



GASIFICATION FOR COMBINED PRODUCTION OF ELECTRIC POWER AND CHEMICALS



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A G E N D A

- INTRODUCTION
- BASES OF DESIGN AND PLANT ALTERNATIVES
- PROCESS DESCRIPTION
- PERFORMANCE DATA
- INVESTMENT COSTS
- COST OF ELECTRICITY (C.O.E.) AND COST OF CHEMICALS (C.O.C)
- SENSITIVITY ANALYSIS
- SUMMARY FINDINGS

Gasification for Combined Production of Electric Power and Chemicals

INTRODUCTION

The target of this study is to investigate the technical-economical feasibility of capture-ready IGCC plants, designed for the combined production of electric power and chemicals, from coal and petcoke

Two main case studies are developed:

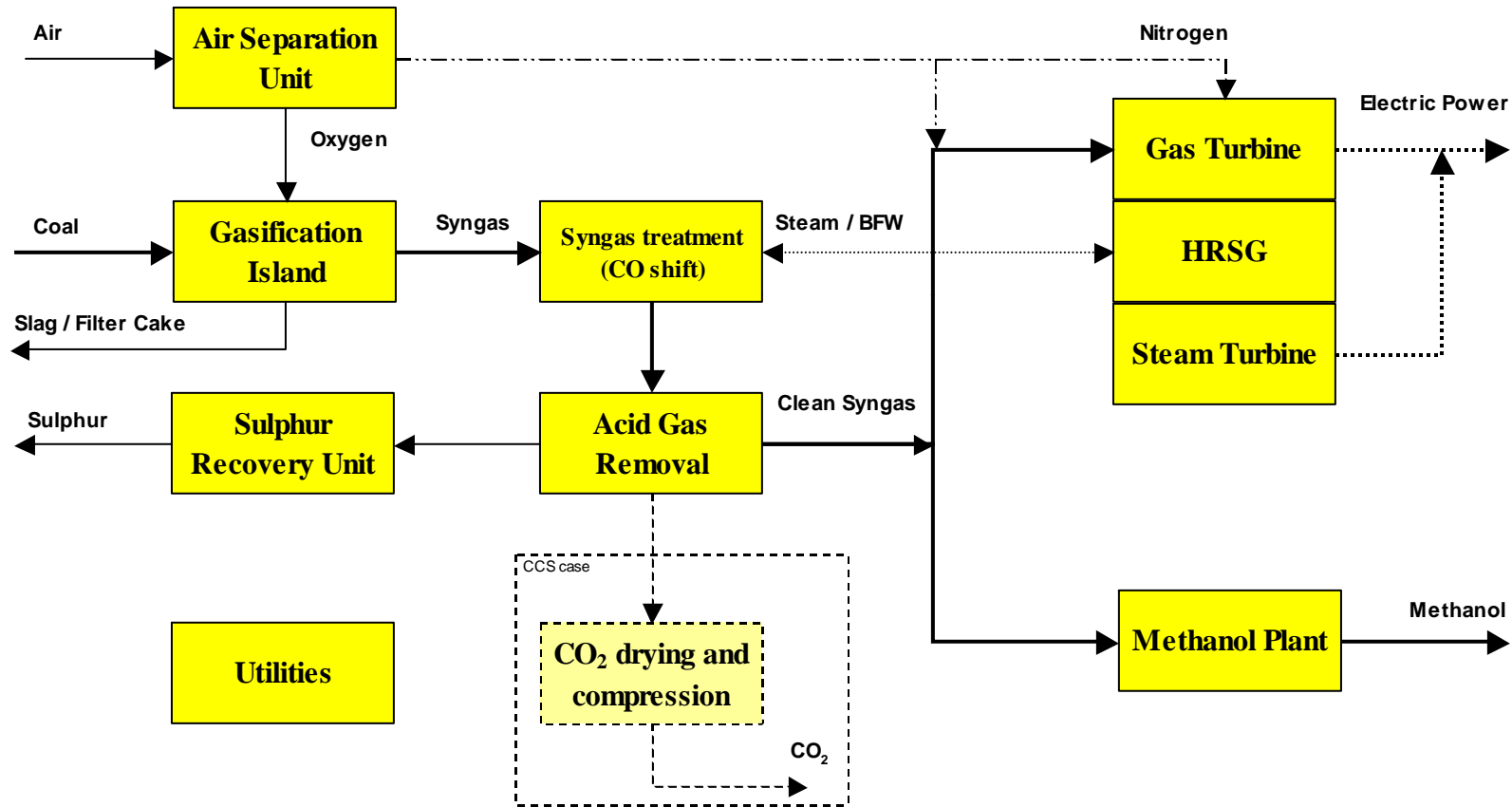
- Co-production of methanol and electric power from coal gasification (IGCC-MeOH)
- Co-production of urea and electric power from petcoke gasification (IGCC-Urea)

Overall performances and investment costs are evaluated and shown through:

- A sensitivity analysis on Cost of Electricity and Cost of Chemicals
- Performance and cost penalties due to the CO₂ capture retrofit

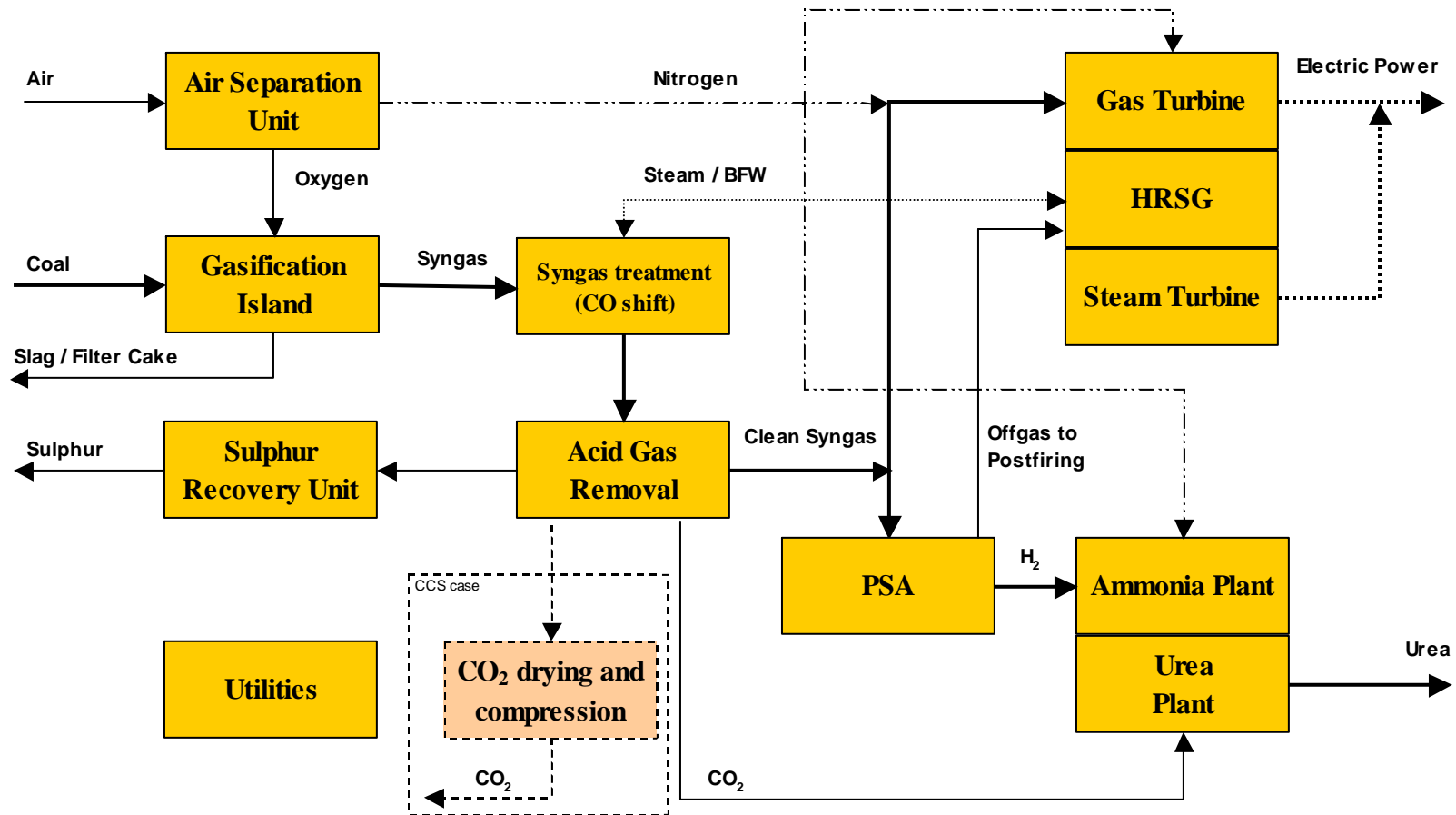
Gasification for Combined Production of Electric Power and Chemicals

IGCC Electrical Energy and Methanol Co-production



Gasification for Combined Production of Electric Power and Chemicals

IGCC Electrical Energy and Urea Co-production



Gasification for Combined Production of Electric Power and Chemicals

BASES OF DESIGN AND PROCESS ALTERNATIVES

Case	Feedstock	CO ₂ capture	GT	Methanol / Urea production, t/d
IGCC-MeOH	Bitumious Coal	No	250 MWe F-class	5,000
IGCC-MeOH	Bitumious Coal	Yes	250 MWe F-class	5,000
IGCC-Urea	Petcoke	No	120 MWe E-class	3,400
IGCC-Urea	Petcoke	Yes	120 MWe E-class	3,400

- Location is a generic European coastal site at iso-standard conditions
- Gaseous emissions (mg/Nm³ @ 15% O₂ vol. dry):
 - NO_x : < = 50
 - SO_x : < = 10

**GASIFIERS CAPACITY IS FIXED TO PRODUCE REQUIRED SYNGAS
FOR THE TARGETED CHEMICAL PRODUCTION
AND TO SATISFY THE APPETITE OF THE SELECTED GAS TURBINE**

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PERFORMANCE DATA

CASE	Fuel	MeOH / Urea production	Gross Power Output	Net Power Output	CO ₂ emission	Overall carbon removal efficiency *
	<i>t/h</i>	<i>t/d</i>	<i>MWe</i>	<i>MWe</i>	<i>t/h</i>	<i>%</i>
IGCC-MeOH	474.5	5,000	563.3	253.7	782.8	26.8
IGCC-MeOH with CCS	474.5	5,000	563.3	212.4	183.5	82.8
IGCC-Urea	174.8	3,400	303.5	132.6	414.6	20.0
IGCC-Urea with CCS	174.8	3,400	303.5	110.8	70.6	86.4

* Including carbon present in the chemicals produced (methanol or urea).

Petcoke case meets the target of a modern refinery (delayed coker capacity 100,000 BPSD and internal electrical cons.)

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INVESTMENT COSTS

The overall investment cost includes:

- Direct materials (equipment and bulk materials)
- Construction (mechanical erection, instrument and electrical installation, civil works and site preparation)
- Other costs (temporary facilities, solvents, catalysts, etc.)
- EPC services
- Land purchase
- Technology fees
- Contingencies

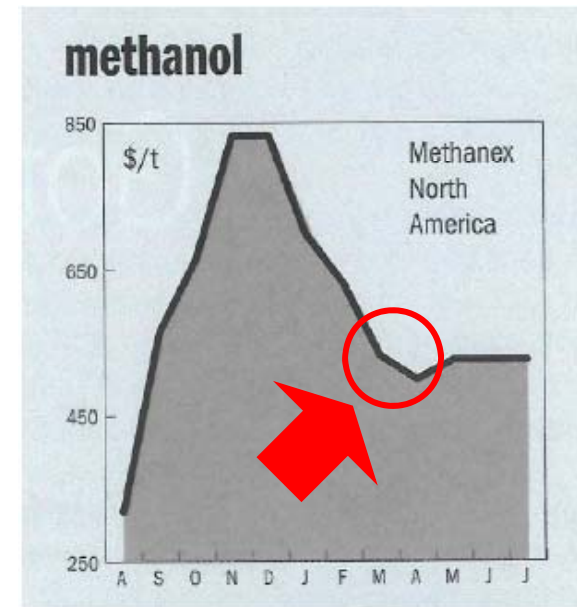
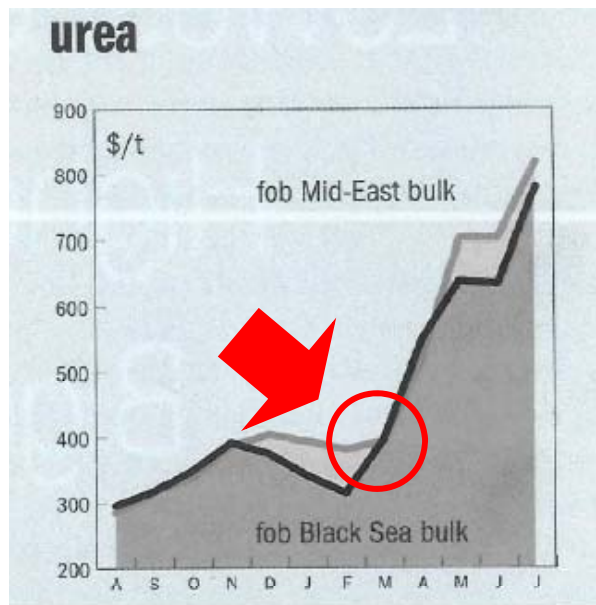
CASE	Total Investment Cost 10 ⁶ €
IGCC-MeOH	2,051
IGCC-MeOH with CCS	+ 36 (delta)
IGCC-Urea	1,558
IGCC-Urea with CCS	+ 26 (delta)

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PRODUCTION COSTS

Main Economic Data:

- Methanol selling price: 380 €/t
(Sensitivity to 250÷450 €/t)



- Urea selling price: 260 €/t
(Sensitivity to 230÷300 €/t)

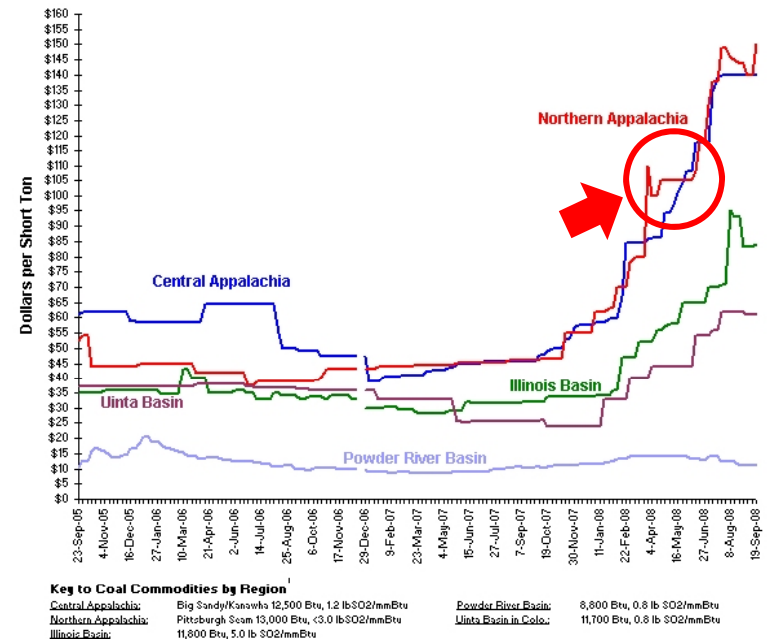
Graphs from "nitrogen + syngas" - September / October 2008

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PRODUCTION COSTS

Main Economic Data:

- Cost of petcoke: 35 €/t (Sensitivity to 20÷50 €/t)
- Cost of coal: 85 €/t (Sensitivity to 60÷110 €/t)



- 7,621 syngas equivalent operating hours (87% equivalent availability)
- 10% discount rate on the investment cost over 25 years
- Maintenance cost: approx 3.0% of the total capital costs

Gasification for Combined Production of Electric Power and Chemicals

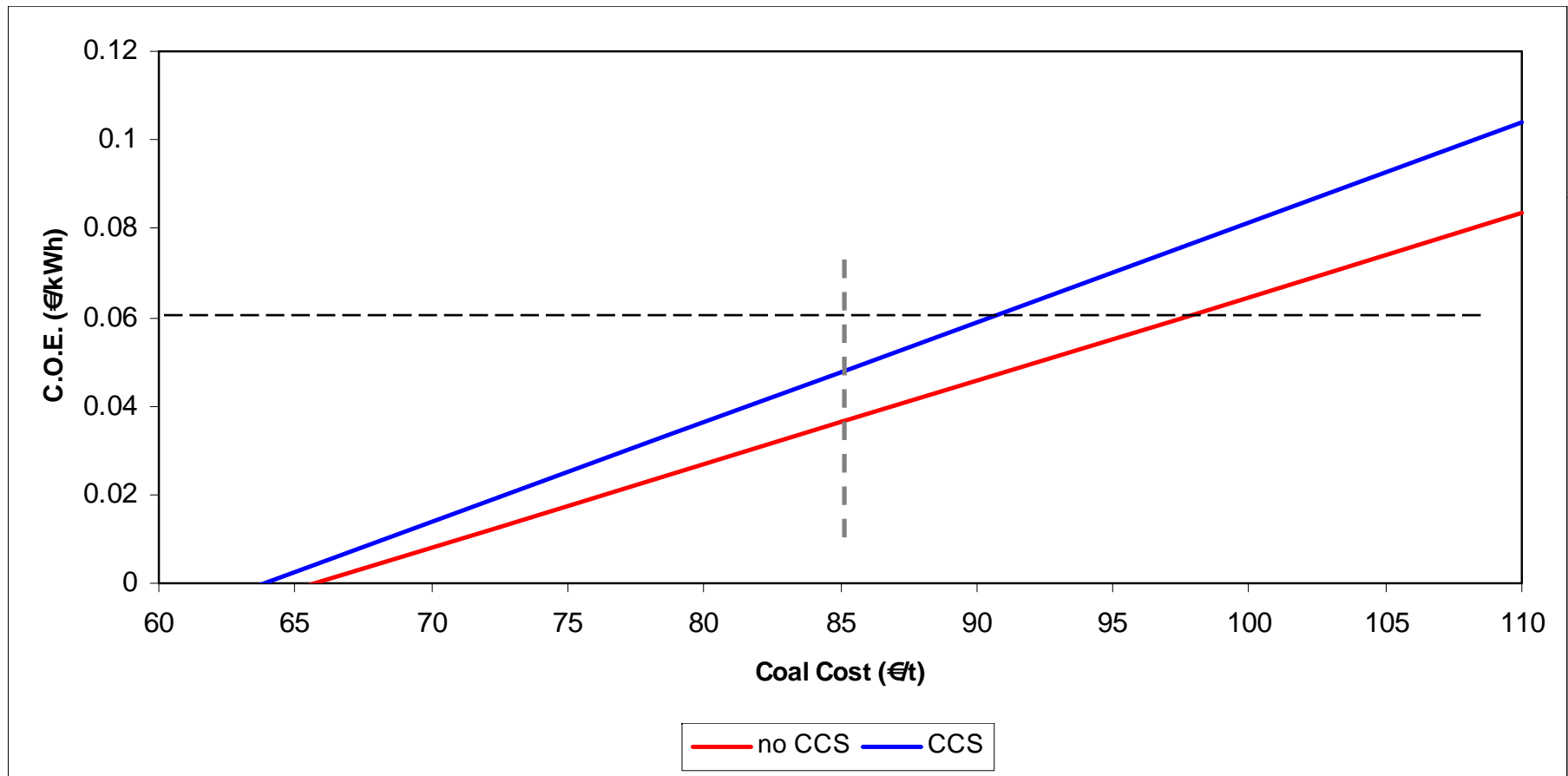
COST OF ELECTRICITY

CASE	MeOH / Urea prod. t/d	Cost of Coal / Petcoke €/t	Cost of MeOH / Urea €/t	C.O.E. cent€/kWh
IGCC-MeOH	5,000	85	380	3.6
IGCC-MeOH with CCS	5,000	85	380	4.7
IGCC-Urea	3,400	35	260	2.8
IGCC-Urea with CCS	3,400	35	260	3.9

Gasification for Combined Production of Electric Power and Chemicals

IGCC-MeOH

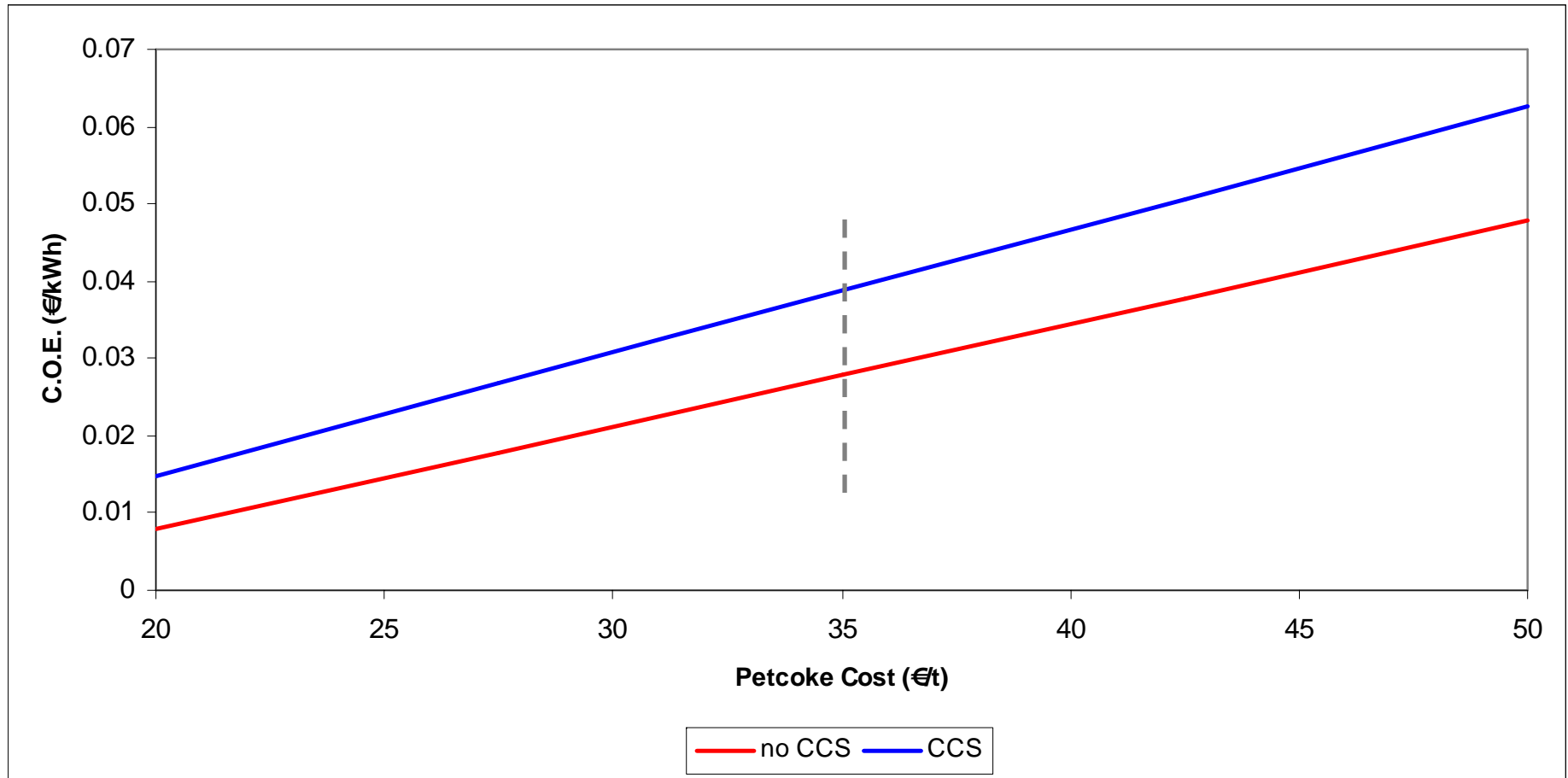
SENSITIVITY TO COAL COST (MeOH price = 380 €/t)



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IGCC-Urea

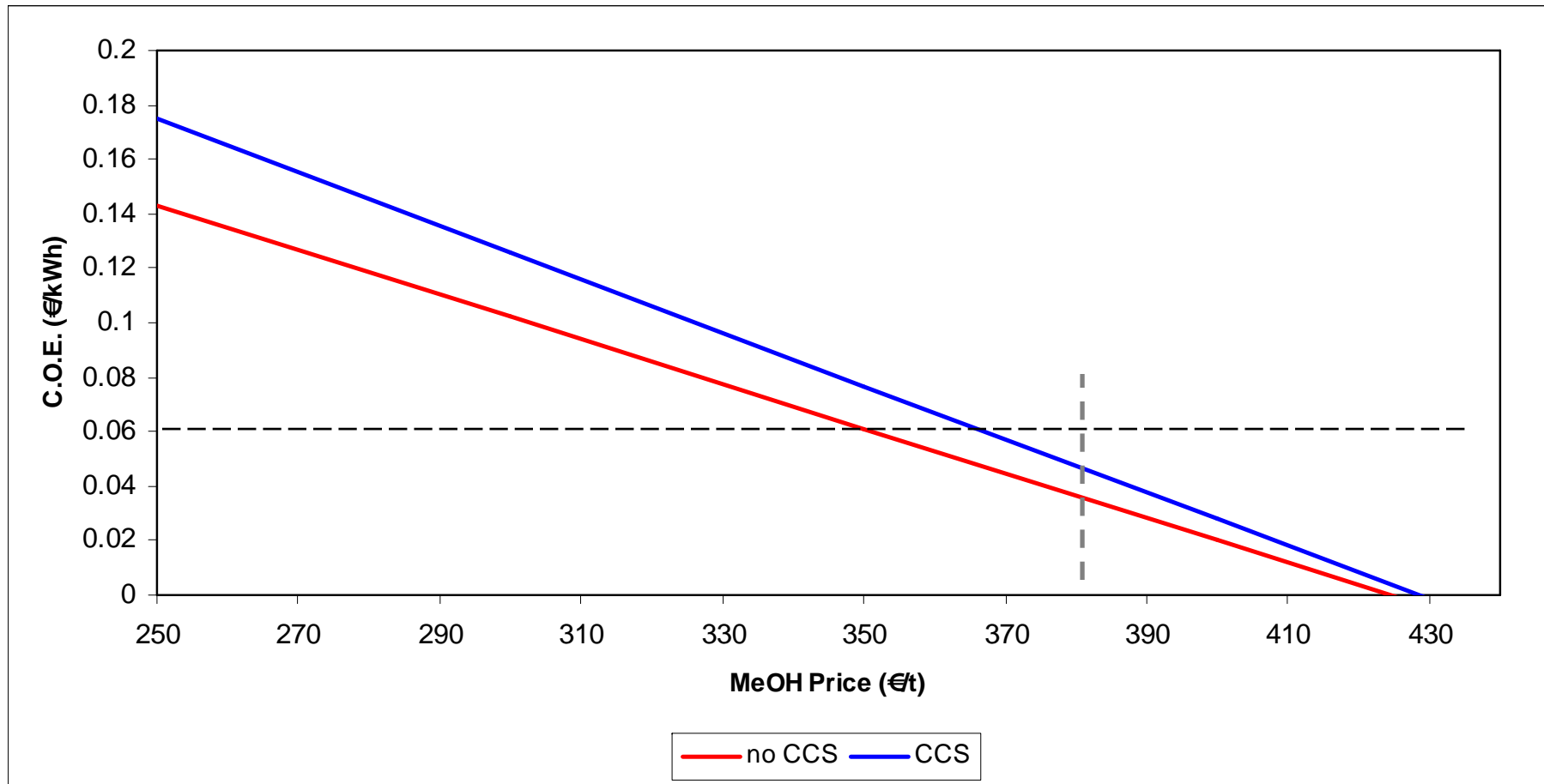
SENSITIVITY TO PETCOKE COST (Urea price = 260 €/t)



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IGCC-MeOH

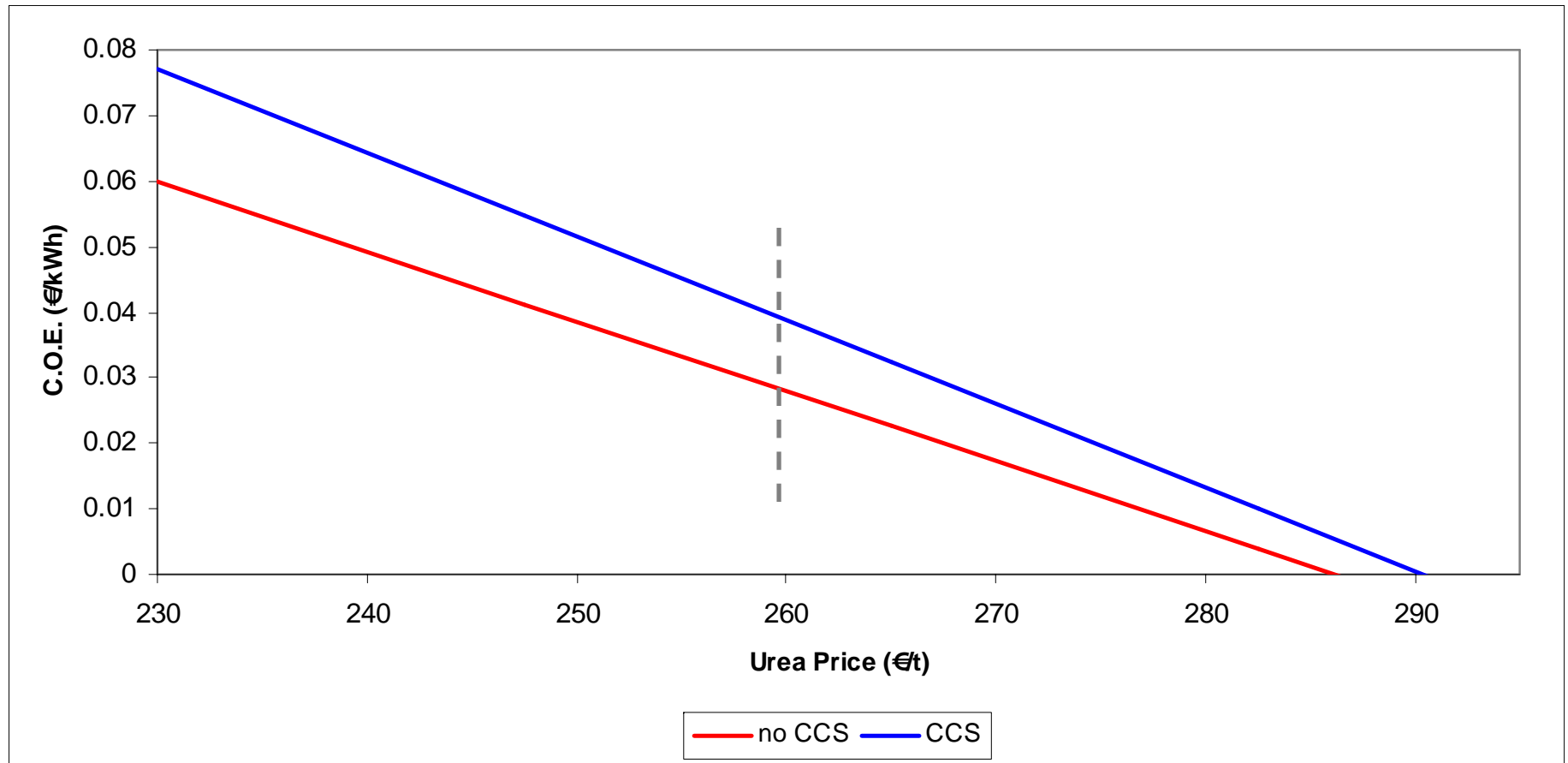
SENSITIVITY TO MeOH SELLING PRICE (Coal cost = 85 €/t)



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IGCC-Urea

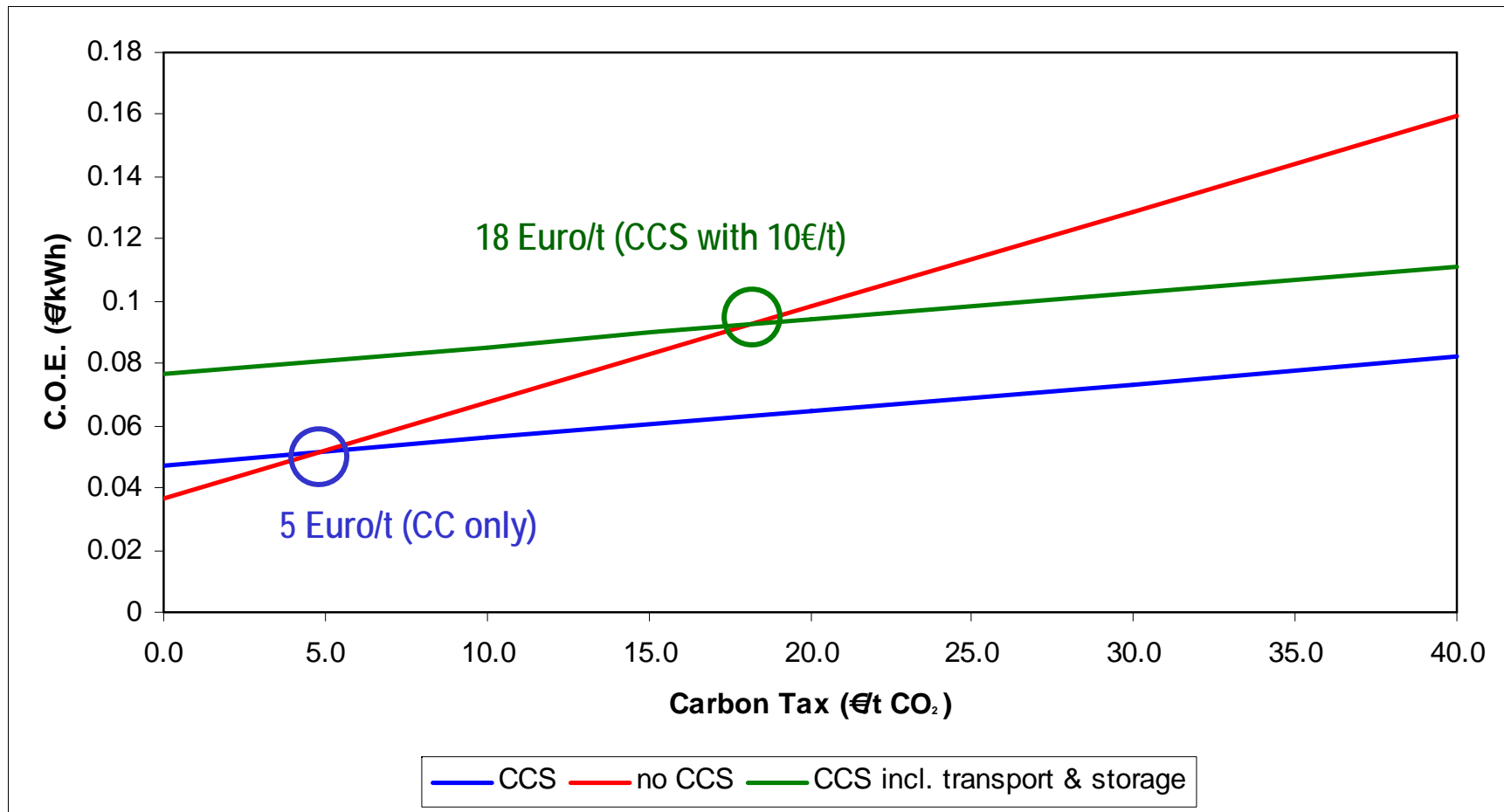
SENSITIVITY TO UREA SELLING PRICE (Petcoke cost = 35 €/t)



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IGCC-MeOH

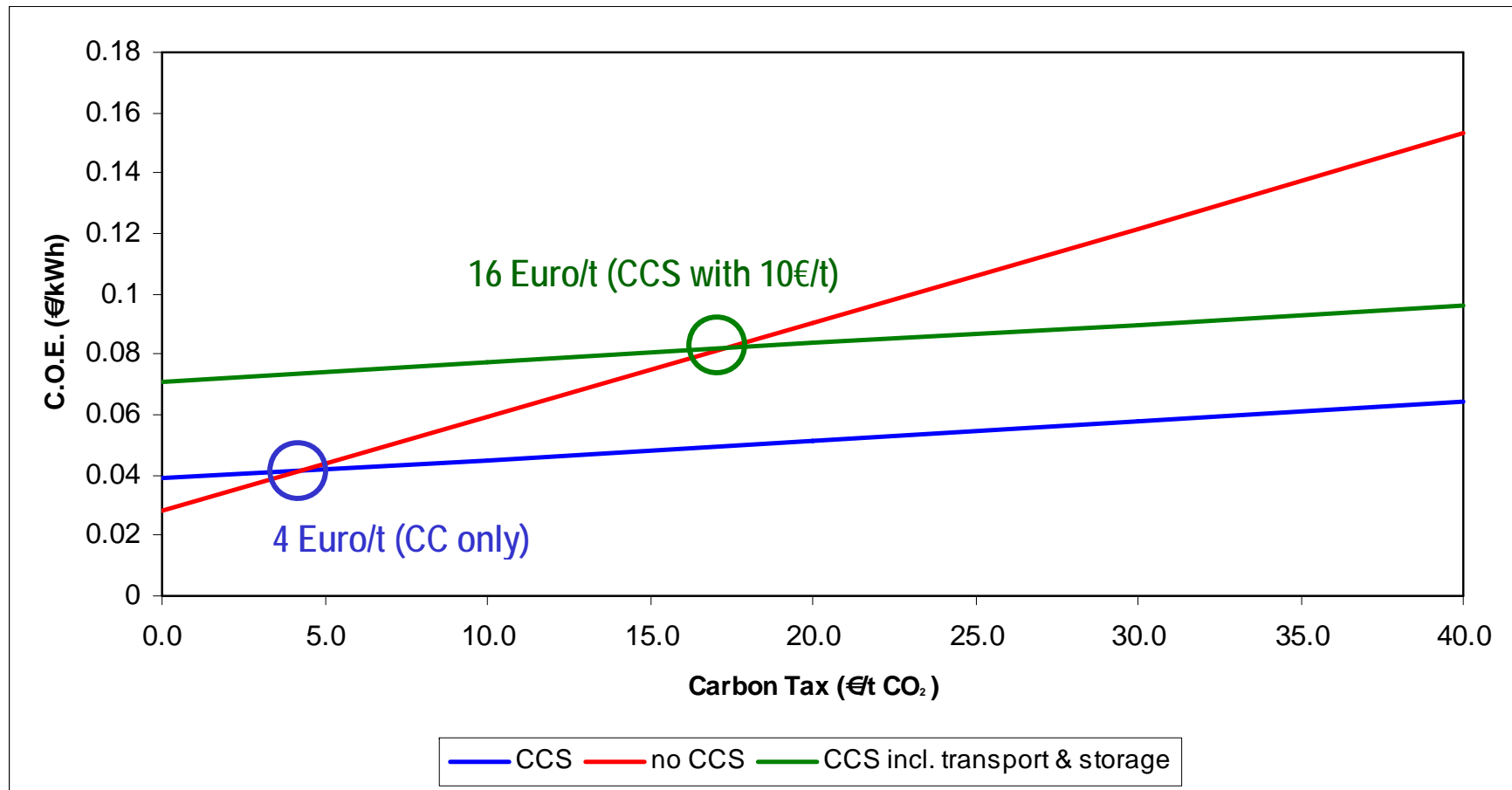
SENSITIVITY TO CARBON TAX – no-CCS vs. CCS (Coal cost = 85 €/t; MeOH price = 380 €/t)



Gasification for Combined Production of Electric Power and Chemicals

IGCC-Urea

SENSITIVITY TO CARBON TAX – no-CCS vs. CCS (Petcoke cost = 35 €/t; Urea price = 260 €/t)



SUMMARY FINDINGS

- Capture-ready IGCC with electric power and chemicals co-production shows attractive COE, especially for a low value feedstock like petcoke
- IGCC-MeOH case is significantly affected by coal cost and MeOH price.
 - > 98 €/t (base 85€/t) of Coal
 - < 350 €/t (base 380 €/t) of MeOH

} non-competitive COE values for European electrical market
- IGCC-Urea case is less affected by the petcoke cost and Urea price.
 - > 60 €/t (base 35 €/t) of Petcoke
 - < 230 €/t (base 260 €/t) of Urea

} non-competitive COE values for European electrical market

SUMMARY FINDINGS

- CO₂ capture retrofit is achievable with low performance and cost penalties.
- CCS alternatives are economically viable even at a very low level of carbon tax (> 18 €/t for IGCC-MeOH and > 16 €/t for IGCC-Urea, assuming 10 €/t for CO₂ transport and storage)
- Improvements in the main areas like GT, gasifiers and ASU are expected in the next years, thus making IGCC's more and more attractive



THANK YOU



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