ENERGY & ENVIRONMENT

A look at incentive policies for BECCS

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Bio-CCS can provide 'negative emissions'

- **Bio-CCS has the potential to <u>reduce</u> atmospheric concentrations of CO_2**
  - CO_2 sequestered from air as biomass grows is not returned to atmosphere

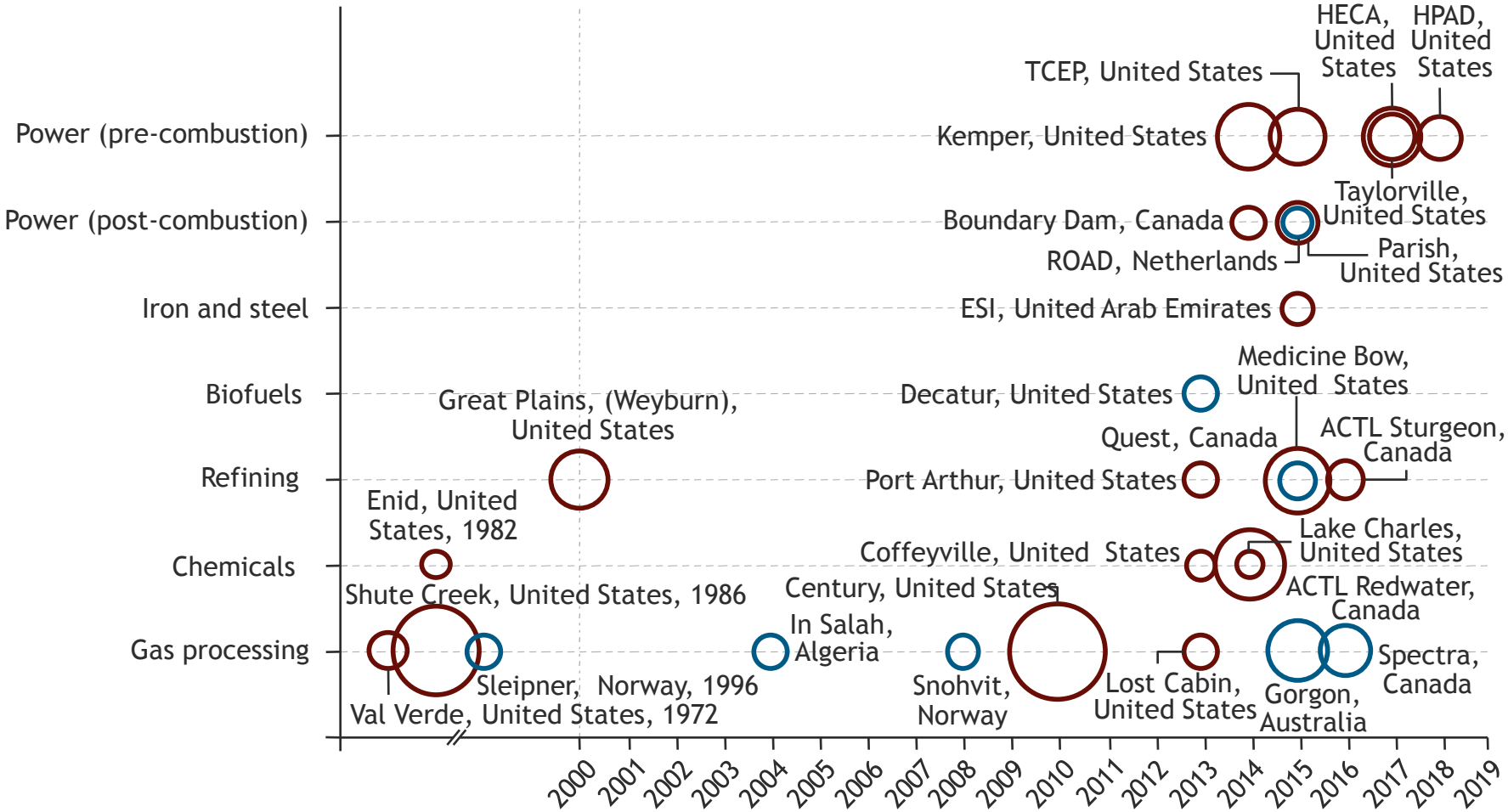
    → sustainability needs to be ensured
  - may well be needed for climate stabilisation, in particular looking <u>beyond 2050</u>

Process	CCS	BECCS
Biological sequestration		-1
Combustion	+1	+1
Storage	-1	-1
Lifecycle emissions	**0**	**-1**

Note: Table only includes abstract values

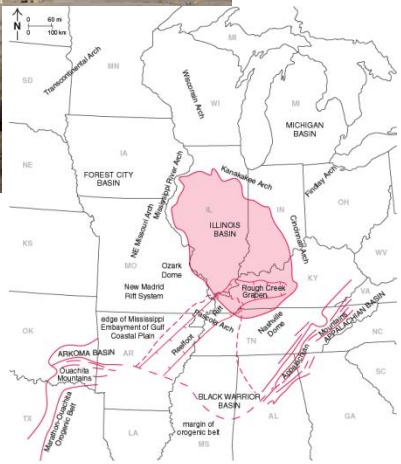
Should be reflected as extra incentive

Large-scale *projects* moving ahead



Size = 1MtCO_2/yr captured CO_2 used for EOR CO_2 used for storage without EOR (based on available information)

Carbon Storage at an Ethanol Production Facility: Illinois Basin – Decatur Project (IBDP), Decatur, Illinois, USA

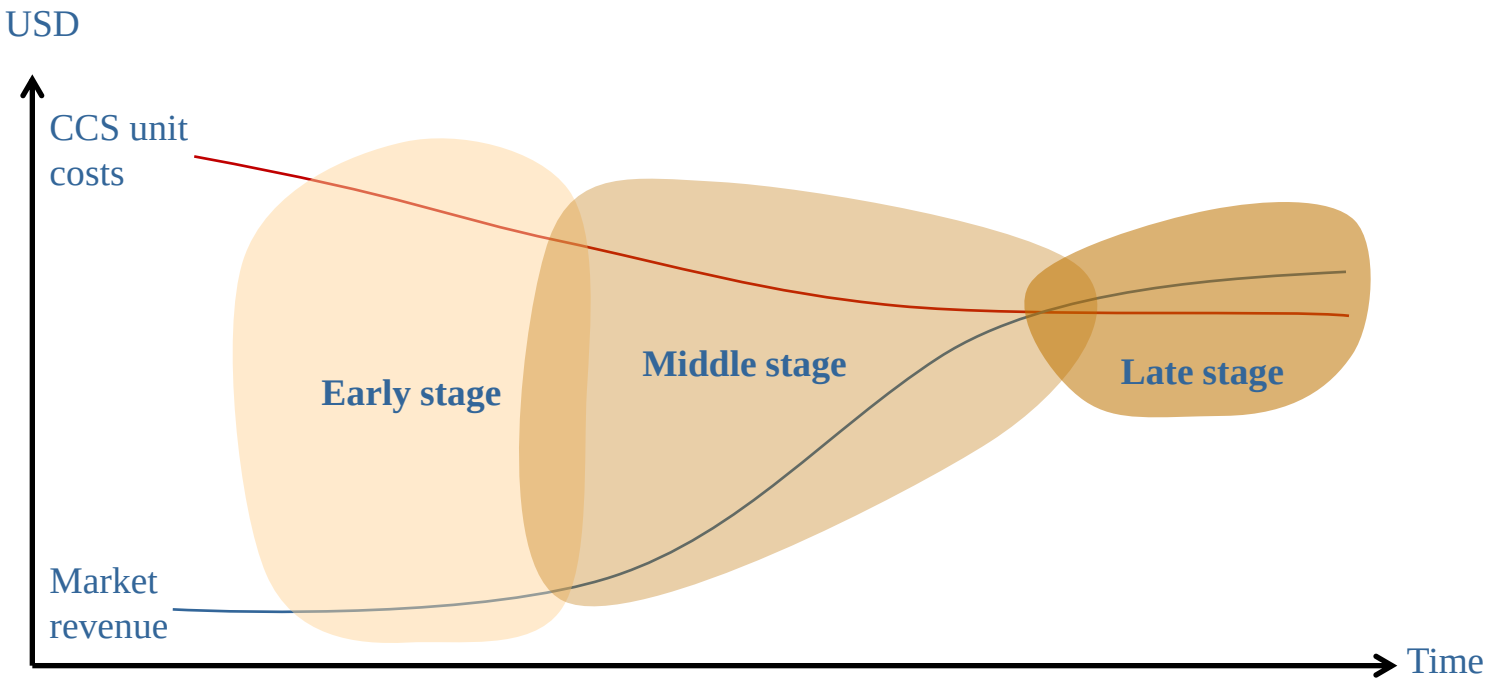


Source: Rob Finley, Midwest Geological Sequestration Consortium, University of Illinois, USA

Operational Injection:
17 November 2011

- **IBDP fully operational 24/7**
- **IBDP is the first 1 million tonne carbon capture and storage project from a biofuel facility in the US**
- **Injection through fall 2014**
- **Intensive post-injection monitoring under MGSC through fall 2017**
- **Cumulative Injection (10 June 2013): 504,900 tonnes**

The starting point: Economic characteristics of CCS technology will change with time



Markets failures produce outcomes that are not socially optimal

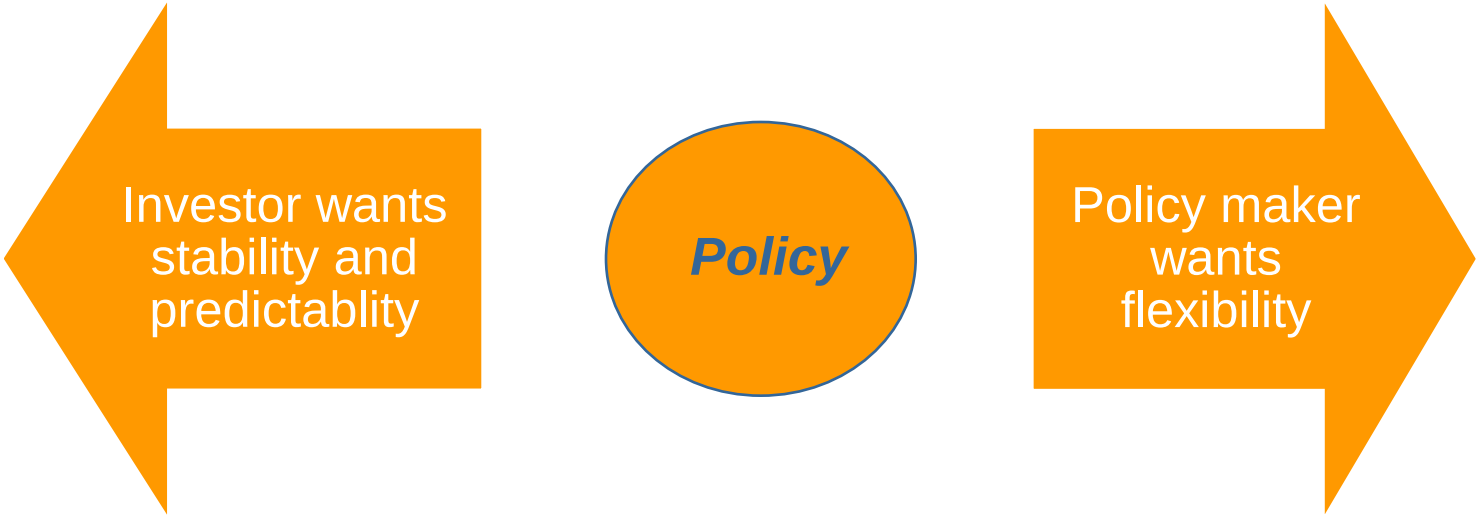
Market failure as rationale for intervention

Market failure	Example policies
Emissions externality *Failure to internalise the cost of greenhouse gas emissions*	Carbon tax or emissions trading scheme
Public good *Failure to appropriate returns generated by investments in innovation*	*Quantity*-based instruments: feed-in tariff, portfolio standards
Risk and capital market failure *Underprovision of private capital resulting from imperfect information*	Provision of debt/equity, grants, investment tax credits, insurance
Complementary markets Undersupply due to dependency on complementary markets and coordination failure	Regulation

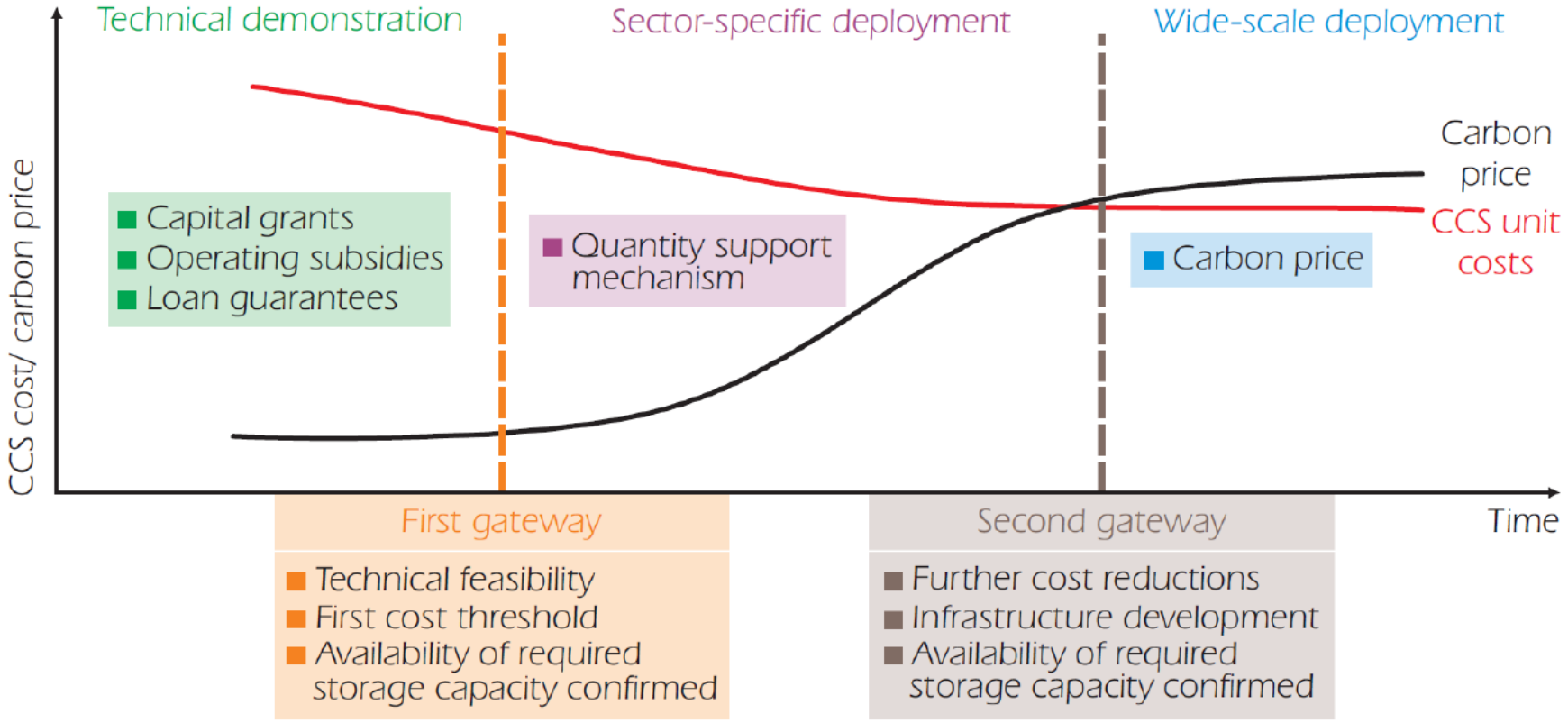
Sorry for the jargon

The policy dilemma

- **Change in the characteristics of CCS, and associated focus of incentive policy, creates a challenge for policy-making**
  - **on the one hand, want to be able to adapt and modify policy as technology changes or new information comes to light**
  - **on the other hand, the (perception of) changing policy may damage investment**



Possible Gateways within a CCS Policy Framework



Incentive mechanisms are specific to deployment stage

Decarbonising electricity generation from coal

Large-scale, commercial power generation

Cases analyzed:

- **Coal without CCS** (*Coal*)
- **Coal with CCS** (*Coal-CCS*)
- **Bioenergy without CCS** (*Bioenergy*)
- **Bioenergy with CCS** (*Bioenergy-CCS*)
- **Coal co-fired with 30 % biomass with CCS** (*Coal-Cofired*)

Instruments analyzed

- **CO_2 Emission Penalty** per tonne of CO_2 emitted (as used in CO_2 Cap and Trade Scheme or CO_2 Tax)
- **Feed-in-Tariff** per kWh produced using biomass and/or CCS

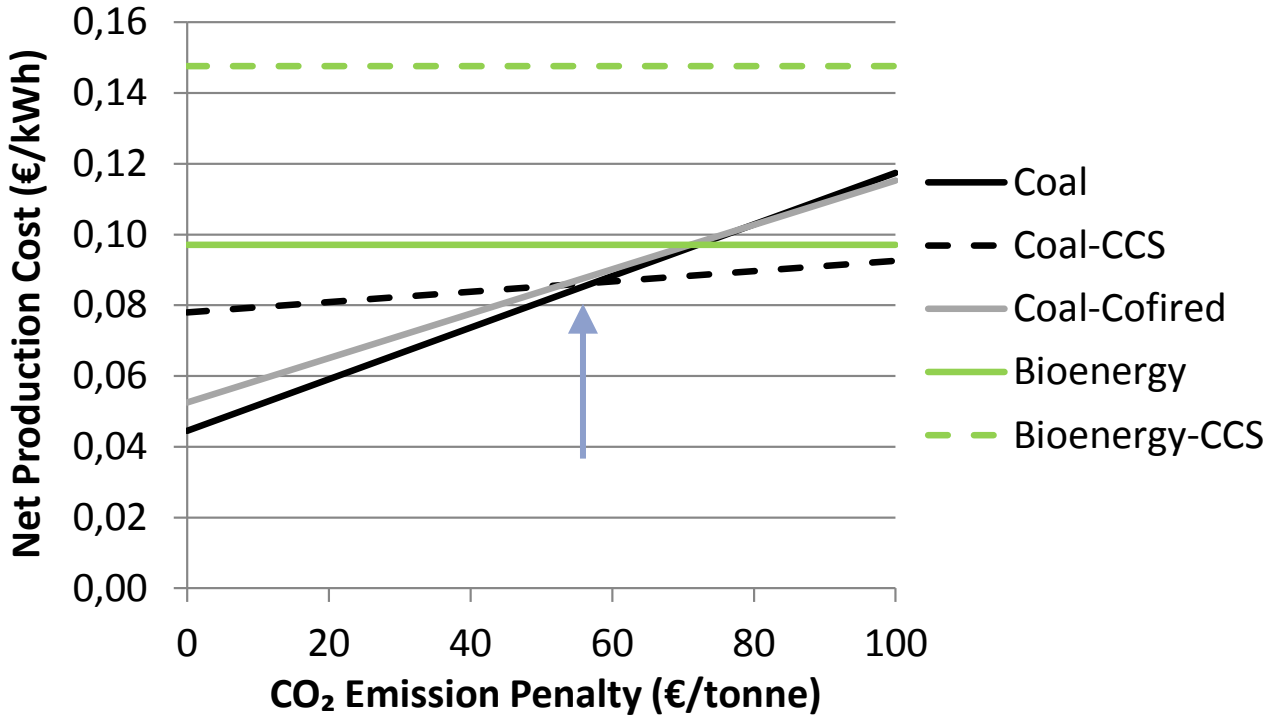
Additional BECCS-specific mechanisms:

- **Bonus for negative emissions**
- **Feed-in-Tariff for using BECCS**

Impact on net production cost analyzed

Costs and emission penalty

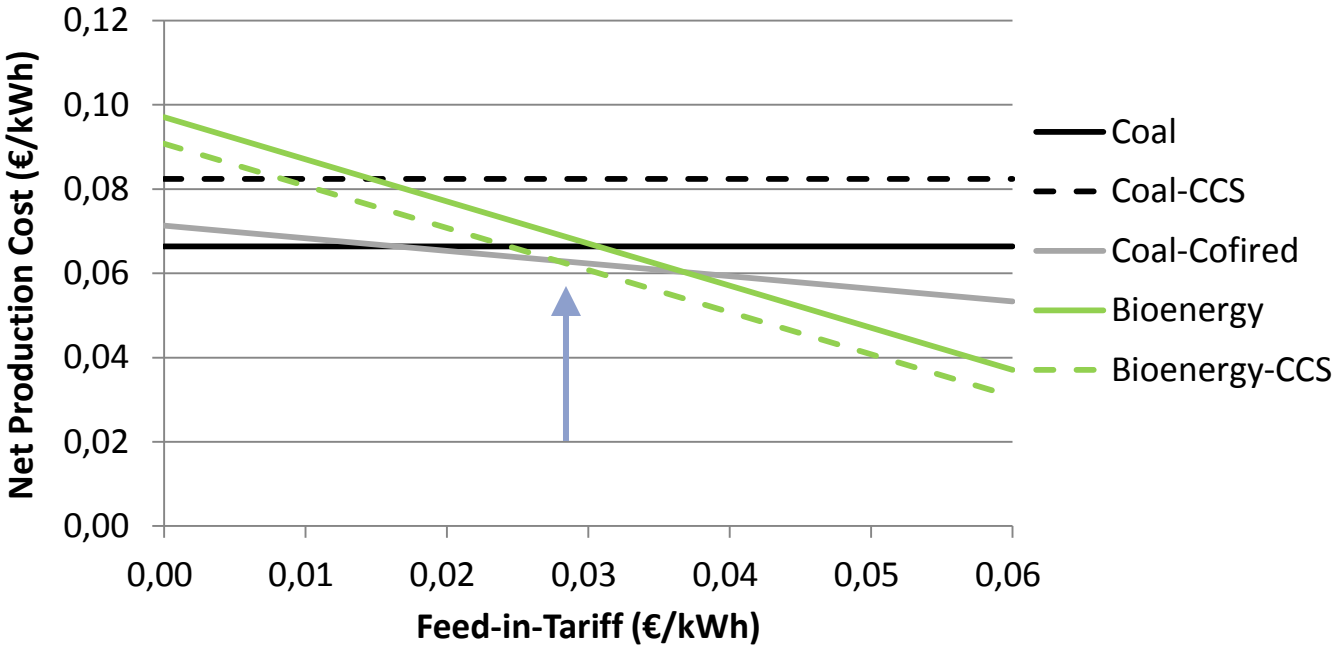
- CO_2 emission penalty for coal power emissions
- No feed-in-tariff
- No negative CO_2 emission bonus



Coal-CCS most attractive above ~60 €/t_{CO2}
No incentive for using Bioenergy-CCS

Costs and feed-in tarif

- CO_2 emission penalty for coal power emissions at 30 €/tonne
- Feed-in-tariff for using biomass
- Negative CO_2 emission bonus for BECCS (of same value as CO_2 emission penalty)



Bioenergy-CCS most attractive above ~2.8 €-ct/kWh
Strong incentive for using Bioenergy-CCS

Summary of Results

Sce-nario	CO_2 Emission Penalty	Feed-in-Tariff	Negative CO_2 Emission Bonus	Most economic low-CO_2 emission option	Inventive for using BECCS
1	For coal	-	-	Coal-CCS above ~60 €/t_{CO2}	✗
2	For coal	-	for BECCS	BECCS above ~40 €/t_{CO2}	✓✓
3	-	For CCS	-	Coal-CCS above ~2.5 €-ct/kWh	✗
4	-	For biomass	-	Bioenergy above ~60 €-ct/kWh	✗
5	-	For CCS and biomass		BECCS above ~6.5 €-ct/kWh	✓
6	For coal (at 30 €/t_{CO2})	For biomass	For BECCS (at 30 €/t_{CO2})	BECCS above ~2.8 €-ct/kWh	✓

Conclusions

- Today, neither conventional CCS nor BECCS are competitive
- A CO_2 emission penalty alone does stimulate conv. CCS but not BECCS
- A feed-in-tariff for using CCS reduces costs of conventional CCS and BECCS, but conventional CCS always remains more attractive
- A feed-in-tariff for using biomass reduces costs of conventional bioenergy and BECCS, but bioenergy without CCS always remains more attractive
- A combined feed-in-tariff for CCS and biomass would incentivize using BECCS
- An additional bonus for negative CO_2 emissions would effectively incentivize using BECCS (at comparably low €/t_{CO2})

Thank you

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