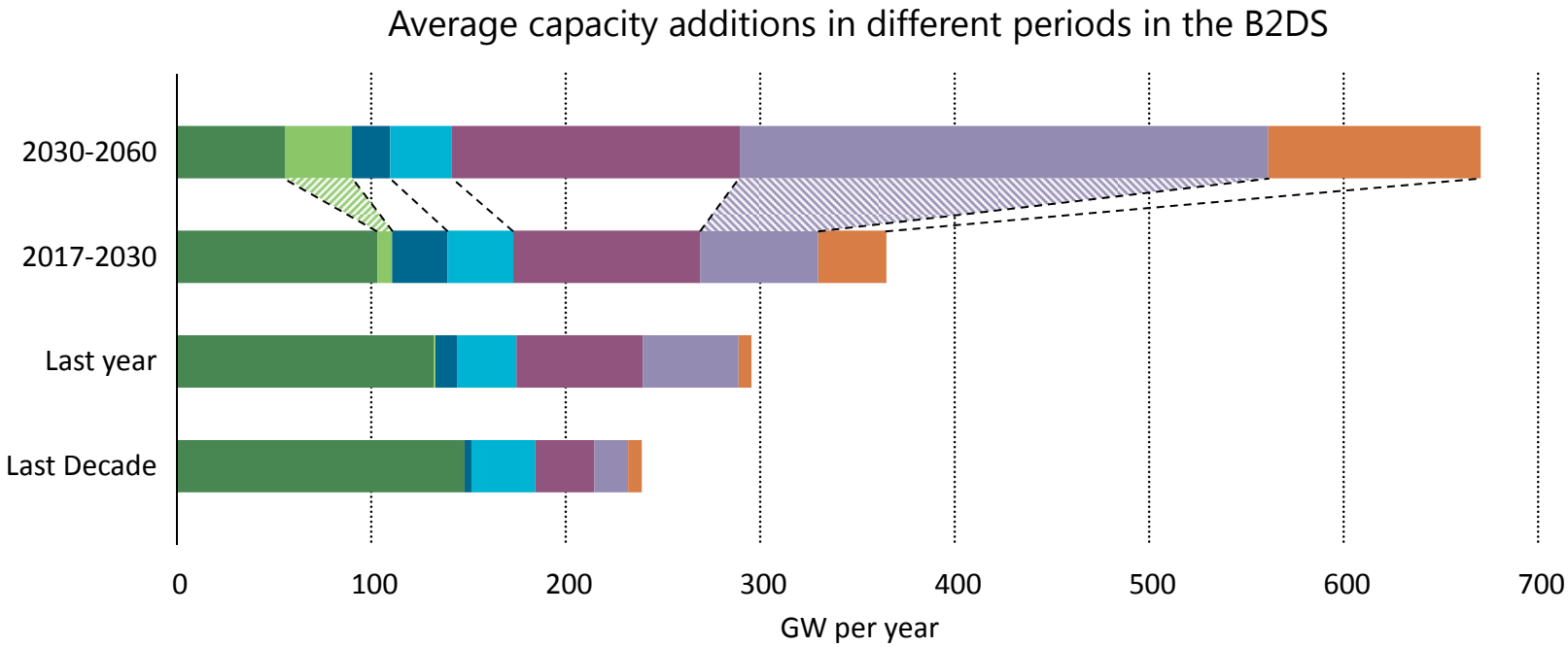


Enhanced energy efficiency in buildings



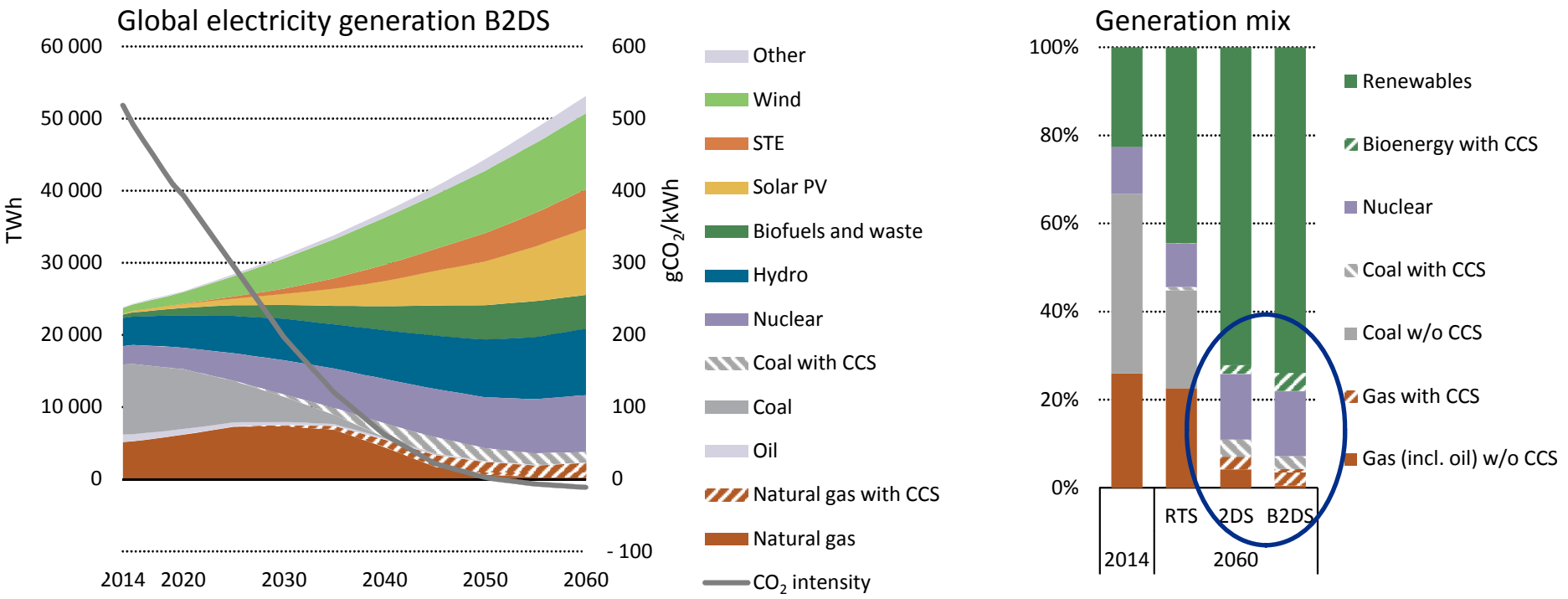
Efficiency technologies can provide the same level of comfort while reducing energy demand despite doubling floor area.

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



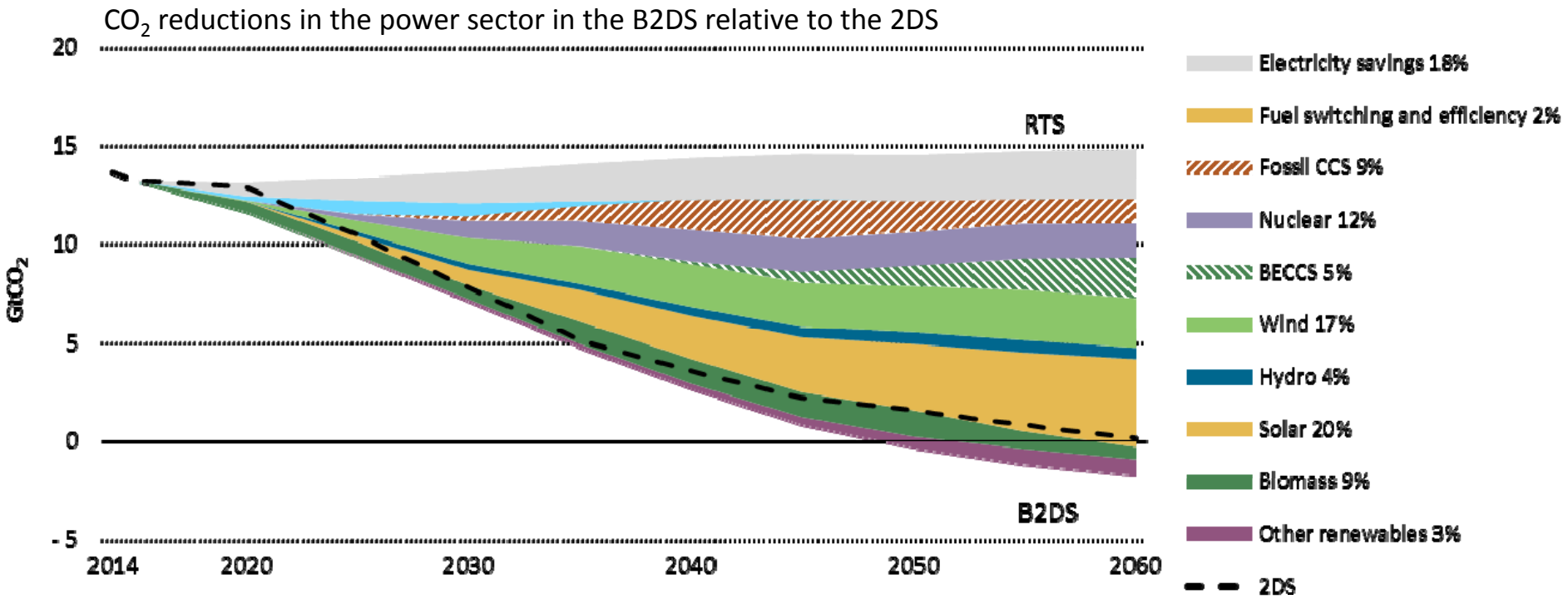
Recent successes in solar and wind
will have to be extended to all low-carbon solutions, and brought to a scale never experienced before.

Decarbonising electricity



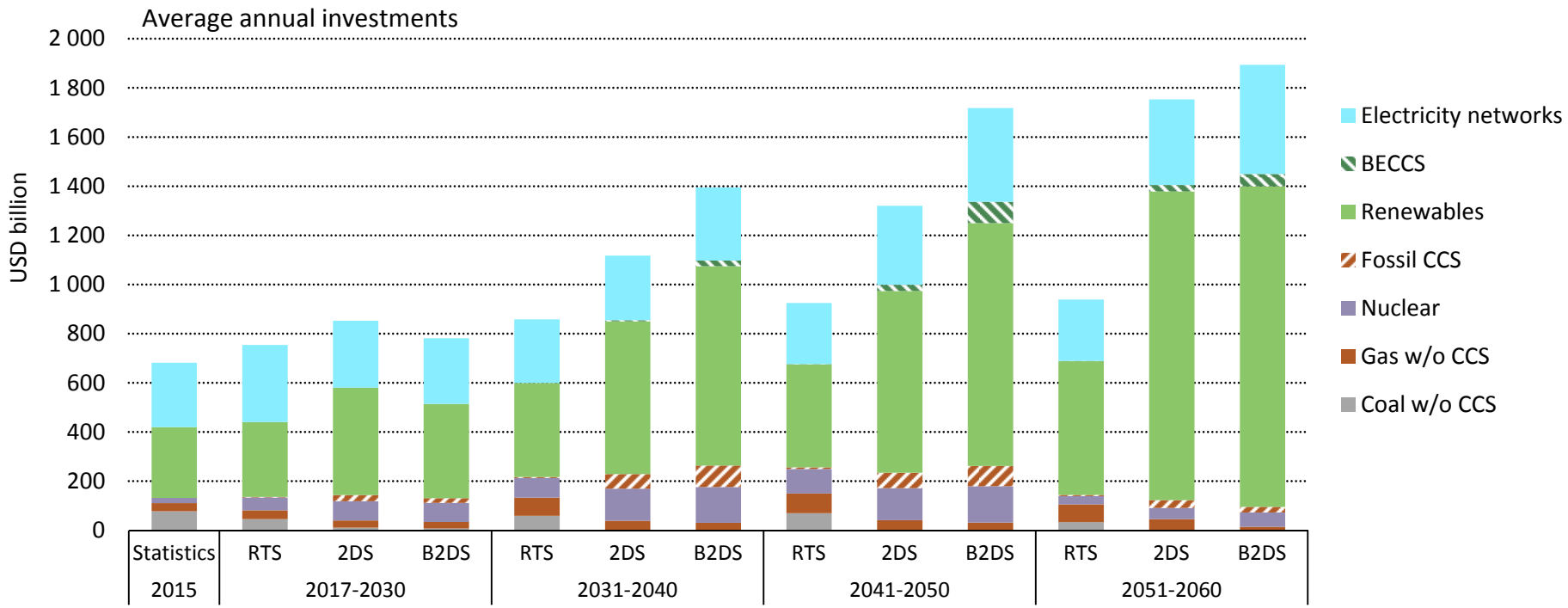
Renewables dominate electricity generation in the 2DS and B2DS. Thanks to bioenergy with CCS, the average global CO_2 intensity falls below zero after 2050.

Power sector key for deep decarbonisation of the energy system



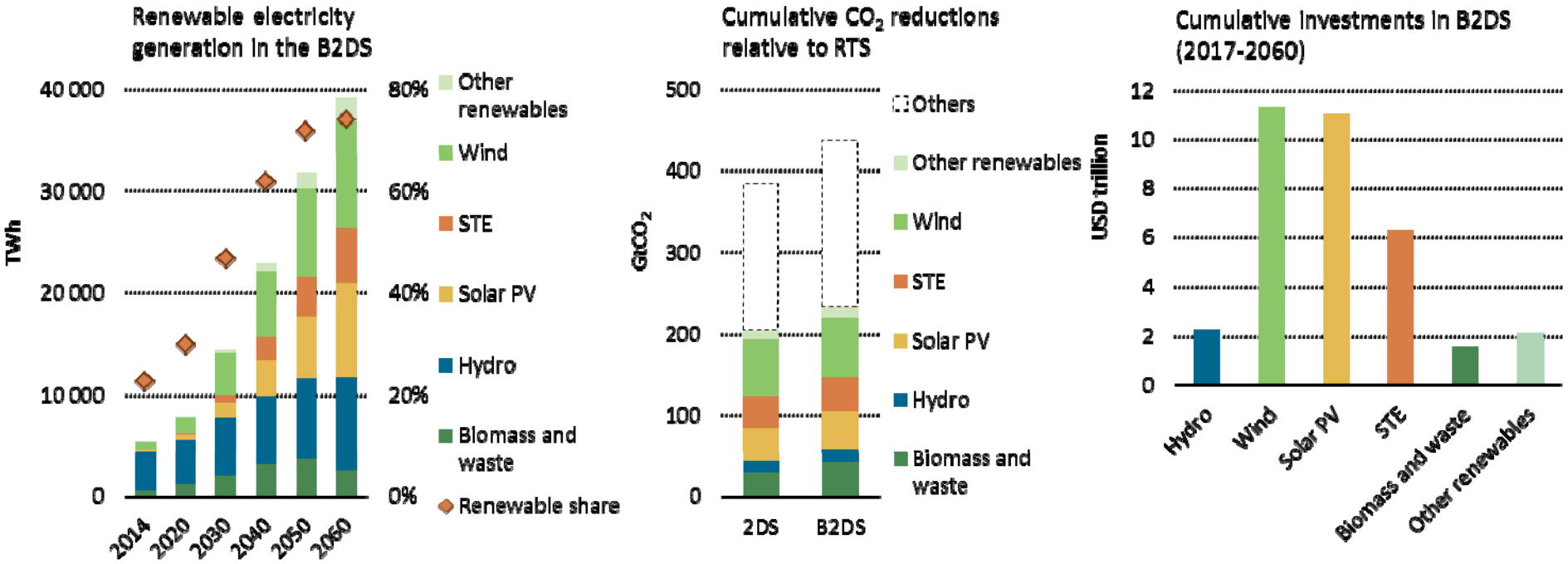
The power sector provides around 40% of the cumulative CO_2 reductions across all sectors to move from the RTS to the B2DS, with renewables being responsible for more than half of the reductions in the power sector.

How much investments are needed in the power sector?



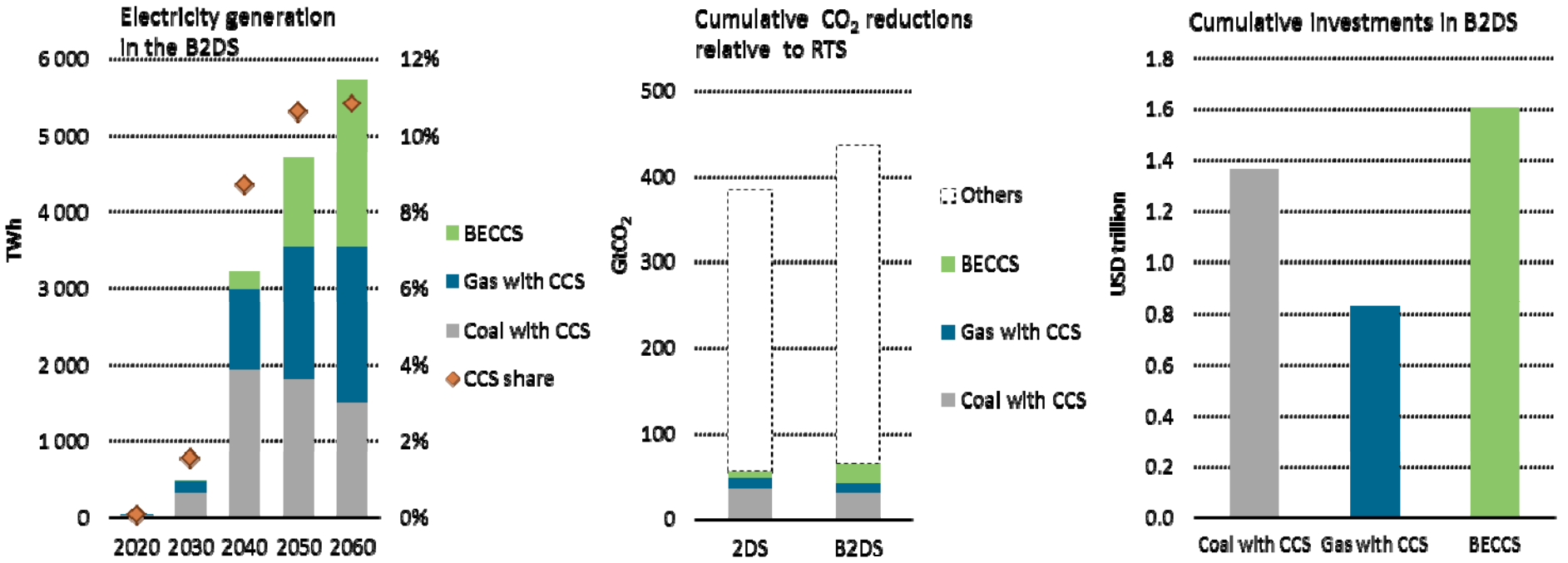
Total investments of USD 65 trillion are needed in the B2DS in the power sector, an increase of USD 23 trillion compared to the RTS and USD 6 trillion to the 2DS.

Renewables: Becoming the dominant electricity source



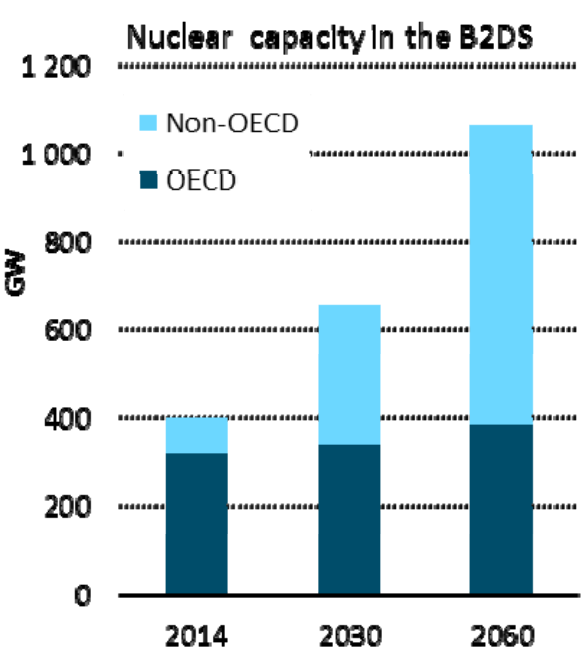
Renewables cover almost 75% of all electricity demand in 2060, account for 53% of the cumulative power sector CO_2 reductions in the B2DS and require 78% of the cumulative investment needs for power generation.

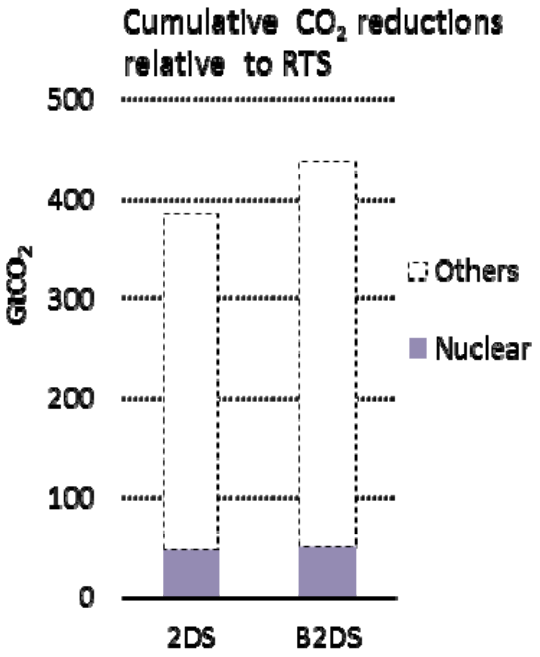
CCS: Slow progress today, but huge potential in the future

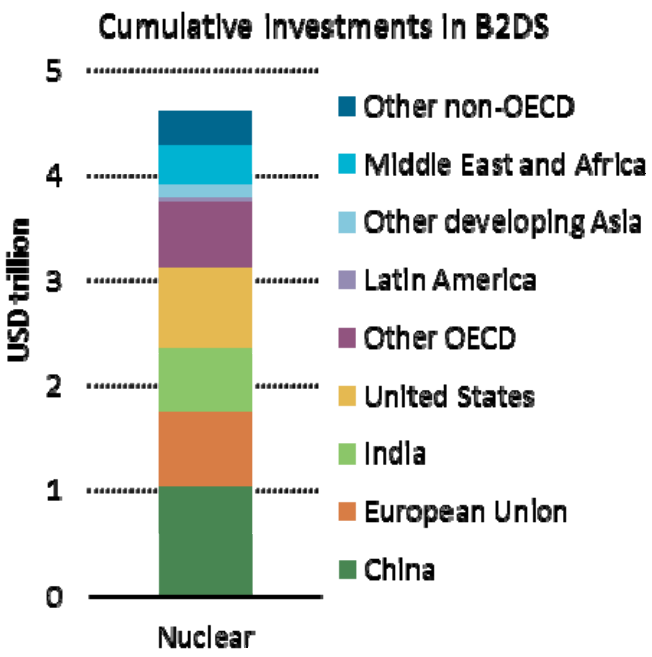


CCS provides 20% of the cumulative CO_2 reductions in the B2DS (relative to the RTS), with BECCS accounting for more than 40% of the cumulative reductions from CCS and for half of the CCS investment.

Nuclear: Doubling of global capacity in the B2DS



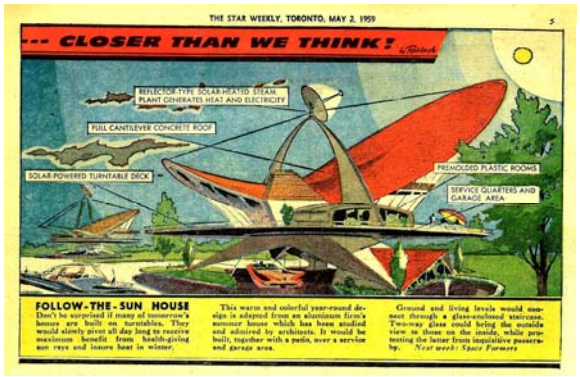




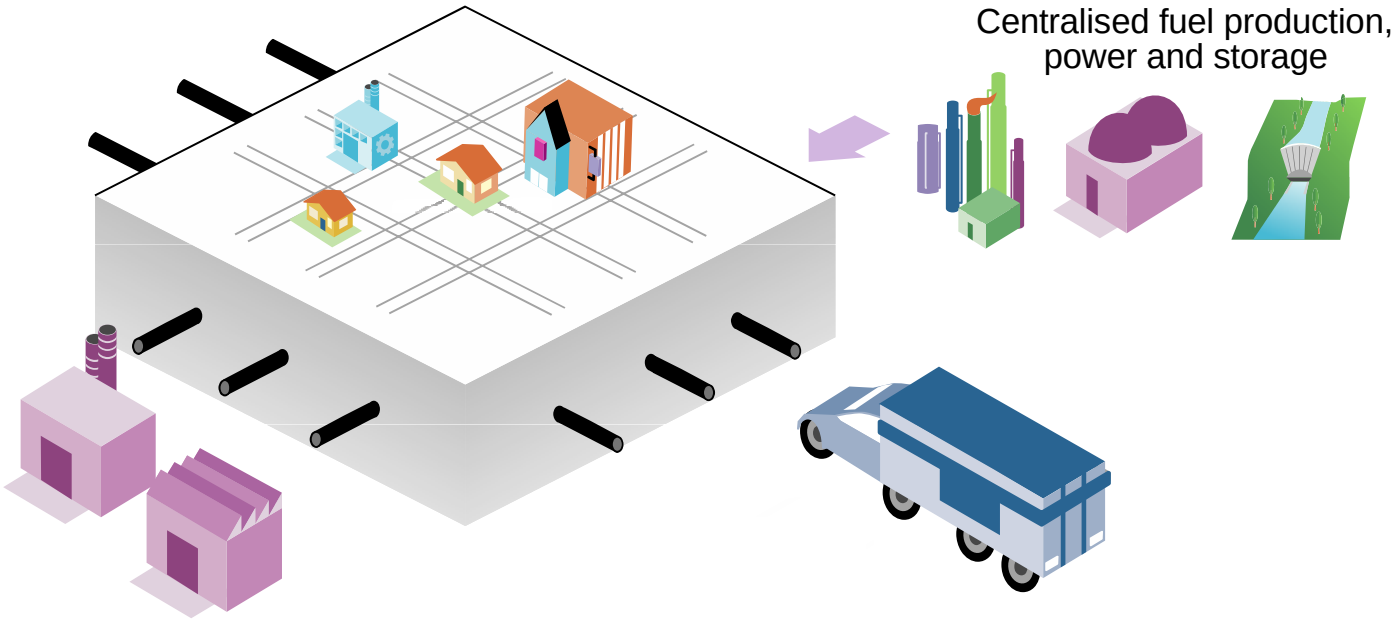
With its share reaching 15% by 2060 in the B2DS, nuclear provides around 10% of the cumulative CO_2 reductions to move from the RTS to the B2DS and requires 5% of the power sector investments in the B2DS.

Infrastructure needs for the transformation

1959 → **2014** → **2060?**

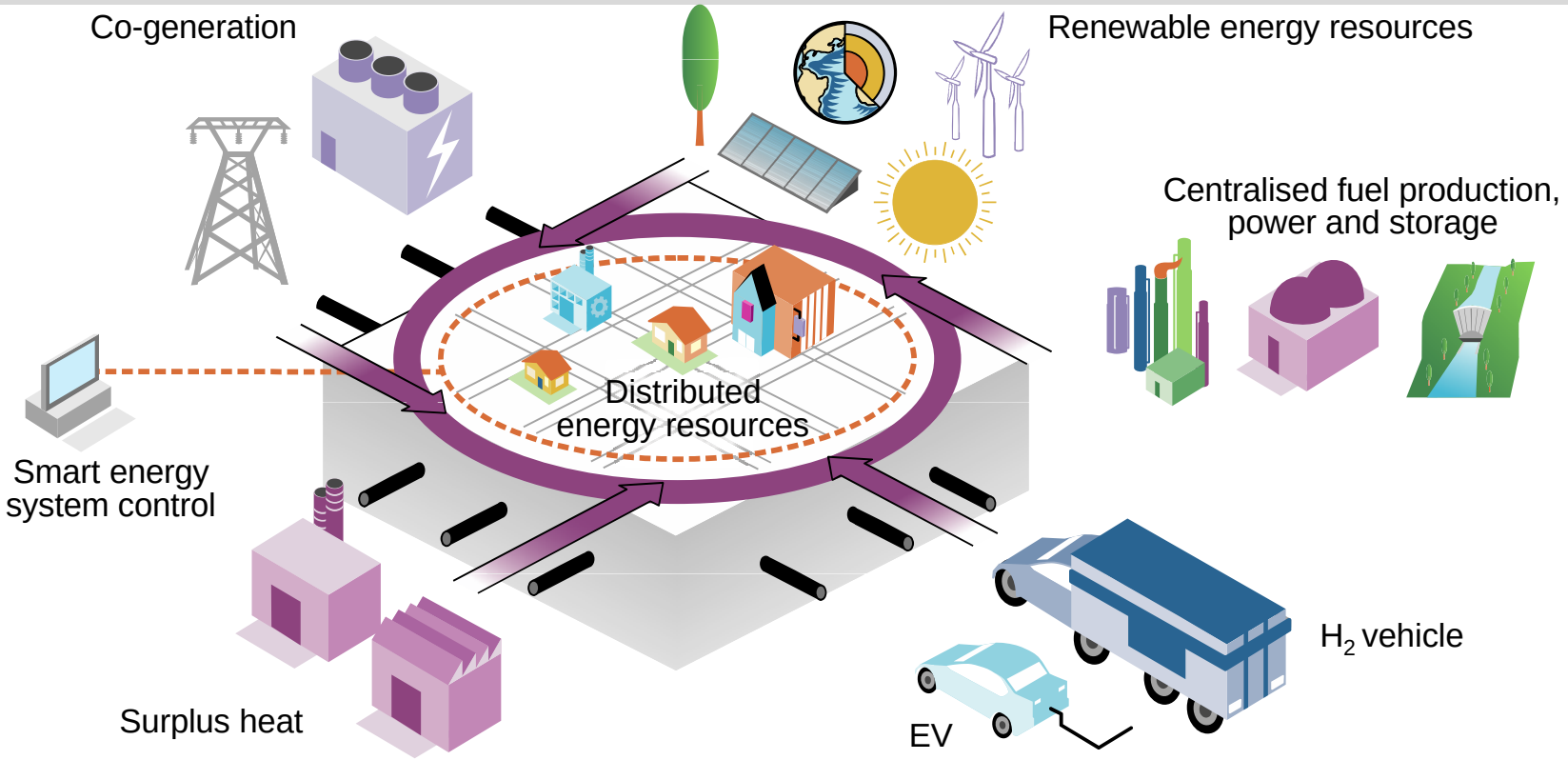


Systems Integration is essential for a sustainable energy future



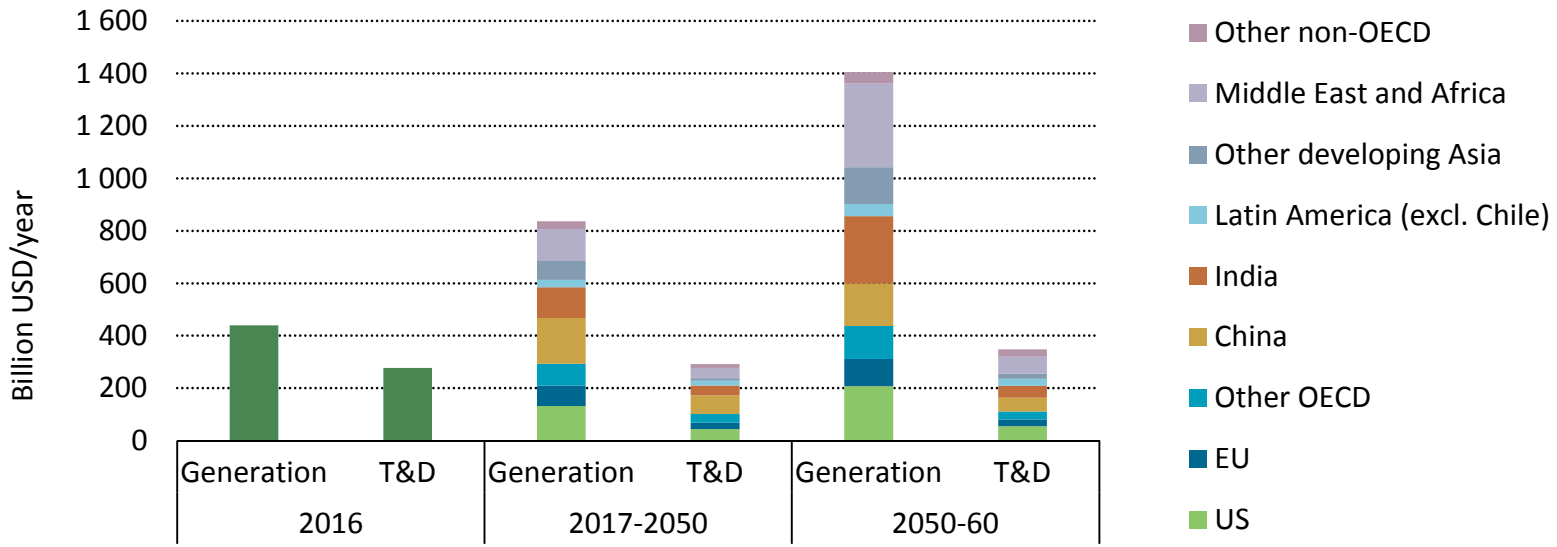
We need to move away from a one-directional energy delivery philosophy

Systems Integration is essential for a sustainable energy future



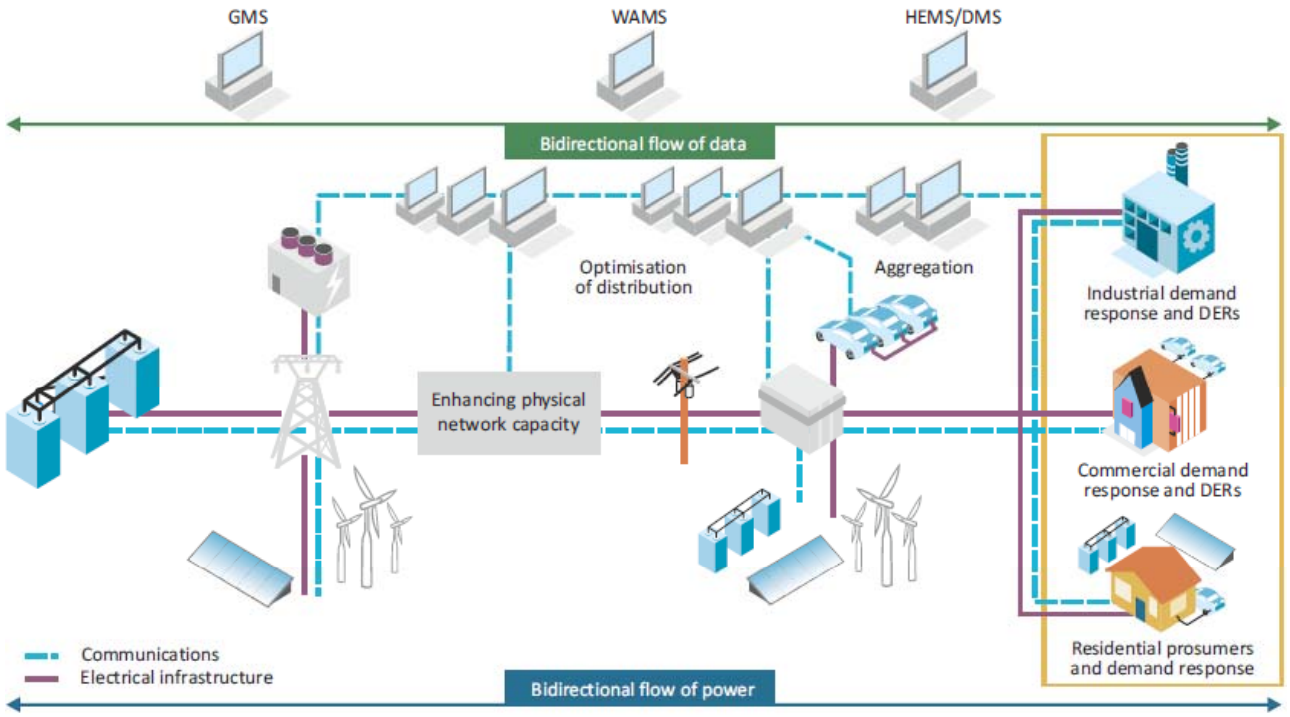
We need to move away from a one-directional energy delivery philosophy to a digitally-enhanced, multidirectional and integrated system that requires long-term planning for services delivery.

A different need for power sector infrastructure in deep decarbonisation scenarios

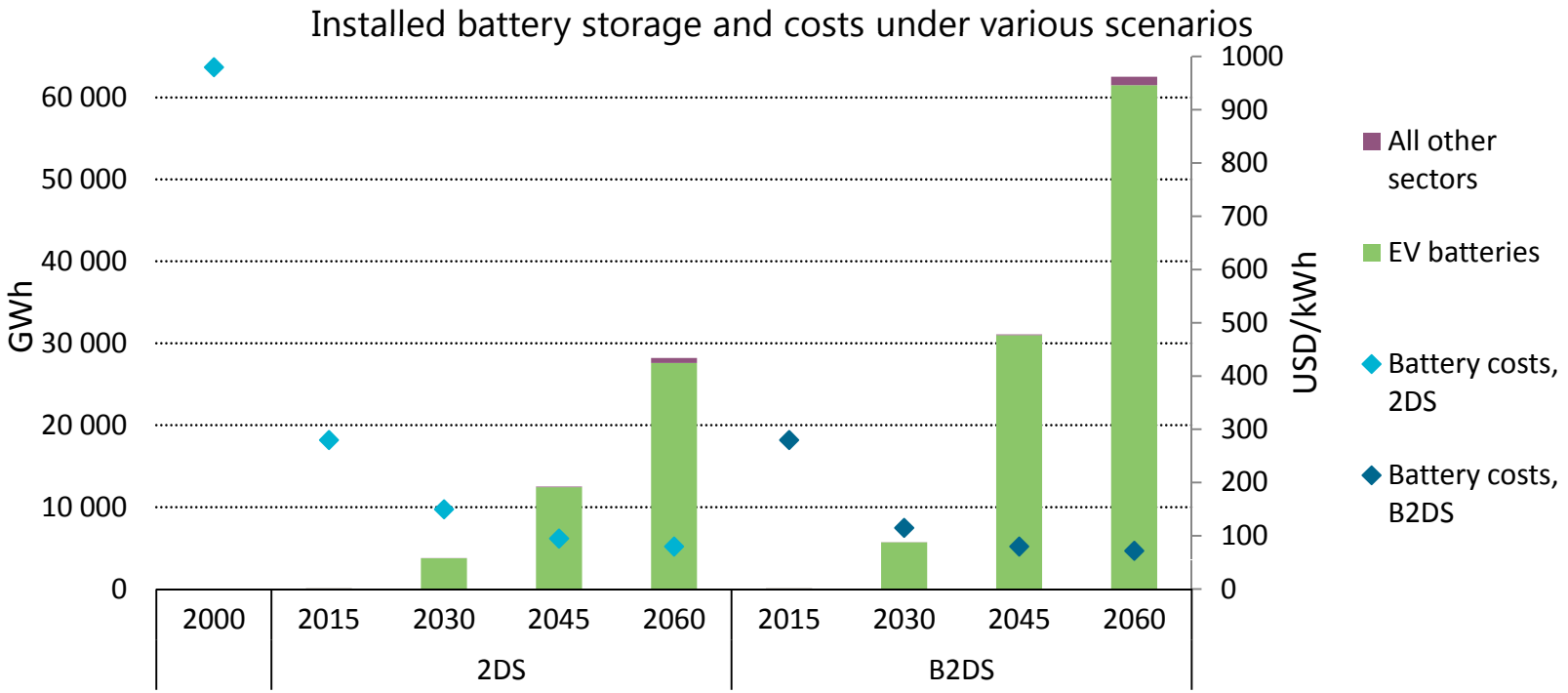


Investments in power sector infrastructure accelerate in the final decade to 2060

Where distribution networks are hubs for smartness and integration

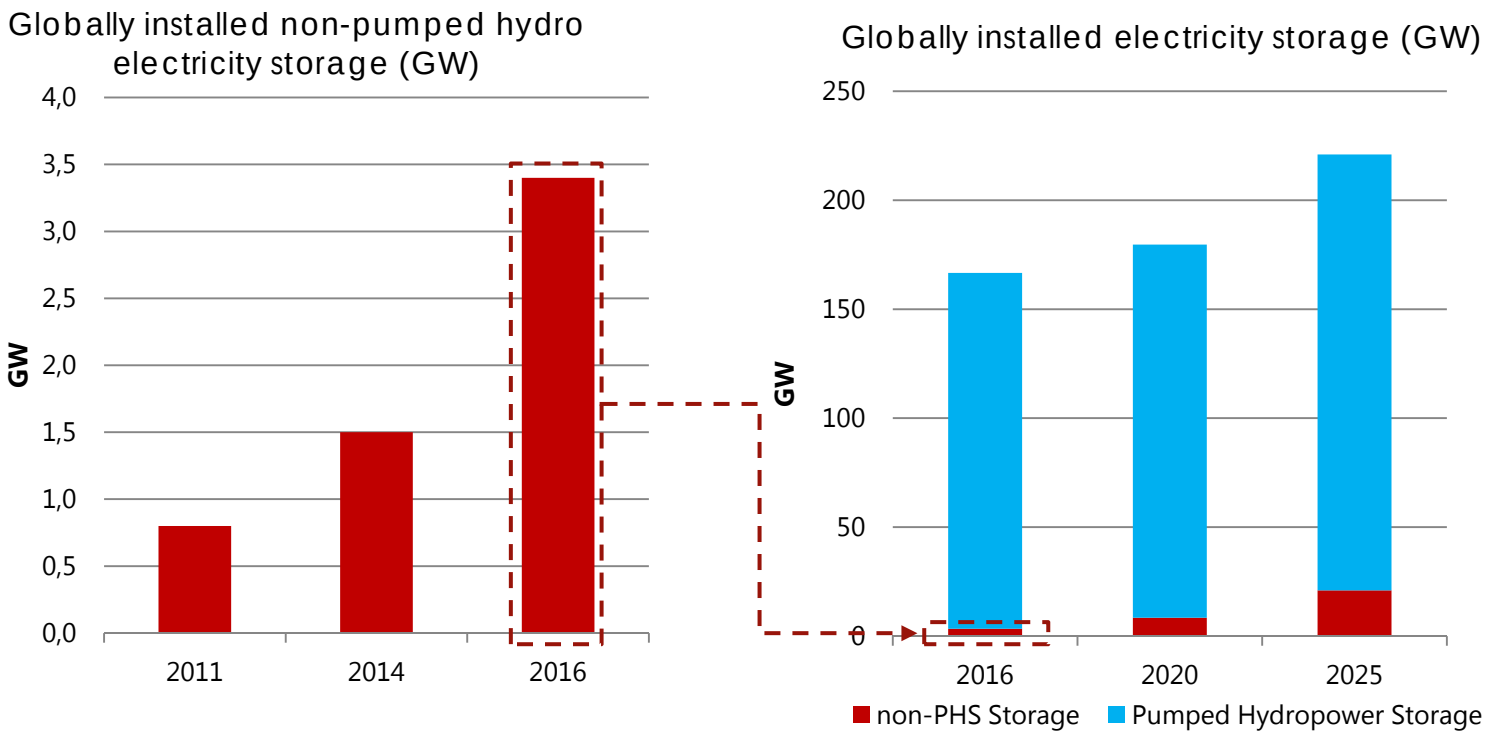


Infrastructure becomes more distributed



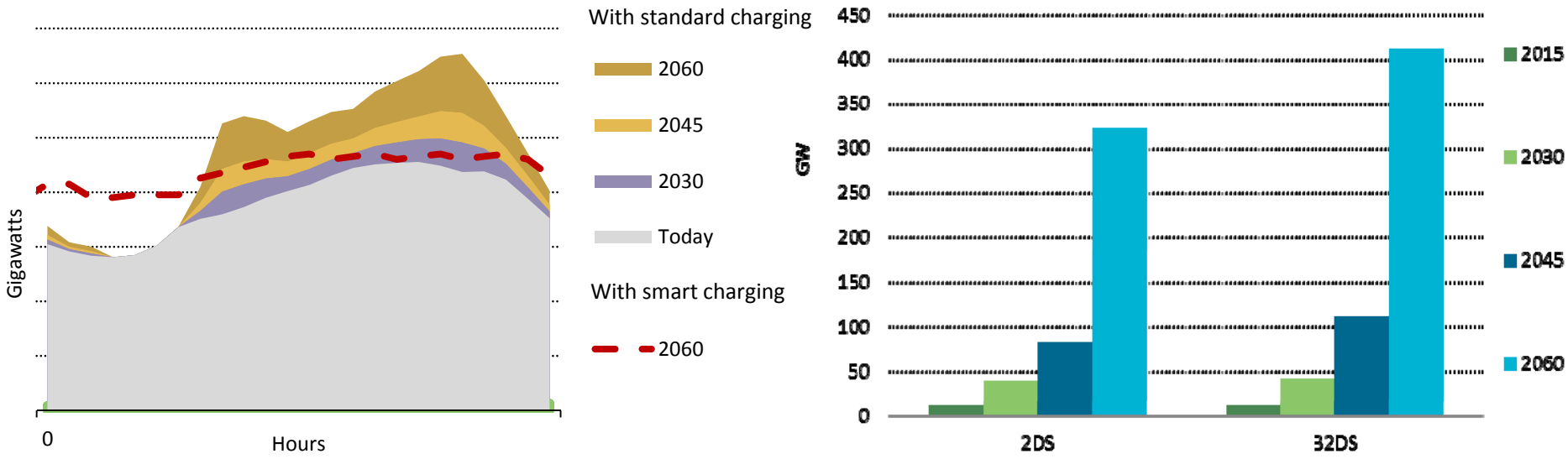
Batteries experience a huge scale-up in the B2DS, with EV battery markets leading other sectors in size

While the impact of storage could be disruptive, it remains highly uncertain



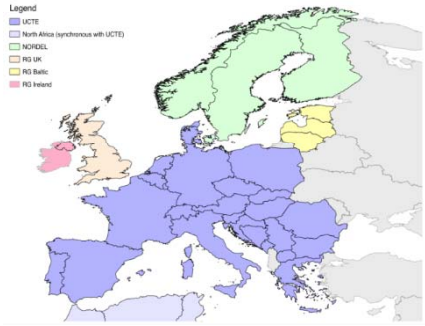
Positive market and policy trends supported a year-on-year growth of over 50% for non-pumped hydro storage
But near-term storage needs will remain largely answered by existing or planned pumped hydro capacity

Smart infrastructure can make demand part of the solution



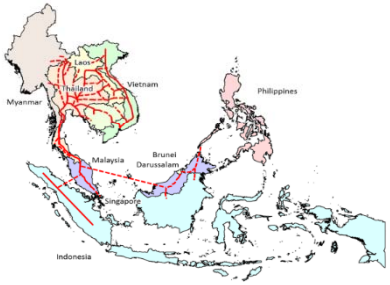
Smart EV charging infrastucture, smart meters and remote load control devices have a huge potential for low cost flexibility – but there are uncertainties on diffusion and scale-up

Transmission investment needs to be scaled up, particularly international interconnectors

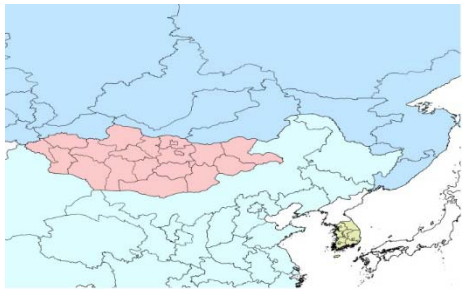


Europe and North Africa

Central America



South East Asia

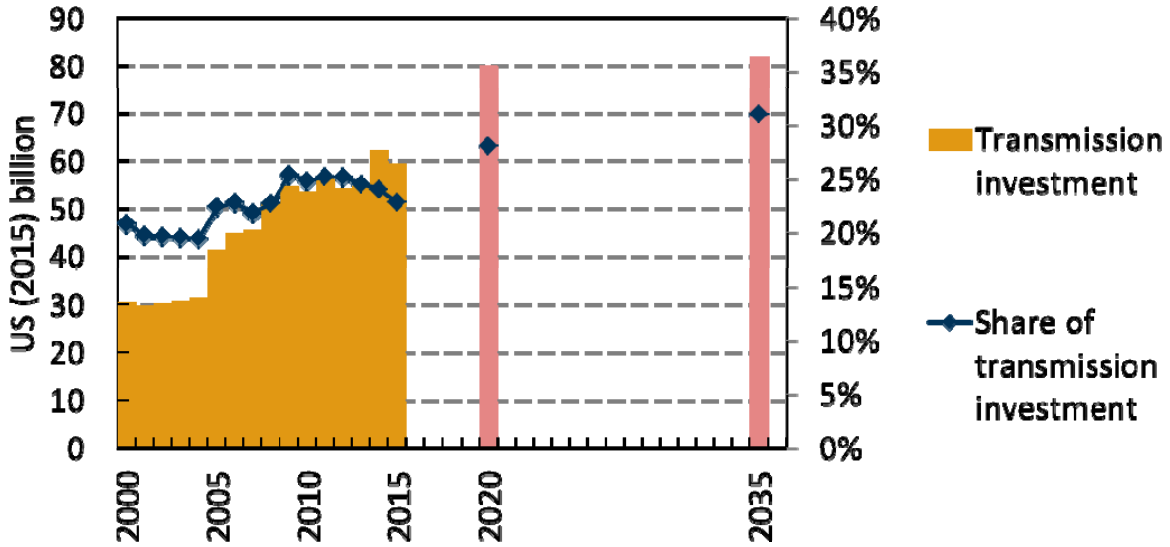


North East Asia

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area

Rigorous analysis of current technology and potential deployment trends in key regions

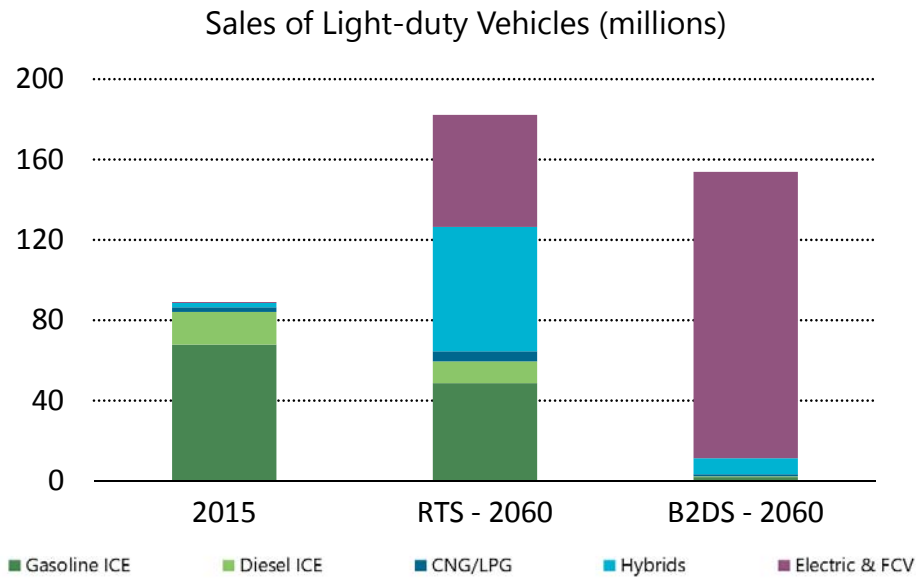
Transmission investment needs to be scaled up, particularly international interconnectors

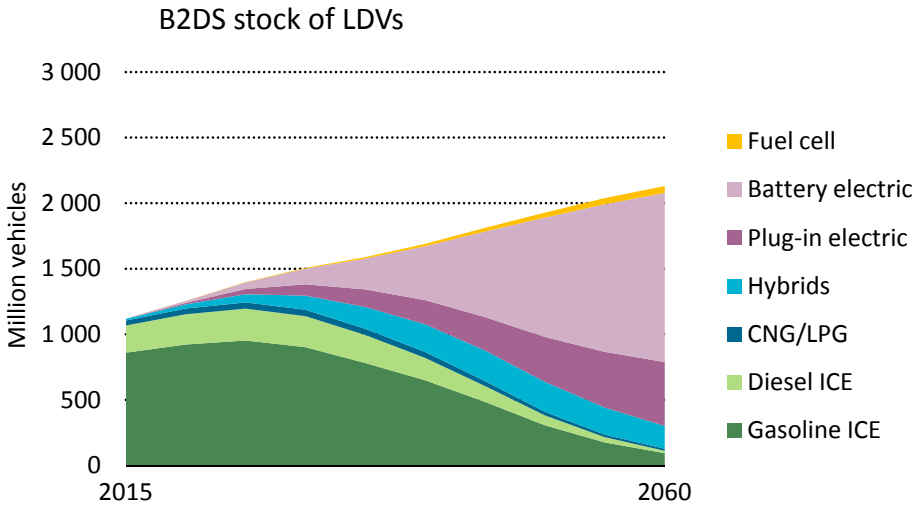


Transmission will account for 40% of all electricity grid investment needs; half of all transmission lines will have to be replaced between now and 2040

Can we change the landscape of transport ?

Vehicle sales and technology shares under different scenarios

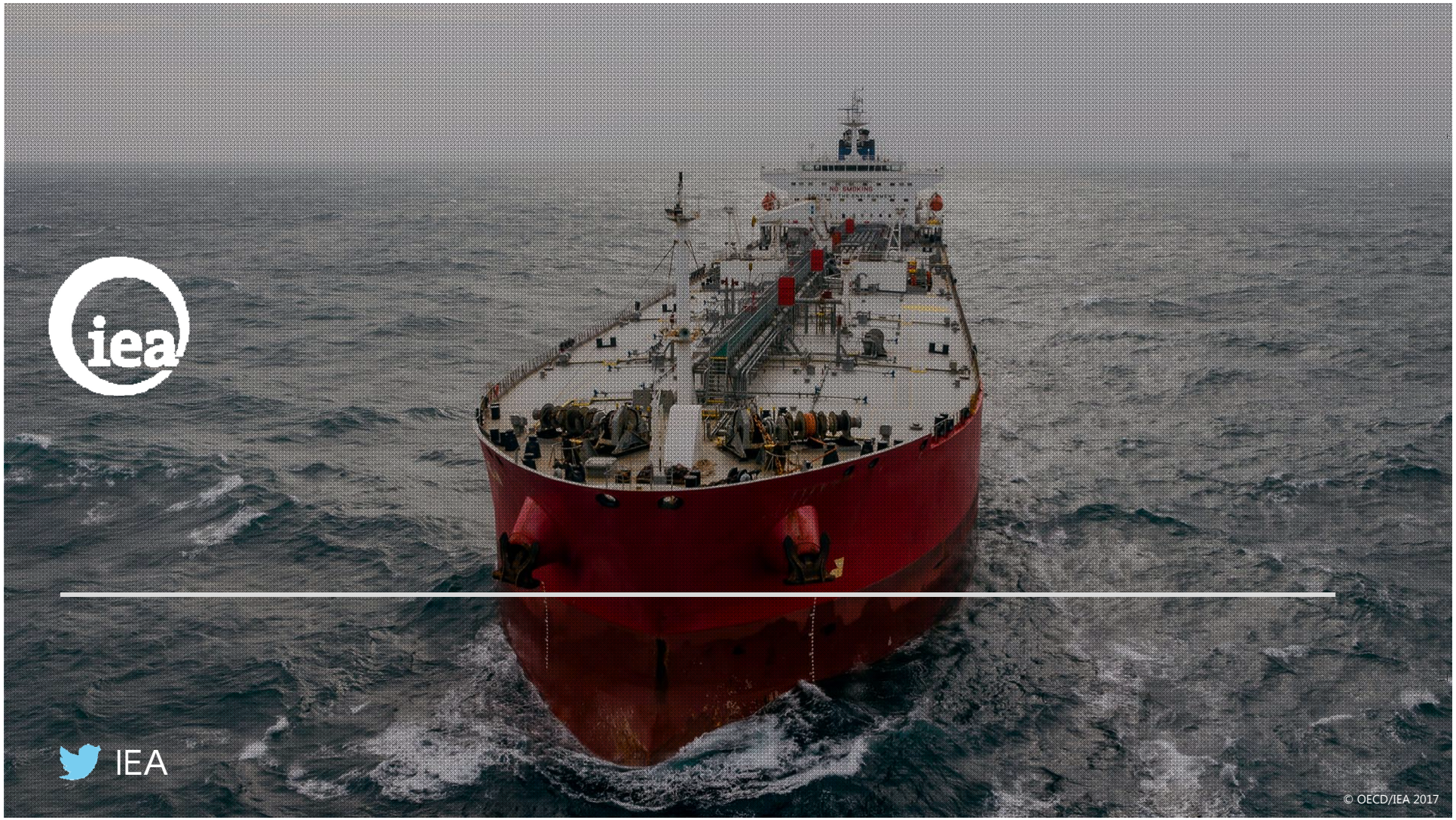




The transportation sector already experiences technological change, but won't shed its oil dependency without assertive policies

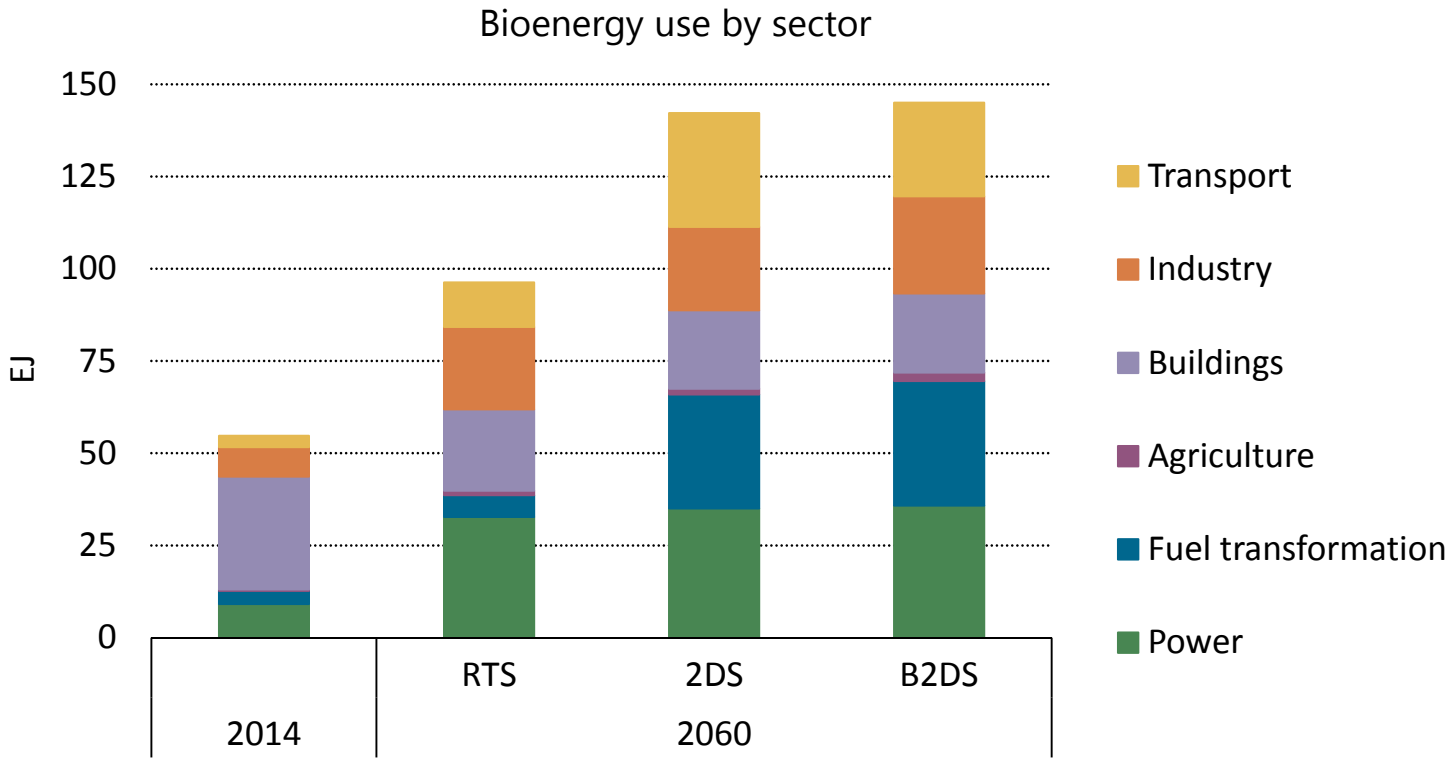
Heavy duty transport: no easy routes

Capillary lines are a mature technology than needs policy driven rollout whereas fuels cells still need innovation and R&D but less infrastructure



IEA

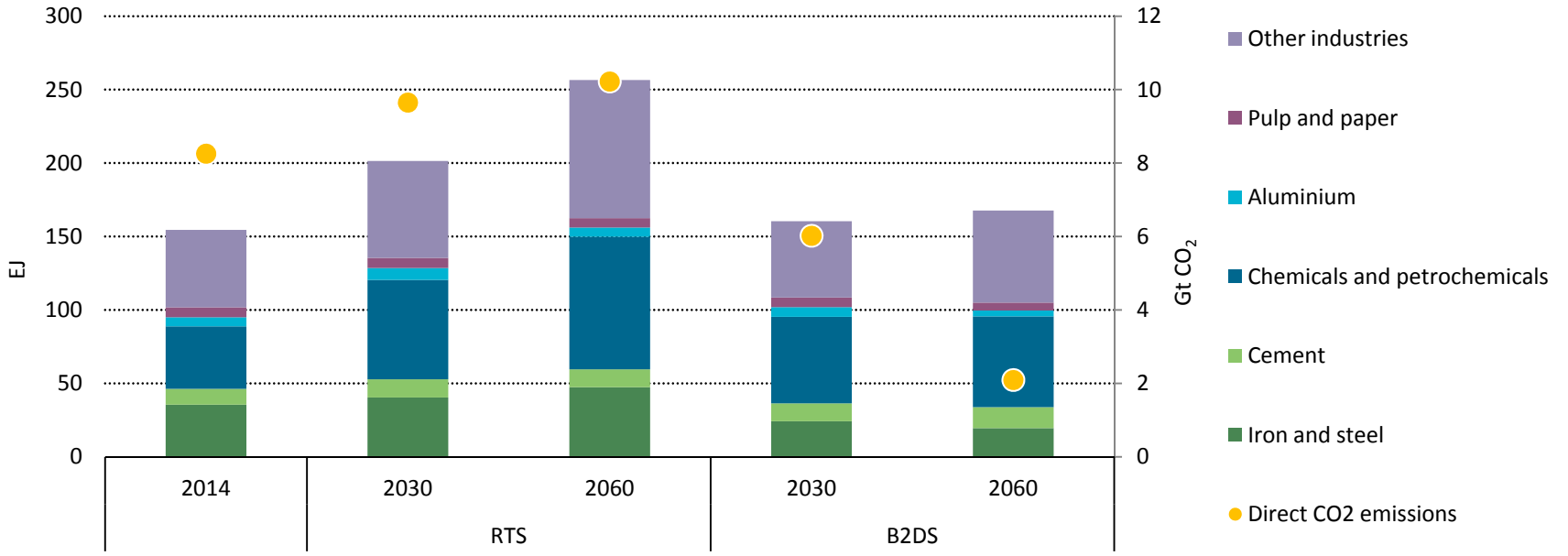
Can we produce enough sustainable biomass ?



Around 145 EJ of sustainable bioenergy is available by 2060 in all our decarbonisation scenarios, but gets used differently between the 2DS and the B2DS.

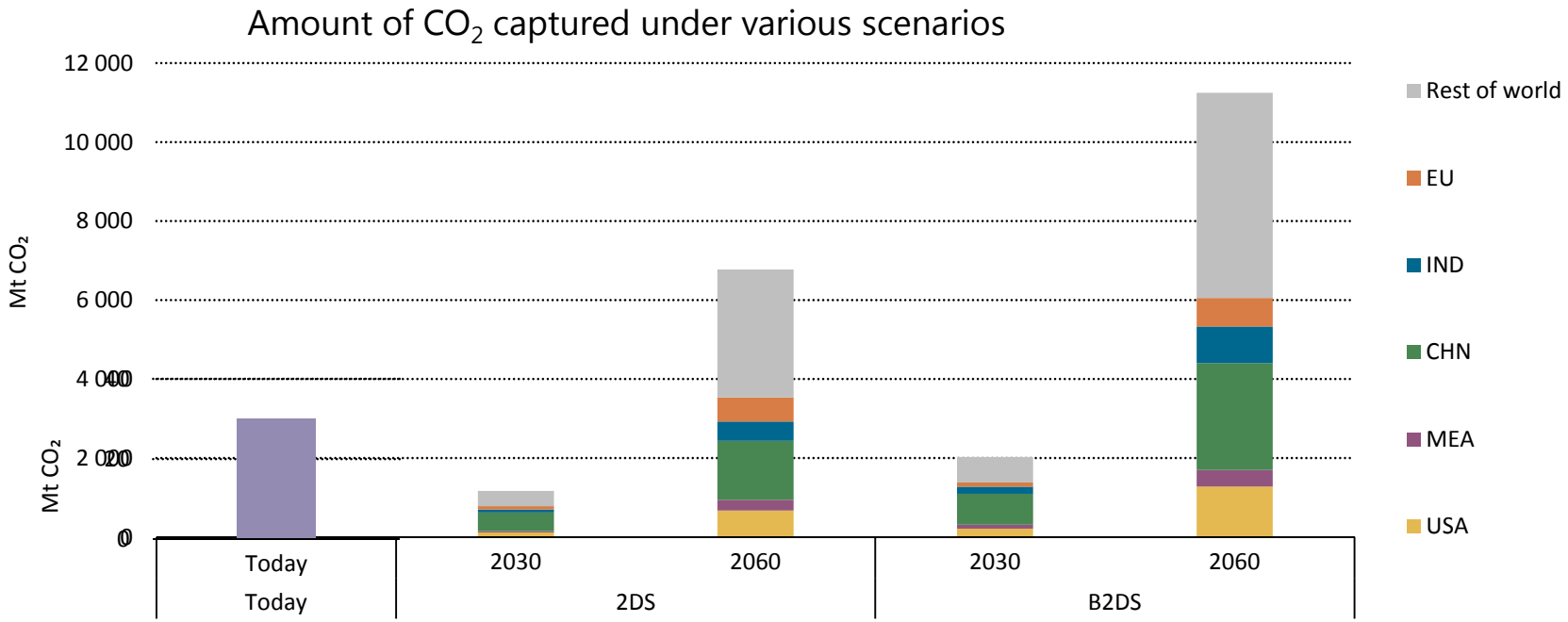
Can we produce materials more sustainably ?

Energy use and direct CO_2 emissions in various industrial sectors under different scenarios



Effective policies and public-private collaboration are needed to enable an extensive roll out of energy and material efficiency strategies as well as a suite of innovative technologies.

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.

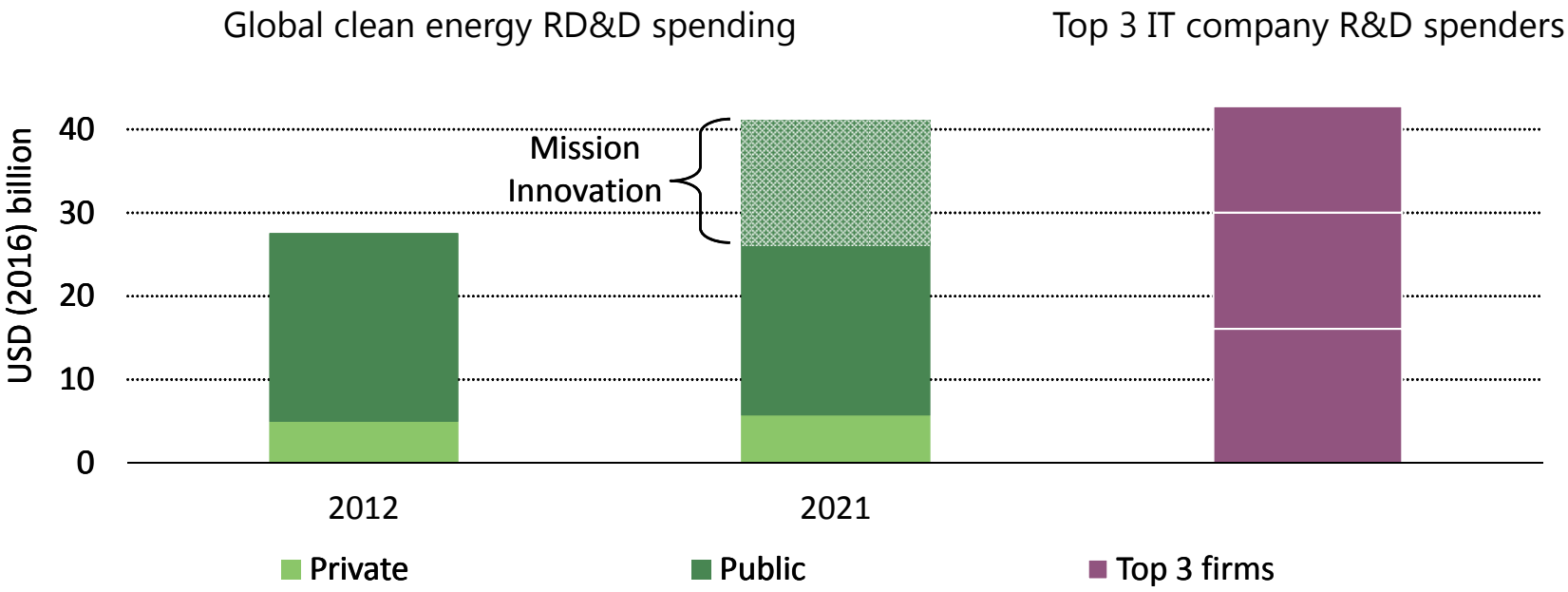
Opportunities for policy action

- **Approaches to technological innovation have to be tailored to the development status of specific low-carbon power technologies.** RD&D has to take an integrated view of power systems in its design and operation, exploring stronger linkages among electricity, heat and mobility.
- **Strong carbon pricing policies are needed.** On their own, however, carbon prices are unlikely to be sufficient to deliver the necessary investment in time or at scale. Carbon prices should be complemented by technology support measures to reduce investment risks.
- **With both increased electrification and greater supply from VRE sources, opportunities to boost the flexibility and reliability of electricity systems should be explored and exploited.** Assessment of the potential should be based on local conditions and roadmaps for implementation.
- **Coal-fired power generation without CCS becomes unsustainable in the 2DS and B2DS by 2040-45, increasing the risk that coal plants built in the near term become stranded assets.** At a minimum, new coal plants that are built should be CCS-ready. Fostering research for higher capture rates at coal-fired plants equipped with CCS may extend their use under more stringent climate targets.
- **BECCS in power generation needs to be demonstrated on a commercial scale to gain experience.** RD&D for BECCS in the power sector should focus on improving the efficiency of smaller plants, which are likely to be required due to constraints on bioenergy sourcing.

Conclusions

- 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

Global clean energy RD&D spending needs a strong boost



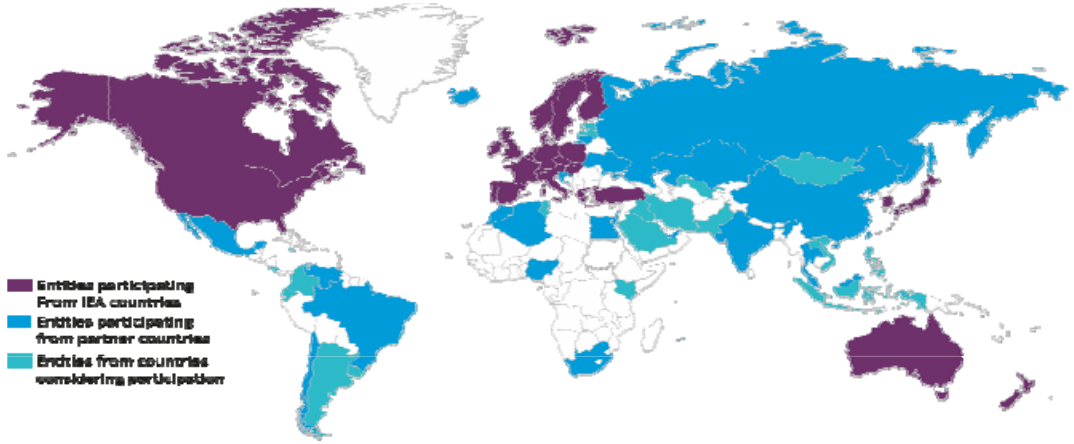
Global RD&D spending in efficiency, renewables, nuclear and CCS plateaued at $26 billion annually, coming mostly from governments.
Mission Innovation could provide a much needed boost.

IEA Technology Collaboration Programmes (TCPs)

- **38 TCPs, five groups:**
  - Cross-cutting activities (2)
  - End use and energy efficiency (14)
  - Fossil fuels (5)
  - Fusion power (8)
  - Renewable energy and hydrogen (9)

Spain participates in 17 TCPs:

- Cross-cutting: 1
- End use and energy efficiency: 7
- Fossil fuels: 3
- Renewables: 6



- Close to 6,000 experts
- More than 2,000 topics to date
- Nearly 300 public or private organisations
- 52 countries
- 38 Technology Collaboration Programmes
- 4 intergovernmental organisations

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.

CLEAN ENERGY MINISTERIAL

Accelerating the Global Clean Energy Transition

清洁能源·创新使命峰会

EIGHTH CLEAN ENERGY MINISTERIAL (CEM8)
SECOND MISSION INNOVATION MINISTERIAL (MI-2)

IEA is the host of the Clean Energy Ministerial Secretariat

Explore the data behind *ETP*

www.iea.org/etp

www.iea.org

IEA

Available on the App Store

GET IT ON Google play

Download from Windows Phone Store

www.iea.org/statistics