IRENA
International Renewable Energy Agency

Innovation for the Energy Transition

Preliminary Findings

May 2017

1 Introduction

Innovation agenda to decarbonise the energy sector

- **Objectives:**
  - Goal is not to create a roadmap set in stone, uncertainties to 2050 are huge
  - Create a flexible framework that nurtures innovation

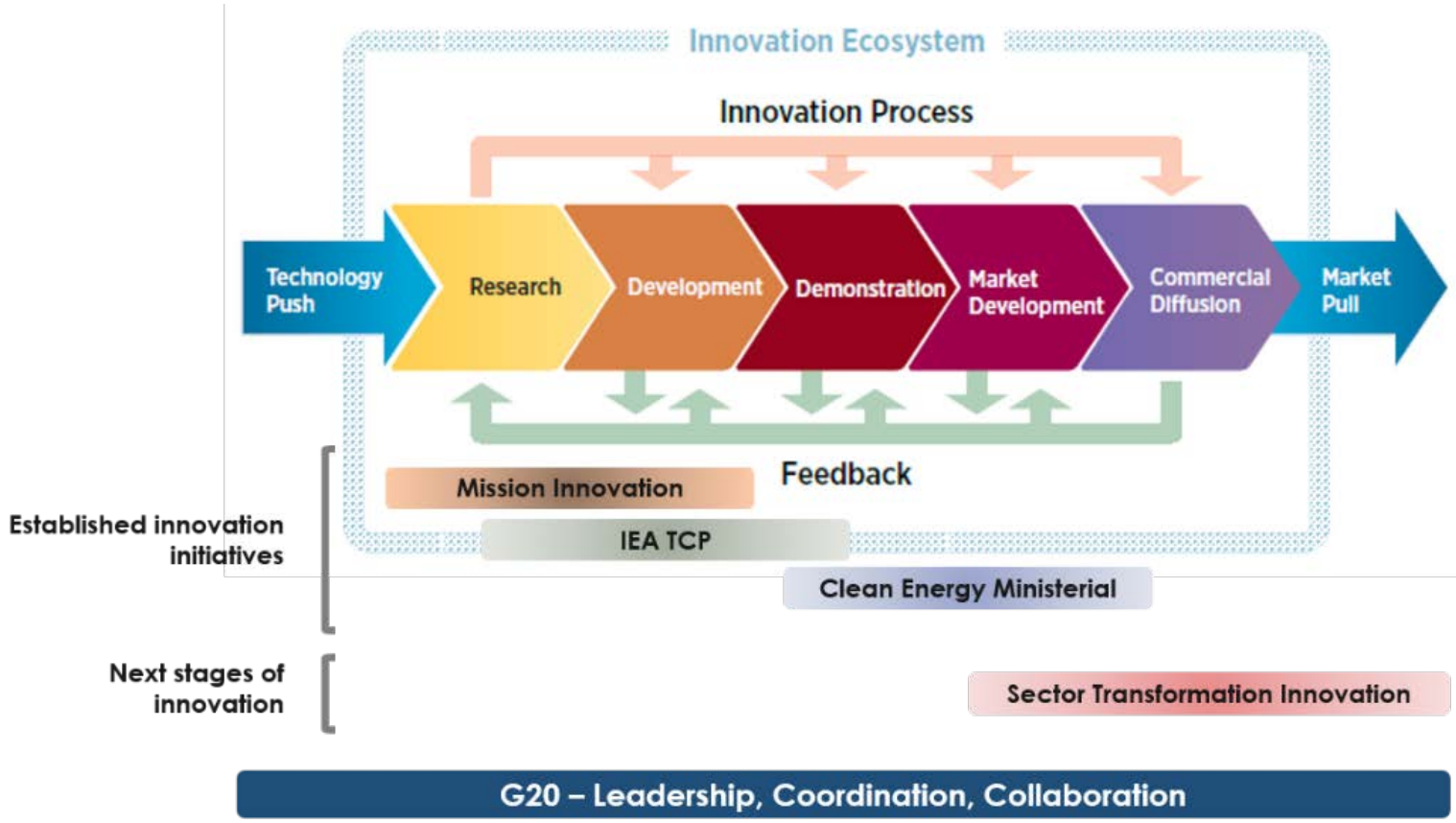
- **Expected outcomes:**
  - Identify innovation gaps
    - Gaps by sector, application and technology
  - An innovation timeline (roadmap)
  - Contribution to ongoing international efforts: Mission Innovation, Clean Energy Ministerial, UNFCCC and others

Innovation agenda to decarbonise the energy sector

- **Starting point:**
  - Innovation is more than research and development (R&D), from technology push to market pull
  - Major increase in R&D investment is needed.
  - Technology innovation must be accompanied by innovation in infrastructure, system operation, business models and regulation
  - While the renewable power sector is attracting significant attention, end-use sectors continue to be overlooked

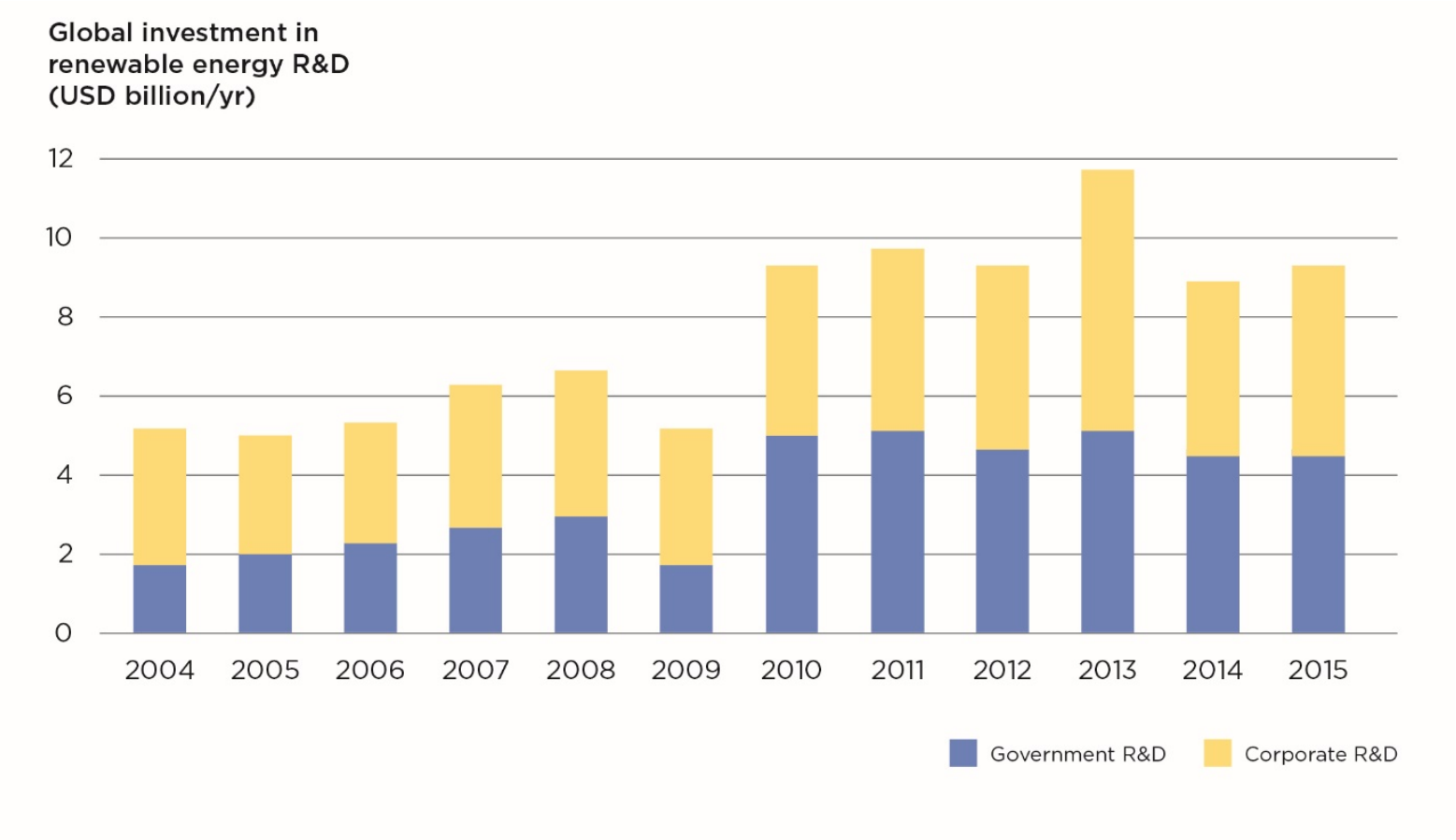
2 Need for a holistic innovation approach

Energy sector innovation ecosystem



The emergence of urgently needed solutions to decarbonise the global energy sector requires combining various policy instruments across the whole technology lifecycle, from R&D to market scale-up

R&D spending on renewable energy in 2004-2015

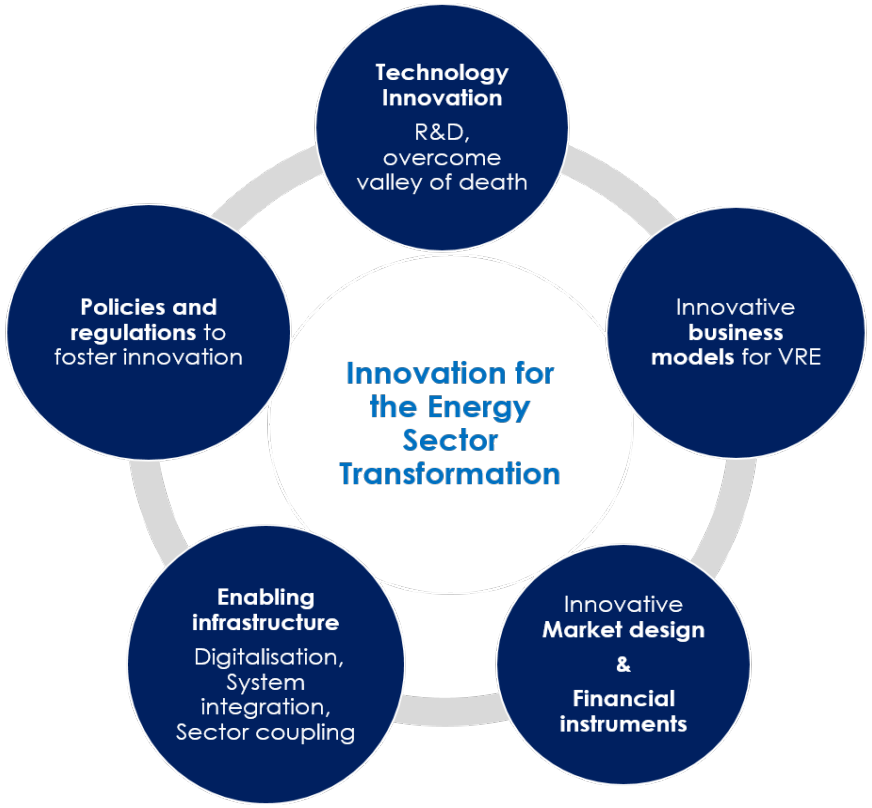


There is an urgent need to increase R&D investment

R&D for renewables is not currently growing

Most R&D investments directed to the power sector | end-use sectors overlooked

Innovation for power sector transformation



The technology to push a global renewable power transition in the next two decades is already here, but more innovation is needed in enabling infrastructure, system operation, and business models to scale up deployment

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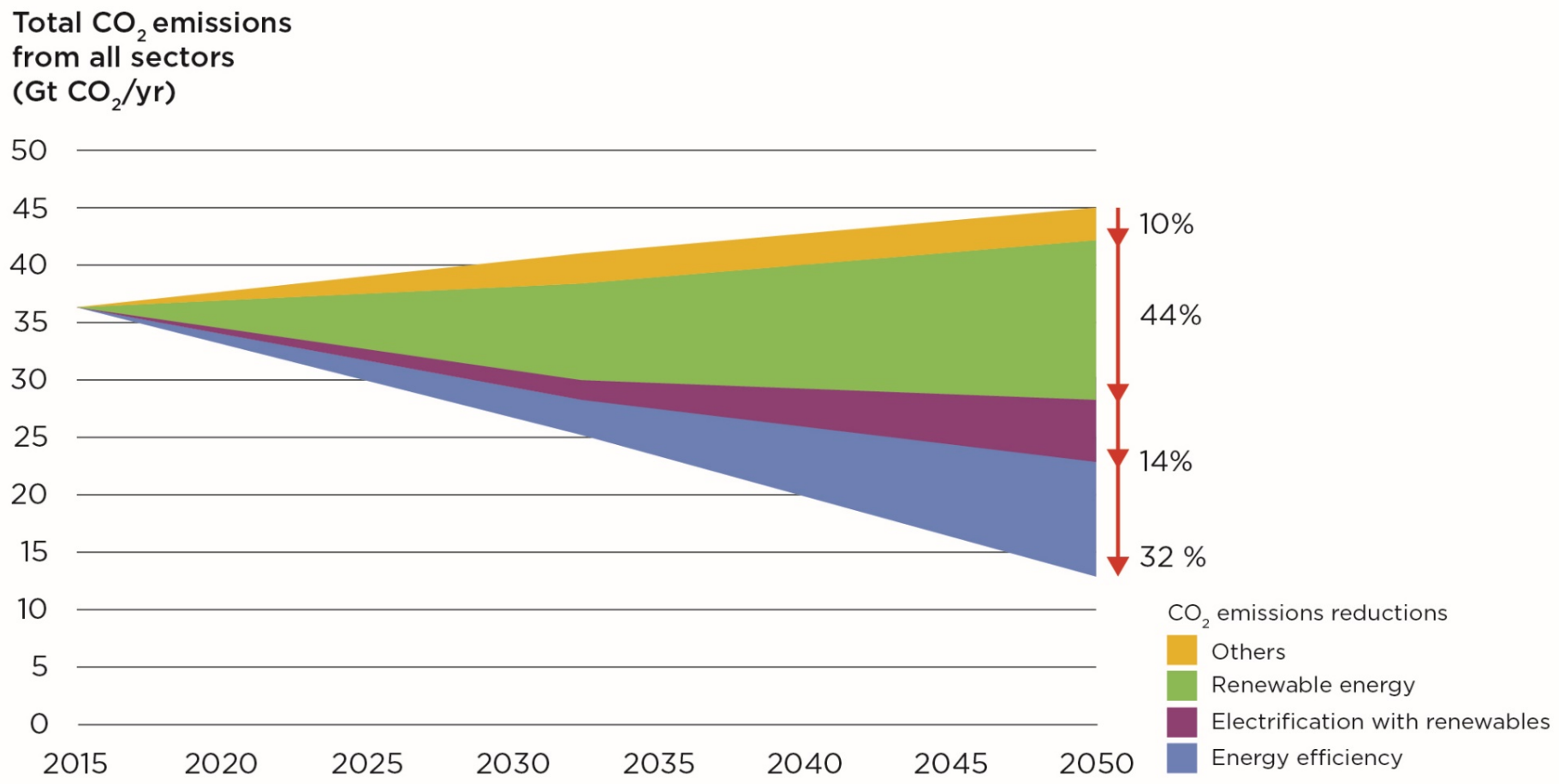
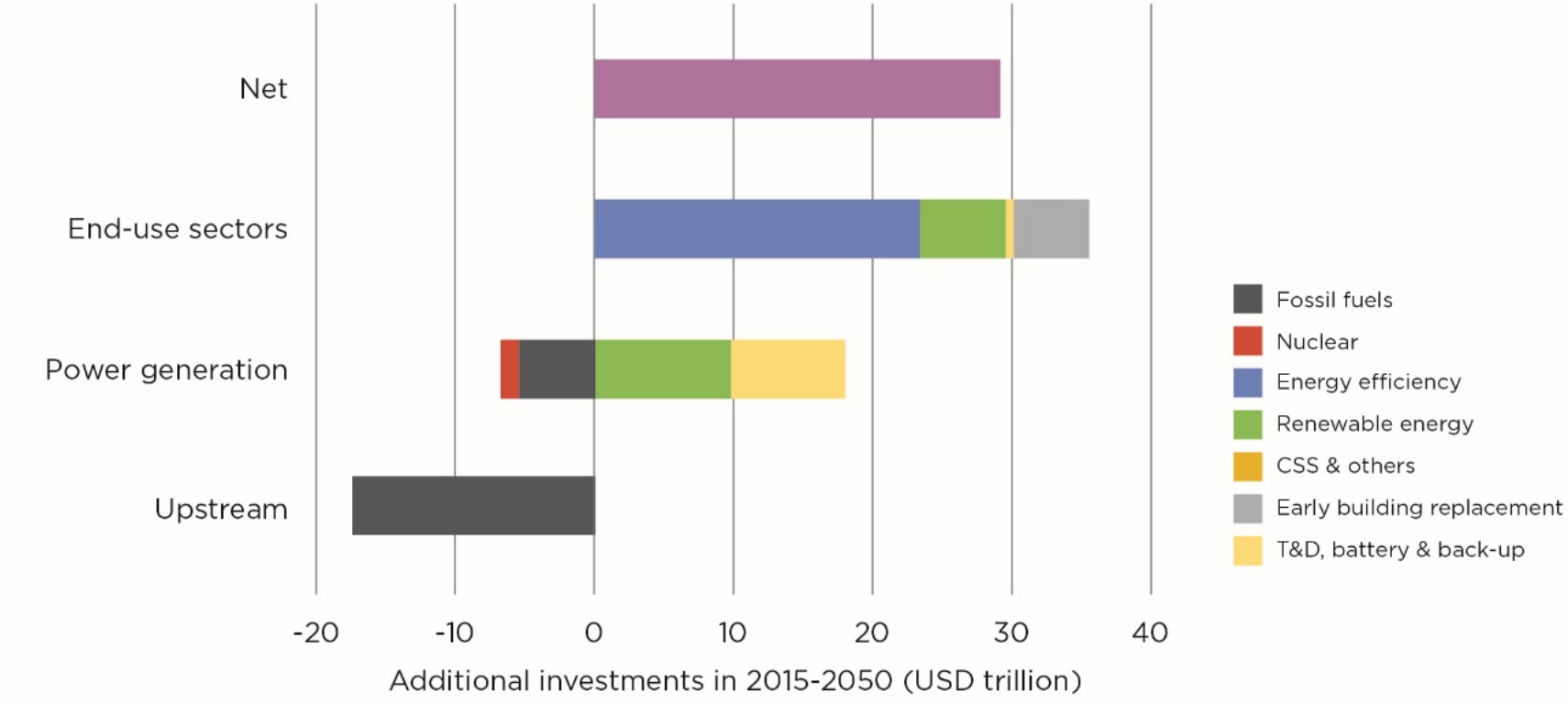
The role of renewables in the decarbonisation

Renewables are a crucial part of the solution



Renewables would account for half of total emission reductions in 2050

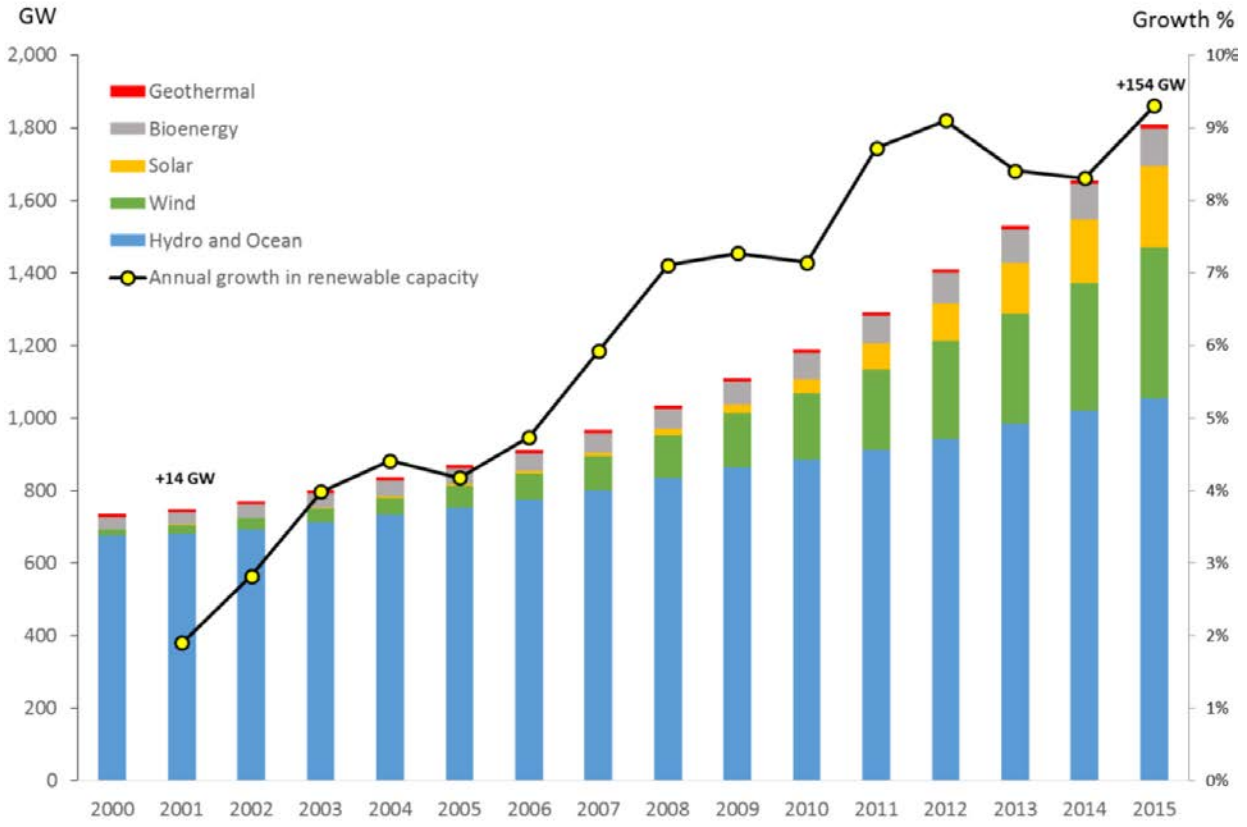
Increased investment needs by sector and technology

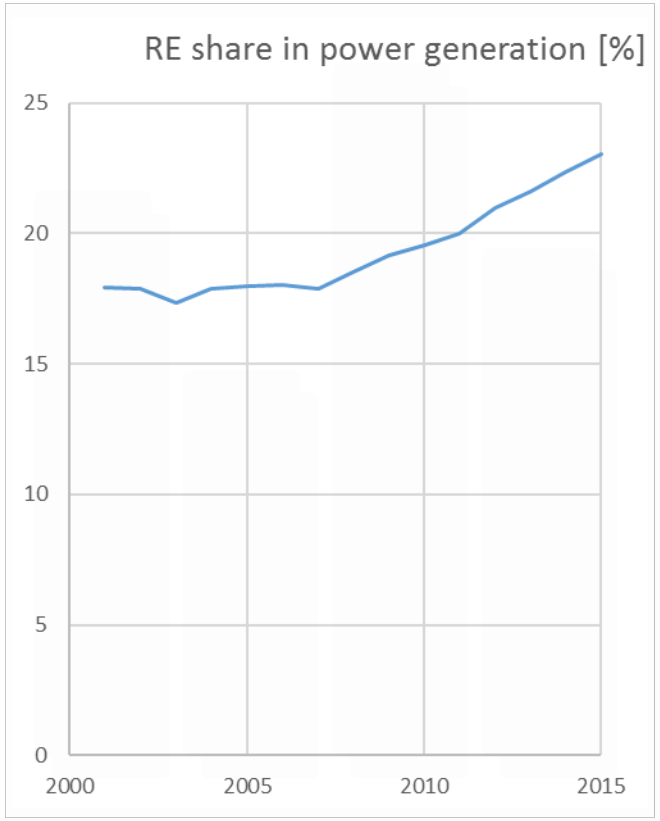


Meeting the 2ºC target requires investing an **additional USD 29 trillion between 2015 and 2050** compared to the Reference Case

End-use sectors dominate increases in investment needs to 2050 by sector and technology

Power sector transformation is ongoing

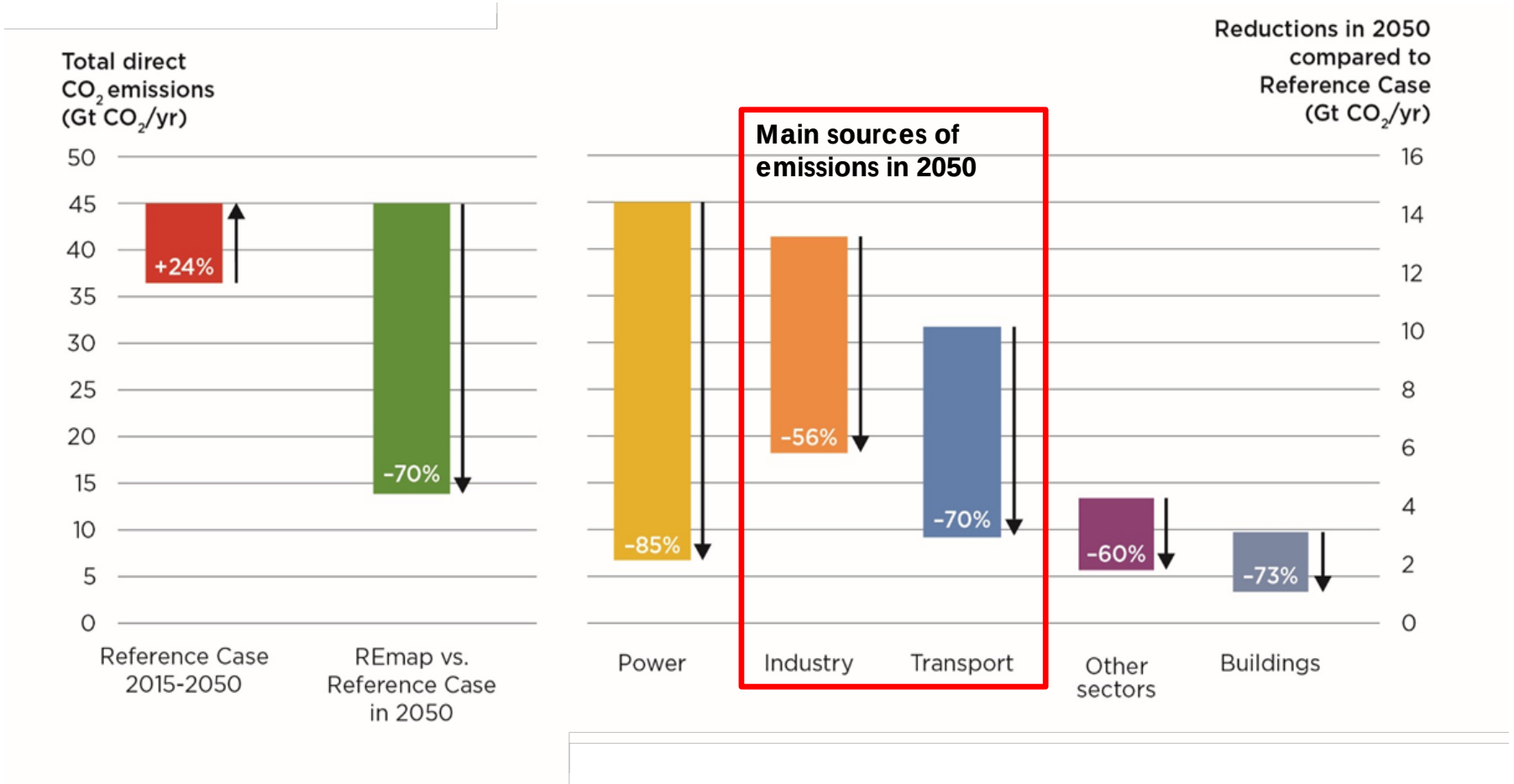




Renewables account for more than half of annual power generation capacity additions since 2012

Renewable energy share in power generation growing at 0.7% per year

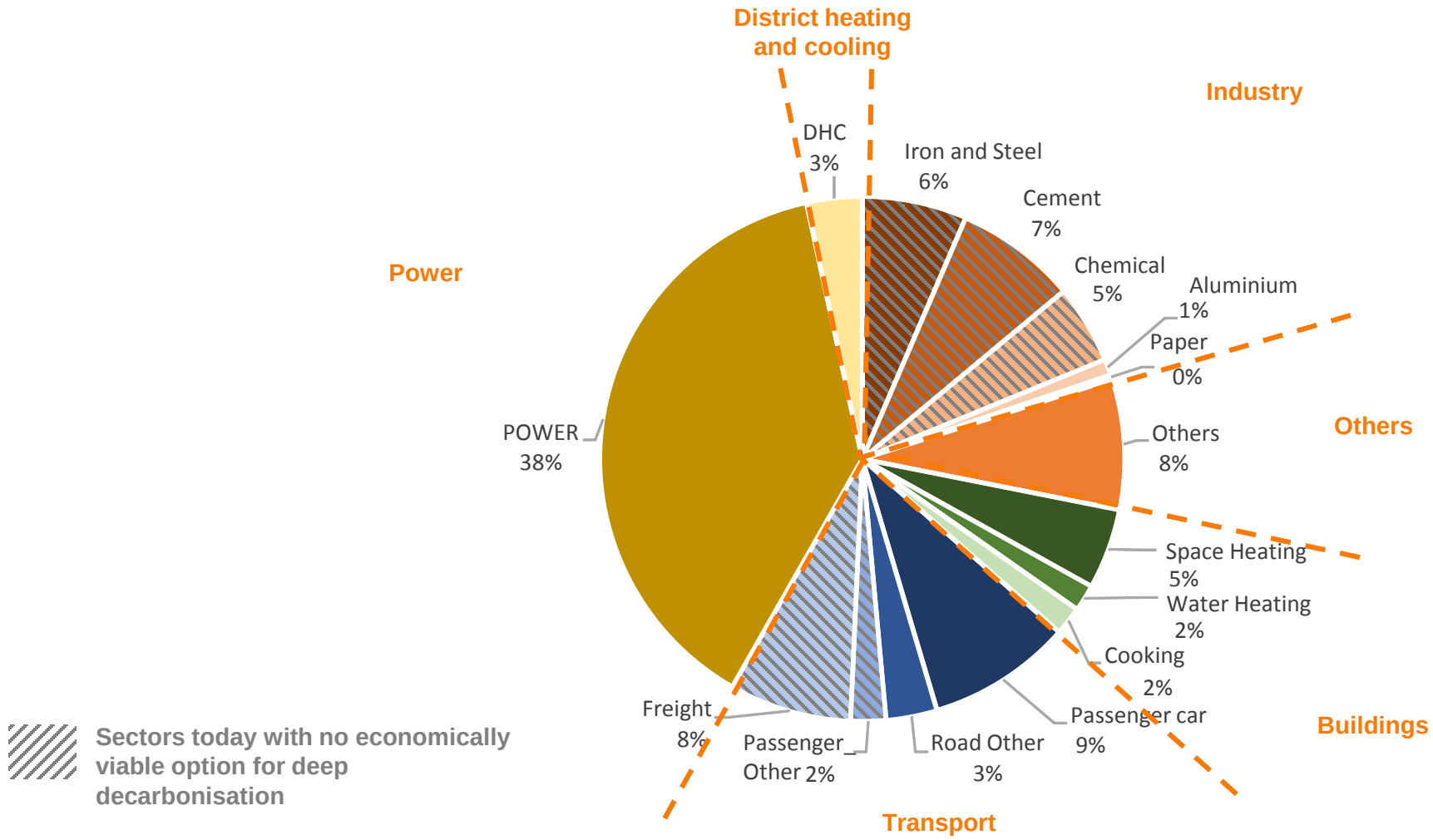
End-use sector transformation is lagging behind



By 2050, total energy-related CO_2 emissions will need to decrease to below 10 Gt/yr

CO_2 emissions from power and buildings sectors will be almost eliminated

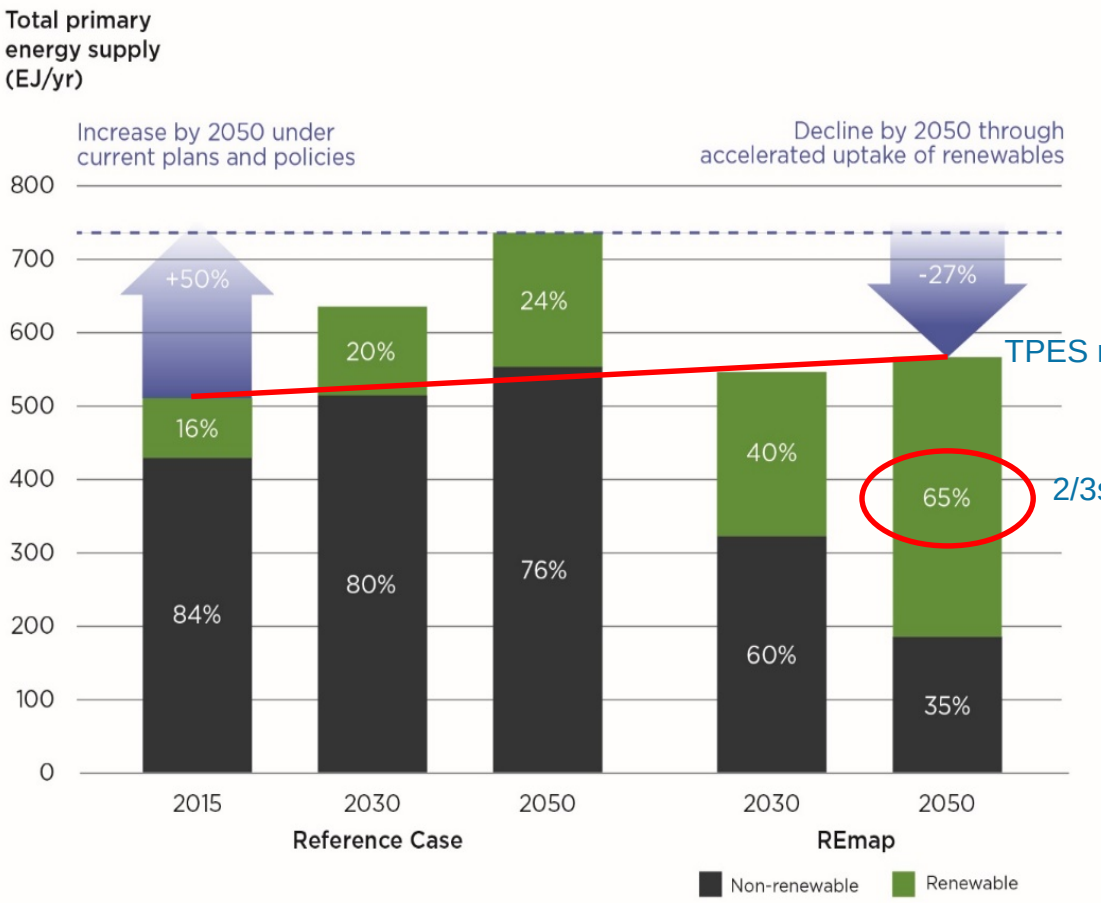
Breakdown of global CO_2 emissions by sector in 2015

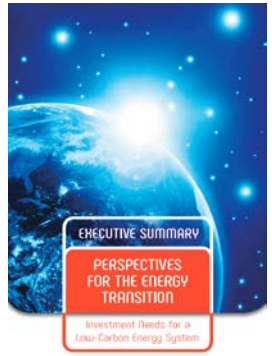


Around one third of energy-related emissions in the Reference Case in 2050 currently have no economically viable options for decarbonisation

Annual growth rate of RE share in global energy mix must dramatically increase

- Reducing energy-related CO_2 emissions to below 10 Gt/yr by 2050 will require an increase of about **1.2%/yr** in renewables' share between 2015-2050
- This represents **seven-fold growth** compared to 0.17%/yr in 2010-2015
- R&D spending on renewable energy is around USD 10 billion per year. Would a **doubling of R&D support** such a deployment growth rate?





March 2017

TPES nearly flat in 2015-2050

2/3s of TPES is renewable energy

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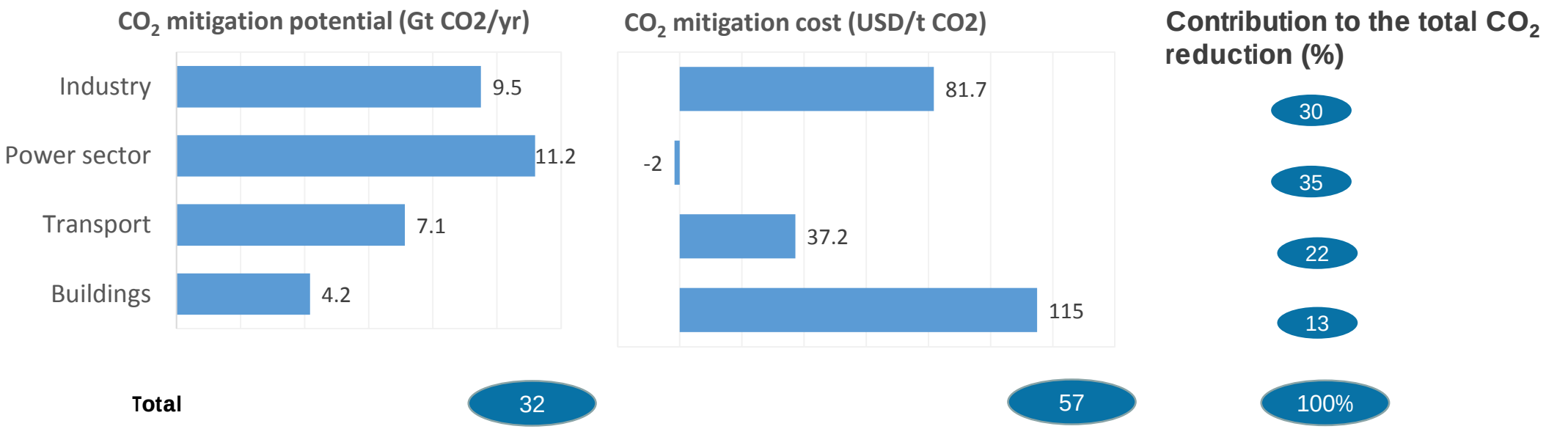
Innovation agenda

Preliminary findings

Innovation agenda: guiding questions

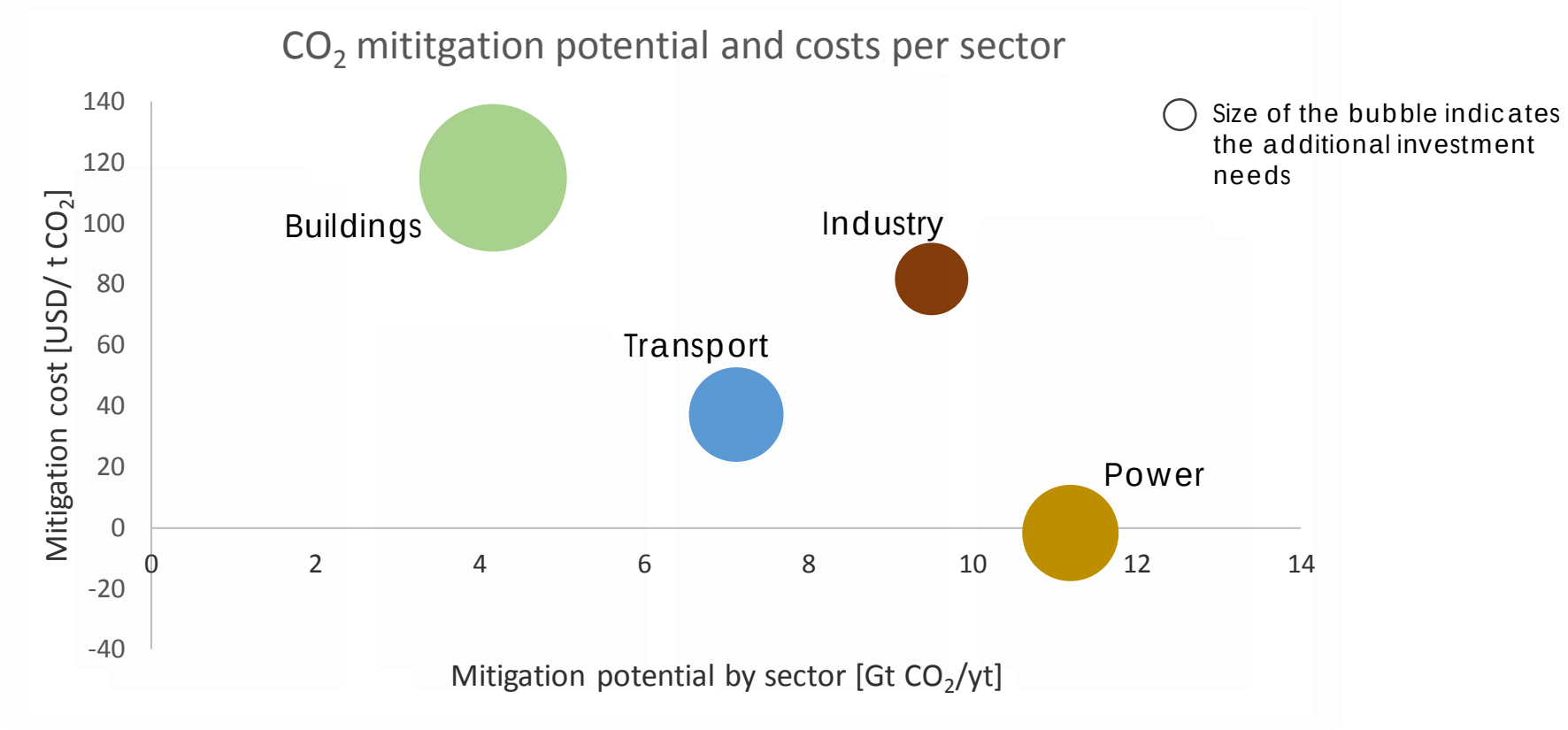
- Energy and emission scenarios include large uncertainty in technology deployment, but what does this mean for **R&D planning**?
- Will there be **a single technology solution** for each sector?
  - E.g. can hydrogen cars survive alongside EVs? Can DHC survive next to NZEB and heat pumps?
- Why do some sectors achieve **rapid innovation** while in others progress is slow?
  - Power sector is on track, moderate developments in transport, and none in industry
- Where are today's major **innovation gaps** and the main areas that require innovation?
  - **VRE integration** in the power sector? What is possible today, where is more action needed?
  - Gaps for **heavy industry** (e.g. high-temp heat, NEU), **transport** (trucks, aviation, shipping), **waste management**, **storage** (thermal, seasonal), **biomass**
  - **Systems thinking**: sector coupling, grids, interaction of EE & RE & access
- What would be the **investment needs** for R&D, demonstration and learning?
- Which **priority areas** beyond technology require innovation?
  - Business cases, enhanced performance/comfort for consumers, SDGs
- What is the **timeline for innovation** to realise a decarbonisation of the energy sector?

Mitigation potential and costs by sector



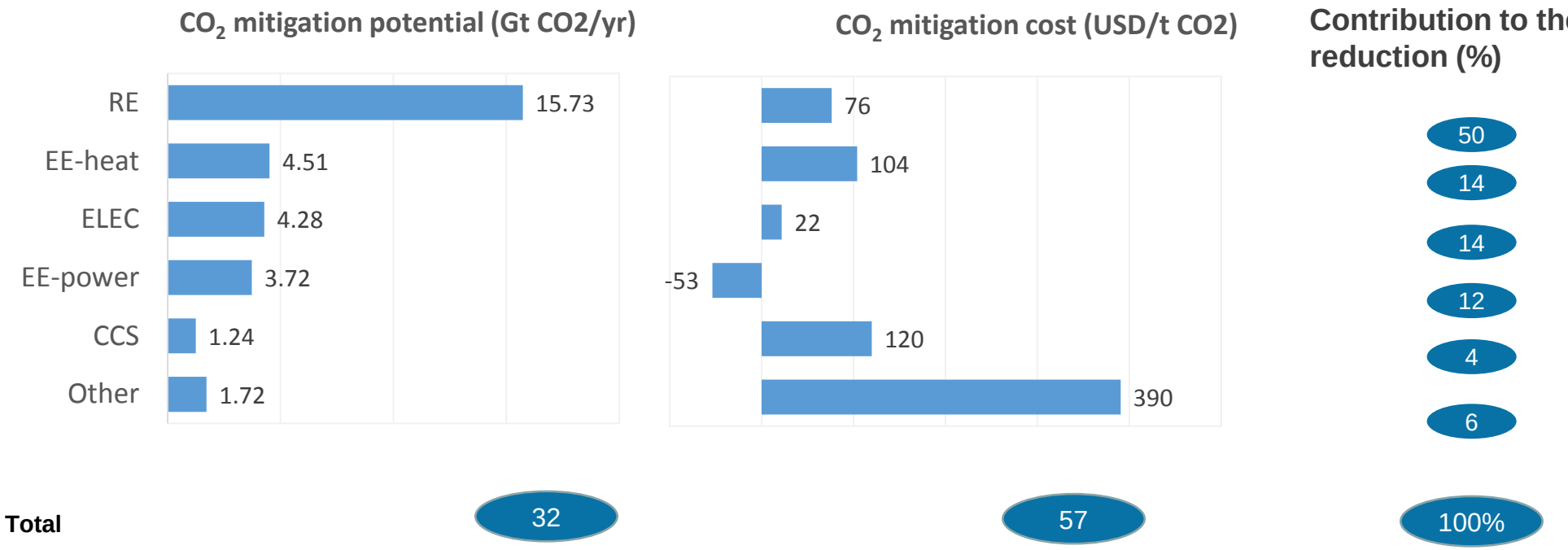
- Largest emission reduction potential exists in power and industry sectors
- Average abatement cost of technologies are highest in the building and industry sectors
- Options in the power sector are economically viable and for the transport sector nearly viable
- While power and transport may require continued improvement of available technologies, building and industry sectors may require breakthroughs

Mitigation potential and costs by sector



The power sector has a strong business case for deployment of renewables, accounting for a significant share of the emission reduction potential. Industry is the most challenging sector where more attention is required to utilise its potential and reduce the costs of technologies. Largest investments for decarbonisation will be needed for buildings.

Mitigation potential and costs by technology



Renewable energy will represent half of all the emission reductions required for decarbonisation. Renewable energy technology costs vary, with RE grid integration measures and biomass-based heating/transport technologies requiring further development focus on cost-reduction as they raise the average cost of renewable energy

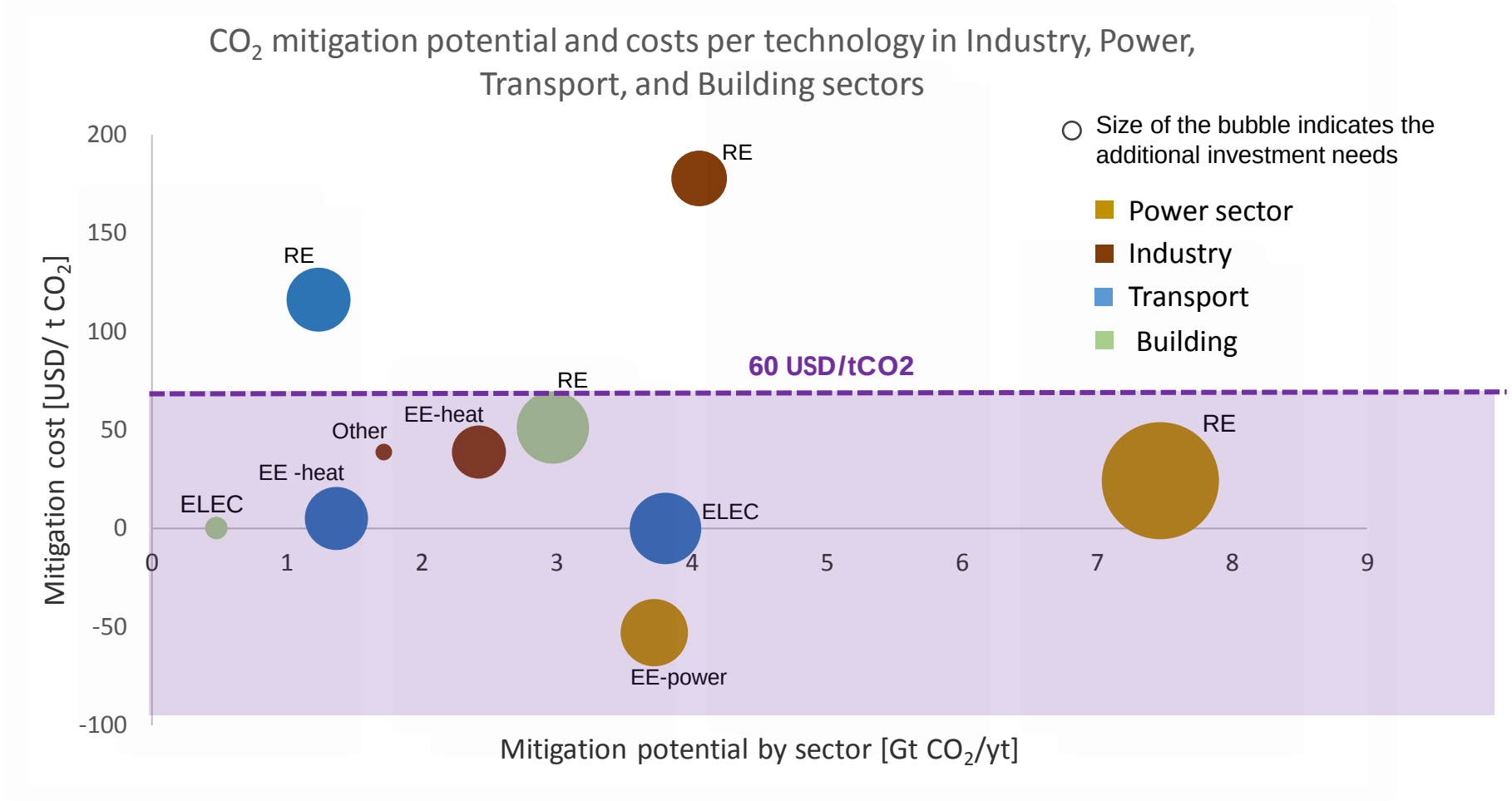
Energy efficiency accounts for bulk of the other half, followed by CCS and other low-carbon technologies such as material efficiency improvements

Electrification leads to savings, assuming that electric vehicle costs will be on par with internal combustion engines

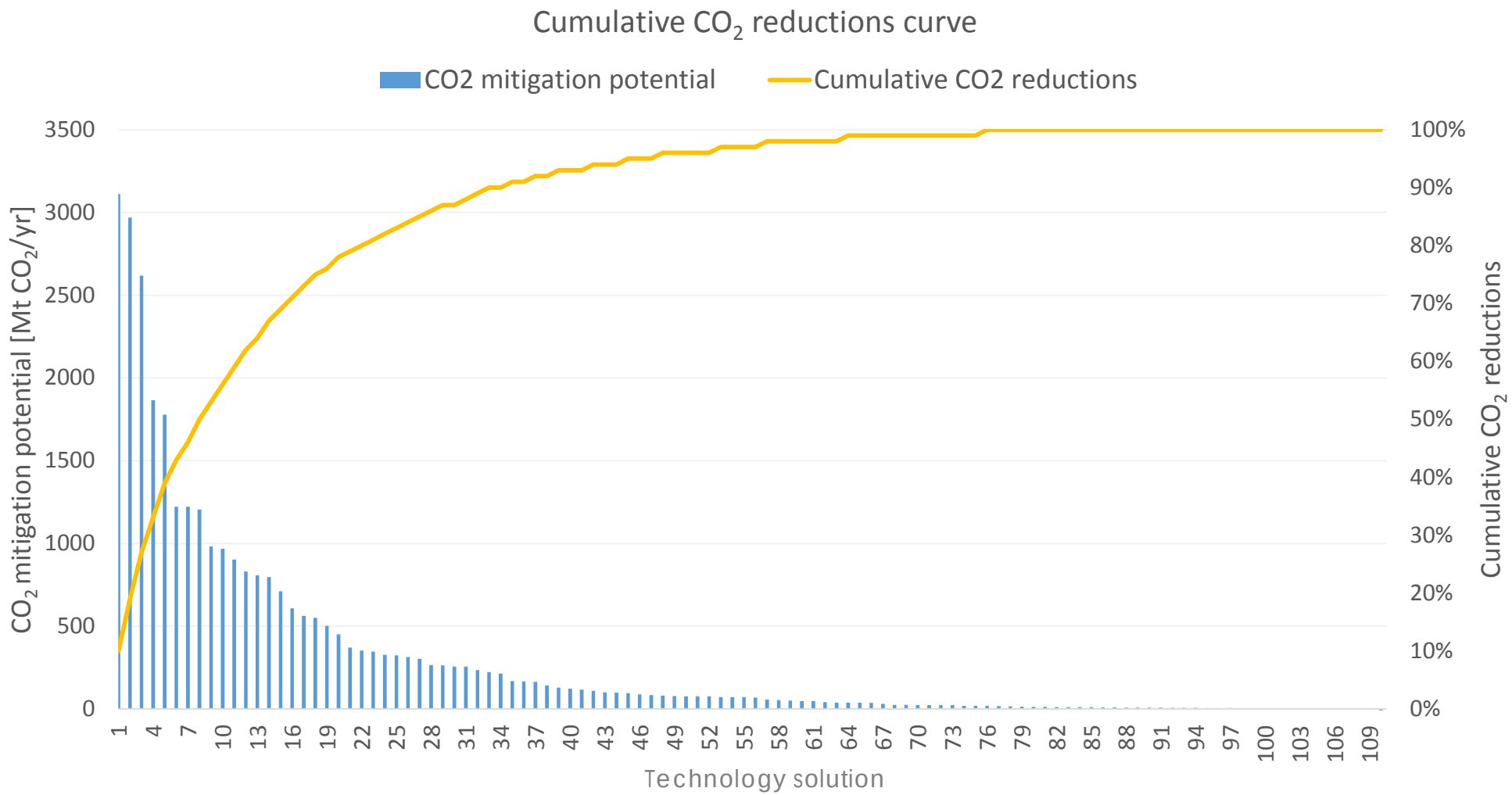
Mitigation potential and costs by technology

What it means for innovation?

- Urgent R&D needs for RE solutions in buildings and transport sectors
- Power sector going Ok
- A CO_2 price above 60 USD/tCO_2 may unlock most of the RE potential
- Transport may require regulation | Buildings may require breakthroughs

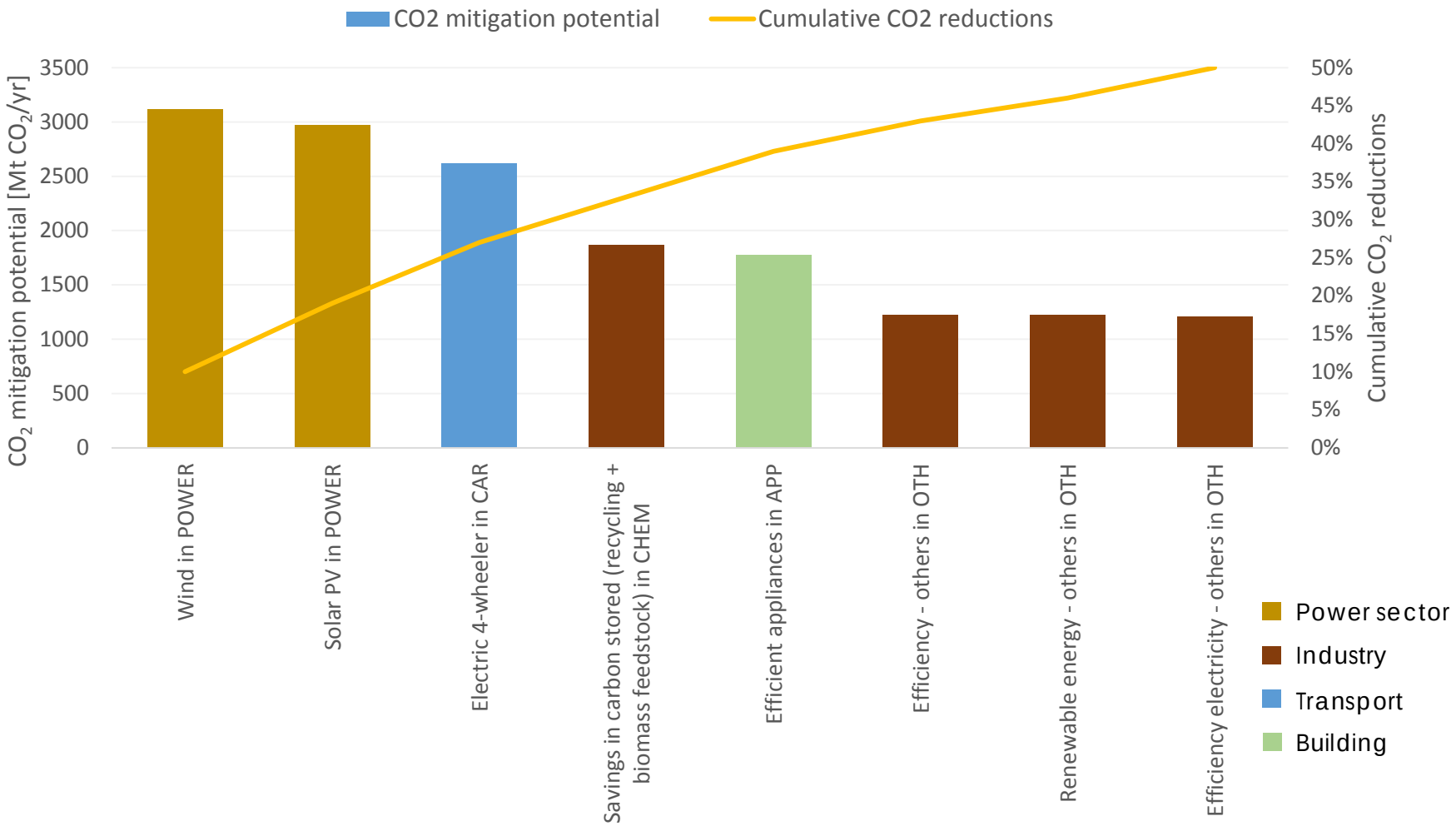


Analysis looked at 110 technology solutions in power and end-use sectors



Top 10 low-carbon technologies account for two-thirds of emission reductions needed for decarbonisation.

Materiality of technology solutions

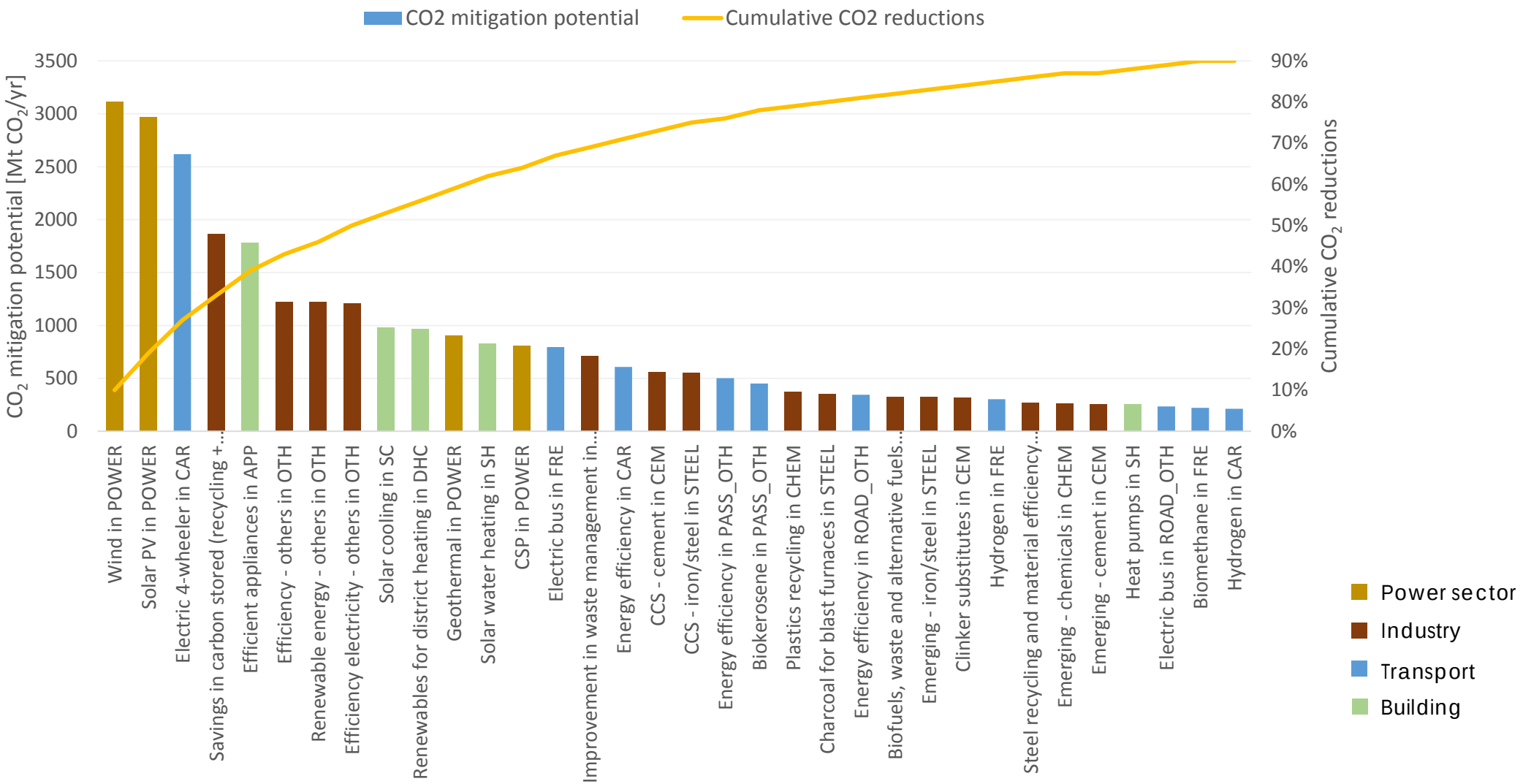


What it means for innovation?

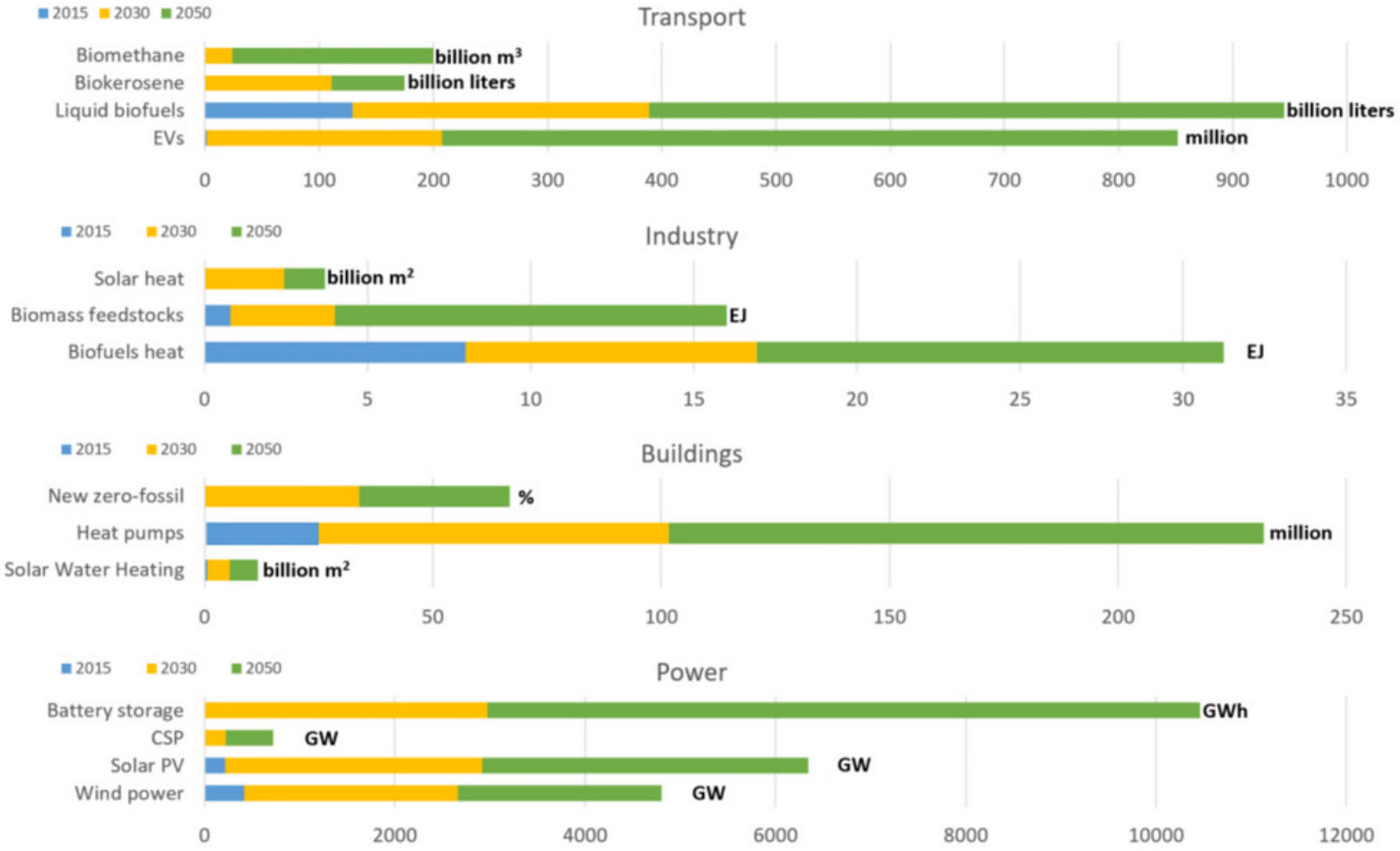
- Wind, solar PV and EVs are the key technologies for the decarbonisations: R&D to focus on system integration and continued cost reduction
- EE technologies are available but not implemented | would regulation help?
- RE in industry is significant but cost is too high | Breakthroughs and R&D urgently needed

Top 8 technologies represent half of the total emission reductions needed. Wind, solar PV, electric mobility for passenger cars, plastics recycling and efficient appliances represent more than 1/3

Contribution to mitigation by technology and sector



End-use sector transition: untapped areas



Transport

- Will traditional car-makers be able to catch up?
- Significant biofuel trade
- Materials needs (e.g. rare earth for EVs)

Industry

- Industry is the most challenging sector

Buildings

- Significant acceleration of buildings renovation

Power

- Growing equipment industries
- Materials needs (e.g. for batteries, inverters)

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