CARBON CAPTURE AND STORAGE

International Energy Agency

CCS: an option to reduce CO_2 emissions

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Division for Asia Pacific/Latin America

CCS in Energy-Intensive Industry: Beijing October 16

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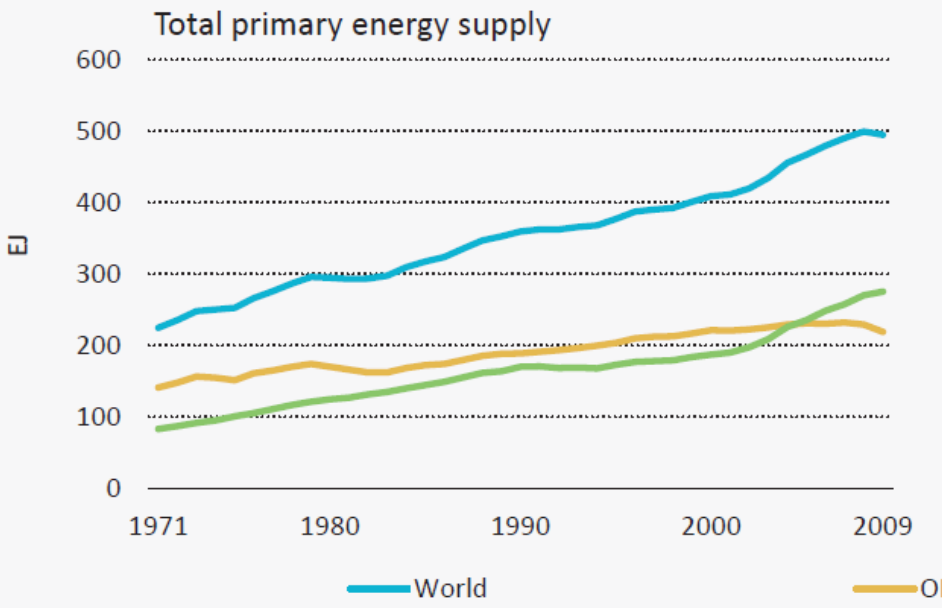
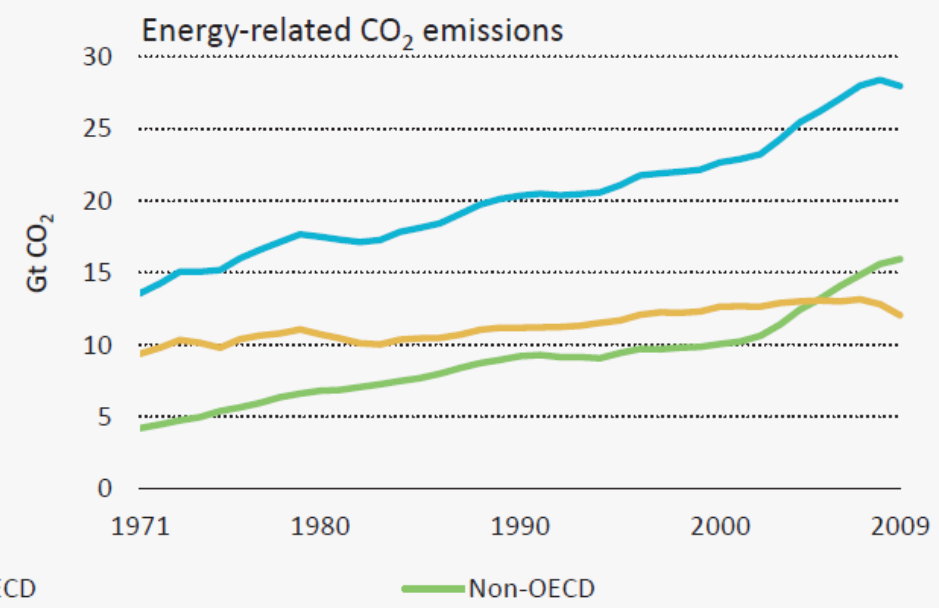
ENERGY DEMAND AND CO_2 EMISSIONS DOUBLED IN PAST 40 YEARS





- From 6000 Mtoe to 12 000 Mtoe
- Rapid demand growth outside OECD
- CO_2 emissions from 14Gt to 30Gt
- Since 2005, non-OECD countries emit more than OECD

Source: IEA statistics

Reducing CO_2 emissions by 50% by 2050

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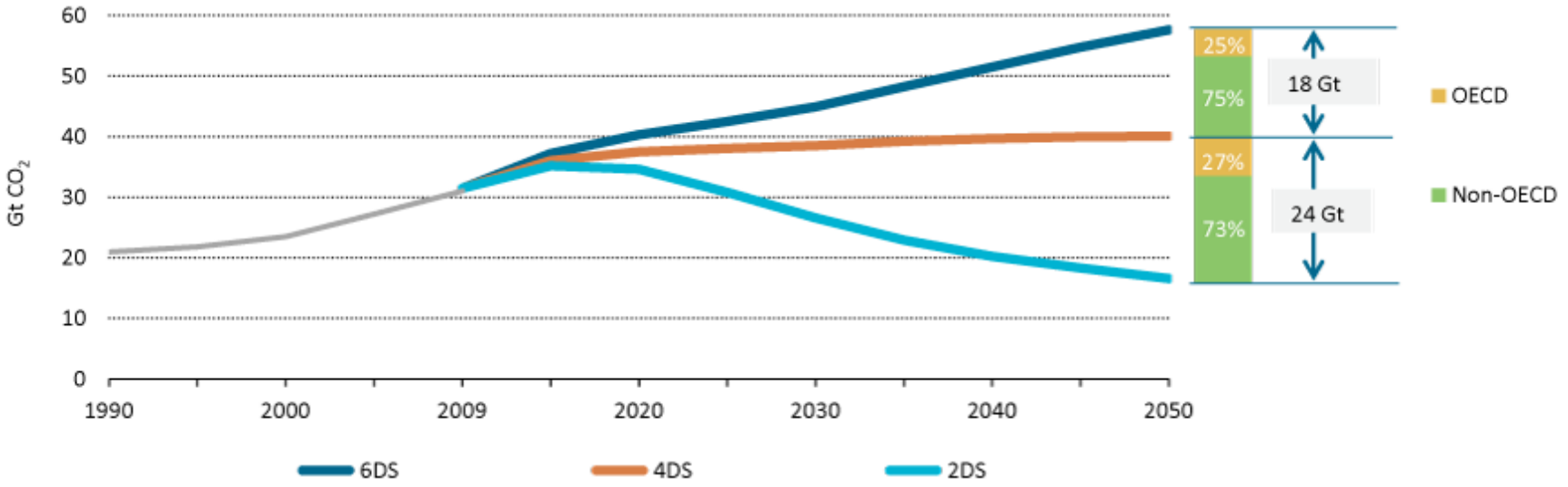
- To achieve ambitious climate goals, the world needs to cut energy-related CO2 emissions by 50% from today's levels…
- …but as populations grow and growth in energy consumption is inevitable, the reduction challenge is even higher: **gap of 24-42 Gt in 2050**



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CCS: part of a technology portfolio

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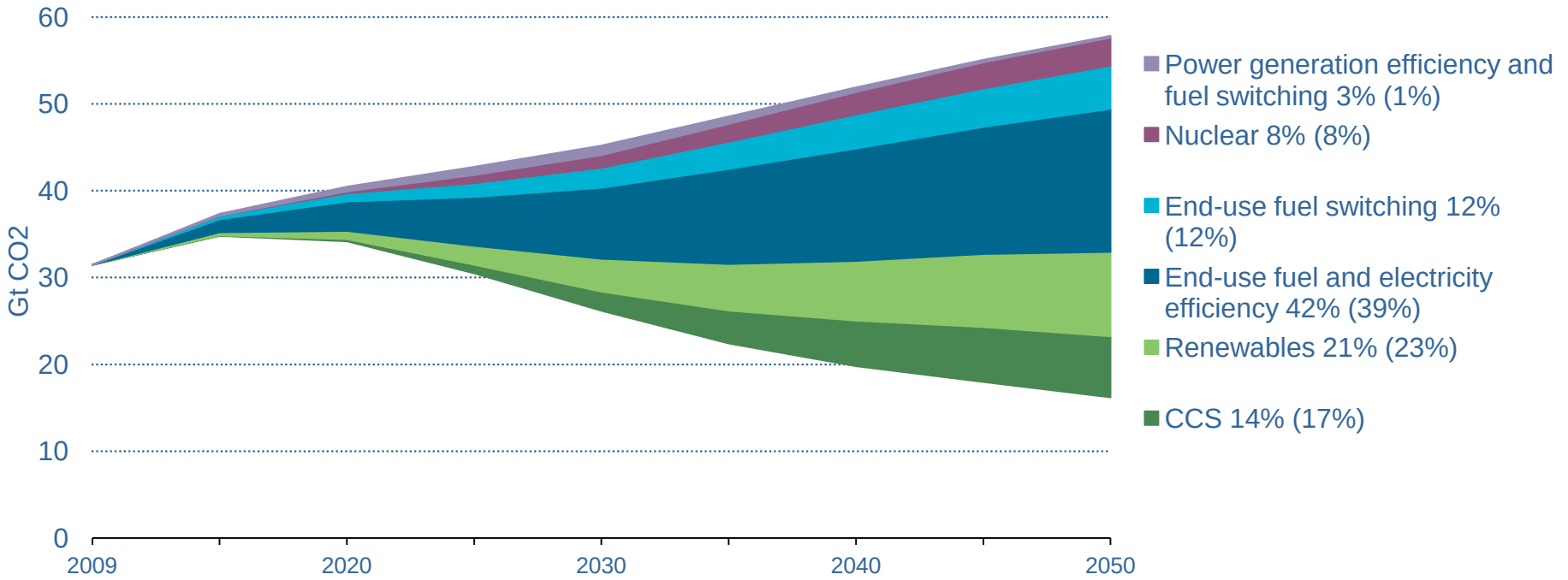

- A range of technologies are required in the power sector: energy efficiency, fuel switching, renewables, nuclear and CCS!
- This is not a prediction of what is likely to happen…
- **…but analysis gives strong evidence that the role of CCS will be significant (almost 20% of cumulative efforts) until 2050**

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CCS must be deployed globally

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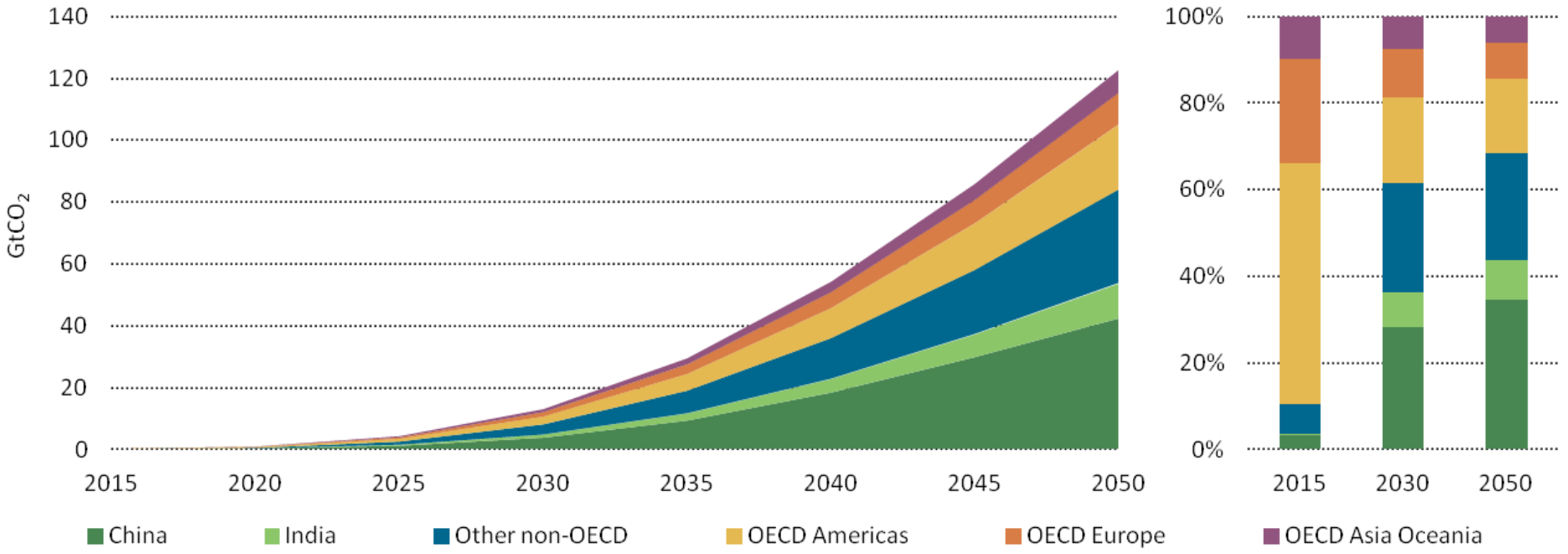

- 2015-2050: almost 123 $GtCO_2$ captured and stored
- Non-OECD countries will dominate by 2030

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How much is 3.6 trillion USD?

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Table 4.1 Investment requirements by sector in the 6DS and 2DS

Sector	6DS (in USD trillions) 2010 to 2020	2020 to 2030	2030 to 2050	2DS (in USD trillions) 2010 to 2020	2020 to 2030	2030 to 2050
Power	5.9	6.5	15.9	6.5	8.7	20.7
Buildings	3.2	3.9	9.1	6.2	6.9	14.7
Industry	2.8	2.3	4.4	3.1	2.7	5.4
Transport	(33.0) 7.0	(44.8) 9.9	(137.3) 32.5	(33.7) 8.1	(47.3) 12.5	(149.9) 44.4
Total investment	19.0	22.7	61.9	23.9	30.9	85.2

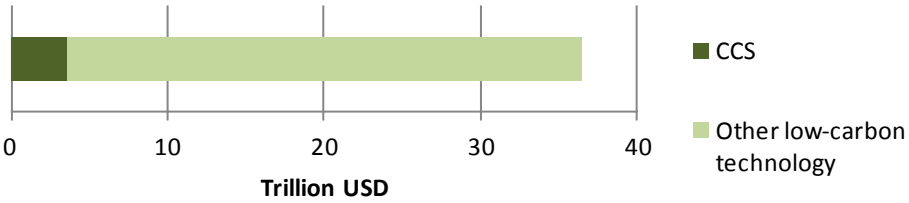
Notes: Industry includes iron and steel, chemicals, cement, pulp and paper, and aluminium. Transport includes the cost of the powertrain only; full vehicle costs are shown in parentheses.
Source: Unless otherwise noted, all tables and figures in the chapter derive from IEA data and analysis.

103.6

140

- Investment requirements without particular clean energy goals are 103.6 trillion USD until 2050
- Investment requirements to reach 2DS scenario are 140 trillion USD until 2050
- Additional investment thus 36,4 trillion USD until 2050

CCS accounts for roughly 10% of the required additional investment:



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CCS is applied in power *and* industry

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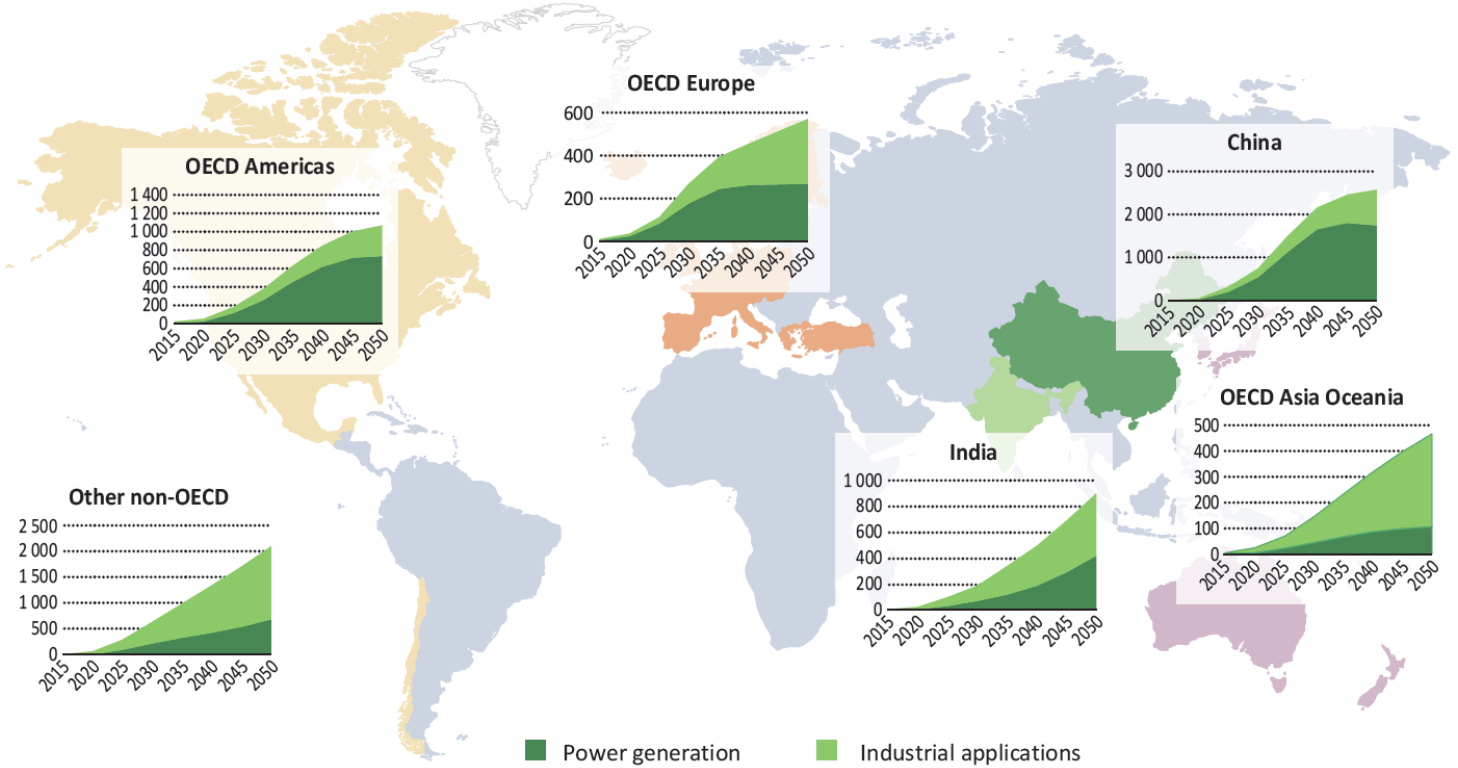

Note: Capture rates shown in $MtCO_2$/year

The majority of CO_2 is captured from power generation globally, but in some regions CO_2 captured from industrial applications dominates

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Three CO_2 capture routes in power

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Post-combustion CO_2 capture	• Fossil fuel or biomass is burnt normally and CO_2 is separated from the exhaust gas
Pre-combustion CO_2 capture	• Fossil fuel or biomass is converted to a mixture of hydrogen and CO_2, from which the CO_2 is separated and hydrogen used for fuel
Oxy-combustion CO_2 capture	• Oxygen is separated from air, and fossil fuels or biomass are then burnt in an atmosphere of oxygen producing only CO_2 and water

At the present time, none of the options is superior; each has particular characteristics making it suitable in different power generation applications

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CCS is applied to coal, gas and biomass

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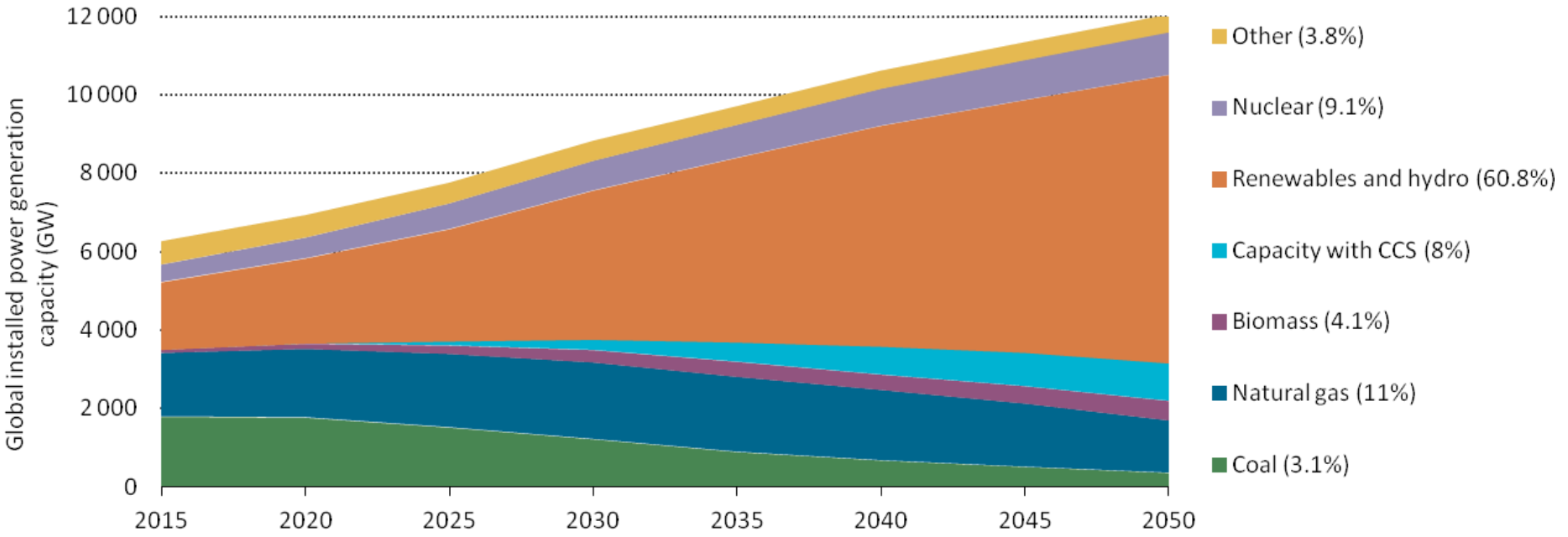

In 2050, 63% of coal-fired electricity generation (630 GW) is CCS equipped, 18% of gas (280 GW) and 9% of biomass (50 GW)

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Considering CCS in Industry

Industrial applications of CCS

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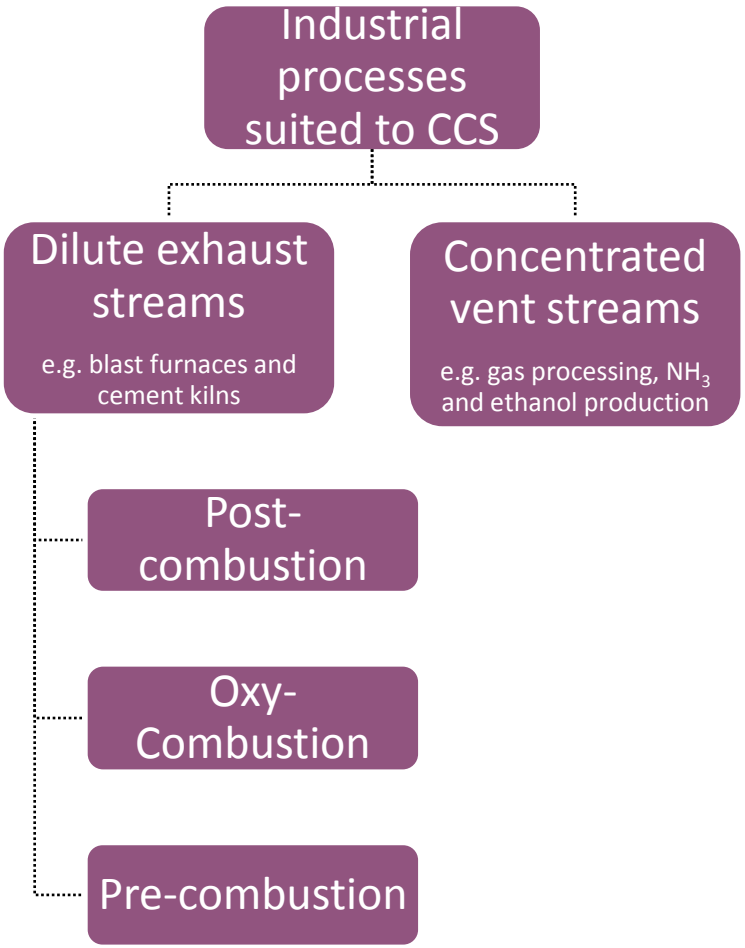
- Some industrial processes produce highly concentrated CO_2 vent streams; capture from these "high-purity" sources is relatively straightforward
- Other industrial applications require additional CO_2 separation technologies to concentrate dilute streams of CO_2
- The same CO_2 separation technologies applied in power generation can be applied to industrial sources



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Bioenergy-CCS or "BECCS"

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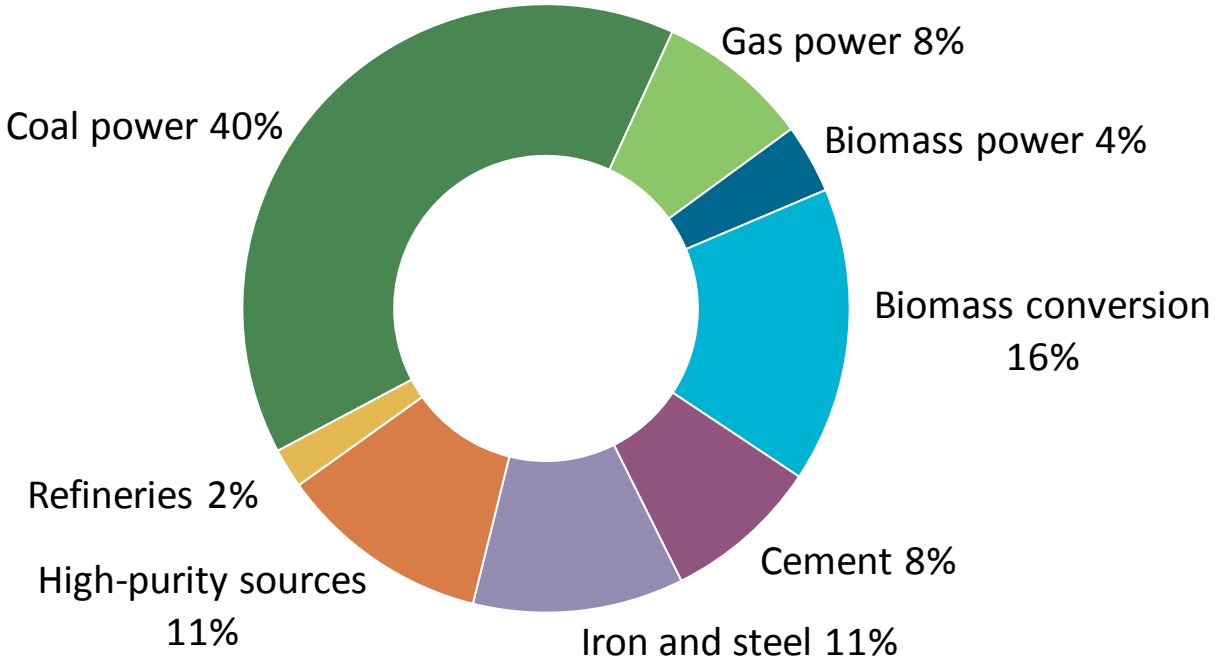
7.9 Gt captured in 2050



Around 1.5Gt of CO_2 are captured at BECCS plants in 2050 in the 2DS.

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Industrial applications vary by region

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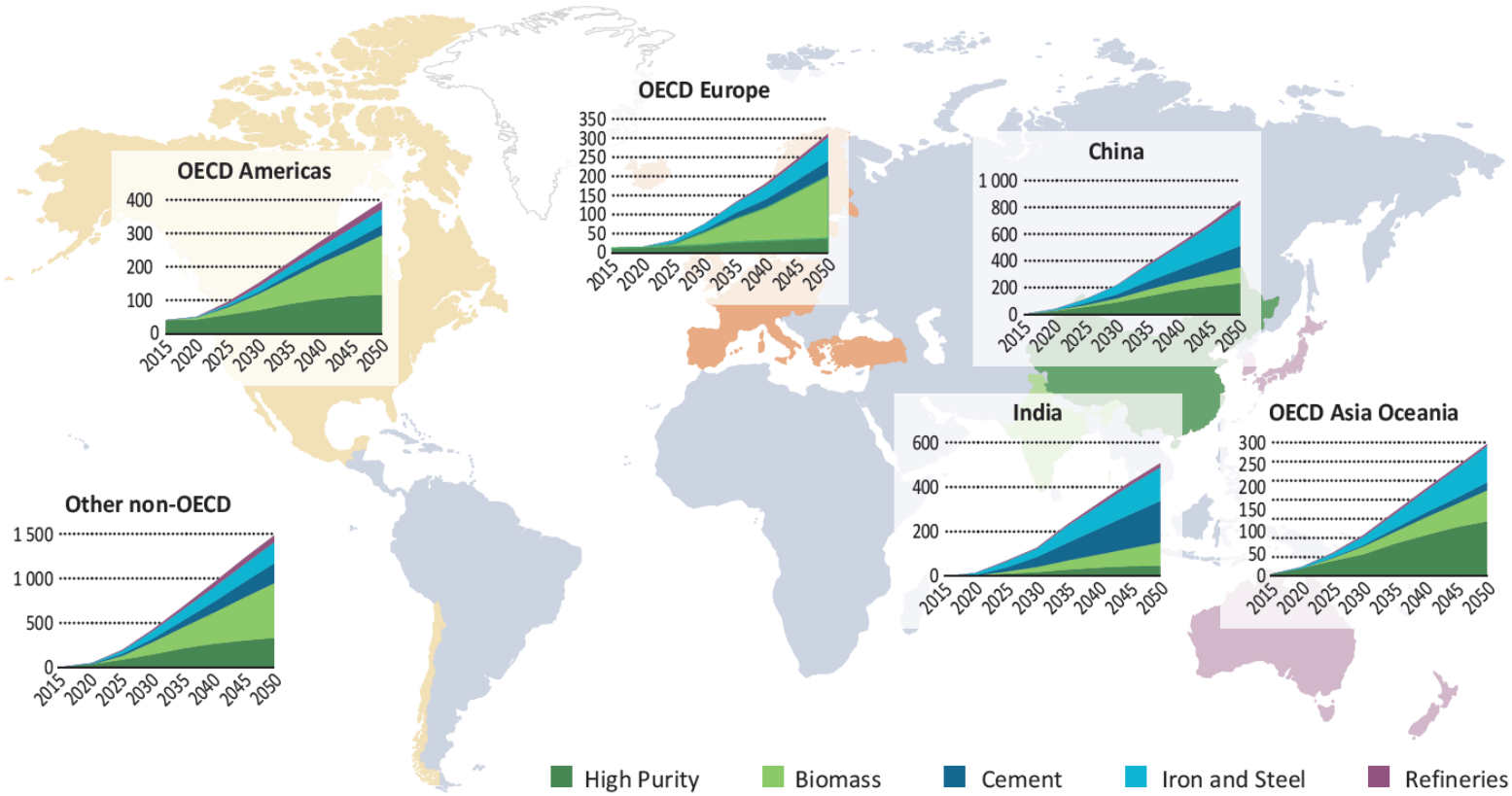

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Note: Capture rates shown in $MtCO_2$/year

The predominant industrial application of CCS will vary by region and over time

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Where is CO_2 storage needed?

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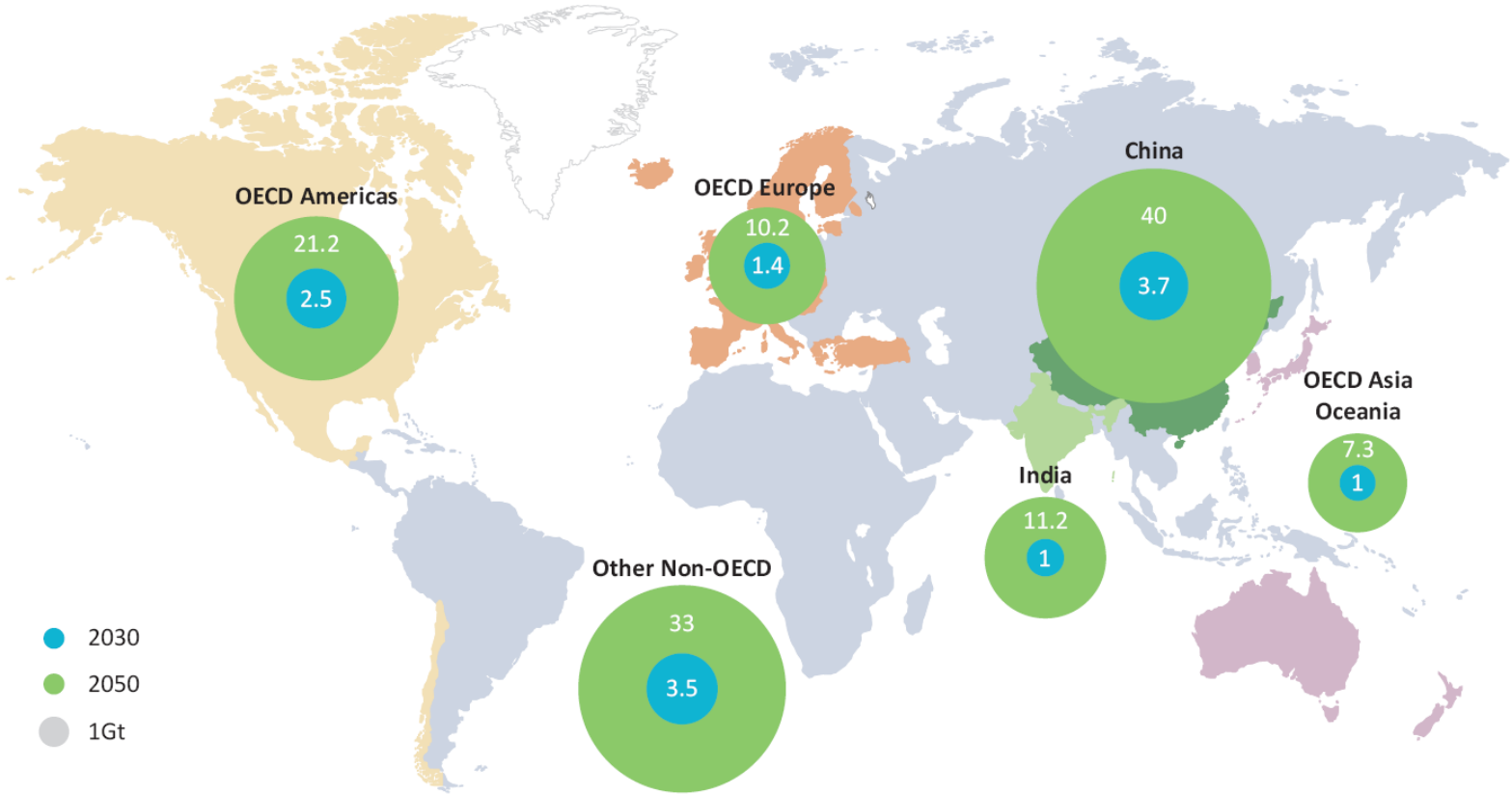

Note: Mass captured shown in $GtCO_2$

Between 2015 and 2050, 123 Gt of CO_2 are captured that need to be transported to suitable sites and stored safely and effectively. Storage sites will need to be developed all around the world.

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Many policy & finance challenges

- Many industry sectors, no one-size-fits-all policy
- Government and industry awareness of CCS as a mitigation option needs a boost
- How can international finance mechanisms help CCS in industry
- Trade issues: need solutions that cover specific sectors globally, not just in one country
- Importance of cluster approach
- R&D for industrial applications
- Storage capacity assessment and investigation

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Thank You!

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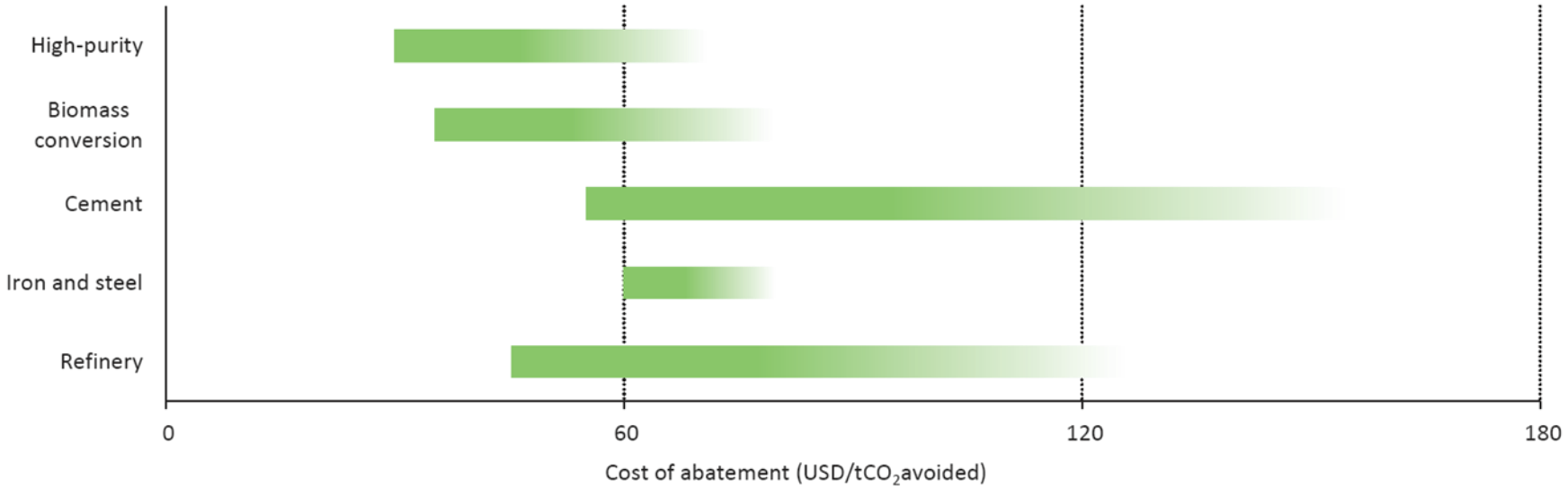
Cost of CCS in industry varies widely



Notes: The range of costs shown here reflect the regional average cost of applying CCS in each sector, and, therefore, the overall cost of abatement in a sector will be affected by the assumed level of CCS uptake in each sector (IEA, 2009 and IEA and UNIDO, 2011). These costs include the cost of capture, transport, and storage, but do not assume that storage generates revenues – *i.e.* CO_2 storage through enhanced oil recovery (EOR) is not considered as a storage option.

A wide range of abatement costs through CCS exists in industrial applications