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Bridging the gap: improving the economic and policy framework for carbon capture and storage in the European Union

A policy brief by the Grantham Research Institute on Climate Change and the Environment (LSE) & the Grantham Institute (Imperial College)

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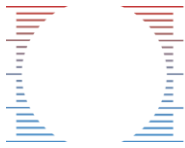


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This presentation

- ❖ **Aim and focus**
- ❖ **CCS globally and in the EU**
 - Scenarios
 - State of CCS
- ❖ **Key challenges**
 - Technology, infrastructure & storage
 - Costs
 - Finance
 - Regulation & policy
- ❖ **Policy recommendations**
- ❖ **Conclusions**



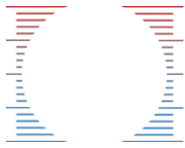
Aim and focus of the study

Aim of the study: Provide policy advice on how to make CCS more bankable in the EU

Focus on CCS - Why?

- ❖ Central in most energy scenarios & EU Energy Roadmap:
 - Essential in lowest cost technology portfolios
 - Can provide low-carbon electricity back up
 - Potential for negative emissions (BECCS)
 - Industrial applications

- ❖ Yet not progressing as fast as expected in the EU



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CCS globally and in the European Union



CCS in 2C scenarios (2050)

Source	Scenario	CCS generation	% total generation	CCS capacity
World		TWh	%	GW
IEA	2DS base	6,299	15%	960
	2DS hiRen	2,945	7%	460
	2DS hiNuc	3,055	7%	470
	2DS no CCS	0	0%	0
Global Energy Assessment	Mix	18,158	35%	n/a
	Efficiency	9,441	22%	n/a
	Supply	11,761	20%	n/a
European Union				
EU Commission	Low nuclear	1,548	32%	248
	Diversified	1,189	24%	193
	High energy efficiency	878	21%	149
	Delayed CCS	926	19%	148
	High RES	355	7%	53
Energy Modelling Forum (EMF28)	80% DEF	570	14%	n/a
	80%EFF	536	14%	0
	80% PESS	0	0%	0
	80% GREEN	0	0%	0
Global Energy Assessment	Mix	2,470	37%	n/a
	Supply	1,841	26%	n/a
	Efficiency	990	19%	n/a

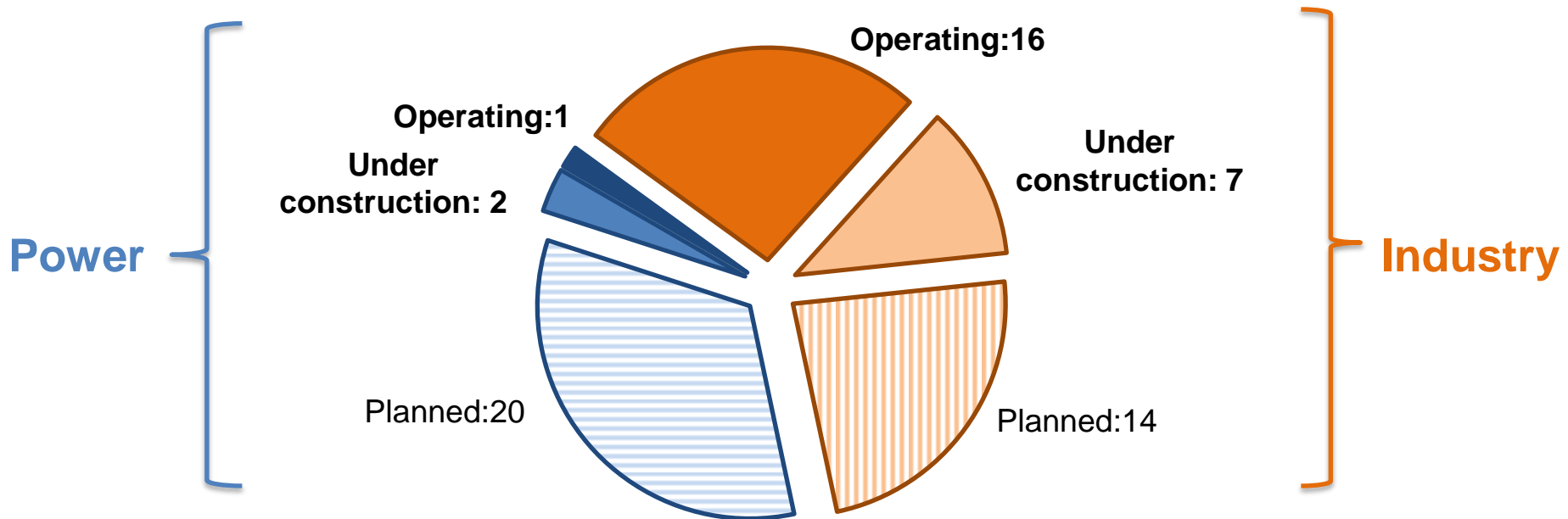
▪ CCS up to 50% of electricity by 2050

▪ Some scenarios not feasible without CCS

▪ If feasible, more expensive (IPCC: +140%)

All scenarios in EU Energy Roadmap 2050 include CCS

State of world CCS projects



EU: 12 power plants expected by 2015 , however to date



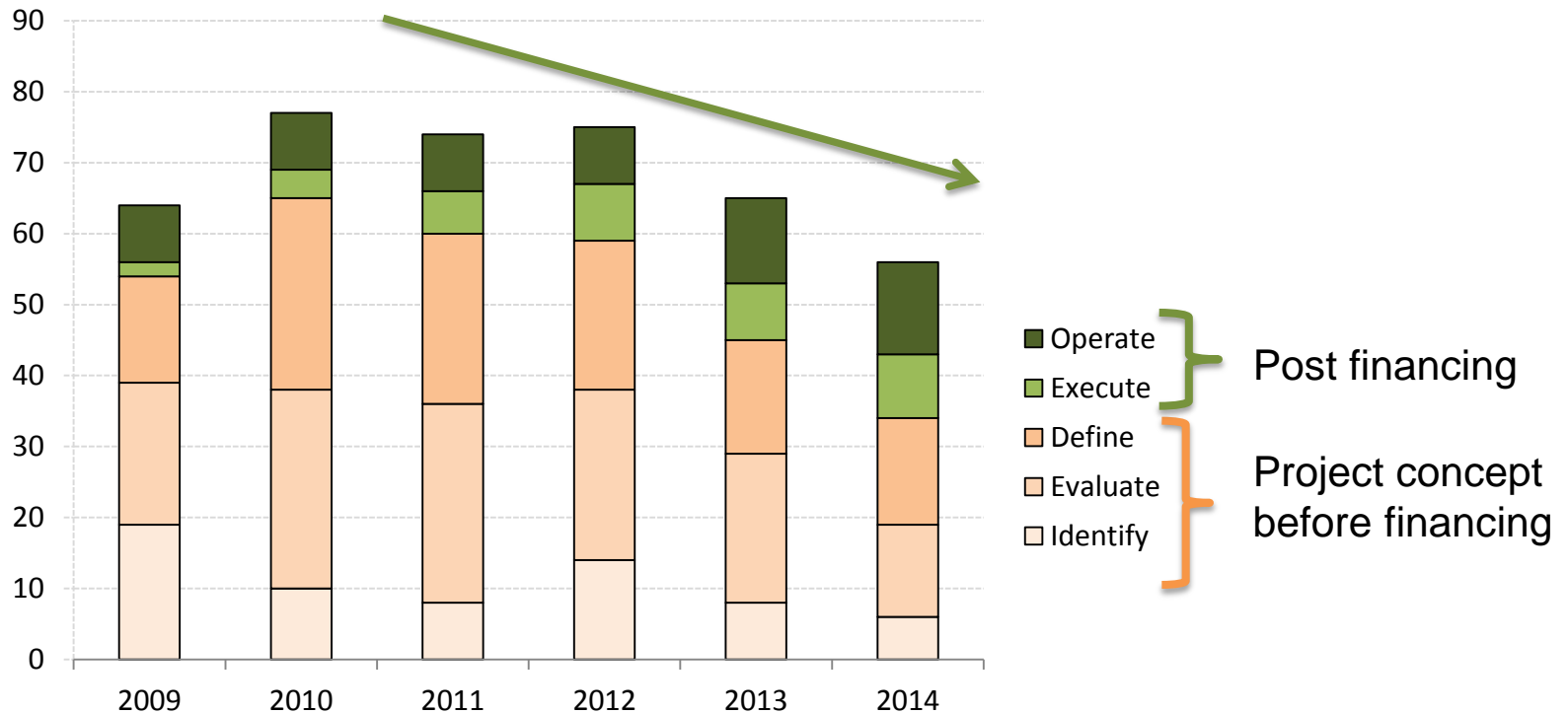
0 operating/under construction

6 planned (power)

- **5 UK** (Peterhead; White Rose; Don Valley; C.GEN; Captain Clean)
- **1 Netherlands** (ROAD)

...and the pipeline of projects is drying out

Global CCS large scale integrated projects by development phase, 2009-2014





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Key challenges



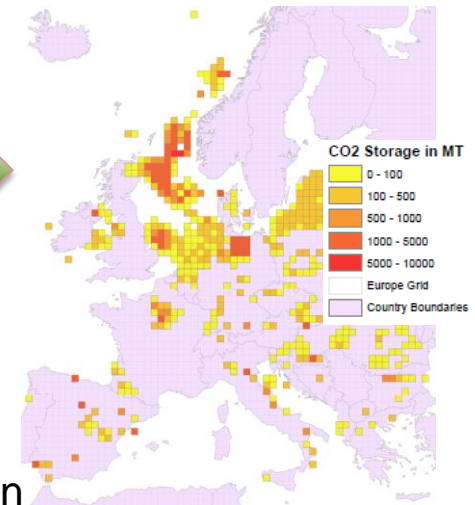
Technology, infrastructure and storage

- ❖ **Capture & infrastructure:** technology is well known, low risk
 - More understanding needed on: integration, cost reductions, industrial CCS, BECCS
 - Pipelines require planning (especially for clustering) + regulation

- ❖ **Storage:** Potential bottleneck
 - Storage shortage in some countries (e.g. central EU)
 - Further **sites characterisation** is crucial



EU potential CO₂ storage



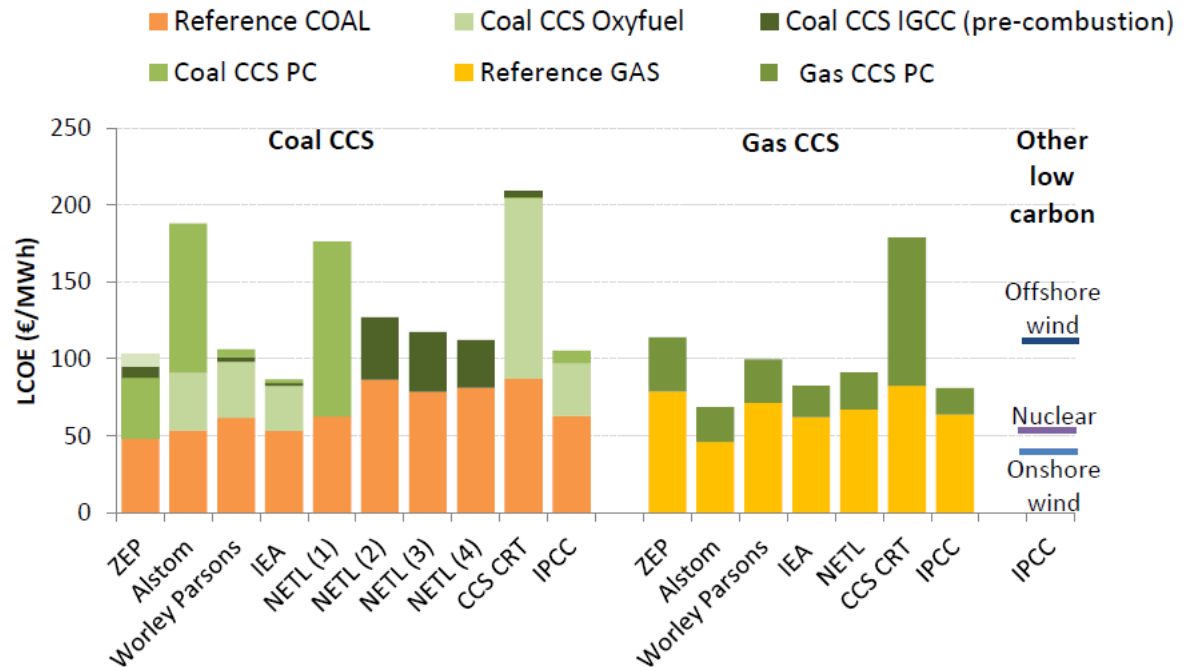
- ❖ **EOR & utilisation (CCSU)** Can provide **near term incentive**
 - Some potential for EOR in North Sea; CCSU still under investigation
 - More research needed, likely not game changer

Costs

ELECTRICITY

- LCOE does not take into account **back-up role of CCS**
- **Large variability of LCOE** – depends on theoretical assumptions
- **CCS is currently 30-120% more expensive than unabated plants**
- **Some estimates within range of offshore wind**

Levelised cost of electricity (LCOE), €2013 values

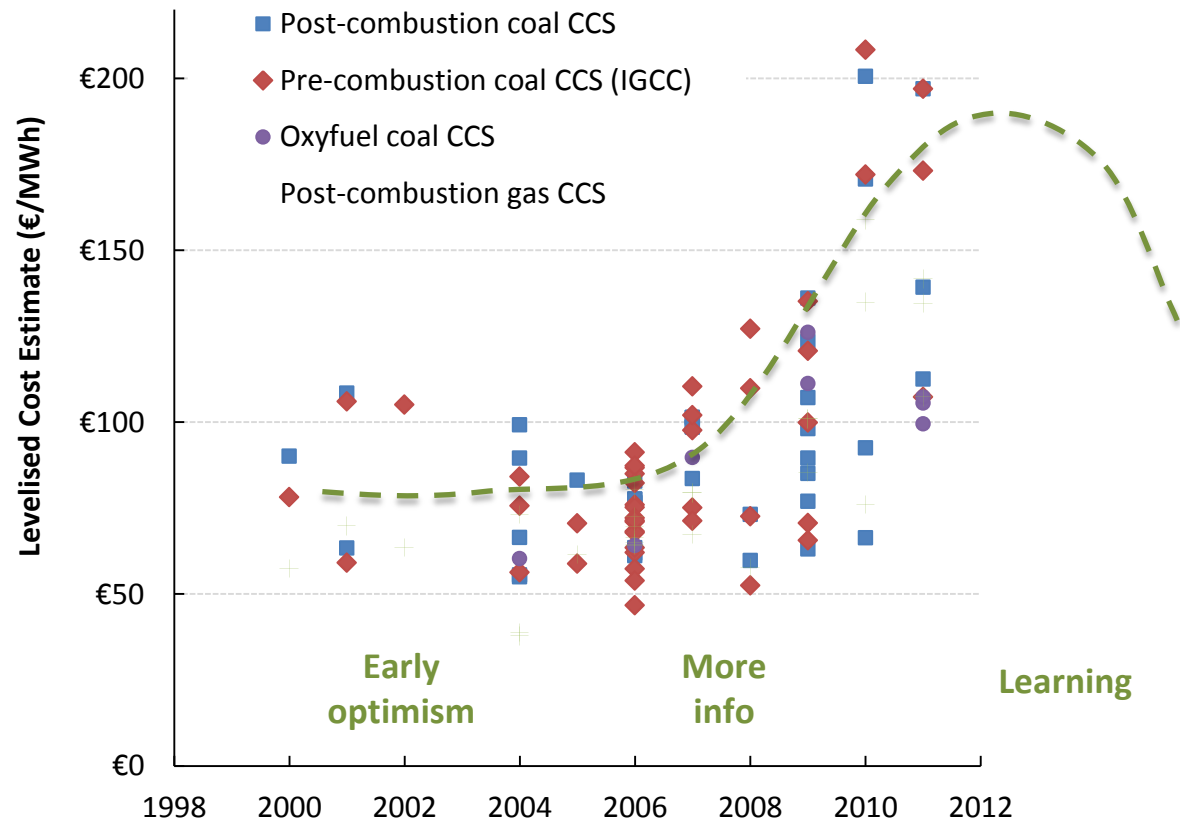


...Costs evolve across time

- ❖ Cost estimates have gone up: + 15-30% compared to 2010
- ❖ But expected cost reductions as technology evolves: **- 14-40% by 2030.**

Boundary Dam: -30% if built again

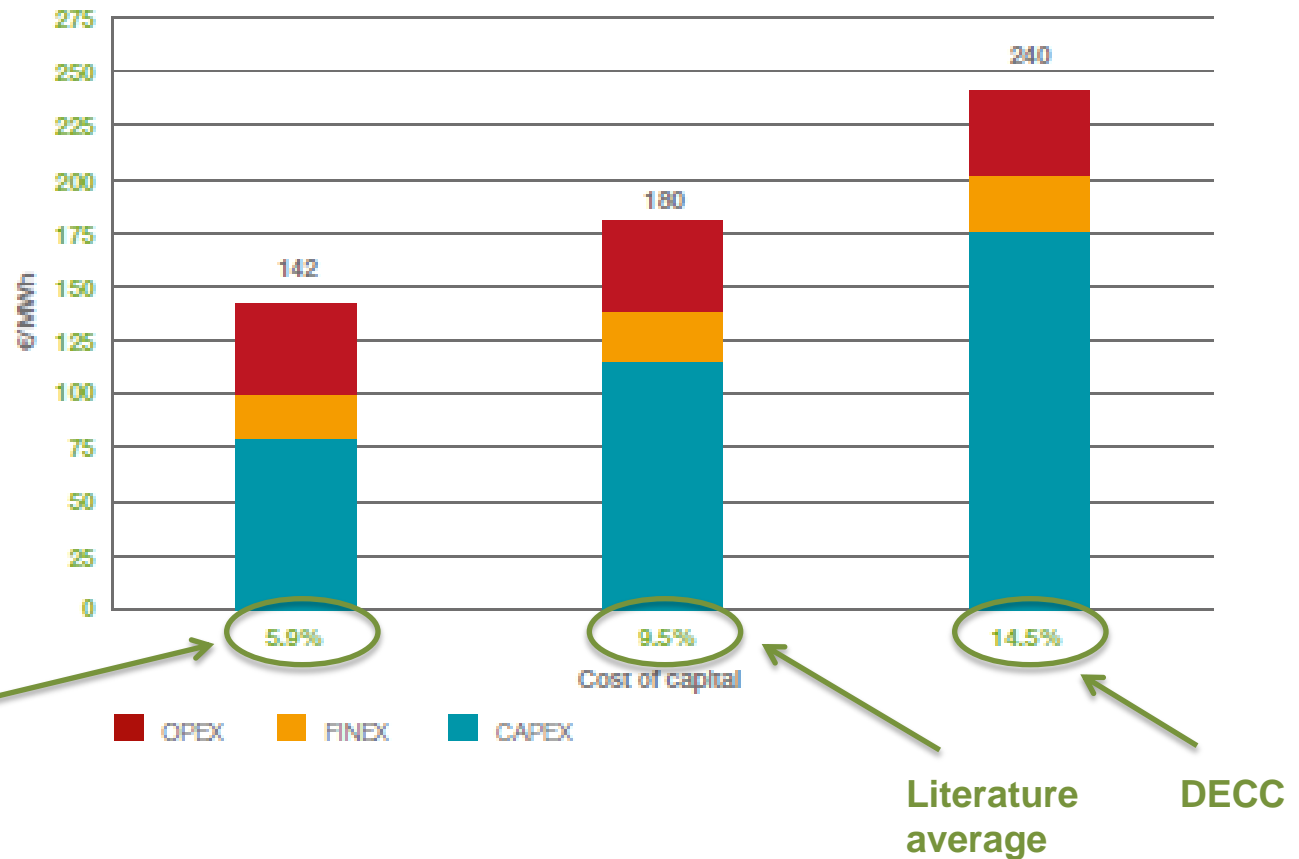
Estimates of CCS levelised cost of electricity since 2000 (€2013 values)



Finance

Estimated LCOEs based on the Boundary Dam project and assumptions on cost of capital

- CCS perceived high risk → **high cost of capital**
- Significant impact on LCOE





Policy & regulation

❖ Funding

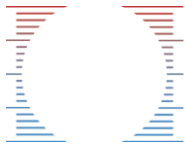
- Limited EU funds (NER300, EEPR) – €1.3 bn
- Almost no national funding programmes except UK - €1.2 bn
- Uncertain size of future funds (e.g. NER400, cohesion funds), likely insufficient
- Low investment in CCS R&D (in 2012: EU €125 m; UK: €32 m)

❖ Policy uncertainty

- No coordination across MS policies.
- Low commitment in EU 2030 framework & Energy Union

❖ Regulatory issues especially on **liability** in case of leakage:

- Storage operators to cover leakage risk at (future) ETS prices: uncertain, potentially open-ended risk



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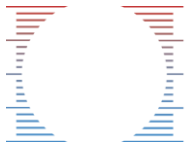
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Policy recommendations

- Policy incentives
- Coordination
- Regulation



Policies to incentivise CCS investment

Carbon pricing alone is not enough:

€40-60/t CO₂ for coal power plants; >€100/t CO₂ for gas → unfeasible in next decade

Up to 2020:

- EU/national funds for CCS research & development (especially on BECCS)
- **New funding mechanism for early stage projects** (complementary to NER 400)

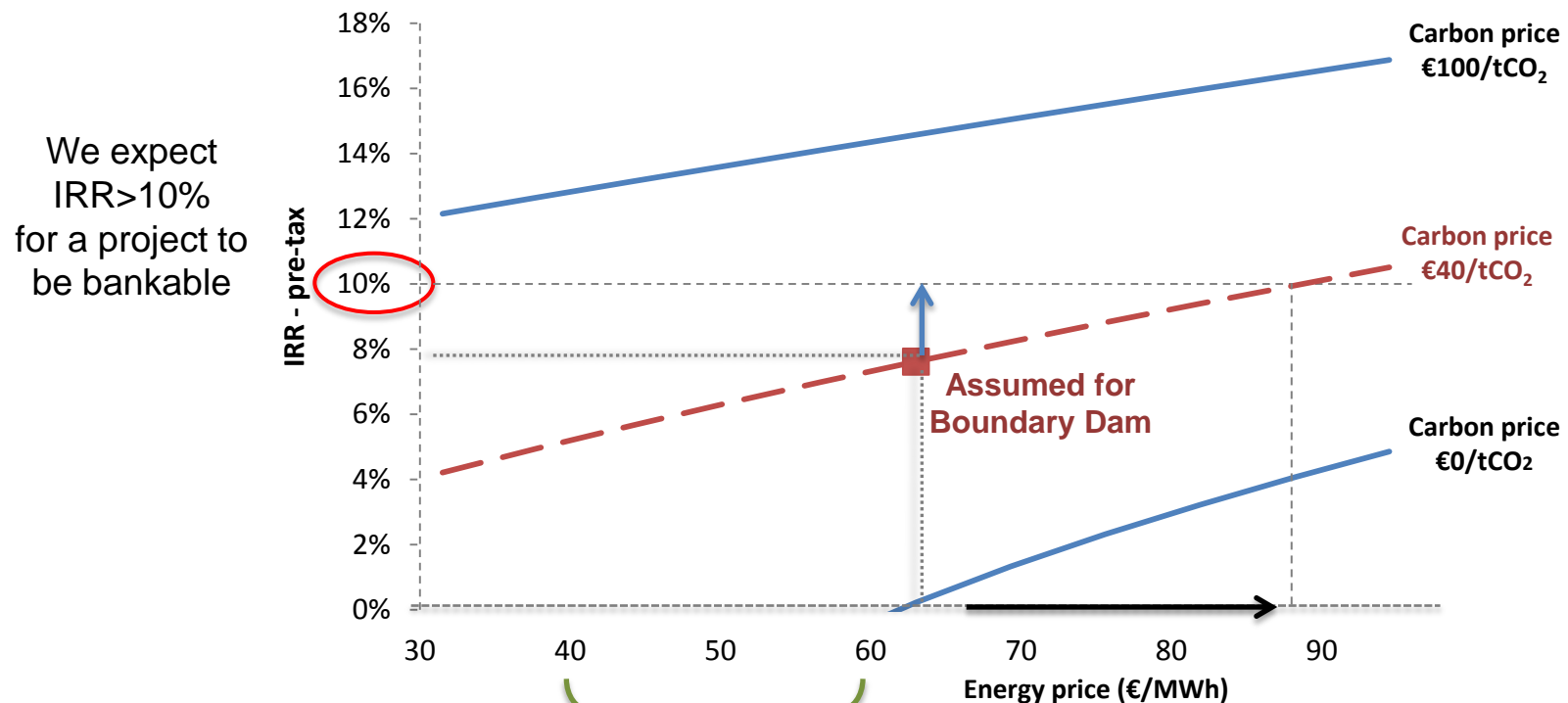
2020-2050:

- **Carbon pricing &**
- **Financial incentives for CCS electricity generation**

- **Support from public financial institutions** to leverage private investment - to reduce cost of capital
- **Mandatory targets**
- **Private sector fund**
- **Tailored incentives for industrial CCS**

...Bankability depends on electricity and CO₂ prices

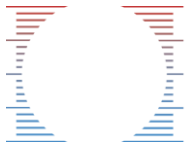
Sensitivity of IRR to carbon and electricity prices – based on Boundary Dam (coal)



To improve bankability:

- Raise carbon price
- Raise electricity price
- Both

EU power wholesale prices range: €40-60/MWh



Ambitious and coordinated action

Piecemeal approach has failed to bring in 12 CCS plants by 2015:

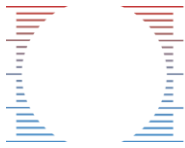
Coordination at EU level or across 'coalition of willing' Member States.

Role for Member States:

- **Assess own potential for CO₂ capture and for storage.**

Role for European Commission (in collaboration with Member States):

- Ensure **coherence across national CCS policies**
- Facilitate **shared learning** on CCS innovation.
- Set **milestones** to measure progress
- Facilitate and support **infrastructure** planning and development



Improved legislation

Increased certainty over size of liability for CO₂ leakage: revision of CCS Directive or alternative legislation

- **Initial cap on long-term liability for carbon dioxide leakage**, to be reviewed as risks become better understood and private insurance mechanisms develop.
- **Financial mechanism for damage remediation**, such as a liability fund or private insurance.
- **Special treatment of demonstration projects** through a public liability scheme.
- Reliance on the **Environmental Liability Directive**, rather than the EU ETS, to determine the size of remediation costs caused by leakage from CO₂ storage sites.



Conclusions

- CCS is crucial in the **EU Energy Roadmap 2050**
- **Progress so far has been too slow**
- Key barriers: **costs (e.g. electricity), financing, infrastructure and technology, inadequate policy and regulation**
- Way forward: **a new EU strategy** to incentivise, coordinate and better regulate CCS action



Thank you.

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