



# Clean energy technologies: tracking progress and the role of digitalization

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**The IEA works around the world to support an accelerated clean energy transitions that is**

**enabled by real-world SOLUTIONS**

**supported by ANALYSIS**

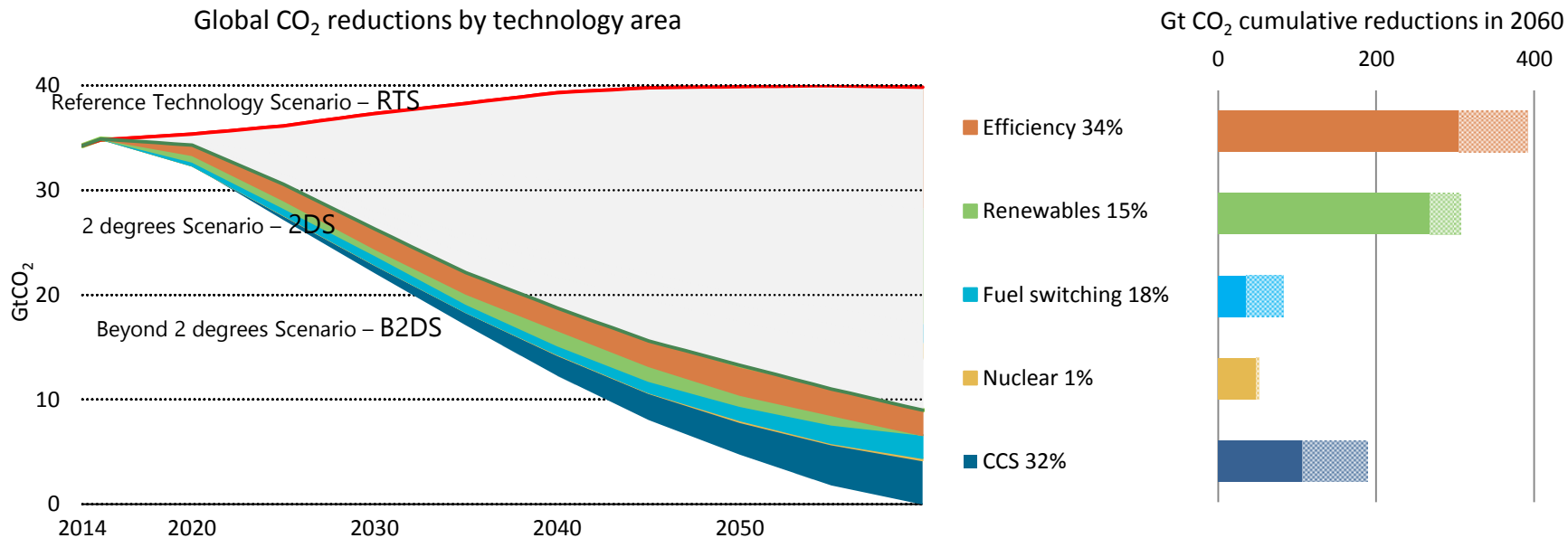
**and built on DATA**



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# How far can technology take us?

## Technology area contribution to global cumulative CO<sub>2</sub> reductions



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

# Measuring the progress of technology for low carbon transition

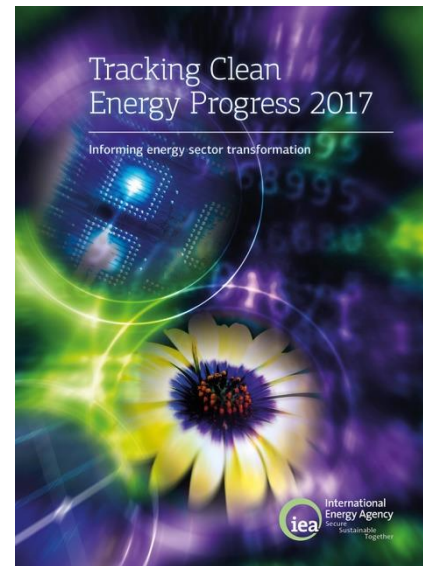
## Technology Status today against 2DS targets



● On track

● Accelerated improvement needed

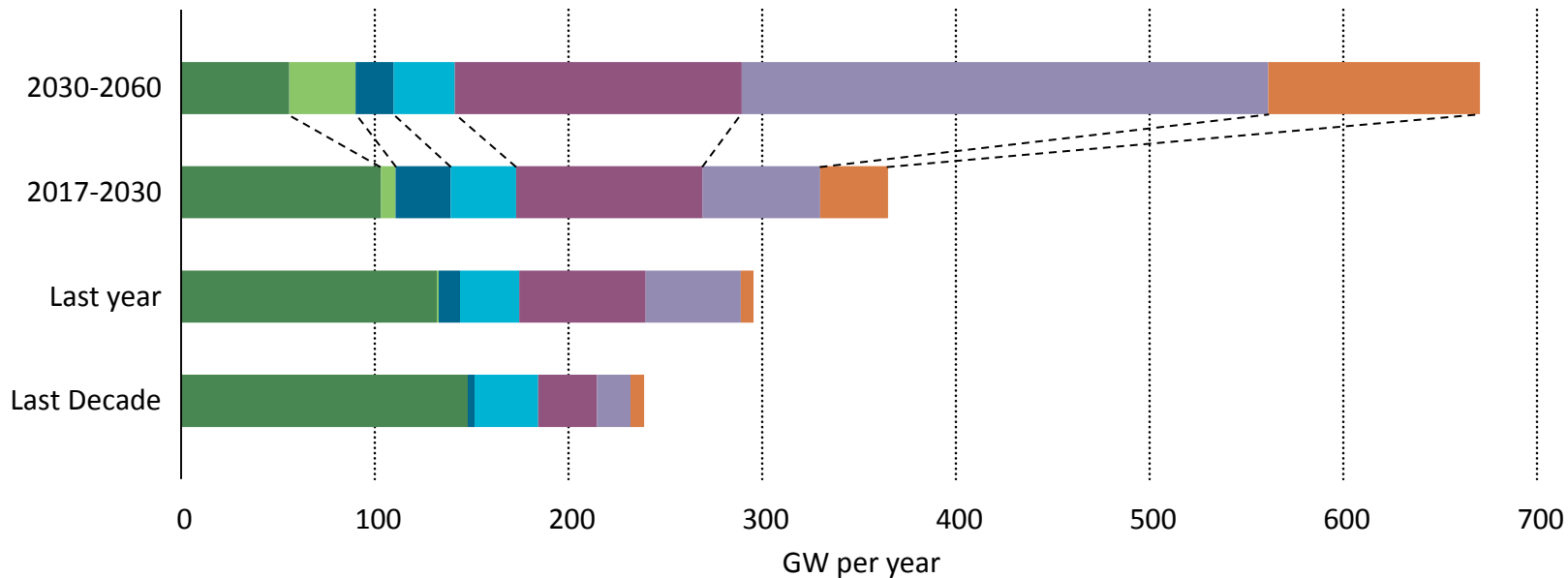
● Not on track



**Recent progress in some clean energy areas is promising,  
But many technologies still need a strong push to achieve their full potential**

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

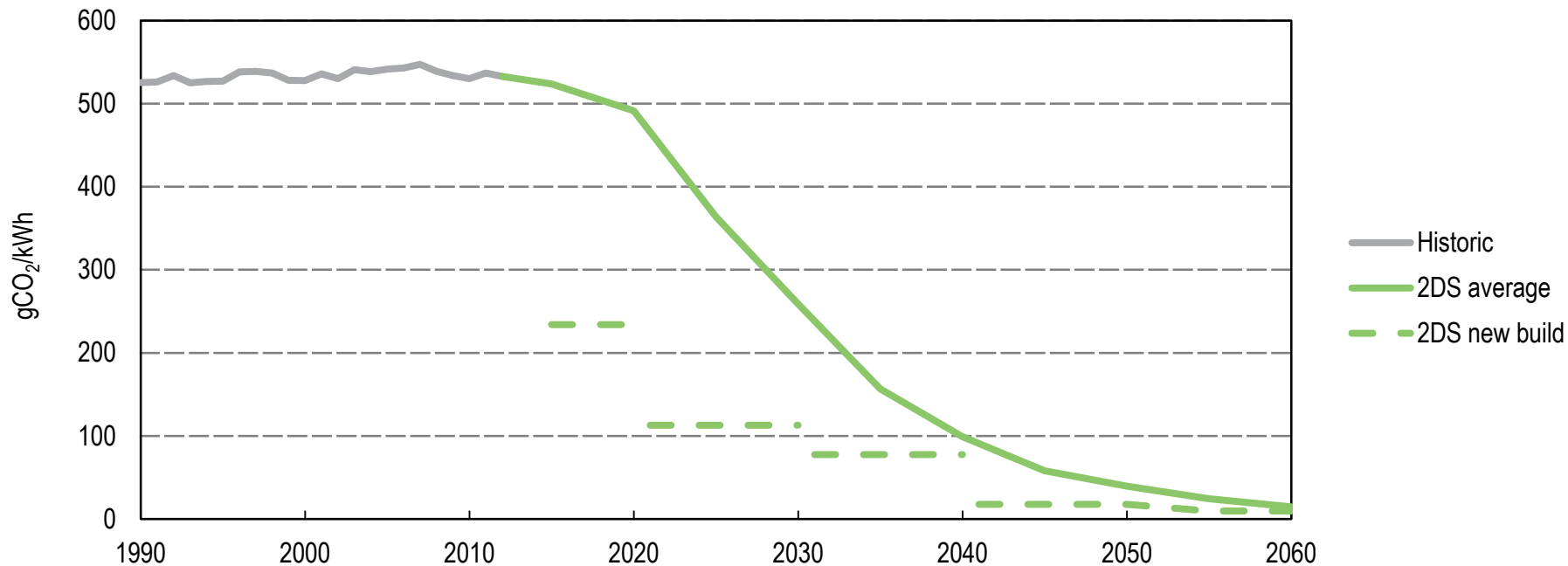
Average capacity additions in different periods in the B2DS



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

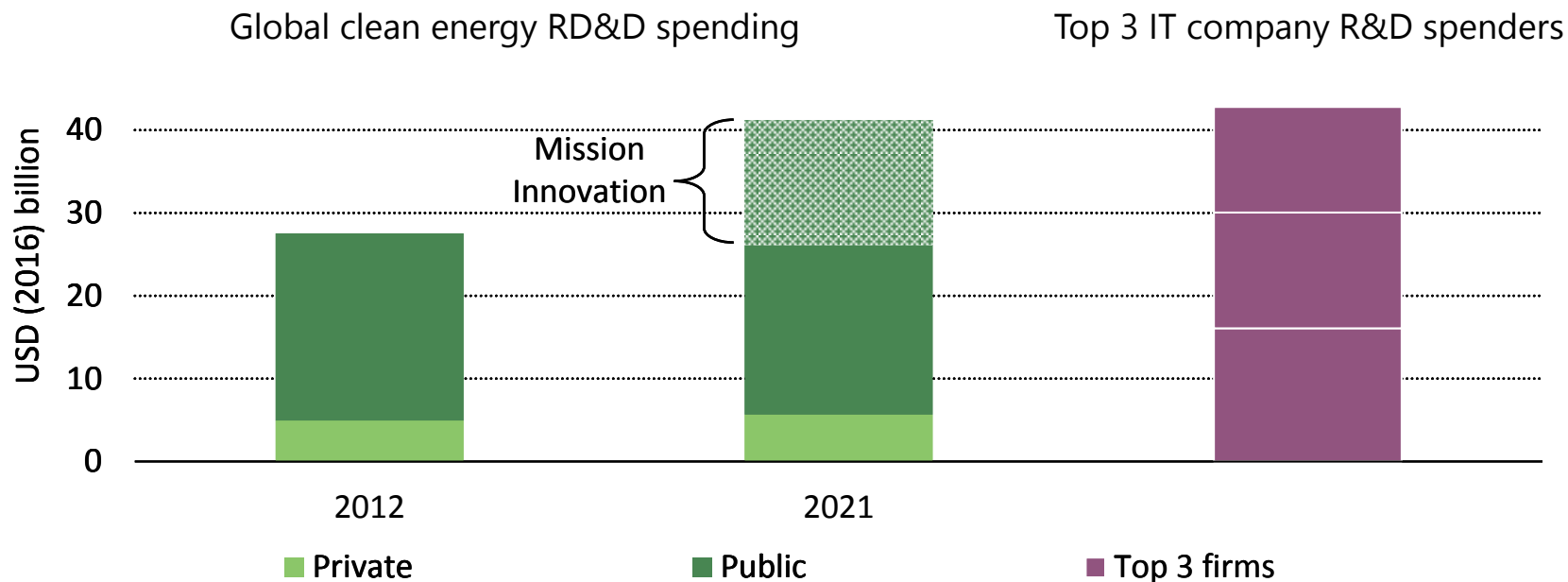
# Indicators of energy system transformation: Power sector example

Global fleet average and new-build plants emissions intensity of power generation in IEA scenarios



**The average carbon intensity of new power capacity needs be at around 100 grammes of CO<sub>2</sub> per kilowatt hour (gCO<sub>2</sub>/kWh) in 2025 and close to zero gCO<sub>2</sub>/kWh by 2050, requiring further steep reduction.**

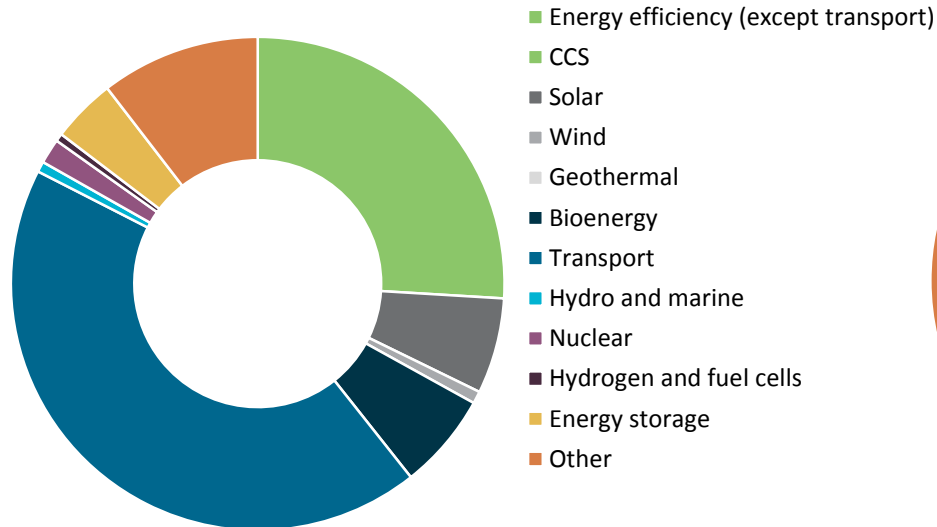
# Measuring long term technology development: spending on R&D



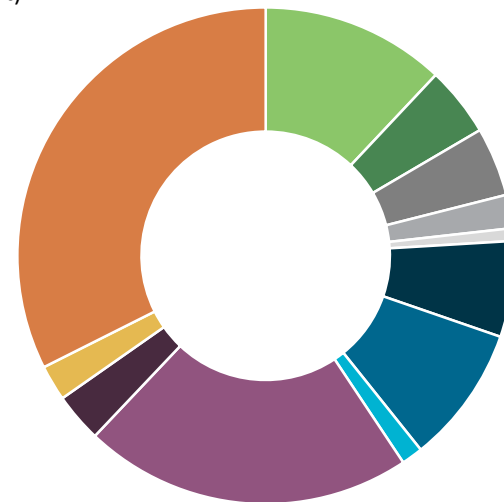
**Global RD&D spending plateaued at \$26 billion annually, coming mostly from governments. Global clean energy RD&D spending needs a strong boost.**

# Tap all the potential: Complementary public and private RD&D is needed

Venture Capital investment breakdown for 2016



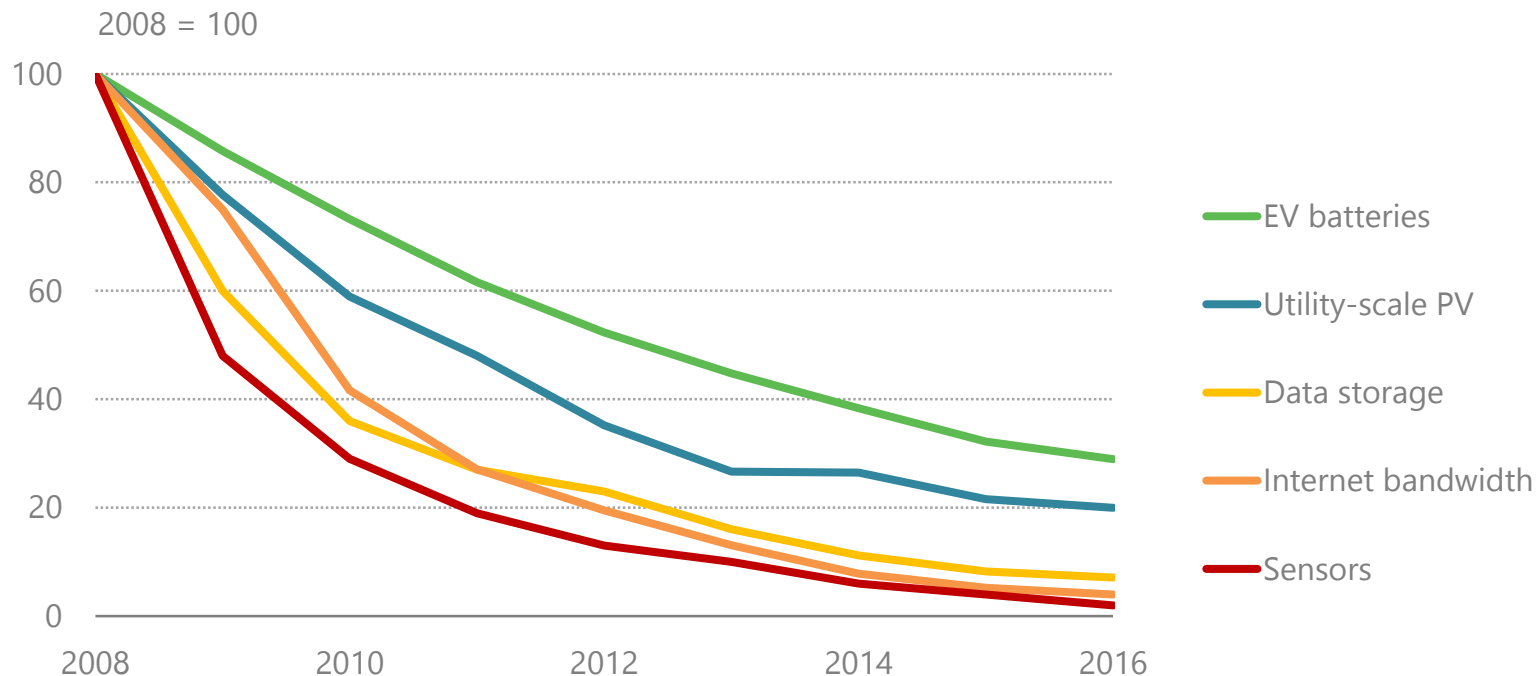
IEA member country spending in 2016



**Public and private sector invest in different type of innovation. Public spending supports technologies that are further from the market or have high development and demonstration costs, including nuclear, CCS and ocean energy.**



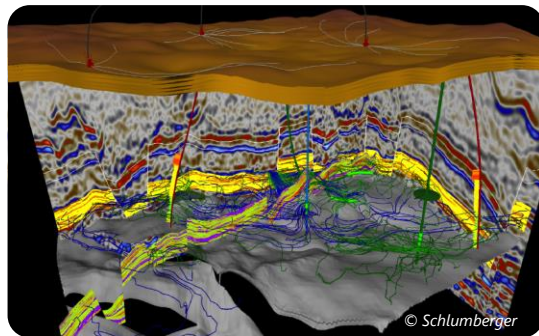
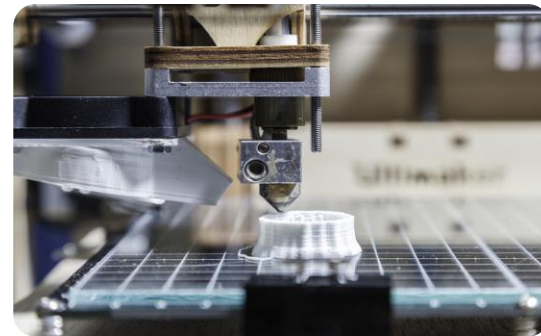
# Drivers of digitalization: data, analytics, and connectivity



Sources: Based on BNEF (2017), Utilities, Smart Thermostats and the Connected Home Opportunity; Holdowsky et al. (2015), Inside the Internet of Things; IEA (2017), Renewables; Tracking Clean Energy Progress; World Energy Investment; Navigant Research (2017), Market data: Demand Response. Global Capacity, Sites, Spending and Revenue Forecasts.

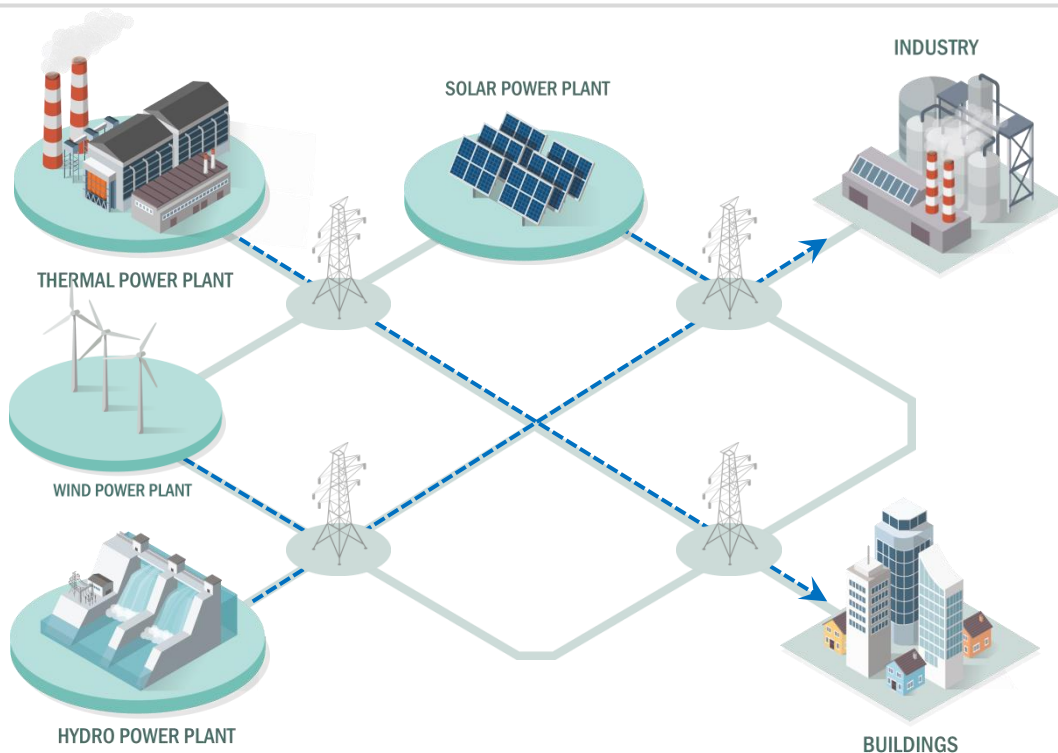
**Data collection, storage, and transmission costs have declined by over 90% since 2008**

# Digitalization is impacting all energy demand and supply sectors...



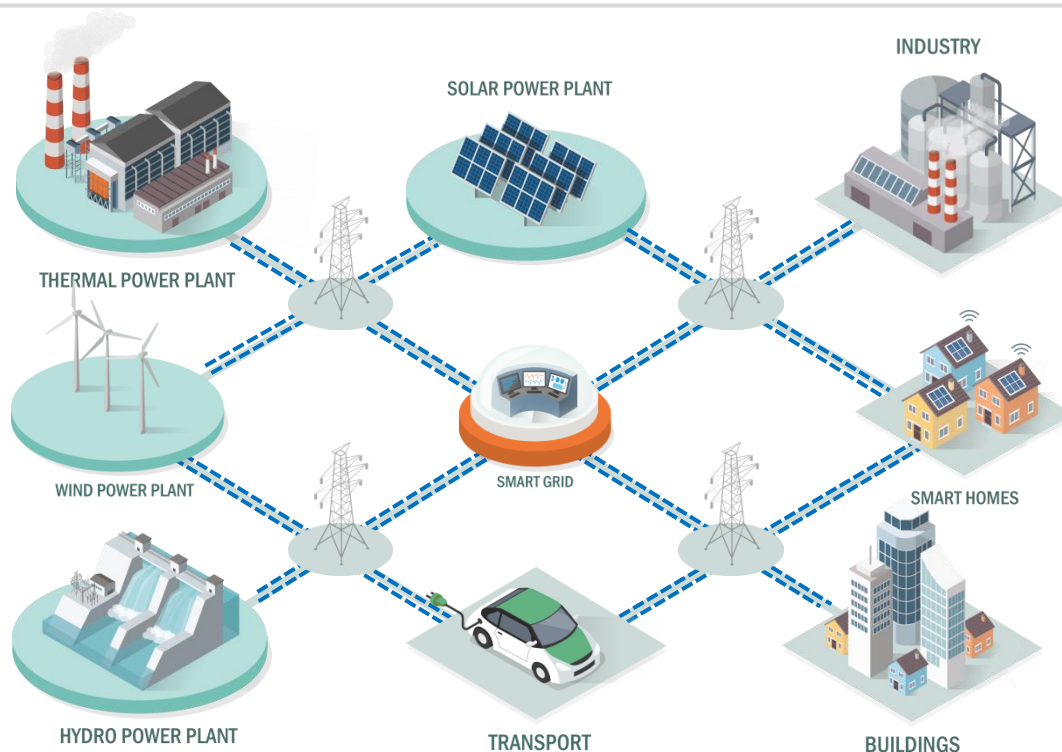
**Digital technologies can help improve safety, productivity, and efficiency of energy systems**

# ...and fundamentally transforming the energy system



**“Pre-digital” energy systems are defined by unidirectional flows and distinct roles**

# ...and fundamentally transforming the energy system



**“Pre-digital” energy systems are defined by unidirectional flows and distinct roles; digital technologies enable a multi-directional and highly integrated energy system**

- **Innovation**
  - AI, machine learning, and “digital twins” in industrial design
- **Electric vehicles**
  - Autonomous and shared mobility: favours lower O&M costs of EVs
  - Smart charging and V2G: providing grid services
- **Renewable energy**
  - Generation and transmission: reduced costs and extended lifetimes
  - Integration of variable renewables
  - Digital tools can facilitate distributed energy resources, e.g. rooftop solar

- Early signs point to changes in energy trajectories, helped by policies and technologies, but progress is too slow
- Each country should define its own transition path and scale-up its RD&D and deployment support accordingly
- Energy metrics can help unpack what clean energy transition means and how it can be measured.
- Digitalization could help in the deployment of clean energy technologies
- Policy will play a critical role in capturing opportunities of digitalization while managing emerging risks

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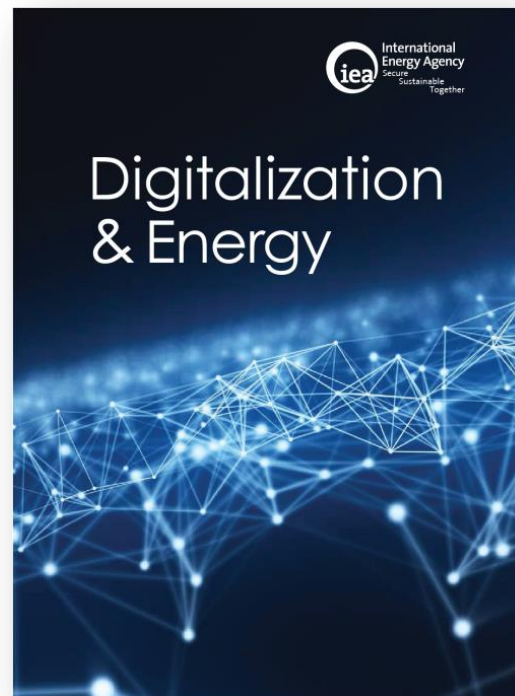
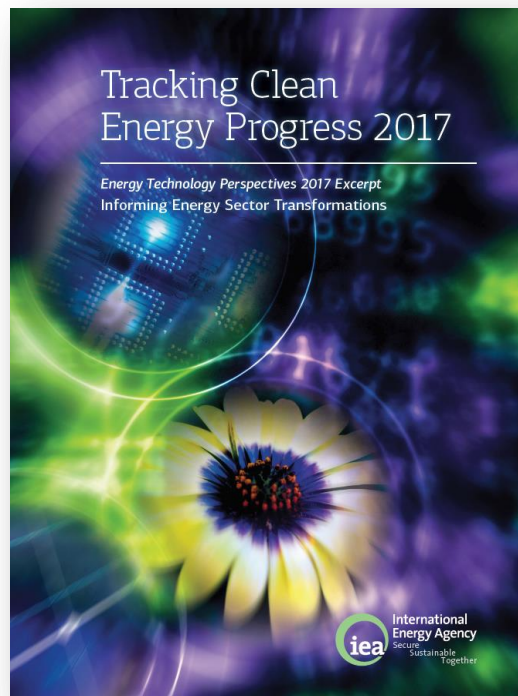


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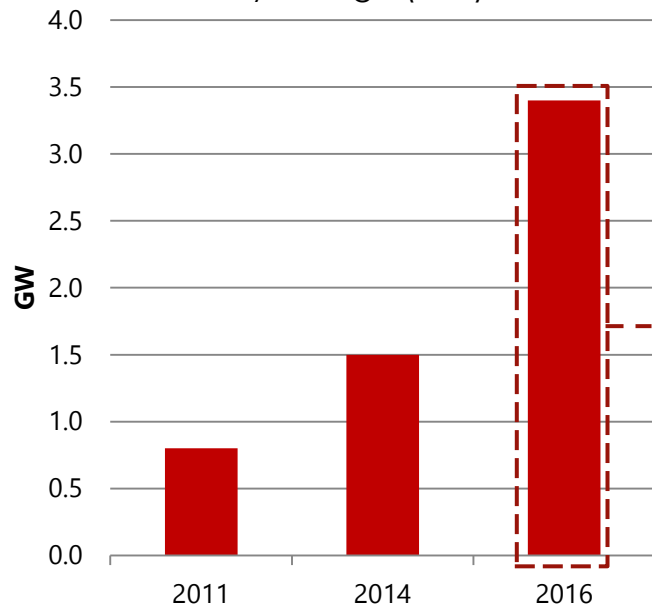
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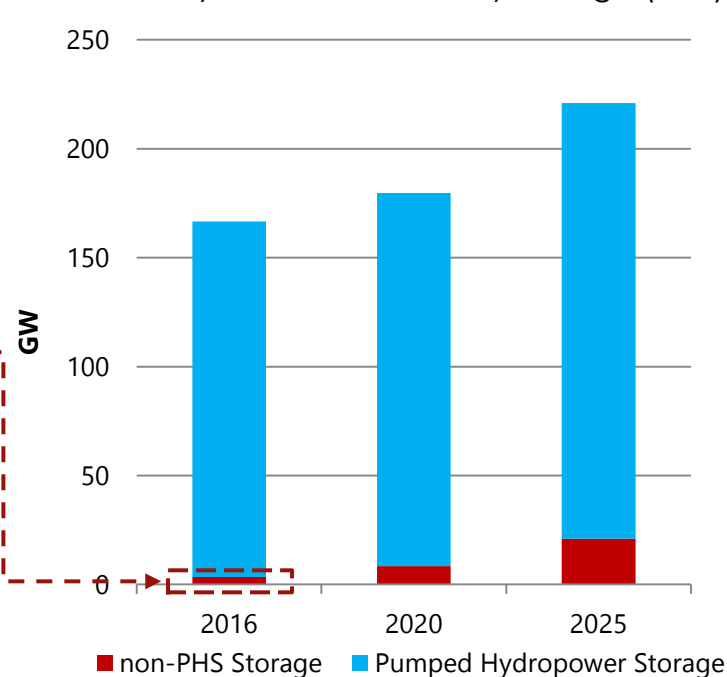


# The value of storage is starting to drive new solutions

Globally installed non-pumped hydro electricity storage (GW)

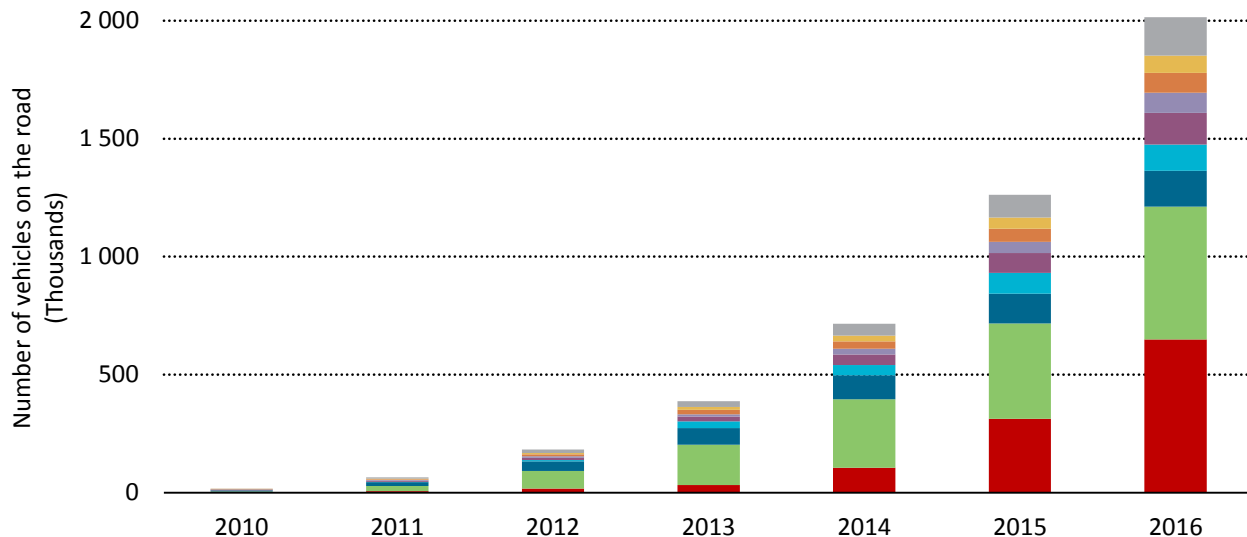


Globally installed electricity storage (GW)



**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.**

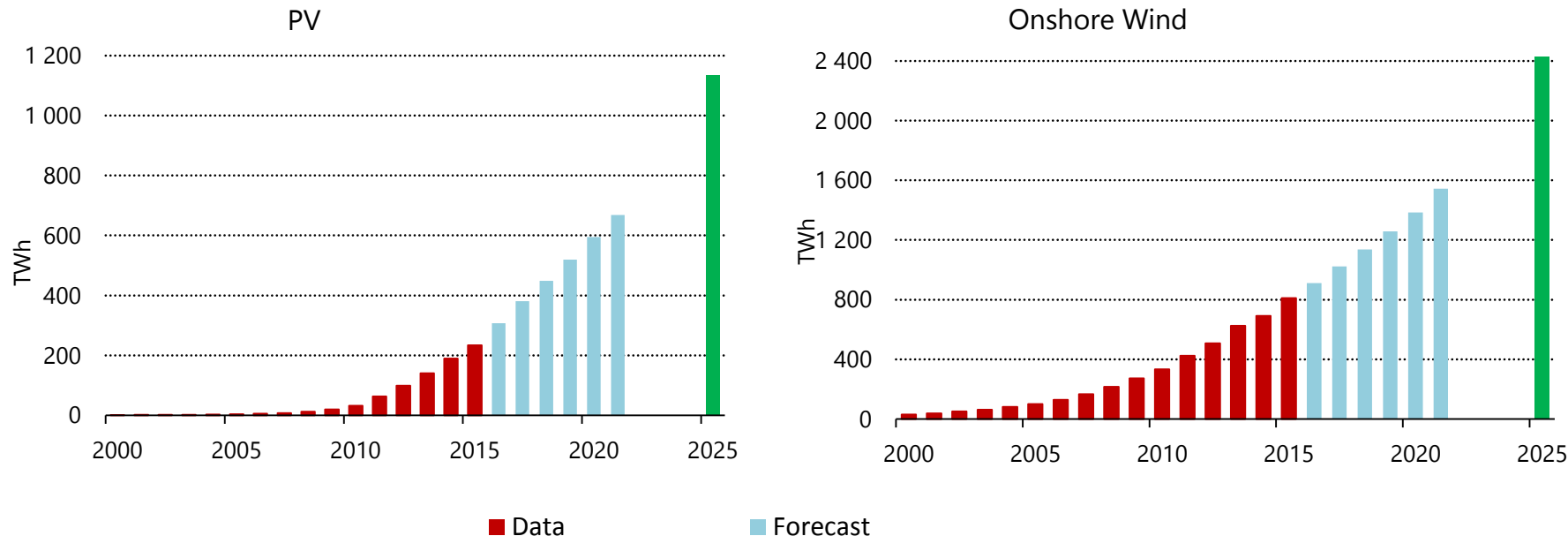
## Global electric car fleet



**The global electric car fleet passed 2 million last year, but sales growth slipped from 70% in 2015 to 40% in 2016, suggesting the boom may not last without sustained policy support**

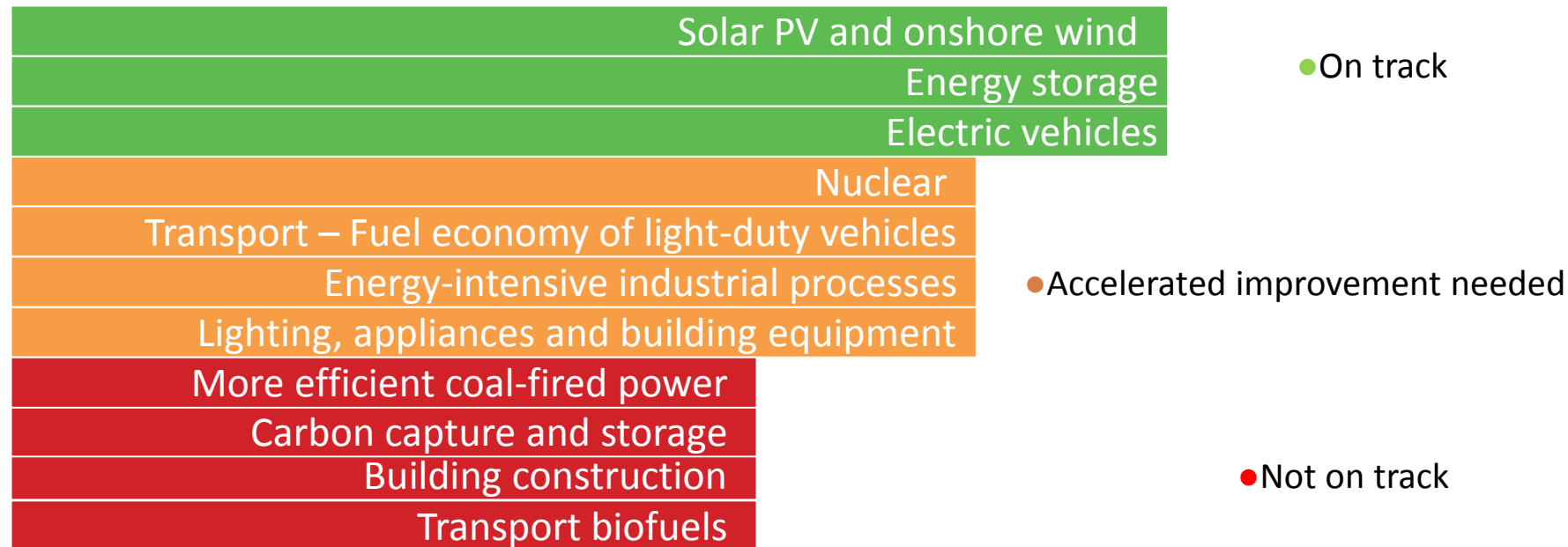
# Solar PV and Wind are still leading the transition...

Electricity generation of selected renewable power generation technologies



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

# The potential of clean energy technology remains under-utilised



**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.**