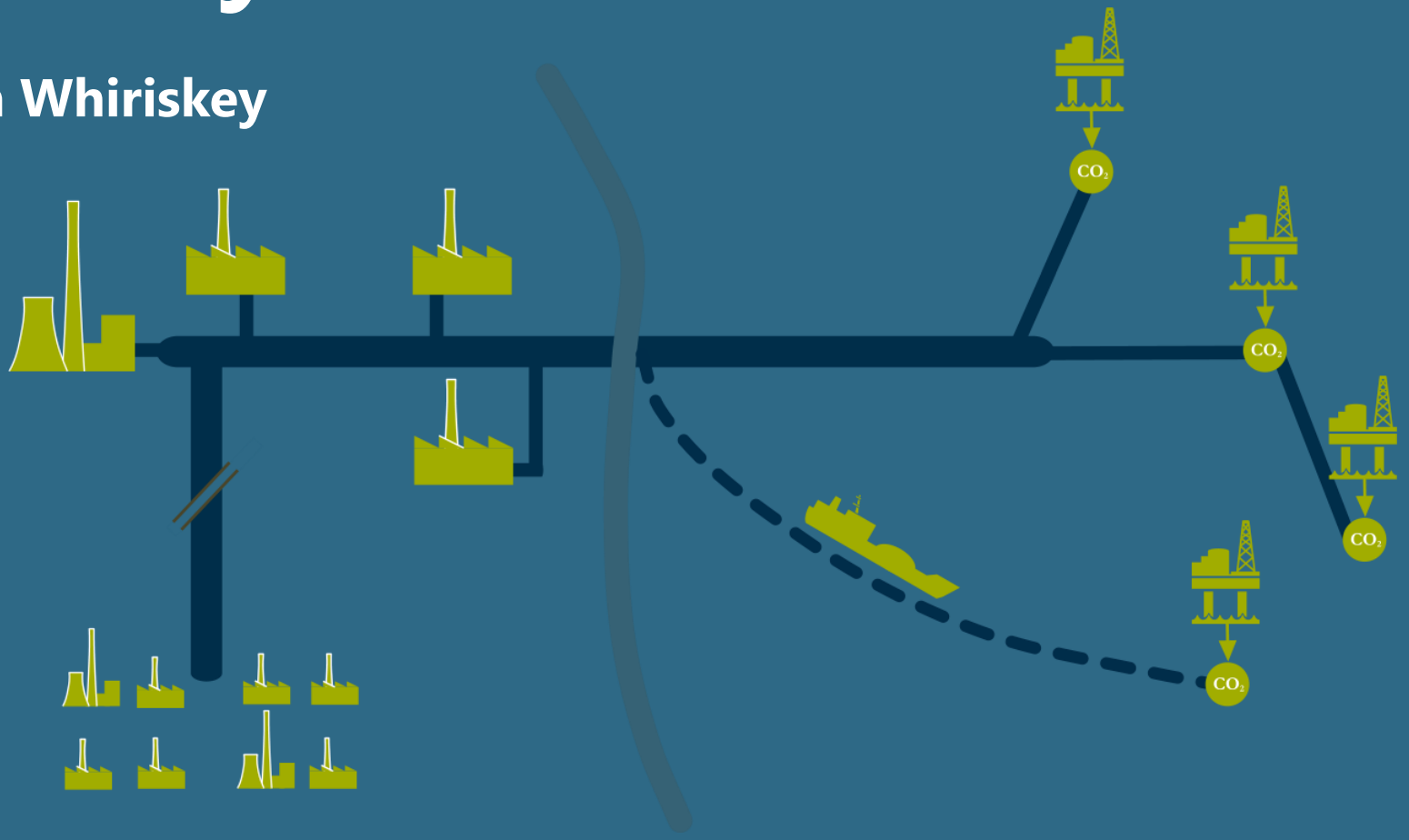
CCS Outlook in Europe and Beyond

Keith Whiriskey

BELLONA EUROPA



1. Does the world need CCS?

2. Who supports CCS and why? Who disagrees with CCS deployment?

3. How has CCS been supported through policies and incentives to date? Has this approach worked? How should future incentives be designed?

4. What is the state of play of CCS in the European Union and Member States? What upcoming policies and mechanism are proposed?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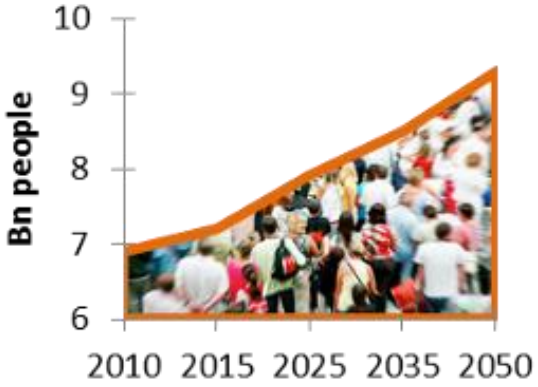
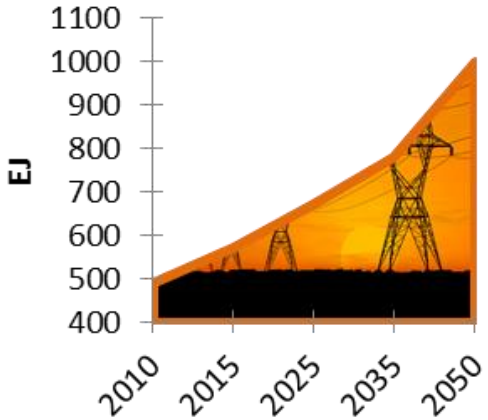
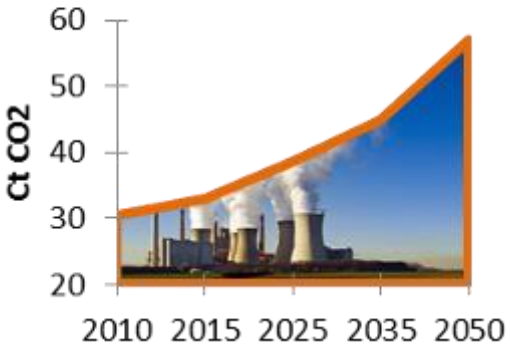
Population



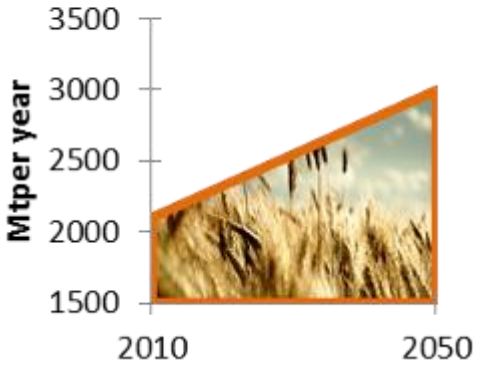
Energy consumption



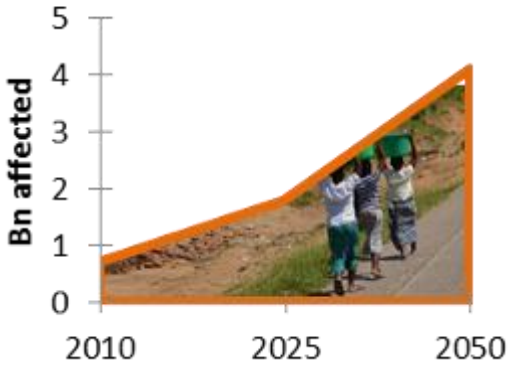
Energy-related CO2 emissions



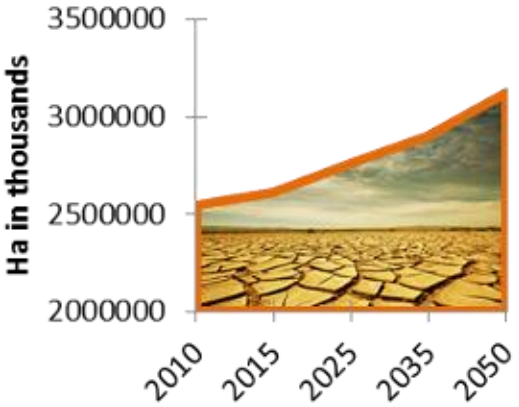
Demand for cereal

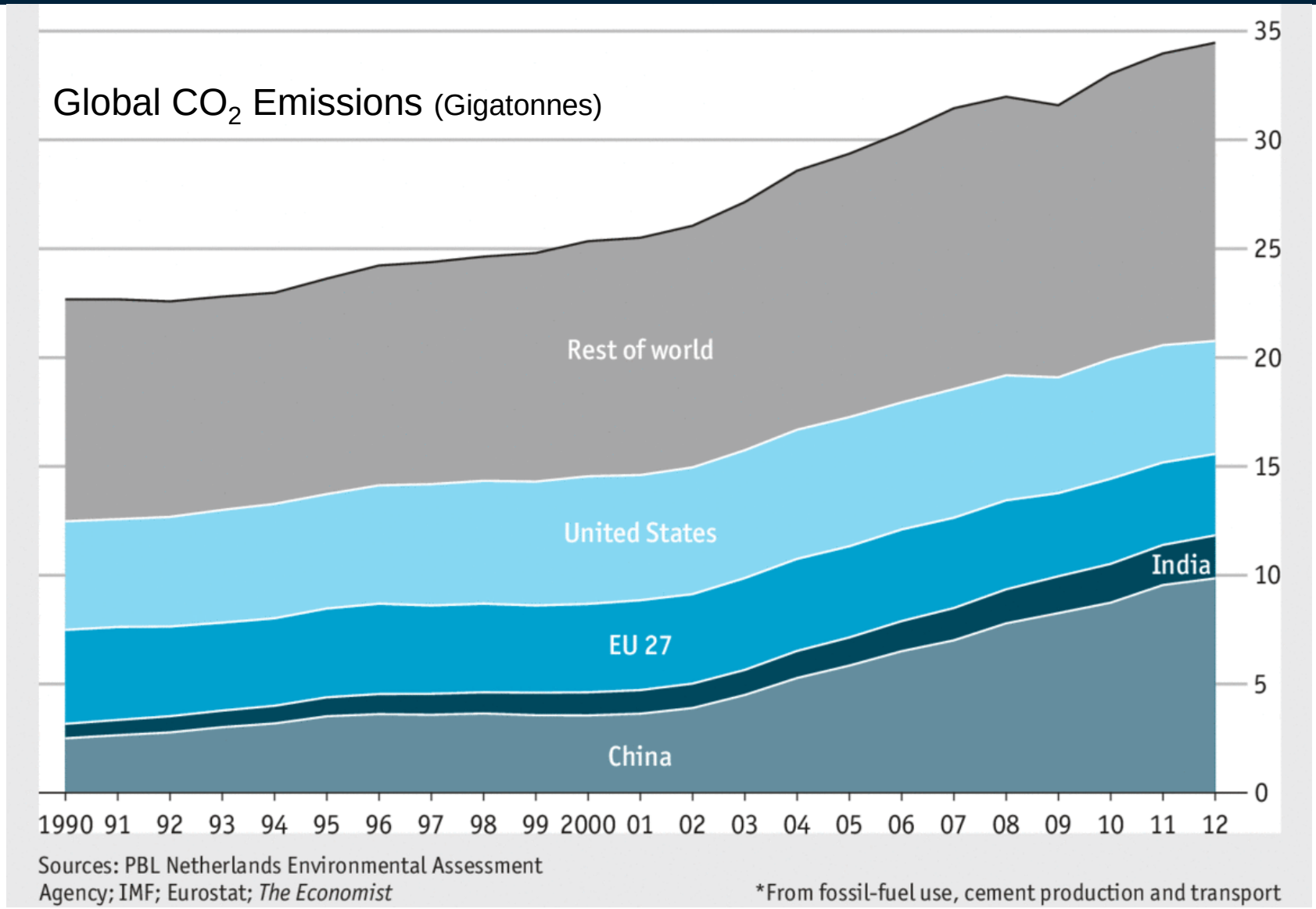


Water scarcity



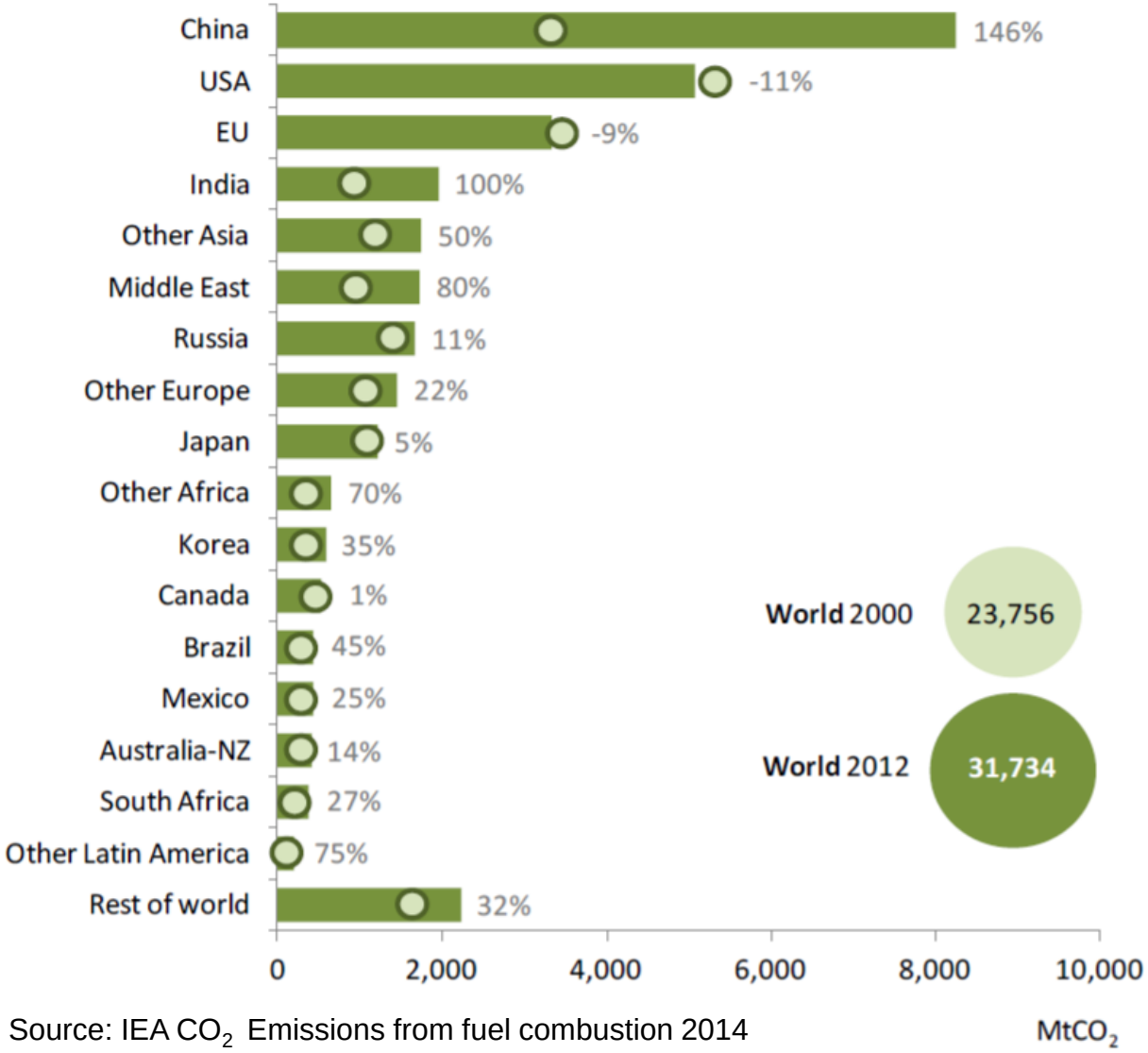
Arid areas





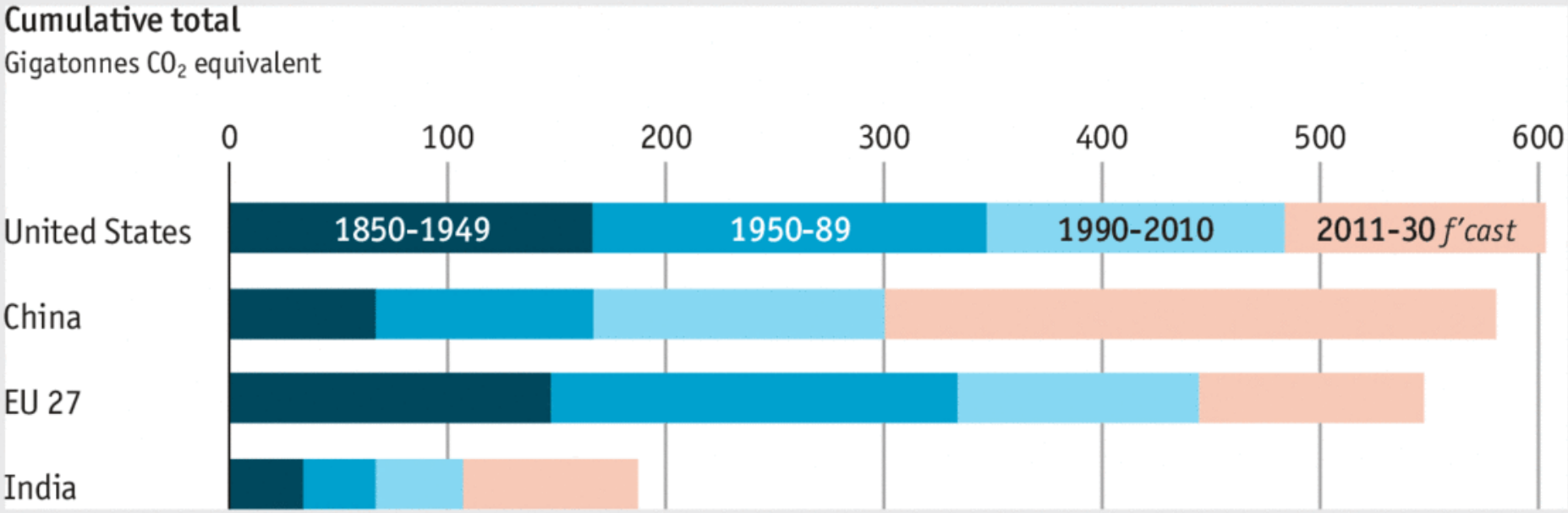
Source: The Economist

Increase in global CO_2 emissions by region, 2000-2012



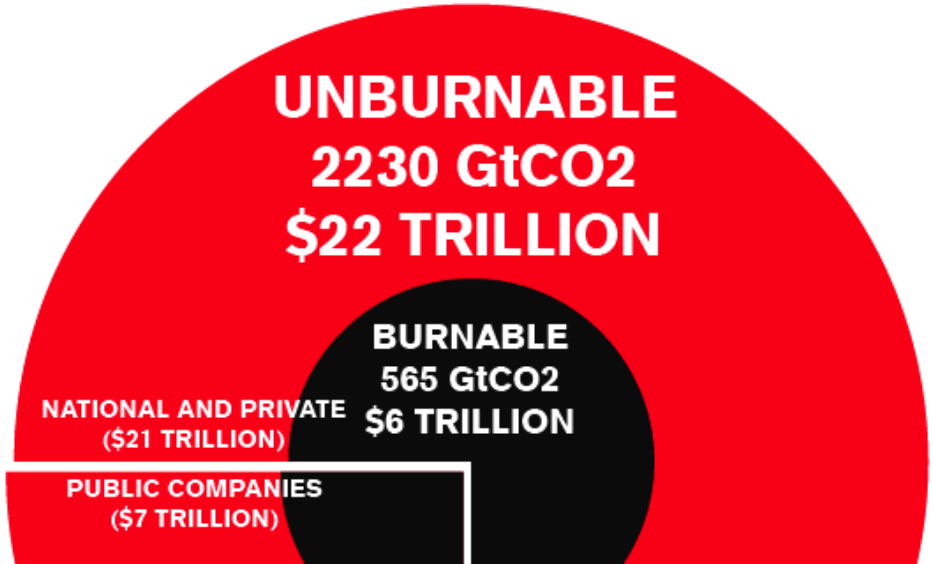
Source: IEA CO_2 Emissions from fuel combustion 2014

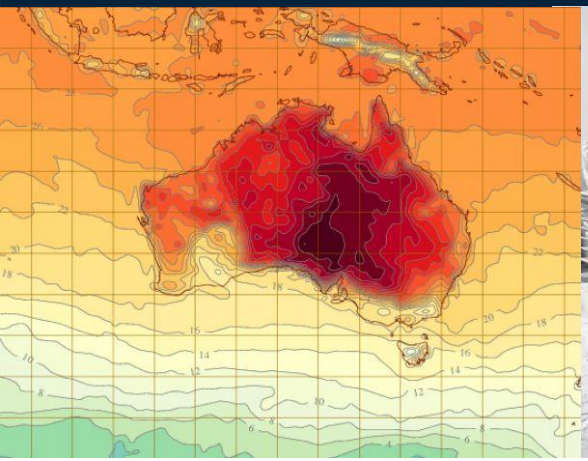
Year	CO_2 ppm
1960	316.91
1985	346.04
2000	369.52
2015 (July)	401.30



To keep warming to 2°C
80 percent of known carbon reserves can not be used conventionally.

Will the world stick to this limit?





Increasing and persistent drought

Damaging weather events

Coastal and inland flooding

<u>Economic Growth and Poverty Reduction</u> = Rising global demand for energy and goods

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

"Many models cannot reach about 450 ppm CO2eq concentration by 2100 in the absence of CCS"

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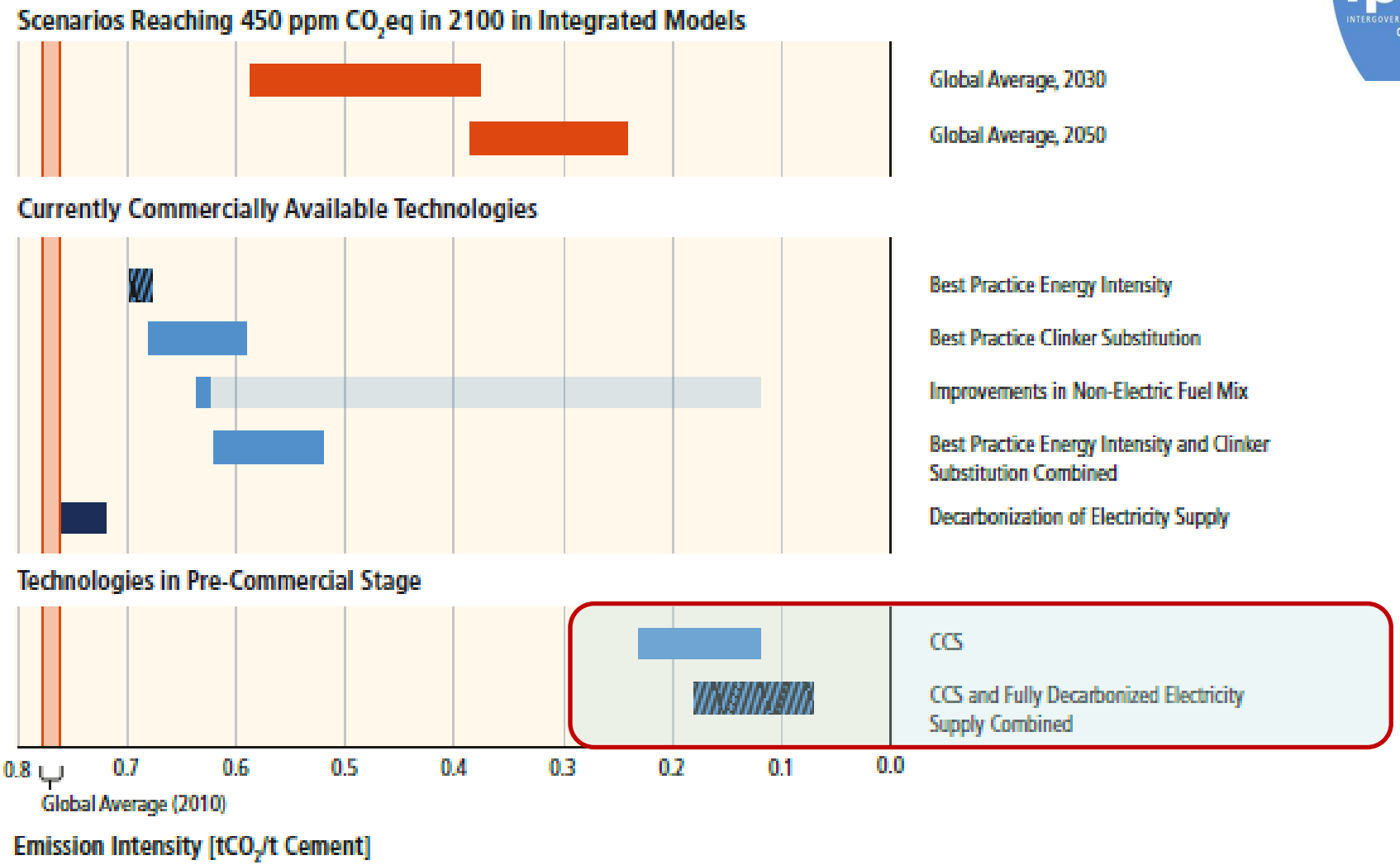
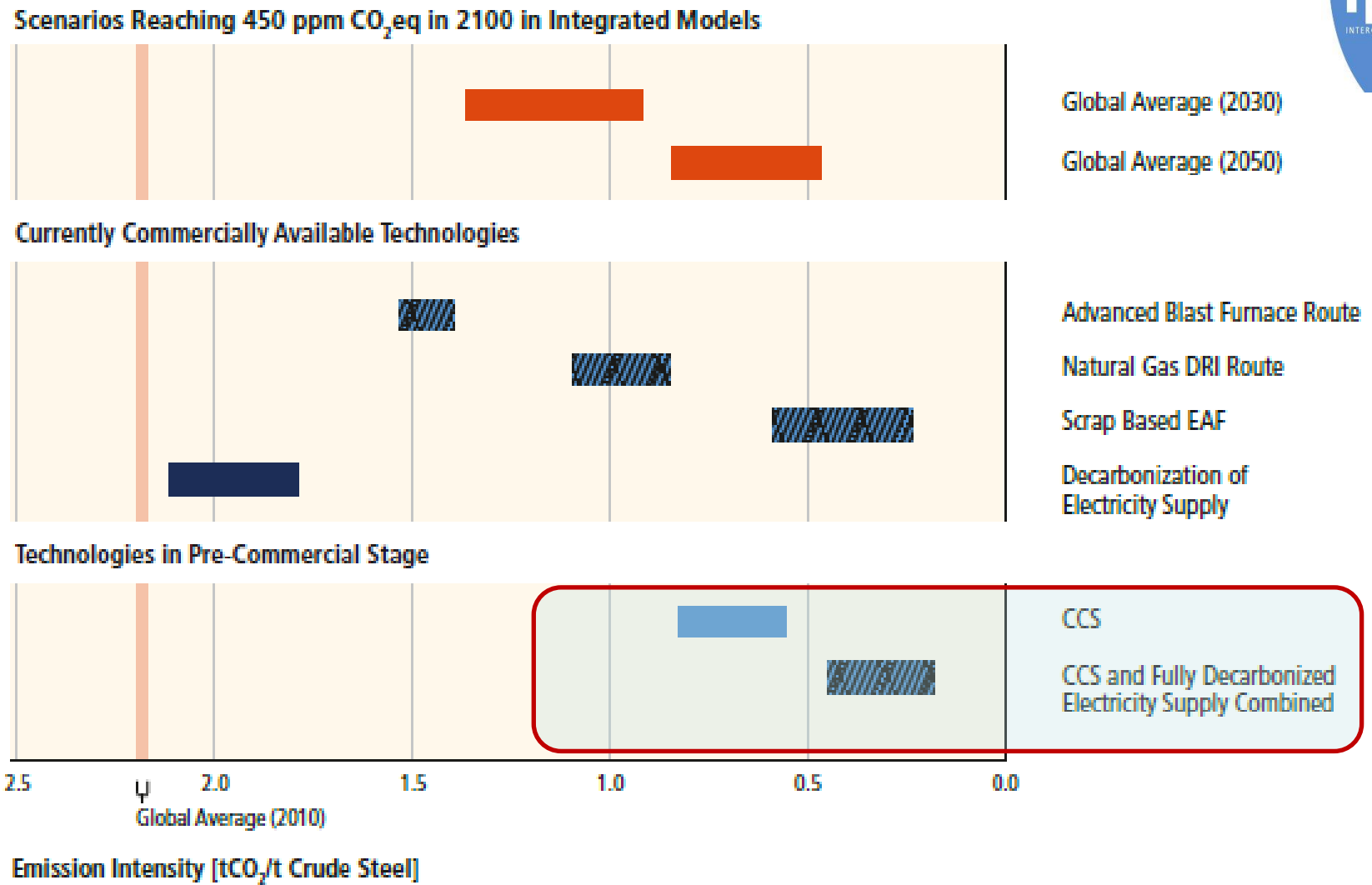
"CDR technologies such as BECCS are fundamental to many scenarios that achieve low-CO2eq concentrations"

CO_2 from cement production



CO_2 from steel production



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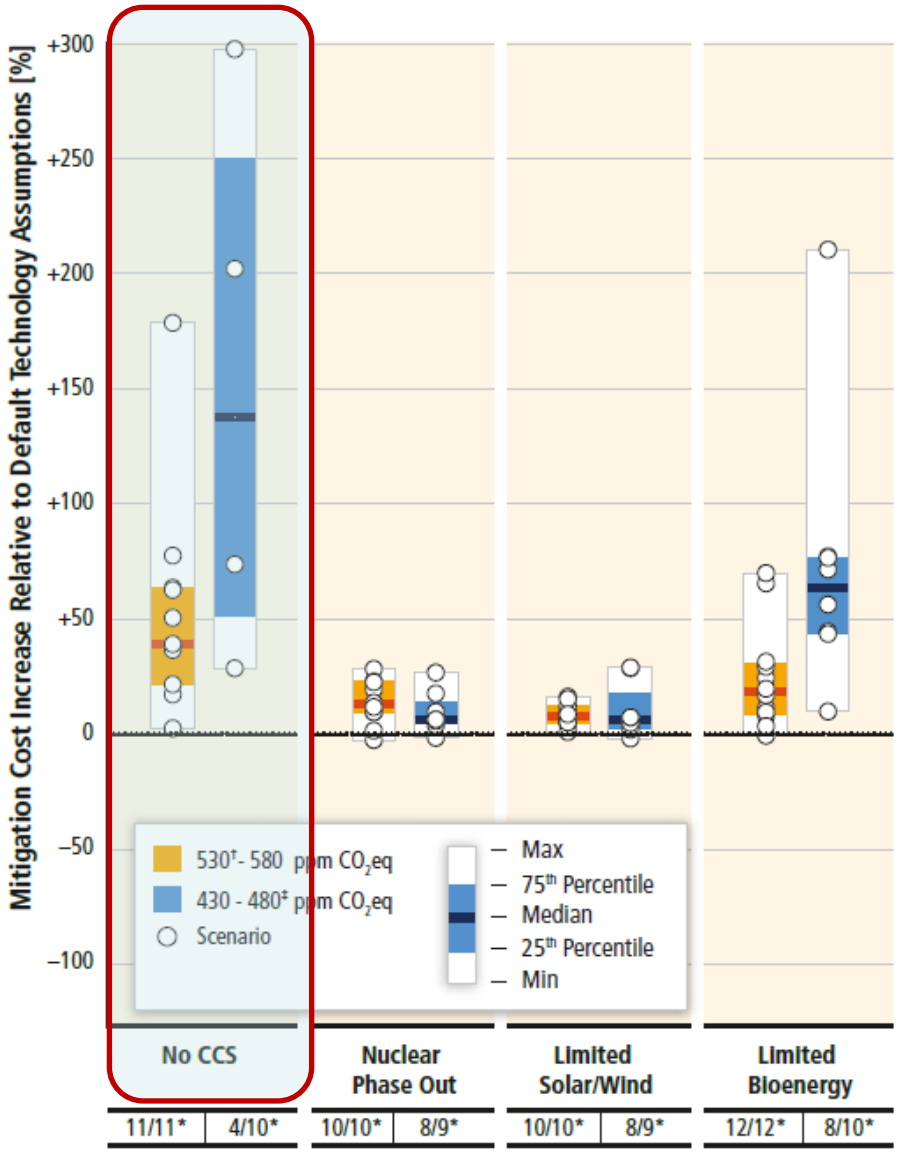
On average **1 MW of wind capacity** requires **103 tonnes of stainless steel, 402 tonnes of concrete, 6.8 tonnes of fiberglass, 3 tonnes of copper and 20 tonnes of cast iron.**

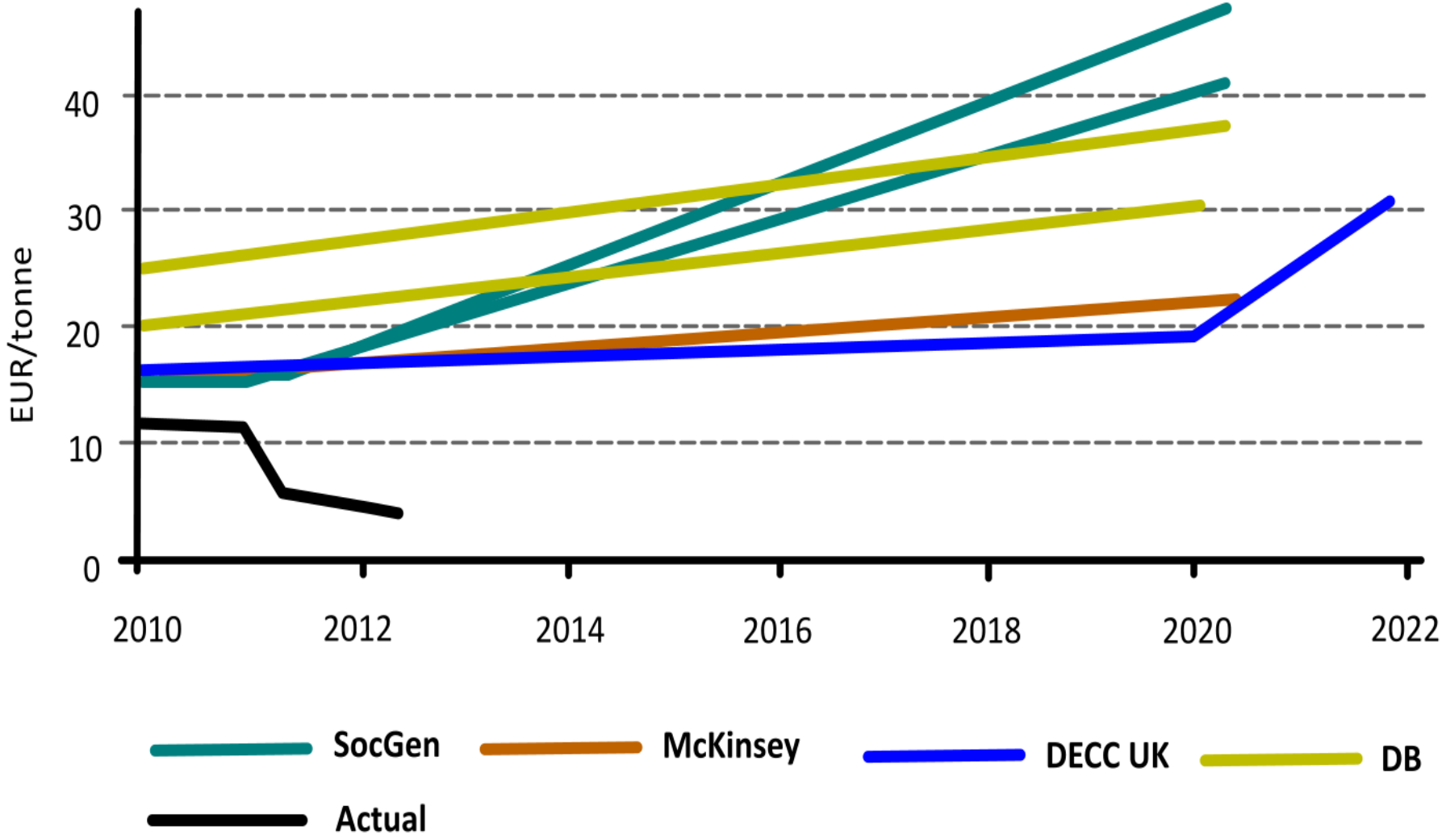


- "If CCS technologies are **not available** then the **cost** of meeting 450 ppm stabilisation could be **1.5 times to 4 times greater** than compared to full CCS availability. Similarly, if there is limited bioenergy supply then costs could be dramatically higher than standard least cost estimates

No CCS = Hugely increased likelihood of runaway climate change

How has CCS been supported through policies and incentives to date? Has this approach worked? How should future incentives be designed?

Emissions Trading System (ETS)



CCS is the only established abatement technology that does not benefit from effective support in the current suite of EU-level policies

Until a structural reform of the ETS can be sufficiently realised, targeted support for CCS will be necessary

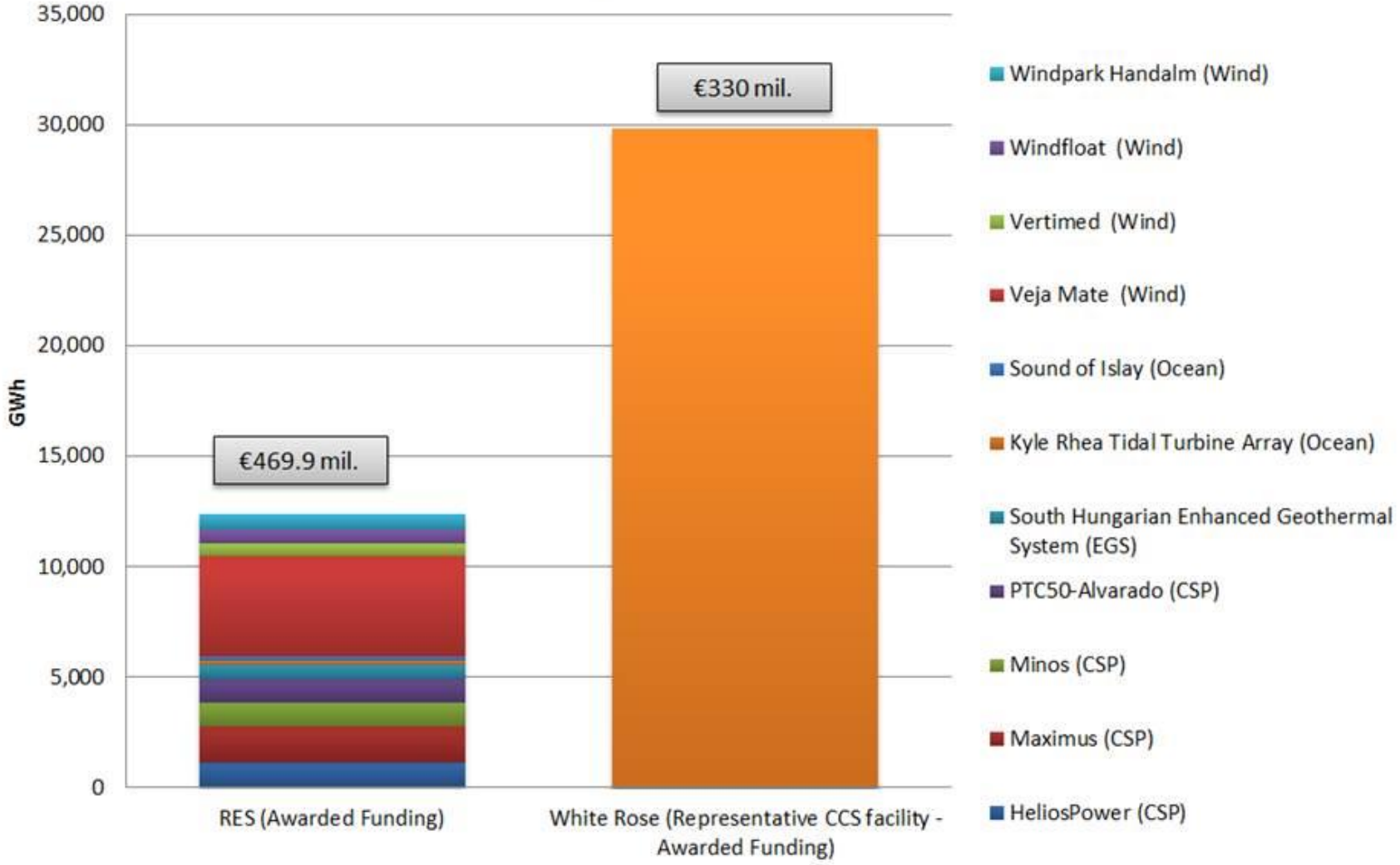
New Entrants Reserve (NER300)

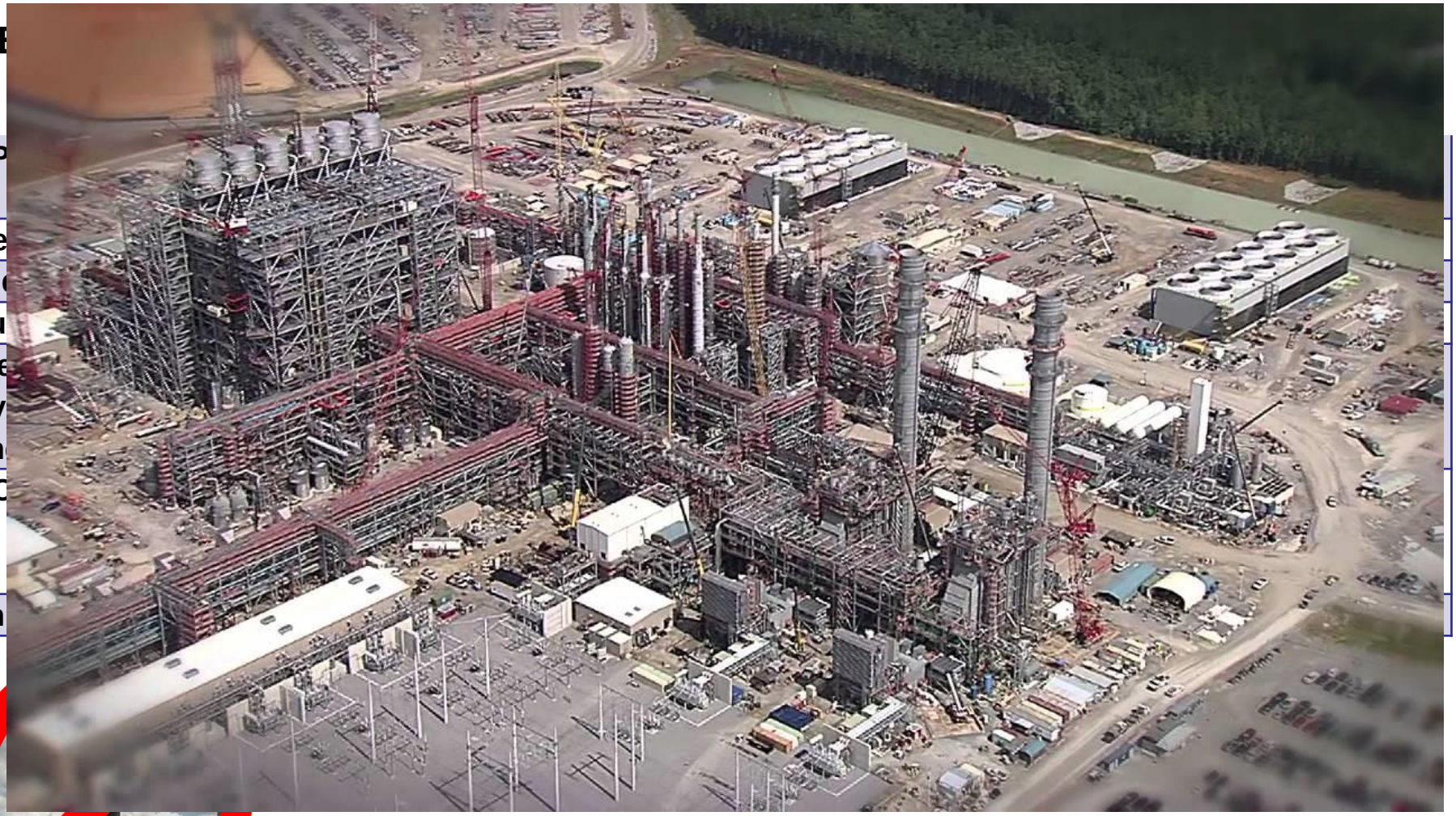
- In 2008 the European Council set aside 300 million EUA (carbon allowances) to be sold to finance up to 12 CCS demonstration projects in Europe

European Energy Programme for Recovery (EEPR)

- In 2009 the European Commission €1 billion to six CO_2 capture and storage projects
- One project remains the ROAD CCS project in Rotterdam

GWh of low-carbon electricity supplied to the grid over a 10 year period as a Result of NER300 (First Tranche) & White Rose CCS





- At current levels function to dissuade coal generation capacity

- Feed i
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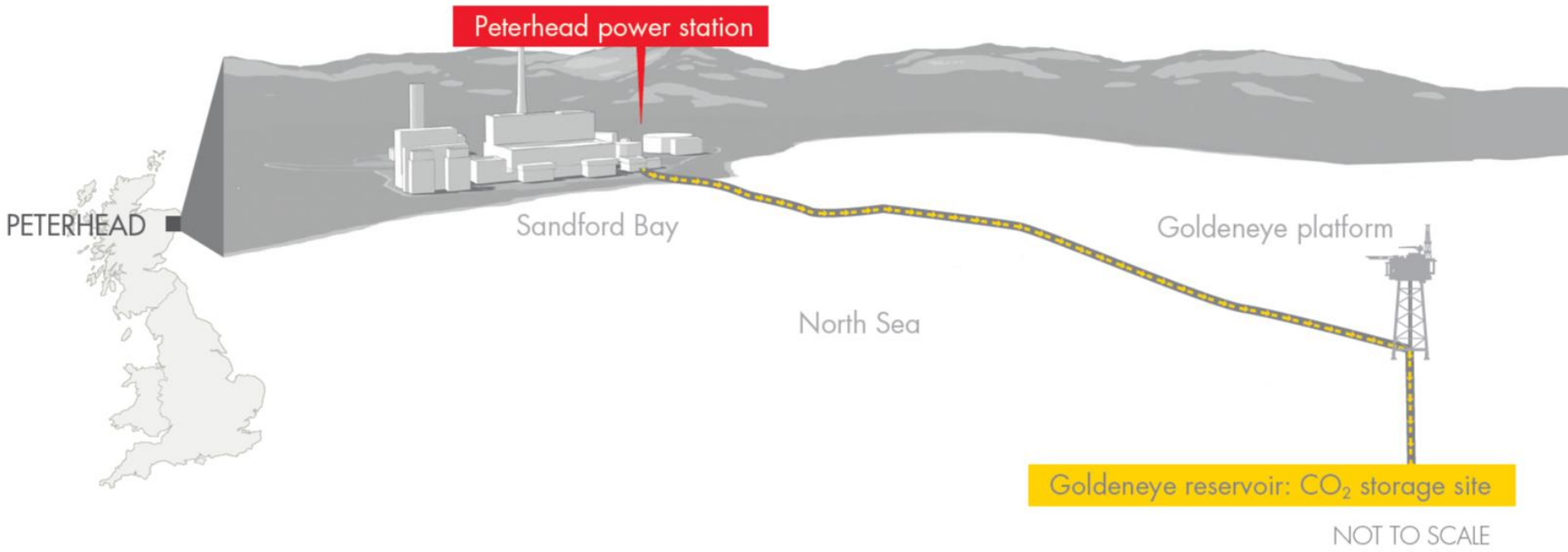
Time

Market Revenue £/MWh | FiT CfD Payment £/MWh | Electricity Price

Peterhead CCS Project, Scotland, UK

- Natural Gas power plant to be equipped with CCS
- ≈ 1 Million tonnes of CO_2 to be Captured and Stored every year
- CO_2 stored in depleted natural gas field (Goldeneye)



WHITE ROSE
CARBON CAPTURE & STORAGE PROJECT

- Coal power plant to be equipped with CCS (Oxygen fired)
- ≈ 2 Million tonnes of CO_2 to be Captured and Stored every year
- 300 MW electrical
- CO_2 stored in saline aquifer

The Alberta government has been successful in delivering the Shell Quest CCS project on time and on budget.

- Clear rules for funding, delivery and operation were set out. In July 2008, the Government of Alberta committed $2 billion to fund large-scale CCS projects

- Funding in steps - Up to 40% of funding allocated during the design and construction stage and up to a further 20% on commercial start-up. The remaining 40% of funding will be paid as CO2 is captured and stored over a maximum period of 10 years.

Government of Alberta
Canada

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What is the state of play of CCS in the European Union and Member States? What upcoming policies and mechanism are proposed?

EU 2030 Climate Framework

40% domestic GHG emission reductions compared to 1990 levels.

At least 27% renewable energy by 2030, with flexibility for Member States to set national objectives.

NO energy efficiency target, but review of Energy Efficiency Directive.

4.3 Carbon Capture and Storage (CCS)

Greenhouse gas emissions from the EU's energy and carbon-intensive industries must come down significantly to be compatible with the EU's long term GHG objective. As theoretical limits of efficiency are being reached and process-related emissions are unavoidable in some sectors, CCS may be the only option available to reduce direct emission from industrial processes at the large scale needed in the longer term. Increased R&D efforts and commercial demonstration of CCS are, therefore, essential over the next decade so that it can be deployed in the 2030 timeframe. A supportive EU framework will be necessary through continued and strengthened use of auctioning revenues.

In the power sector, CCS could be a key technology for fossil fuel-based generation that can provide both base-load and balancing capacity in an electricity system with increasing shares of variable renewable energy. Member States with fossil reserves and/or high shares of fossil-fuels in their energy mix should support CCS through the pre-commercialisation stage in order to bring down costs and enable commercial deployment by the middle of the next decade. This must include the development of an adequate CO_2 storage and transport infrastructure that could benefit from EU funding such as the Connecting Europe Facility and any potential successor.

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Climate Action Commissioner

Energy Commissioner

European Commission

Energy & Climate Action Commissioner

Miguel Arias Cañete (aka MAC)

Energy Union Vice-President

Maroš Šefčovič

#EnergyUnion


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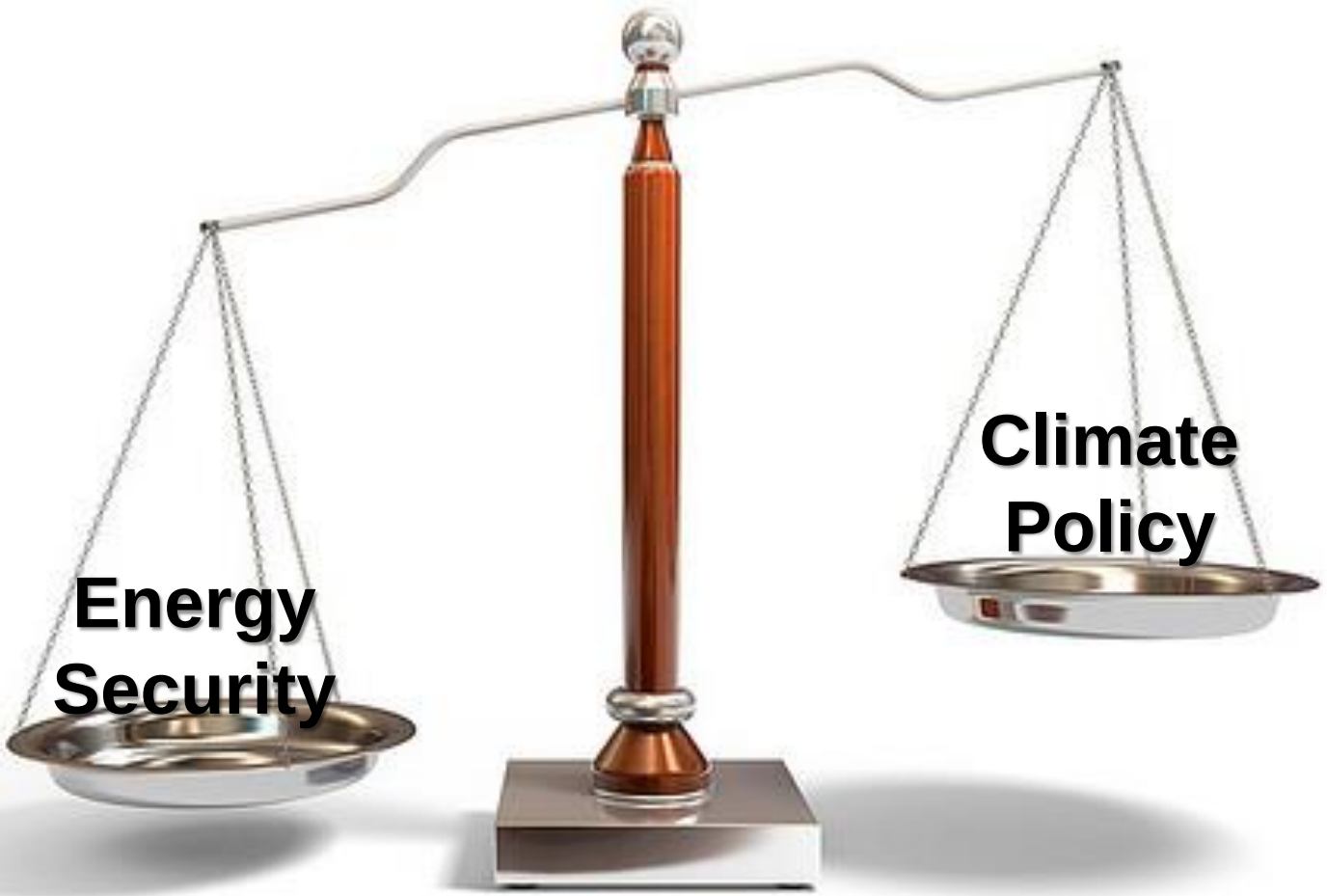
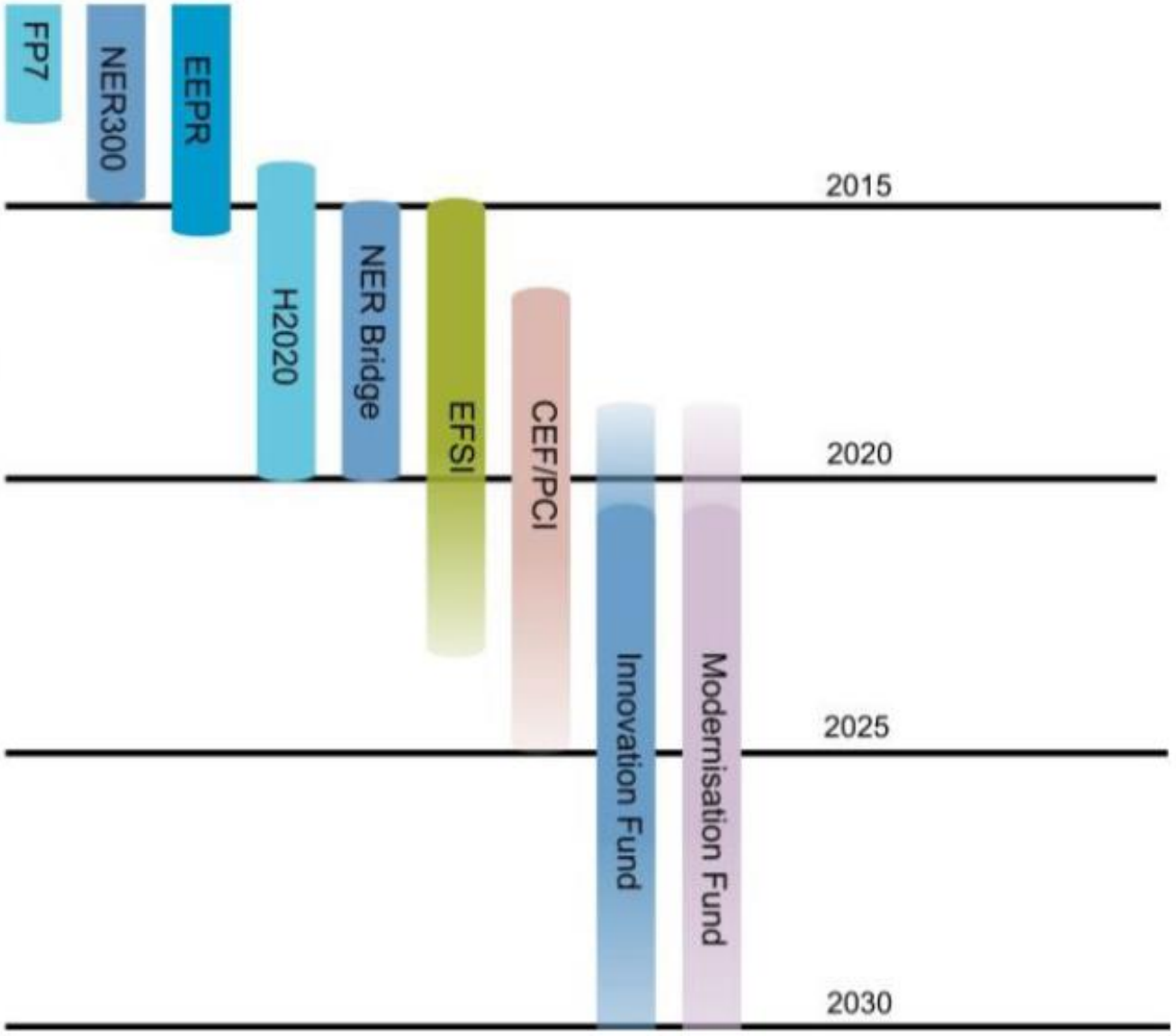

Energy Security
Climate Policy
OR

European Energy Security Strategy

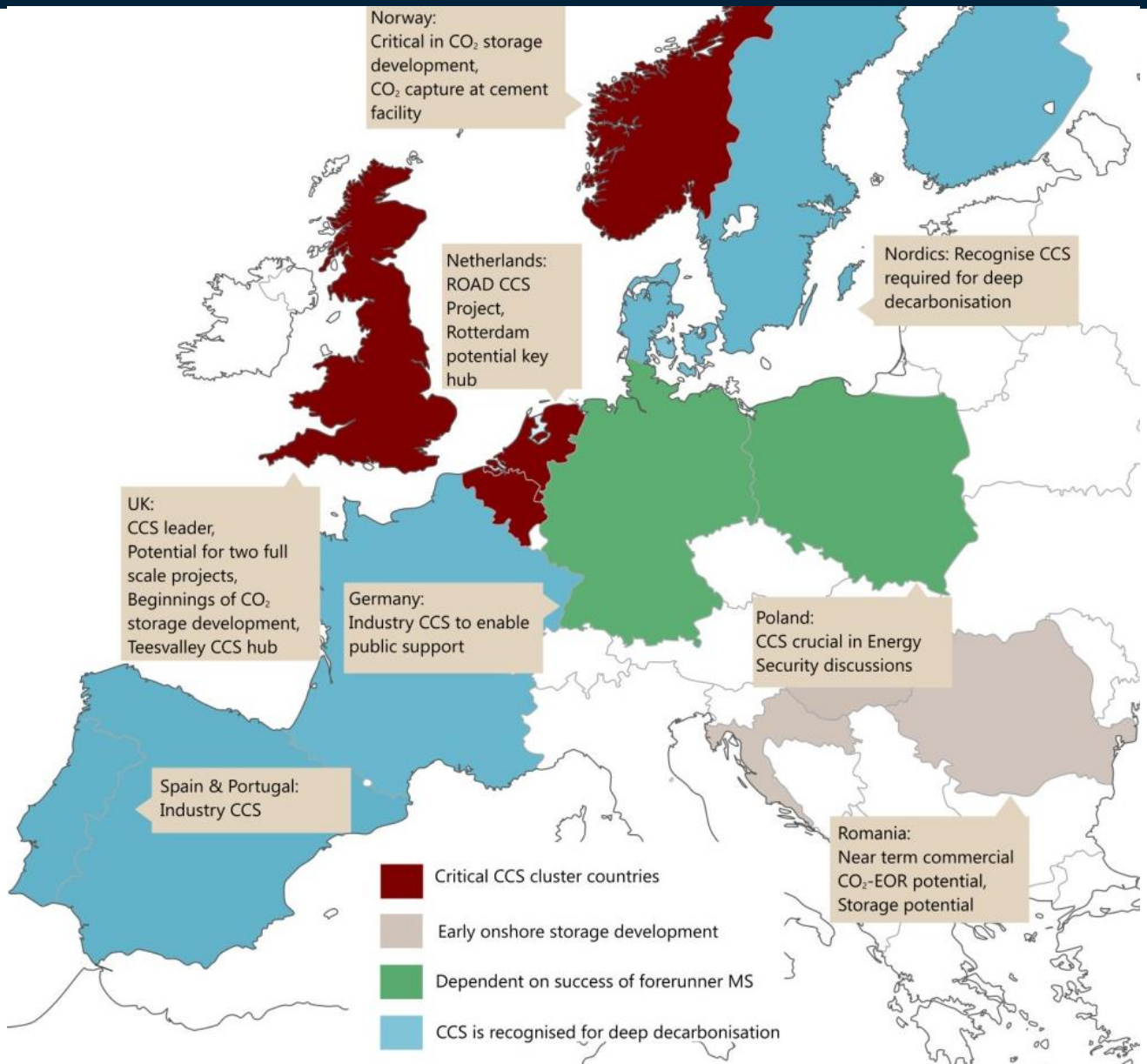
"**Coal and lignite's CO_2-emissions mean that they only have a long-term future in the EU if using Carbon Capture and Storage (CCS).** CCS also offers the potential to further improve gas and oil recovery that would otherwise remain untapped. Therefore, bearing in mind the rather limited uptake of CCS to date, further efforts in research, development and deployment should be made in order to fully benefit from this technology"

Text of the EESS


FP7
NER300
EEPR
H2020
NER Bridge
EFSI
CEF/PCI
Innovation Fund
Modernisation Fund
2015
2020
2025
2030

Innovation Fund (aka NER400)

- An Innovation Fund would be established as of **2021** to channel funding towards industrial low carbon technologies and processes in industrial sectors.
- **400 million allowances** amounting to about EUR 10 billion when sold, would be made available for this purpose. This funding would allow for up to **60% of project costs** to be covered, representing a 10% improvement in cost coverage from its predecessor, the NER300.
- The ETS reform agreement proposes the creation of a **bridge fund** by making an additional 50 million unallocated allowances from the MSR available to complement existing NER300 resources for the funding of projects before 2021.
- If coupled with the **Modernisation Fund**, significant and much-needed amounts of EU funding could become available to support CCS deployment.


Norway:
Critical in CO_2 storage development,
CO_2 capture at cement facility
Netherlands:
ROAD CCS Project,
Rotterdam potential key hub
Nordics: Recognise CCS required for deep decarbonisation
UK:
CCS leader,
Potential for two full scale projects,
Beginnings of CO_2 storage development,
Teesvalley CCS hub
Germany:
Industry CCS to enable public support
Poland:
CCS crucial in Energy Security discussions
Spain & Portugal:
Industry CCS
Romania:
Near term commercial CO_2-EOR potential,
Storage potential
Critical CCS cluster countries
Early onshore storage development
Dependent on success of forerunner MS
CCS is recognised for deep decarbonisation

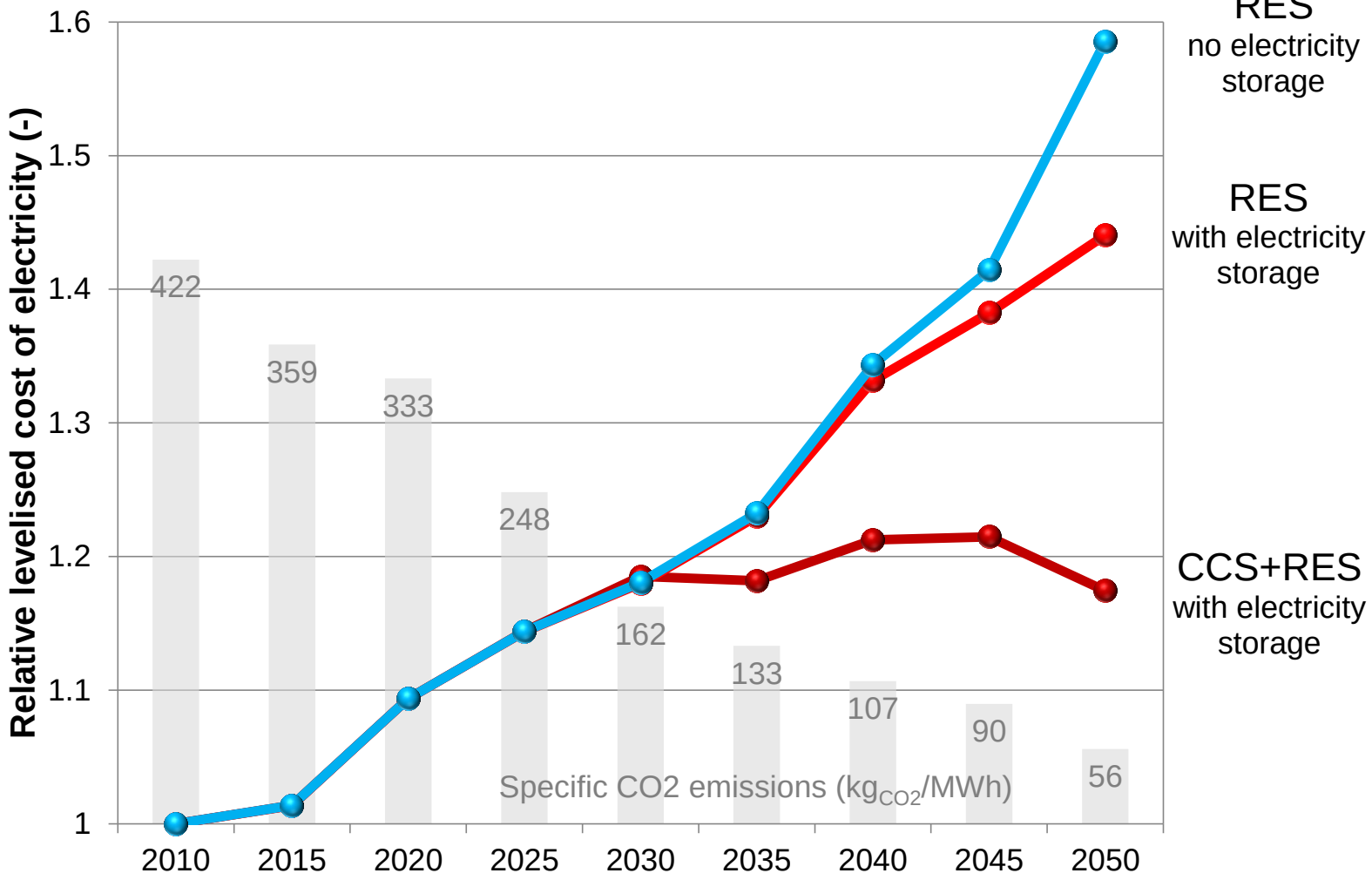


Figure 12: Scenario 6: no limits, low PV costs: — CCS, with electricity storage; — no CCS, no electricity storage; — no CCS, with electricity storage

Source: CCS and the Electricity Market, Modelling the lowest-cost route to decarbonising European power ZEP 2014

Thank you

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