ENERGY & ENVIRONMENT

# Combining Bio-Energy and Carbon Capture and Storage(BECCS)

## An option for Negative Emissions and IEA Perspectives to 2050

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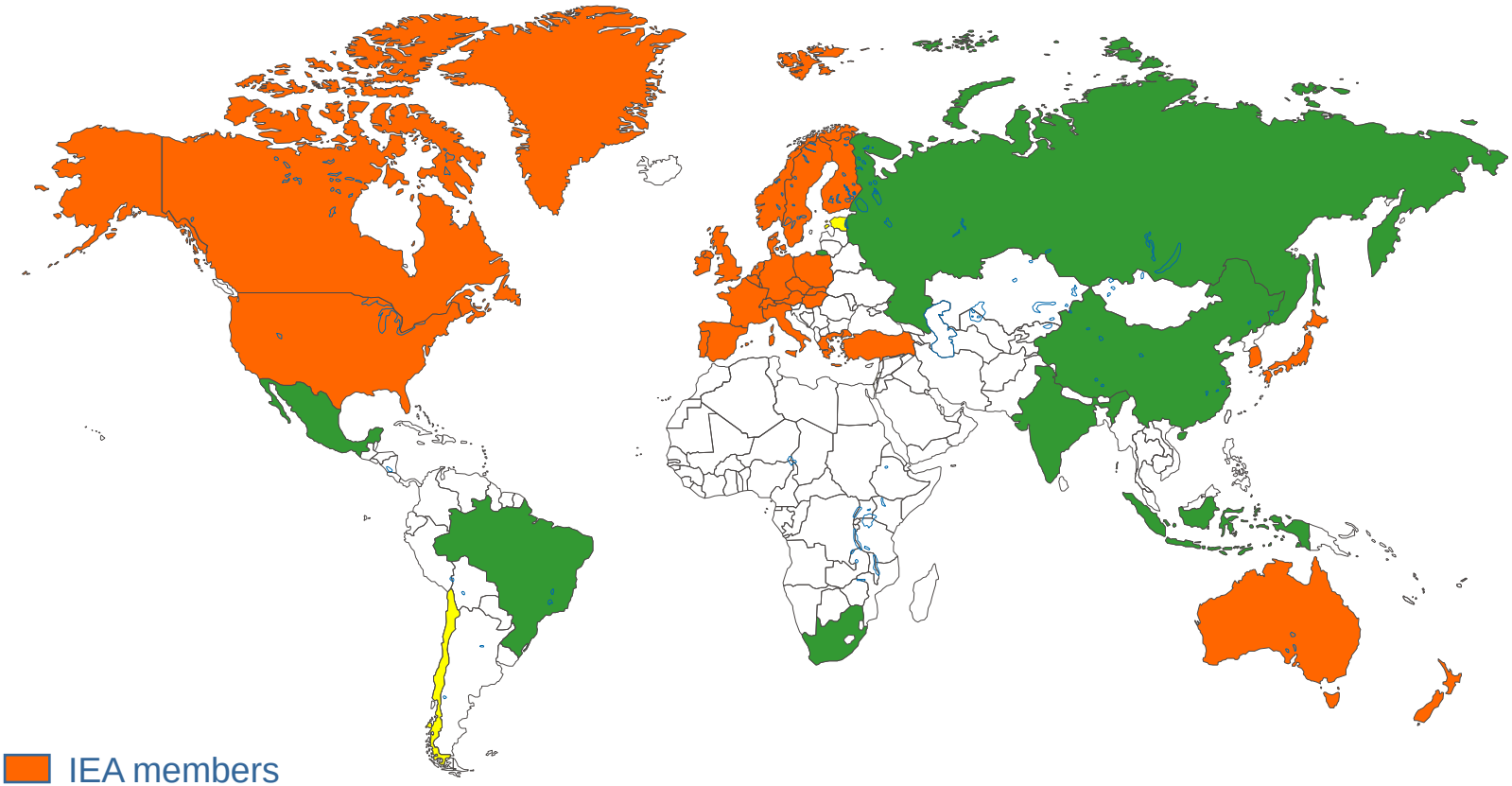
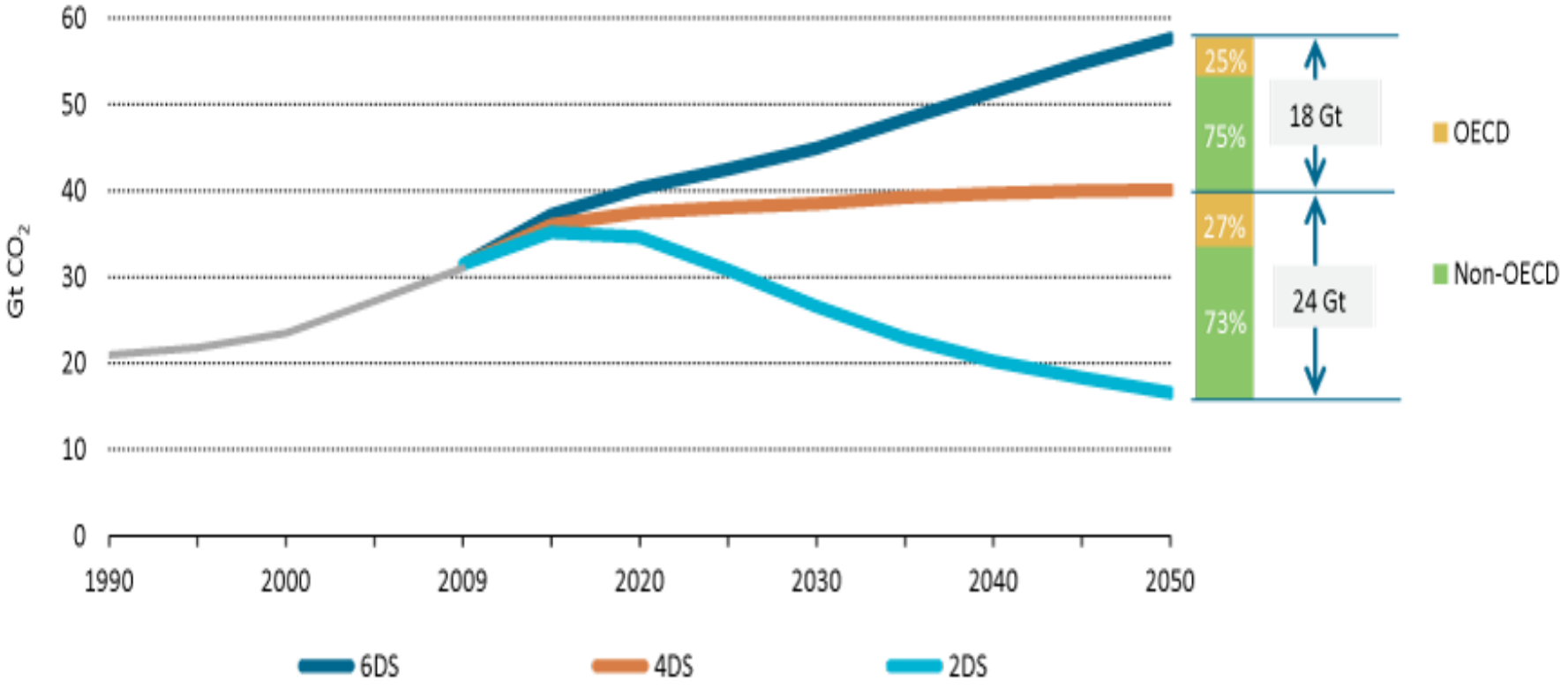
# Twenty-eight IEA member countries



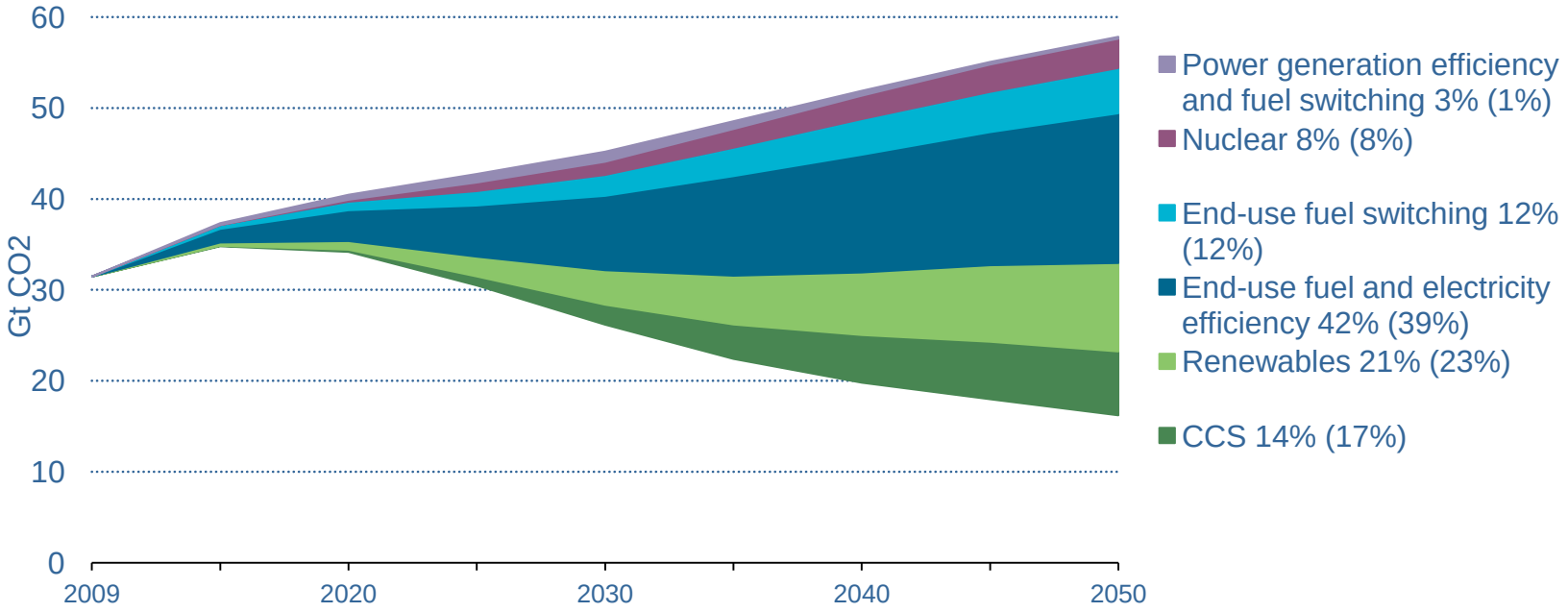
IEA members
Accession countries (Chile and Estonia have begun the process of joining the IEA)
Partner countries that attended the 2011 Ministerial Meeting

**Dedicated CCS Unit since 2010, launched with financial support from Australia (RET / GCCSI)**

# ETP2012: need to cut $CO_2$ by 50% by 2050

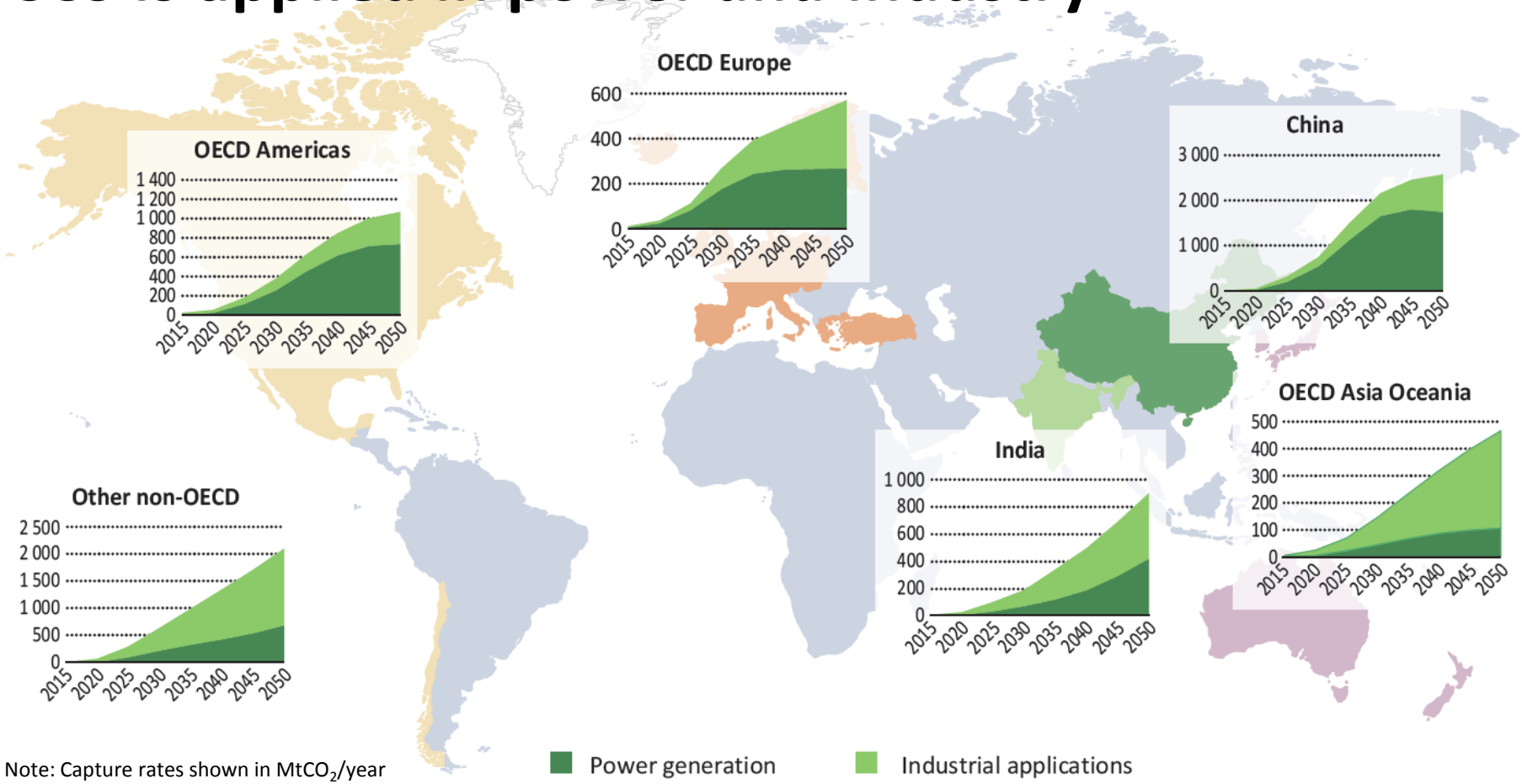


# CCS: part of a technology portfolio




- **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 points to significant role of CCS to 2050**

# CCS is applied in power *and* industry

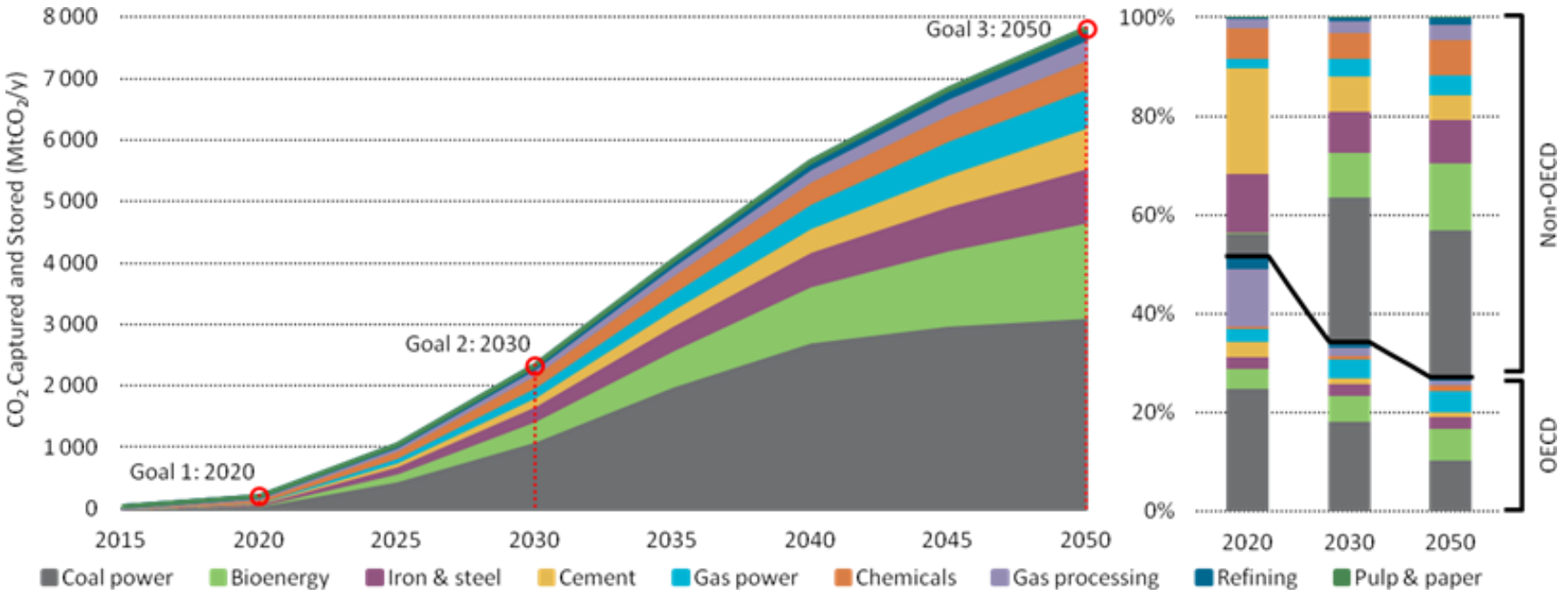



Note: Capture rates shown in $MtCO_2$/year



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

# In 2DS By 2050: 120Gt of $CO_2$ safely stored




- **2020: Several dozen** large-scale projects in coal and gas power and 1st phase industry
- **2030:** > **2000Mt** $CO_2$ stored pa; CCS routinely used in power and industry; ready for deployment in 2nd phase industry
- **2050**: > **7000Mt** $CO_2$ stored pa; CCS **routinely used** in all applicable power and industry

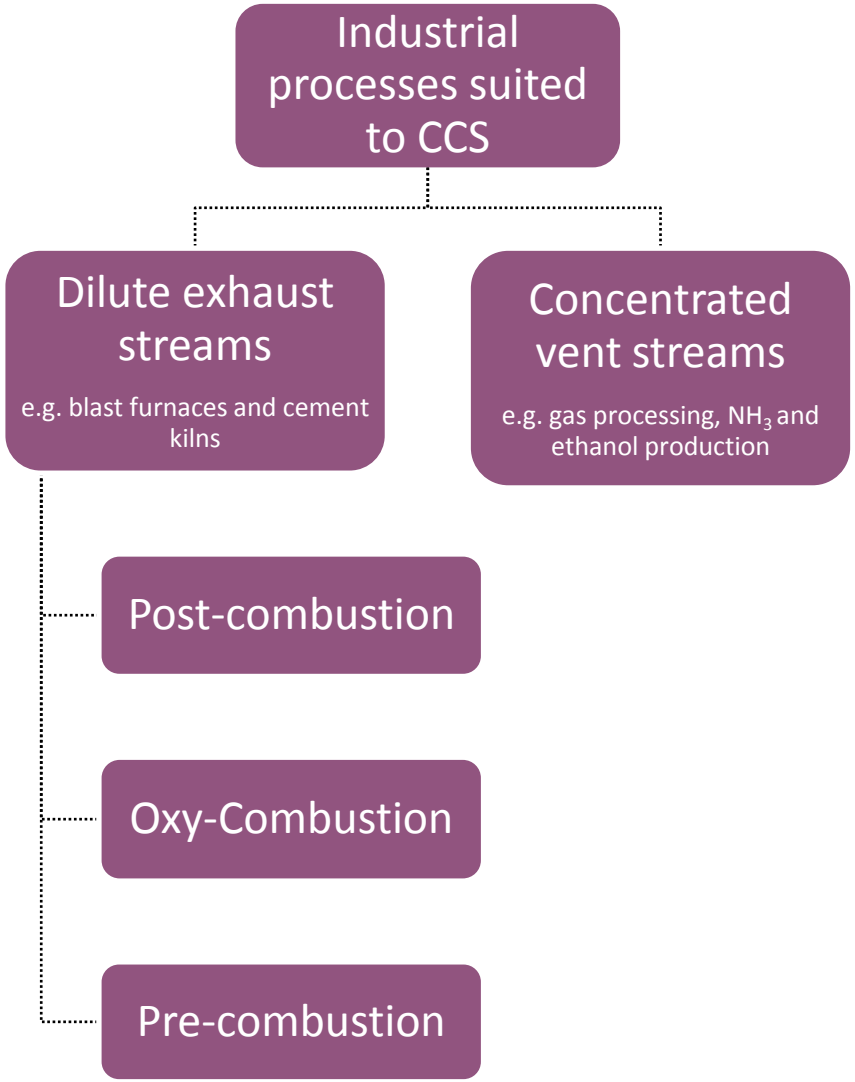
# $CO_2$ capture routes in power

| | |
|---|---|
| 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**

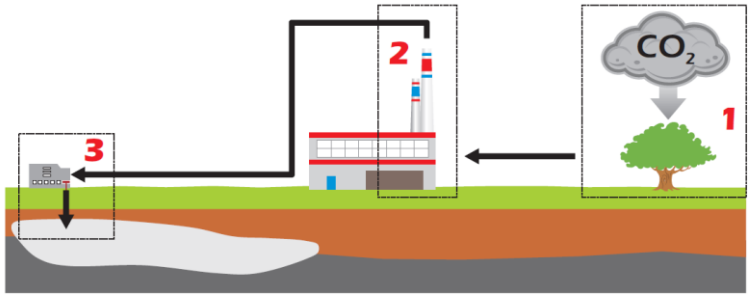
# Industrial applications of CCS

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



# Negative emissions from BECCS
# By linking the Chain

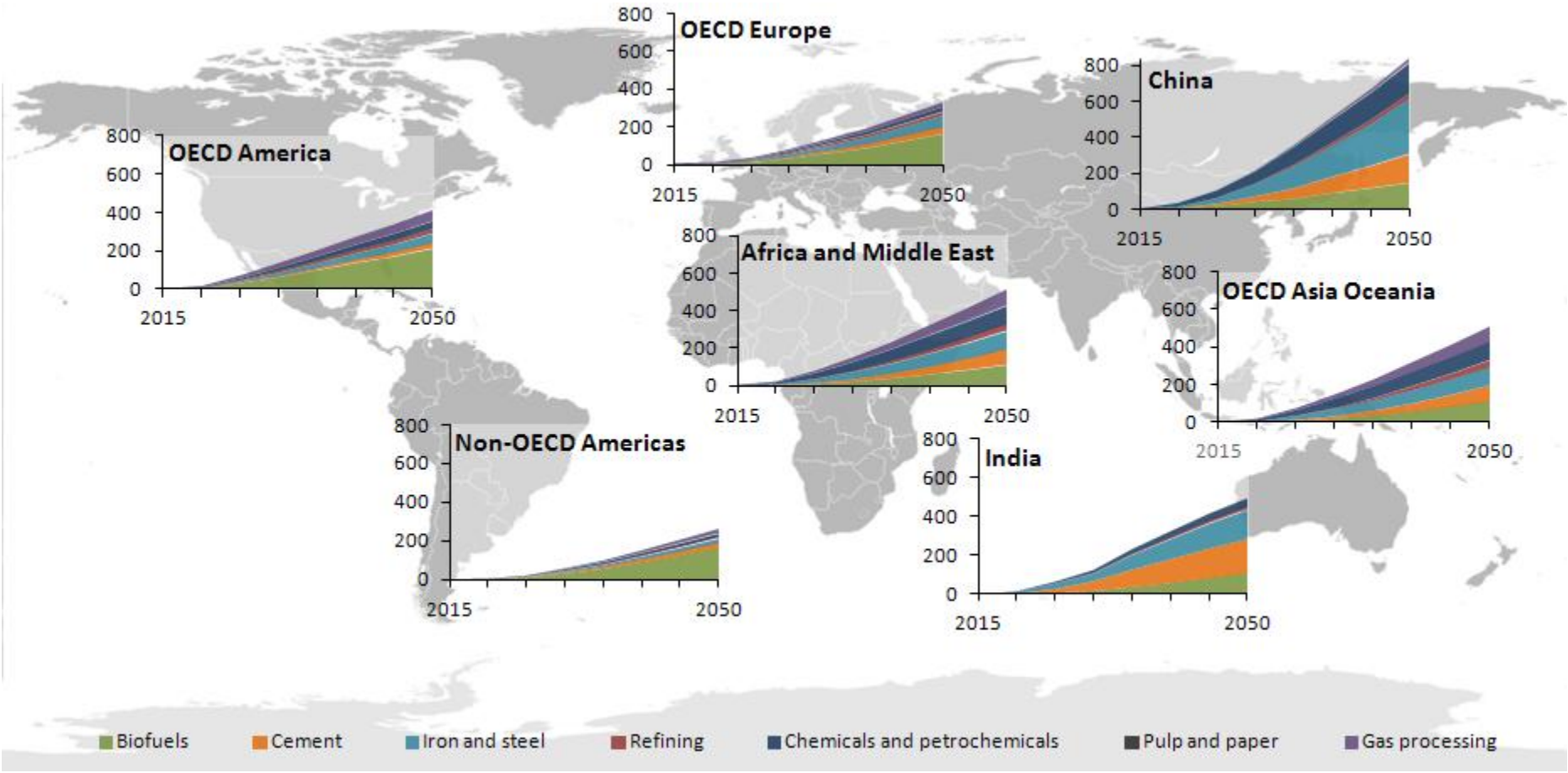
**1. Biomass 2. Capture 3. Storage**



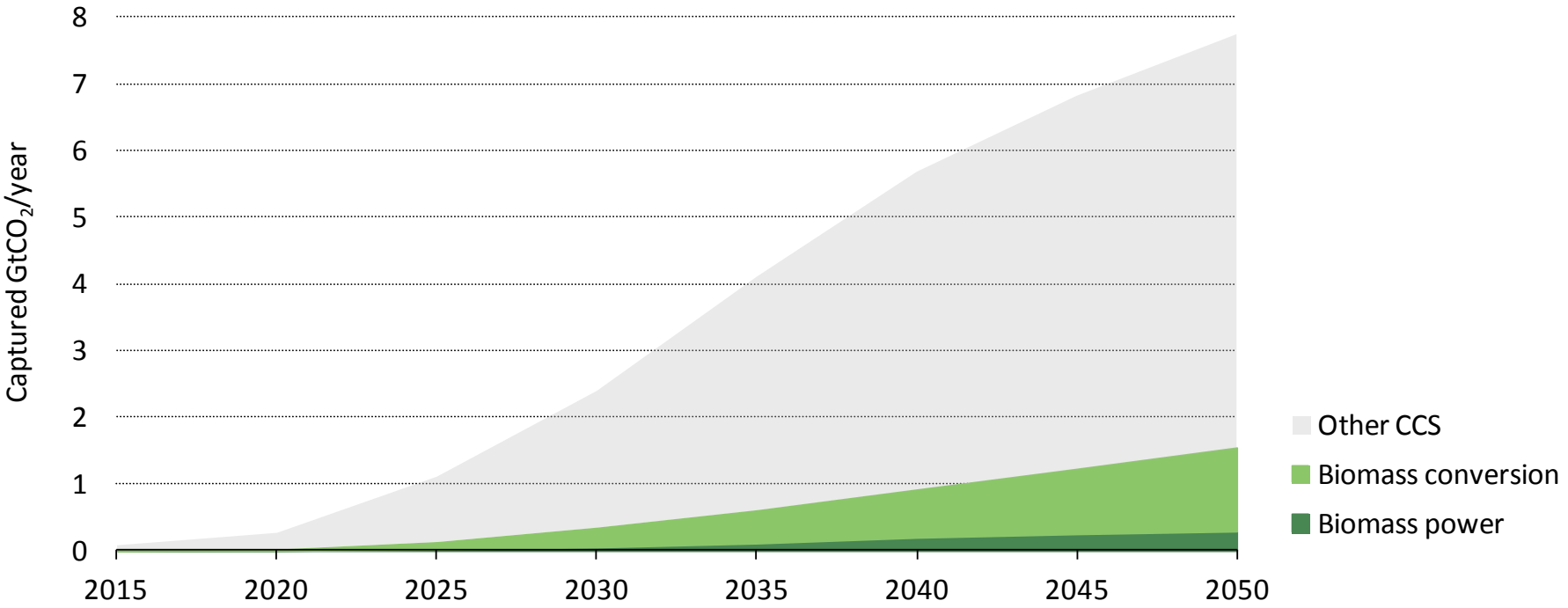

- **Bio-energy with carbon capture and storage (BECCS) can result in permanent net removal of $CO_2$ from the atmosphere, i.e. "negative $CO_2$ emissions"**
- **In BECCS, energy is provided by biomass, which removed atmospheric carbon while it was growing, and the $CO_2$ emissions from its use are captured and stored through CCS**
- **BECCS can be applied to a wide range of biomass conversion processes and may be attractive cost-effective in many cases**

***Biomass must be grown and harvested sustainably, as this significantly impacts the level of emissions reductions that can be achieved***

# Industrial applications vary widely by region

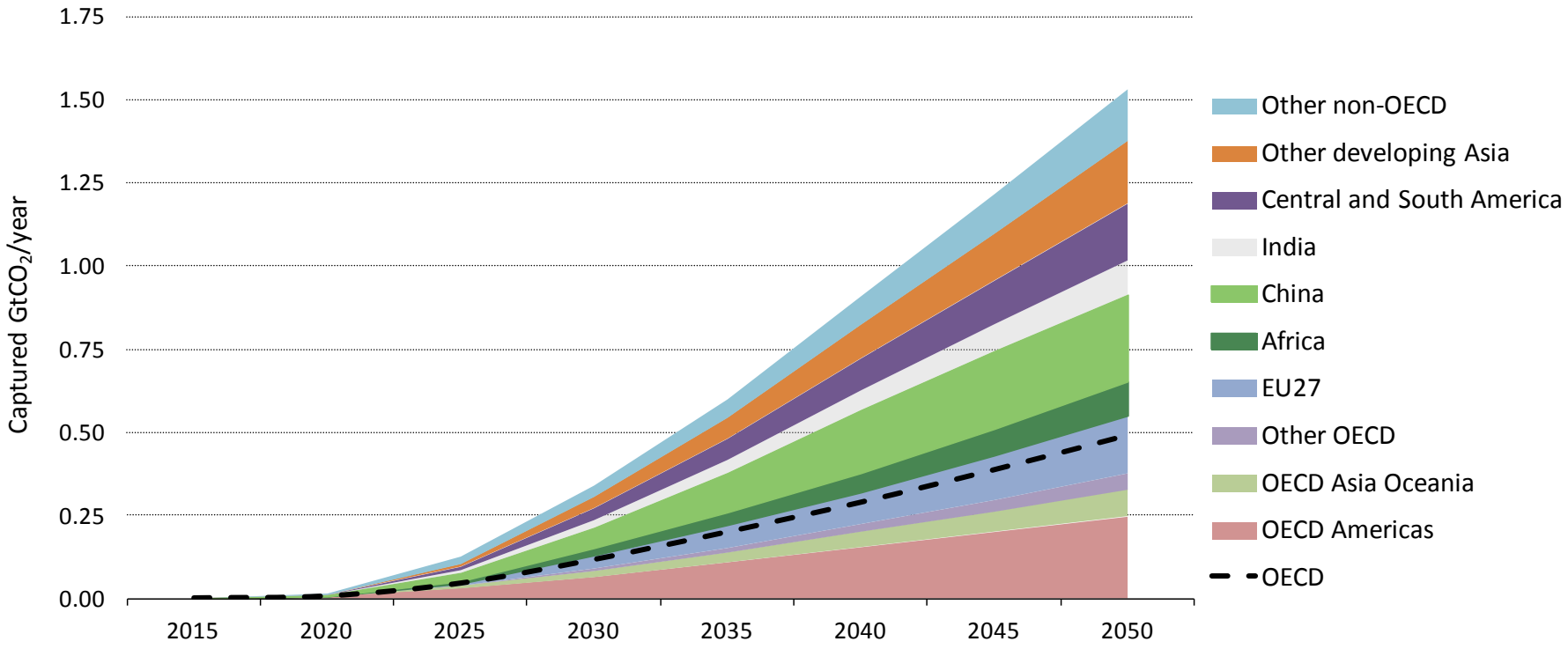


# Captured $CO_2$ from BECCS



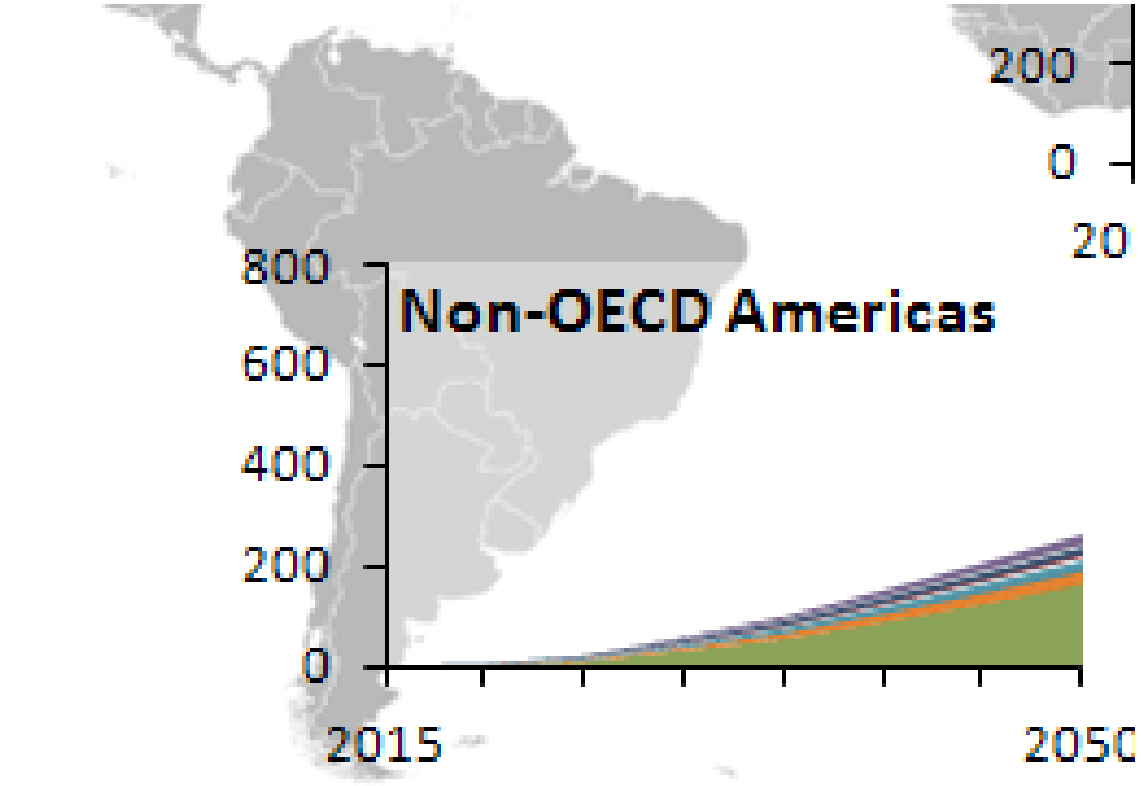

**Around 1.5Gt of $CO_2$ are captured at BECCS plants in 2050 in the 2DS.**

# Regional breakdown of BECCS

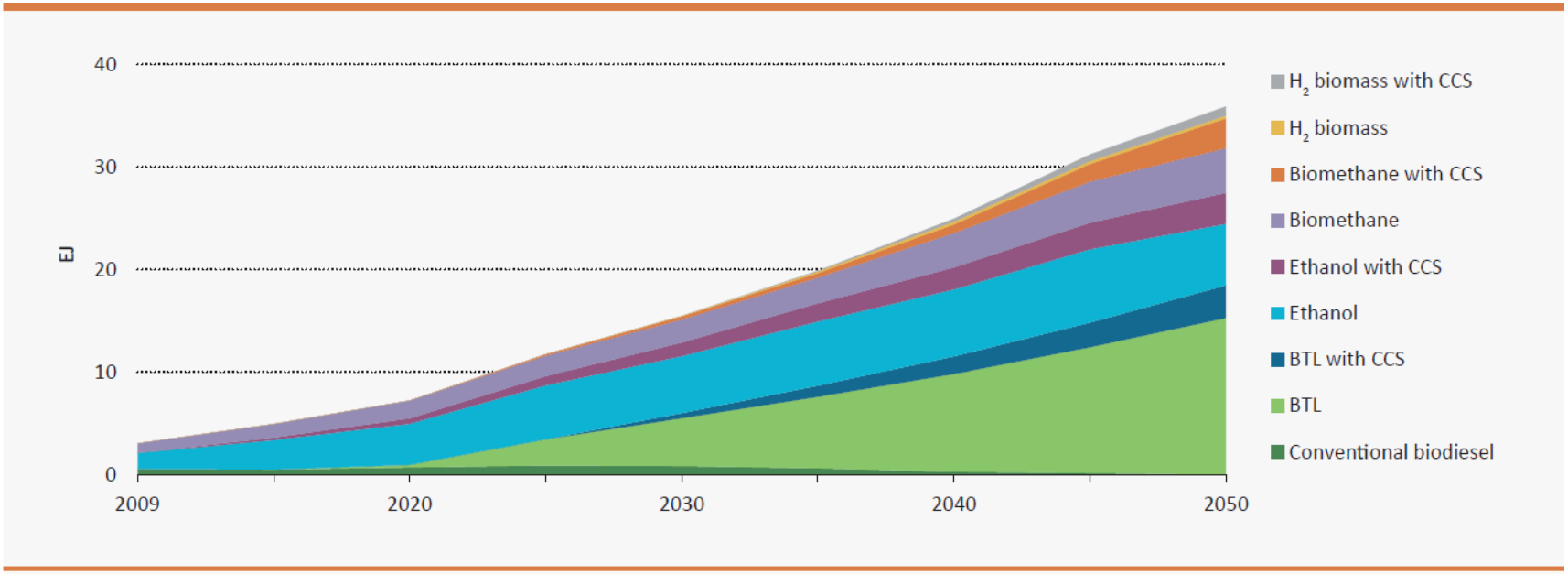



**Non-OECD regions account for two thirds of the $CO_2$ captured at BECCS plants in 2050.**

# Industrial CCS with Biofuels dominates in non-OECD Americas

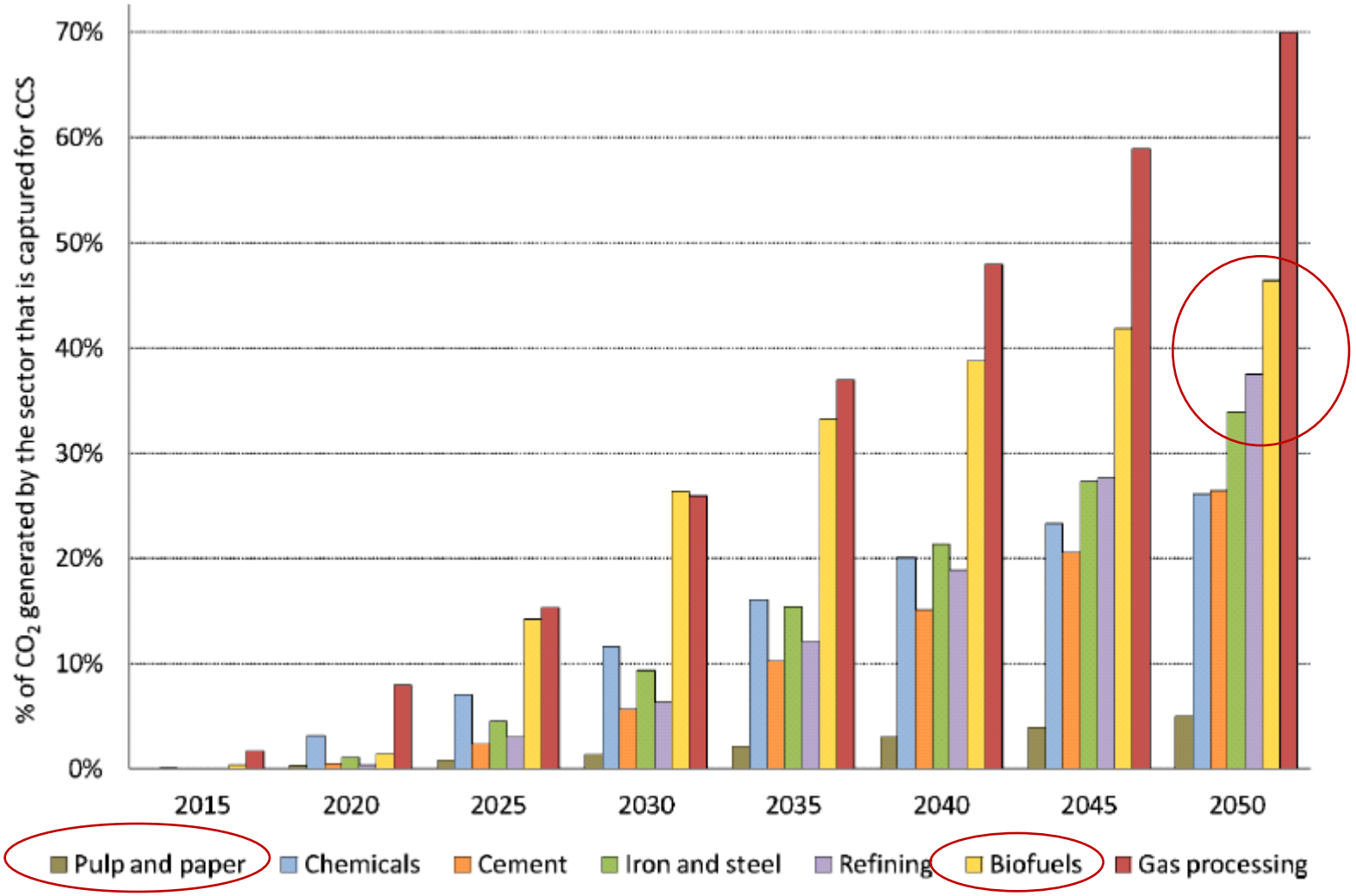


# Almost 30% of Biofuel production to 2050 is based on plants equipped with CCS

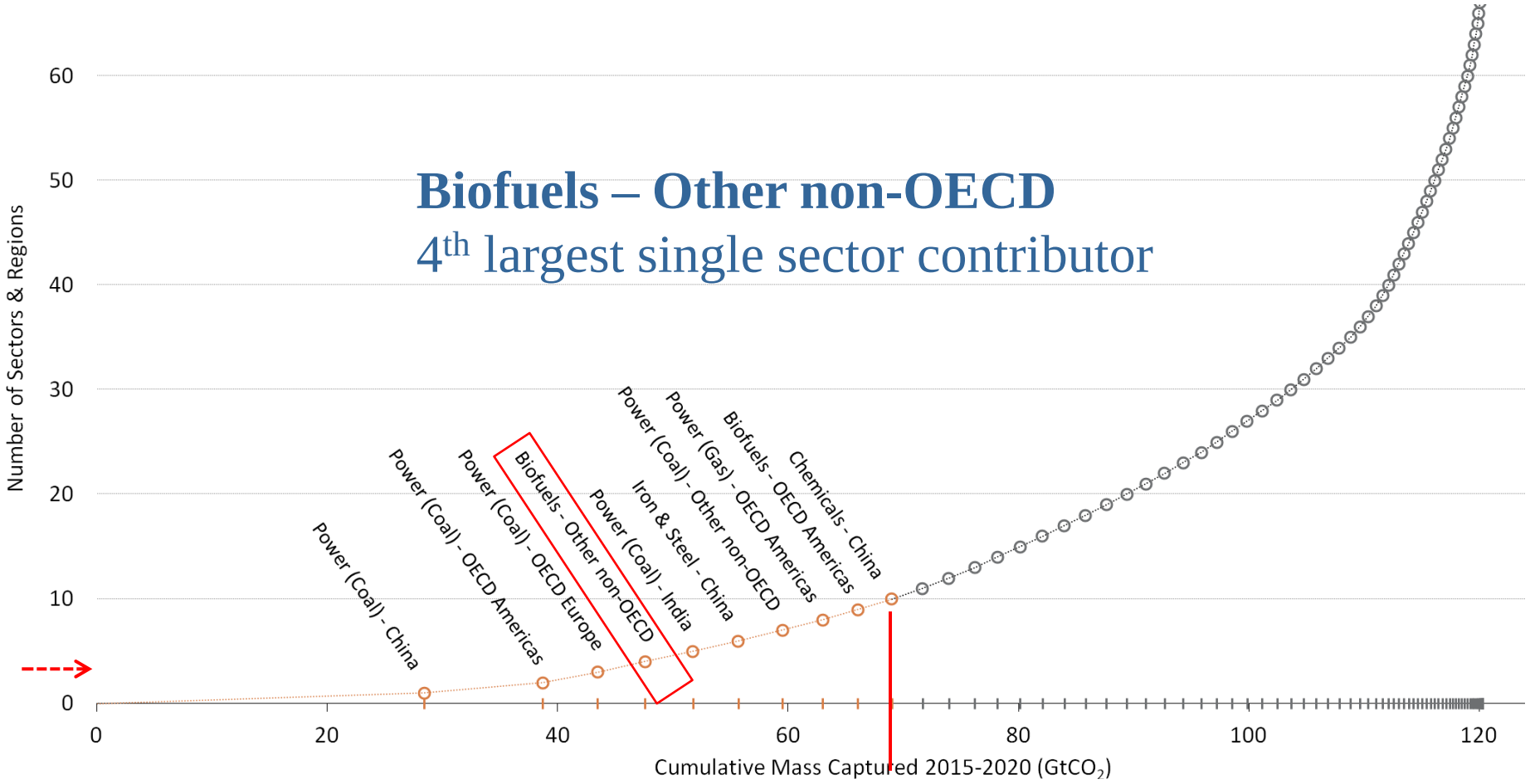



ETP 2012: Fuel production (including hydrogen and biomethane) from biomass by technology in the 2DS

# Proportion of CO2 generated globally that is captured and stored through CCS in the sectors analyzed in the 2DS

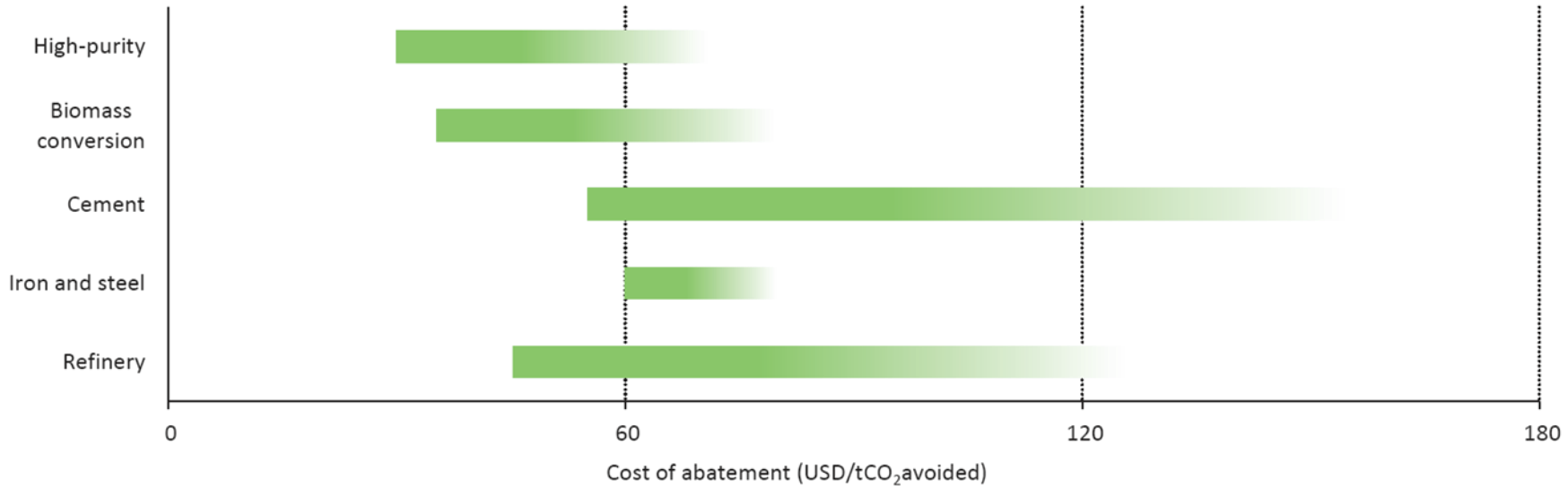


# Top-10 regions/sectors: 55% of total effort




Source: IEA

# Cost of CCS in industry varies widely

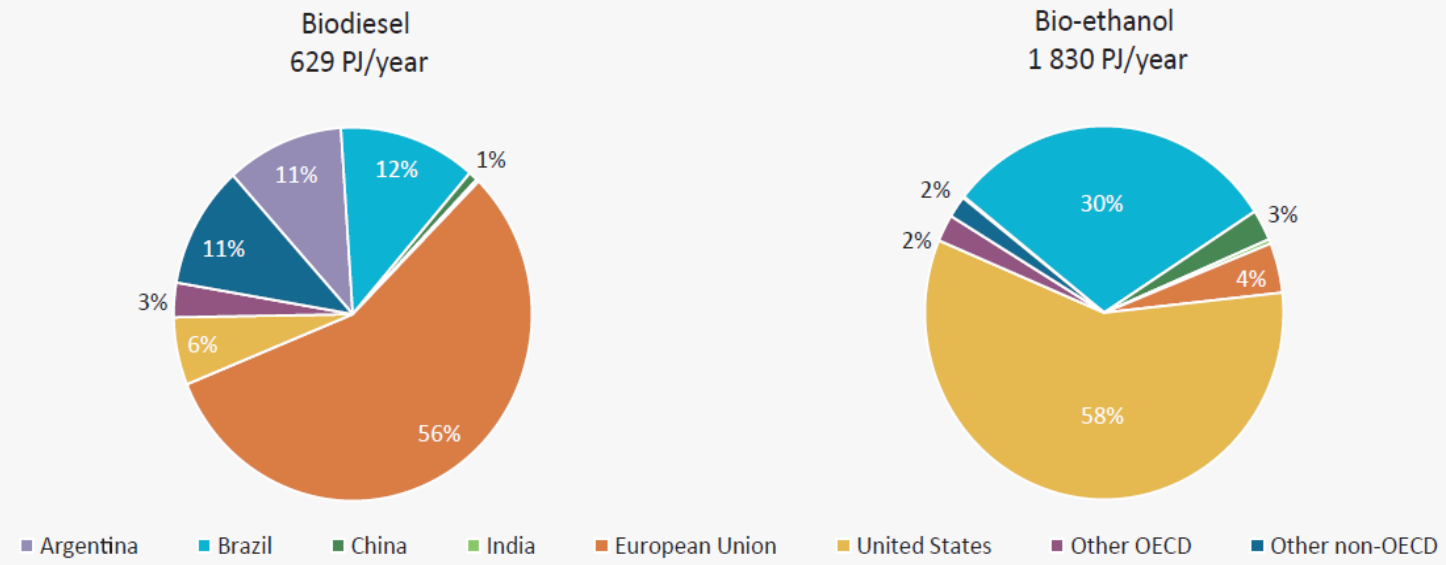



Notes: The range of costs shown here reflect the regional average cost of applying CCS in each sector, and, therefore, the overall cost of abatement in a sector will be affected by the assumed level of CCS uptake in each sector (IEA, 2009 and IEA and UNIDO, 2011). These costs include the cost of capture, 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**

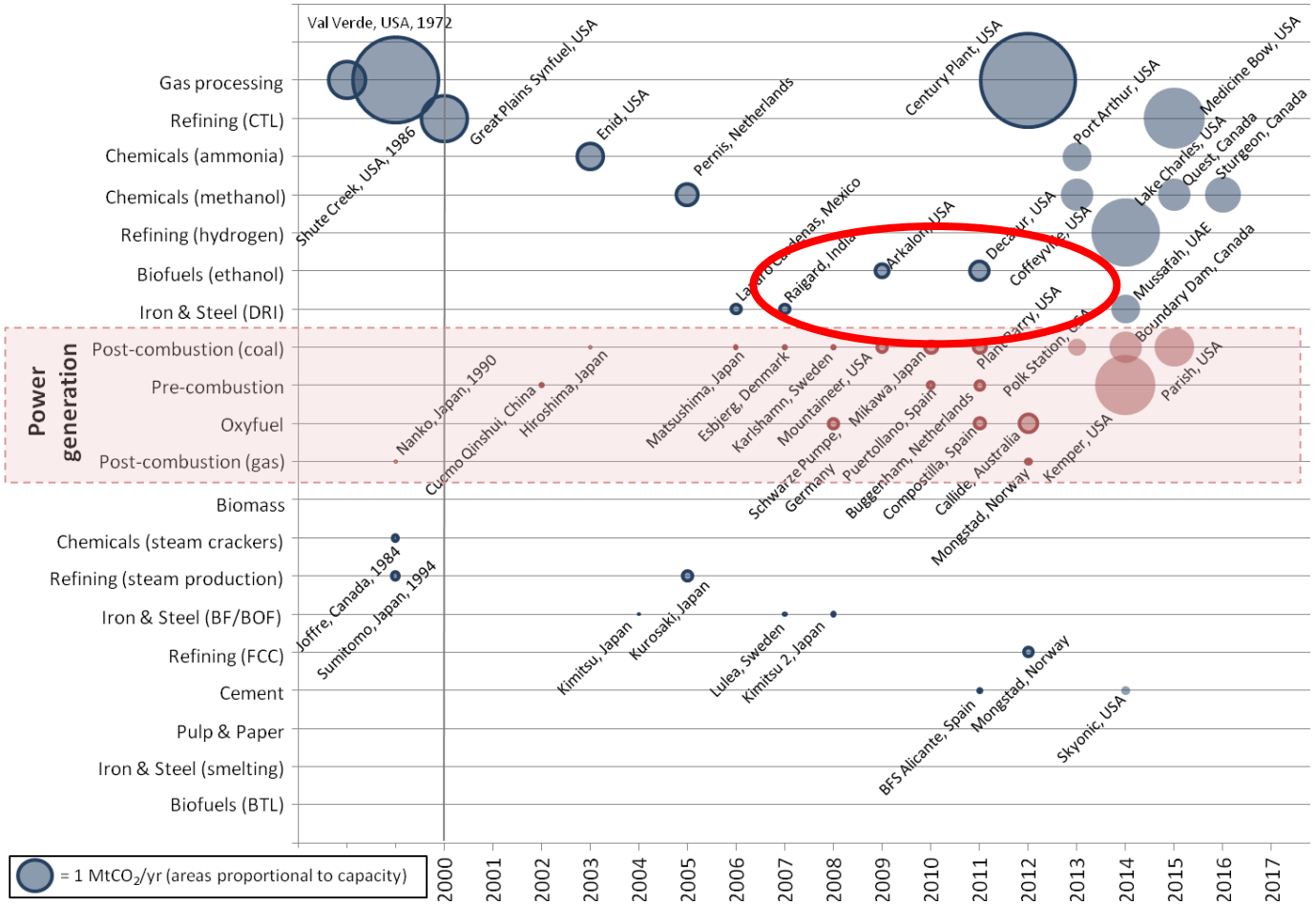
# Where are we today?

# Regional biofuel production capacities, 2010




In ETP 2012: The major share of global biodiesel capacity is installed in Europe, while the United States and Brazil lead in bio-ethanol production

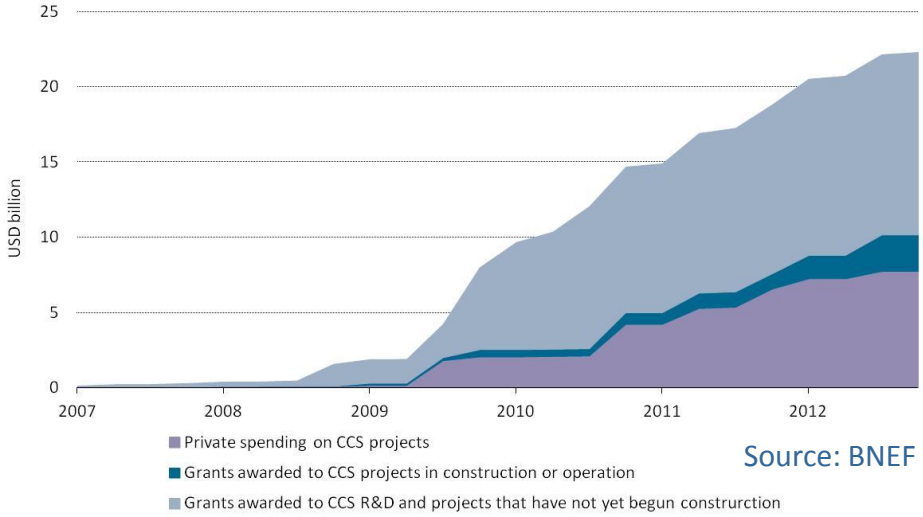
# The need for project experience in industry-CCS (1)




Source: Industry-CCS annex to IEA TCEP report 2013.

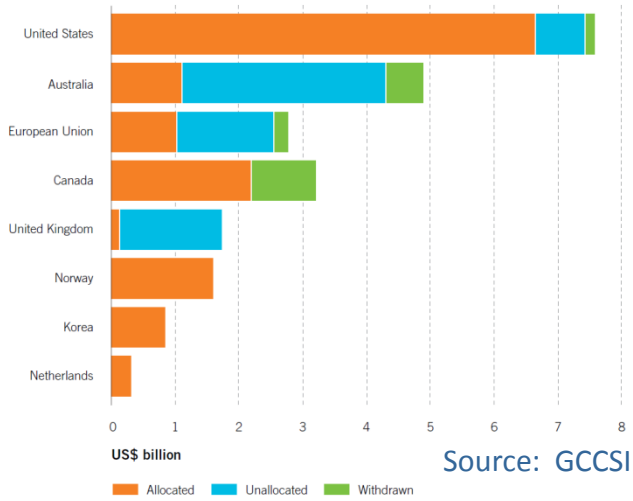
# Inputs into CCS are not negligible...

## Money spent on CCS projects globally



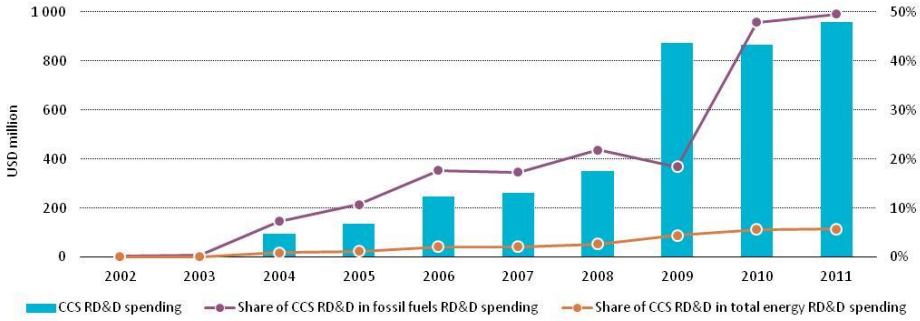

Source: BNEF

## Government pledges for CCS support



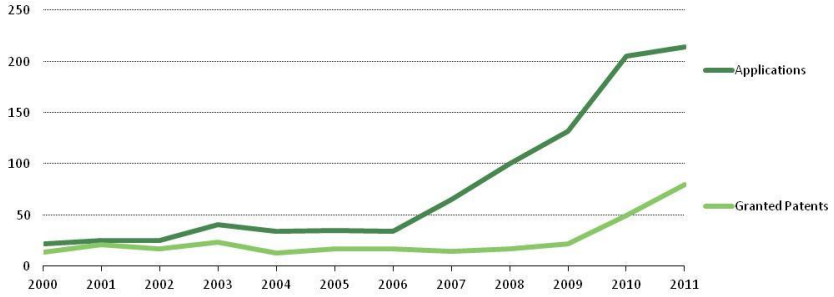

Source: GCCSI

## R&D spending on CCS technologies by IEA countries



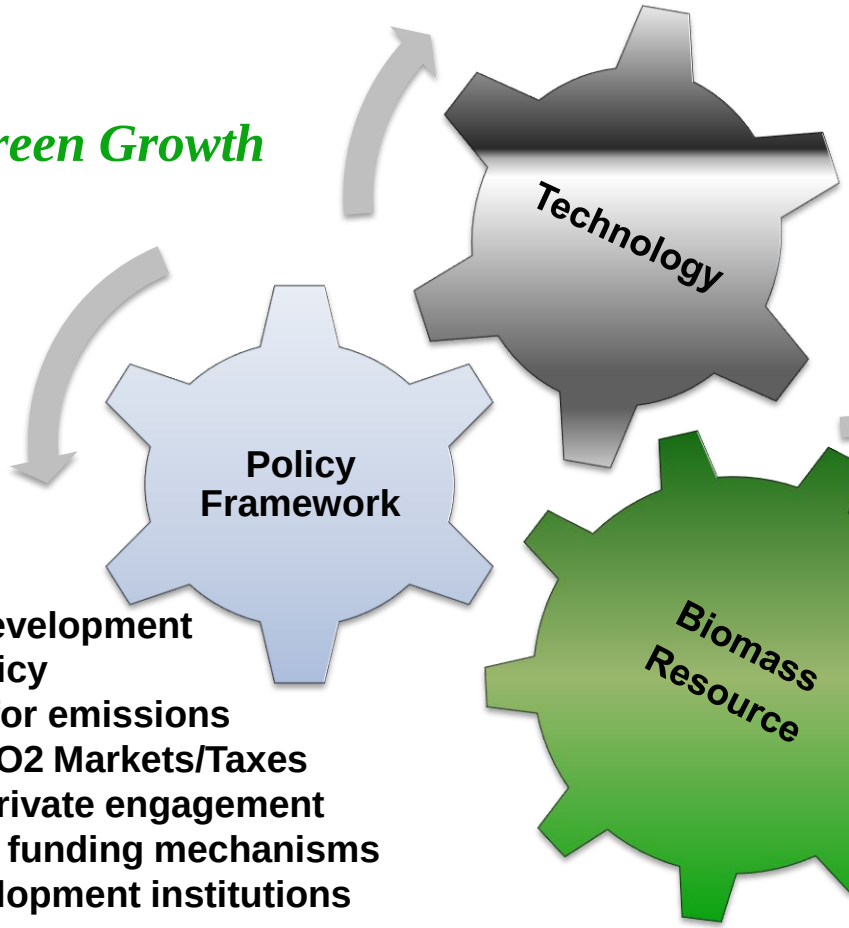

Source: IEA

## Numbers of CCS-related patents




Source: IEA

# BECCS – A challenging technology, resource and policy chain




*Green Growth*

- Technology R&D policy (Biomass/CCS)
- Industry Sectors
- Costs Capture, Transport, Storage
- Storage capacity
- Viable source and sinks (Clustering)
- MMV Systems

*Innovation and Transition Strategy*

- Economic development
- Biomass policy
- Accounting for emissions
- Incentives/CO2 Markets/Taxes
- Public and private engagement
- International funding mechanisms
- Role of development institutions

- Resource availability
- Transport/supply
- Lifecycle Costs
- Sustainability/LULUCF
- Scale
- Markets and Trade

*Climate Change and Energy Access*

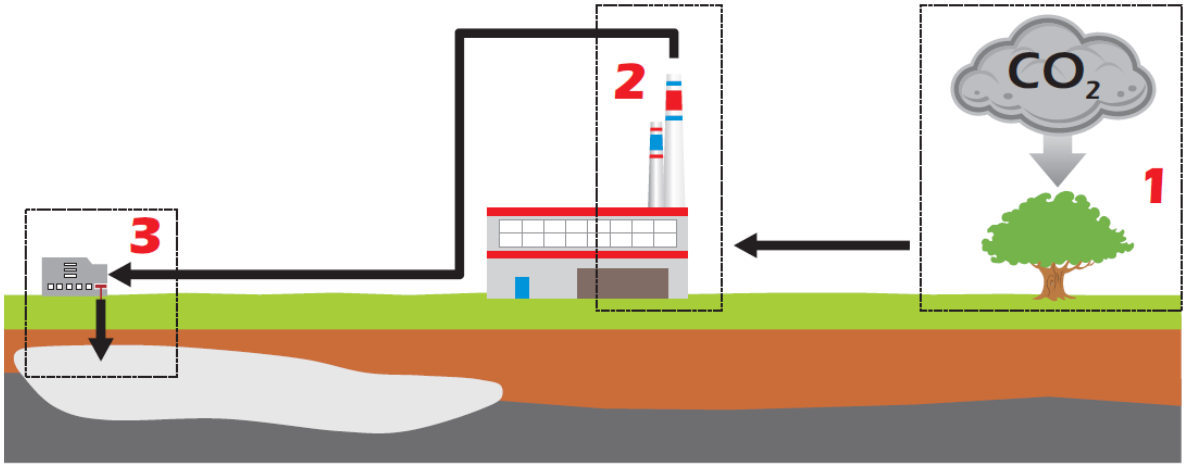
# Relevant IEA Publications

- Energy Technology Perspectives 2012
- IEA/UNIDO Technology Roadmap: CCS in Industrial Applications 2011
- Country Specific Studies: Facing China's Coal Future: Prospects and Challenges for CCS, 2012
- Combining Bioenergy with CCS: Accounting for Negative Emissions
- Bioenergy Roadmaps: IEA Biofuels for transport 2010; Biomass for Heat and Power 2012
- IEA CCS Roadmap 2013 (Forthcoming)

www.iea.org/etp/explore

www.iea.org/ccs

# Thank you!

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