

ECONOMIC ASPECTS OF CCS TECHNOLOGIES INTEGRATION INTO COAL POWER PLANT IN CZECH REPUBLIC

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INTRODUCTION

This paper deals with the economic aspects of CCS technologies integration (oxyfuel, post combustion and pre-combustion) into model lignite power plants in the Czech Republic. The analysis is performed for a 250 MWe output of power plant. Subcritical steam power plant is modelled for cases of oxyfuel and post-combustion CCS technologies. Integrated gasification combined cycle (IGCC) is modelled as an option for pre-combustion CCS technology.

GOALS AND INPUT DATA

The aims of economic evaluation of CCS technologies for lignite power plant in the Czech Republic are:

- to determine the impact of CCS technologies integration into lignite power plant economy
- to identify and analyze important parameters and their effects on the power plant economy
- to determine conditions of economic viability of CCS technologies application for Czech fossil fuel power plant

Analyzed cases of lignite power plant unit:

- ☐ **Reference Unit I.** - subcritical steam power plant without CCS technology
- ☐ **Oxyfuel** - subcritical steam power plant with CCS technology oxyfuel
- ☐ **Post combustion** - subcritical steam power plant with CCS technology - ammonia scrubbing
- ☐ **Reference Unit II.** - IGCC power plant without CCS technology
- ☐ **Pre-combustion** - IGCC power plant with CCS technology - Rectisol wash

Technical input data – general

- Design nominal unit electrical capacity is 250 MWe
- Fuel is Czech brown coal (domestic low rank lignite)

The basic technical and economic input data are shown in tables below.

Parameters	Reference plant I.	Oxyfuel	Post combustion	Reference plant II.	Pre-combustion
Gross power output [MWe]	250	262	238	250	250
Net efficiency [%]	38.9	28.2	31.2	44.7	32.1
CO2 capture factor [%]	-	90	90	-	90
CO2 capture [t/h]	-	177	190	-	265

Input economic data	Unit	Reference unit I. /Oxyfuel /Post combustion	Reference unit II. /Pre-combustion
Annual operating time of power plant	h/year	6300	5500
Fuel price	USD/t	19	20
Water price	USD/m3		0.2
CO2 tax	EUR/t		4,5
Electricity price	USD/MWh		50
Lifetime of power plant	years		25
Construction time	years	4	3
Specific investment cost of power plant	EUR/kWe	2050	2650
Exchange rate CZK/EUR	CZK/EUR		25
Exchange rate CZK/USD	CZK/USD		20

RESULTS – ECONOMIC CRITERIA

CCS technologies integration into power plant has resulted in:

- Increased CAPEX up to 50 %
- Reduction of OPEX up to 20 % => CO₂ tax
- Increase of COE and LCOE up to 50 %, respectively 70%
- Removal cost = CO₂ tax in 2005 or 2008

The specific values of economic criteria are listed in the table below

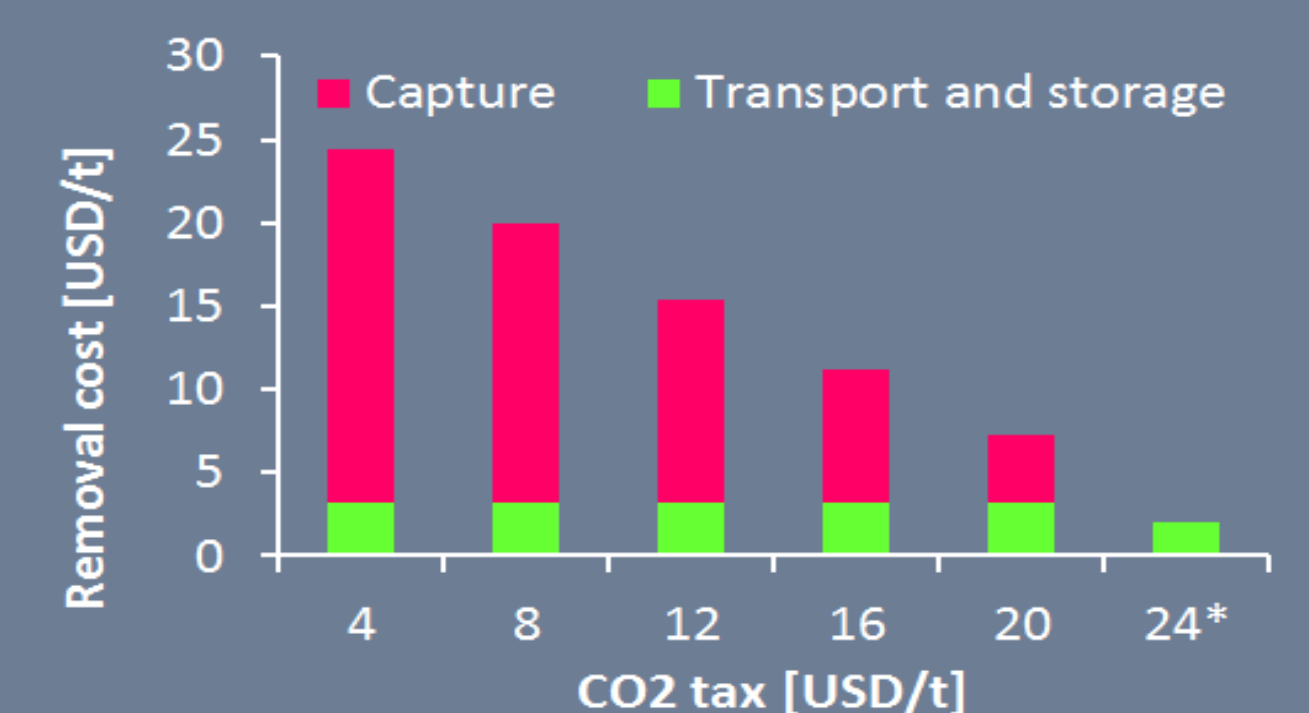
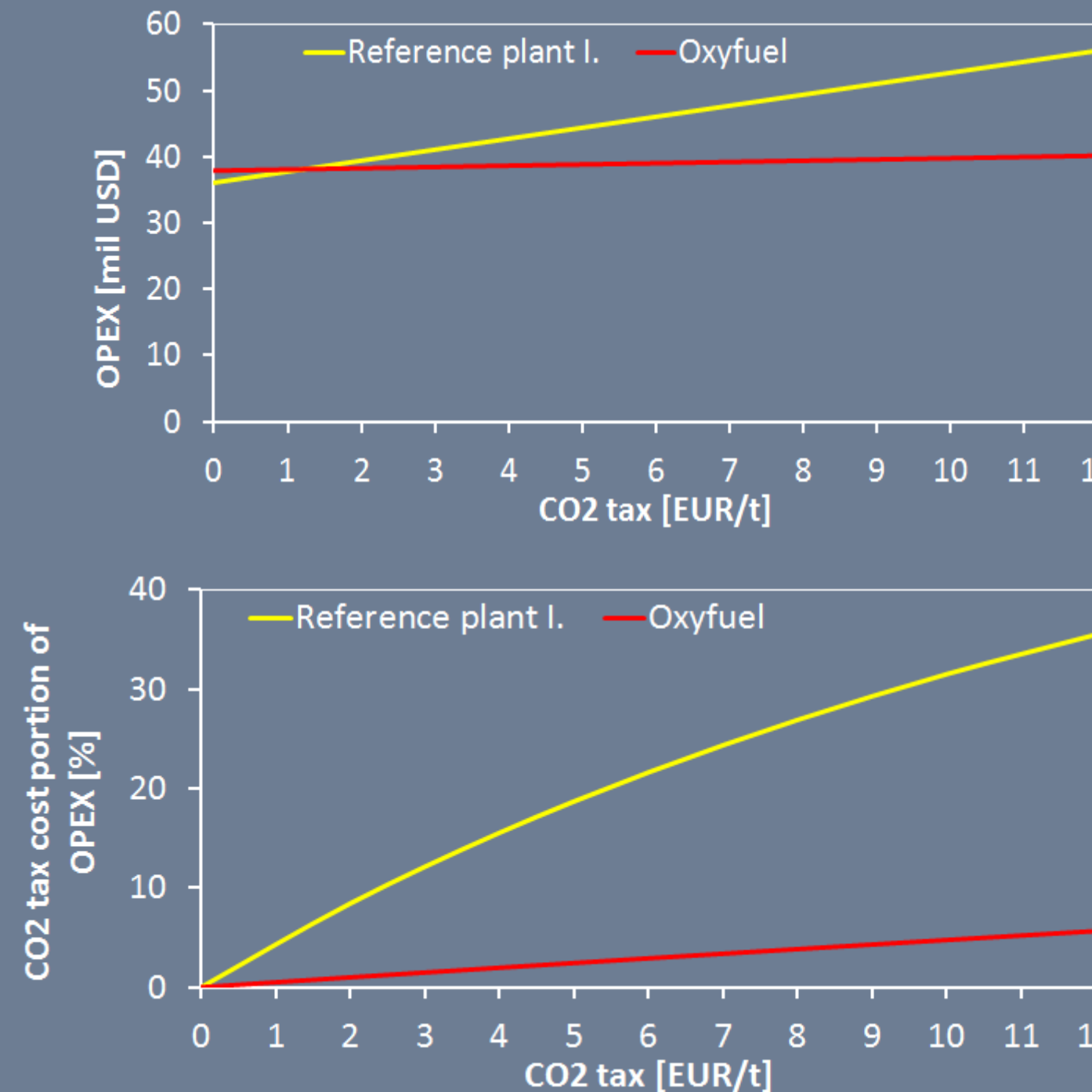
Results	Reference plant I.	Oxyfuel	Post combustion	Reference plant II.	Pre-combustion
CAPEX [mil. USD]	600	900	950	742	1110
COE [USD/MWh]	50	71	75	65	94.5
LCOE [USD/MWh]	62	95	101	80	118
Removal cost [USD/t]	-	25	29	-	35
Avoided cost [USD/t]	-	26	31	-	39

OPEX reduction analysis is shown in graphs on right side, for oxyfuel case.

SENSITIVITY ANALYSIS

The main factors affecting profitability are:

- Investment cost
- Fuel price
- Annual operational time
- Lifetime
- CO₂ tax (see graphs below)



CONCLUSIONS AND FUTURE OPTIMALIZATION

CCS technologies are not economically competitive under current conditions:

- without a clear position of government promotion for these low-emission technologies
- Ineffectiveness of regulation by the CO₂ tax market.

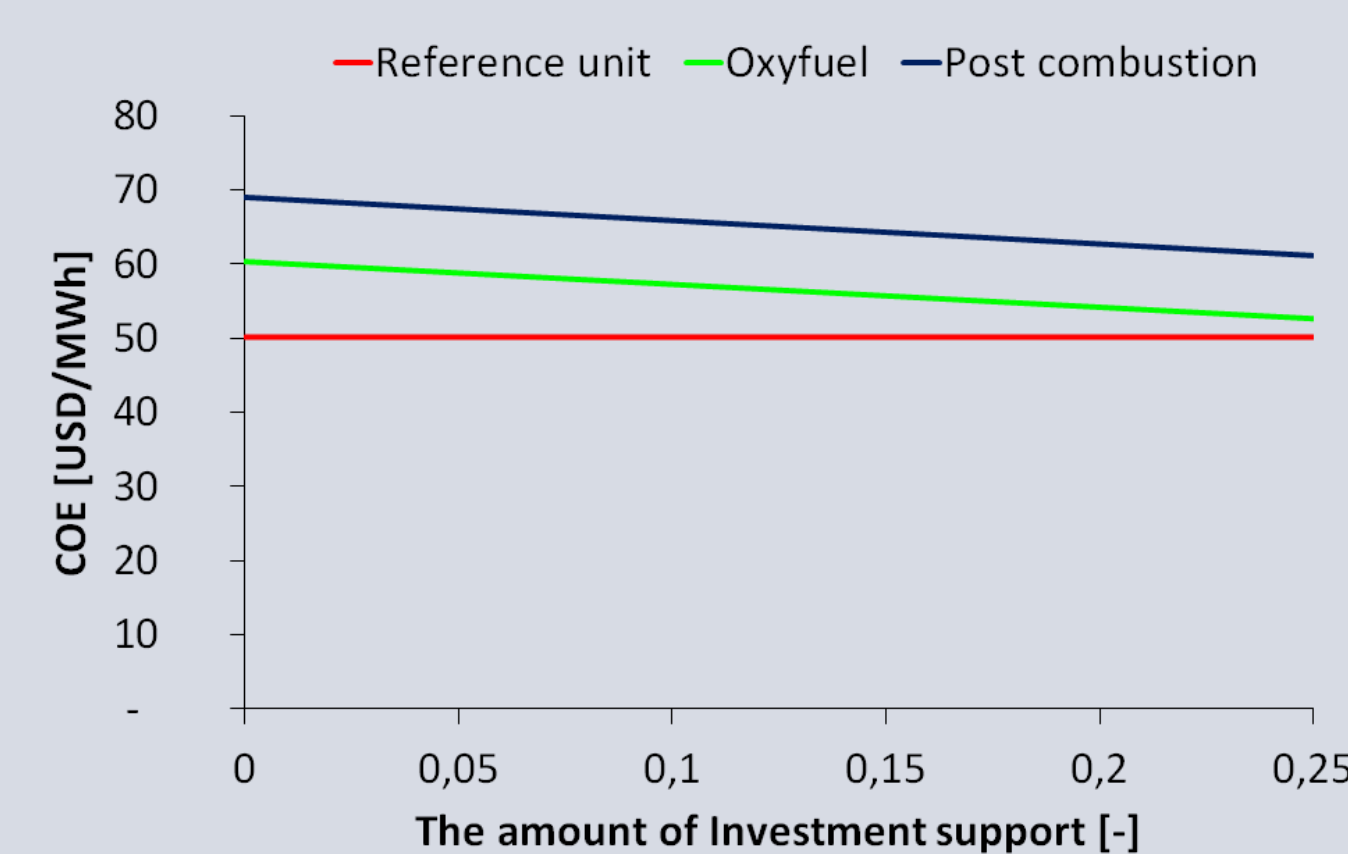
Options to improve economic efficiency of CCS technology integration are:

- Technical Options => to reducing energy consumption
- Economic opportunities / incentives that could streamline CCS include:
 - reducing the capital intensity of CCS (reduction potential of app. 5-15 %)
 - the possibility of production and sale of another product (reduction potential app. 5 %)
 - exploring the possibilities for the use of separated carbon dioxide (reduction potential app. 15-25 %)
- Government or EU support:
 - CO₂ tax market (reduction potential high but unsure)
 - direct government support (reduction potential app. 5-10%)

GOVERNMENT SUPPORT

There are two basic types of government economic support for promoting preferred energy sources existing in the Czech Republic:

- Investment – see graph below
- Operational (minimum electricity and heat sale prices and obligation for priority in electricity purchase from CCS plants, similarly as for renewables production on Czech market)



The amount of operational support – defined minimum electricity sale prices

CCS technology /Other technology	LCOE _{supp} [USD/MWh]
Oxyfuel	71.5
Post combustion	77
Pre-combustion	100.5
Biomass	180 - 215

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