Workshop on Assessing The Impacts Of Environmental Regulation By Macroeconomic Models

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Energy Supply-Side Optimisation Model MESSAGE

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Emission projection on EU level

Objectives

Applied models

Energy planning on EU level for all member states

PRIME technical and econometric model with feed back, output energy data for GAINS

GAINS, up-dated RAINS Spreadsheet model, energy data from PRIME

Emission projection, NEC assignment, CO2 emission limit for EU ETS

Advantages

1. Common approach for all EU countries
2. No ***Energy Island*** - international energy trade can be applied at this approach

Disadvantages

Top-down approach is applied in GAINS model.

It allocates emission from national inventory for the activity based on energy statistics.

It should lead to ***Double Abatement Implementation*** for example in scenarios used for NEC assignment :

1. **Abatement technology is allocated for sources already complying EU emission standards**
2. **Abatement technology is allocated for emission sources, where abatement is already applied**

Objectives of emission projection on national level

- Is country able to comply NEC?
- Which policy should be most effective?
- Which technical action will be most efficient?
- Impact of different policy on future emission level
- Impact of EU ETS on energy and emission balance
- Impact of different macro-economical indicators on emission level and via versa impact of environmental aggressive policy on economical development
- Impact of fiscal and tariff policy on energy and emission balance

<u>Selection of models dependent on following factors</u>

- Availability
- Is model sufficiently user friendly?
- Linear model or feed back on energy demand
- Requirements on input data

<u>What is most important at emission projection?</u>

Activity growth rate - impact of demand and energy conversion efficiency

Fuel mix of activity - impact on GHG emission factor

Technology changes and new technology penetration

Abatement technology implementation

Constrains - emission level, fuel, renewable etc.

Why MESSAGE?

Advantages

- High flexibility
-Load curve modeling
-Energy storage
-Implementation of constrains like emission, fuel, export etc.
-Simulation of emission trading
-Input data based on bottom-up approach i.e. consistency of activity and emission data

Disadvantages

-Minimum cost for national balance ***energy Island***, impossibility to simulate open energy market
-*Penny effect*
-Without *feed back* to energy demand

Case study - Industrial CHP modeling

Input data based on national emission inventory system REZZO

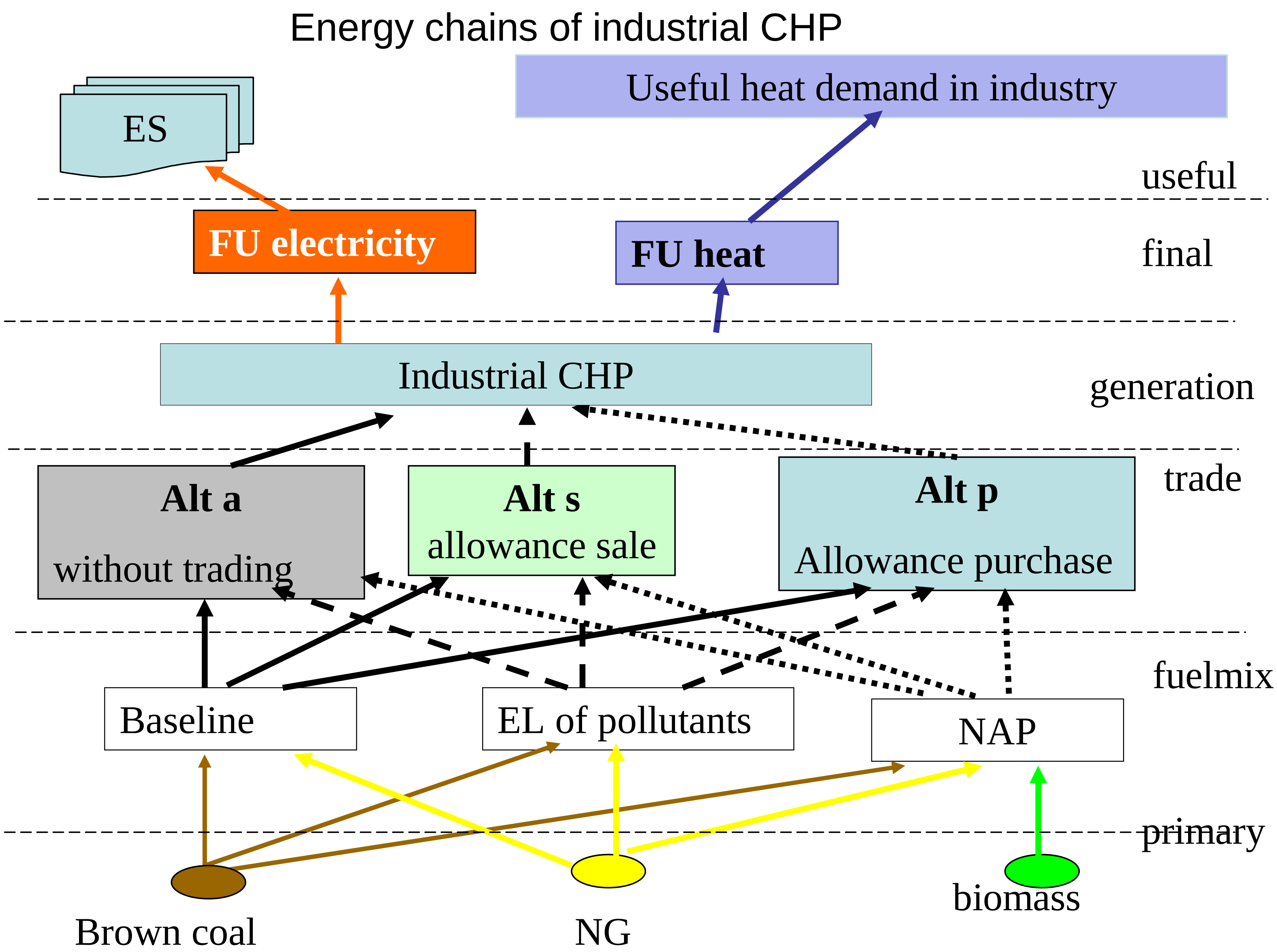
Source	Fuel 1	input1	Fuel 2	input2	Fuel 3	input3	Fuel 4	input4	output
CHM_5	BC	1	IPP	0.0424	HFO	0.0001			1.0425
Spol	BC	1	HFO	0.0031	NG	0.0002			1.0034
SYN	HC	1	BC	0.0413	LFO	0.0014			1.0427
CHM-T	HFO	1	NG	0.0481					1.0481
OMGD	BC	1							1
DEZA	IPP	1	NG	0.0448	HFO	0.0089	OLF	0.14119	1.1949
HEX	BC	1	ITP	0.0045					1.0045
LOV	BC	1	NG	0.0309					1.0309
KAU	HFO	1	NG	0.5226	LPG	0.2472			1.7698
IVAX	NG	1	HFO	0.0116					1.0116
LON	NG	1	OLF	0.2552					1.2552
NG	NG	1							1

BC- brown coal, HC – hard coal, NG / natural gas,
HFO – heavy fuel oil, LFO – light fuel oil, OLF / other liquid fuel
Input represents the share of auxilliary fuel to based fuel (fuel 1)
Output represents the share of auxilliary fuel to based fuel (fuel 1)

3 scenarios

Baseline – business as usual emission and fuel mix of activity is not changed
EL - fuel mix of activity is not changed, the emission sources i.e. industrial CHP comply EU emission standards
NAP – due the impact of EU ETS the CHP, there are included in National Allocation Plan –NAP and use the coal as main fuel apply fuel mix with biomass in order to decrease CO2 emission.
The maximal biomass share in fuel mix is 30% of coal thermal input

Design of energy chain is organized in several levels in order to simulate:
Primary – input of fuel, its cost and cost escalation
Fuelmix - input fuel mixture, its aggregated emission factors
Trade - simulation of CO2 emission trading
Generation- conversion of energy in fuel into heat and electricity
Final – simulation of losses at transport and energy distribution
Useful - energy demand growth rate

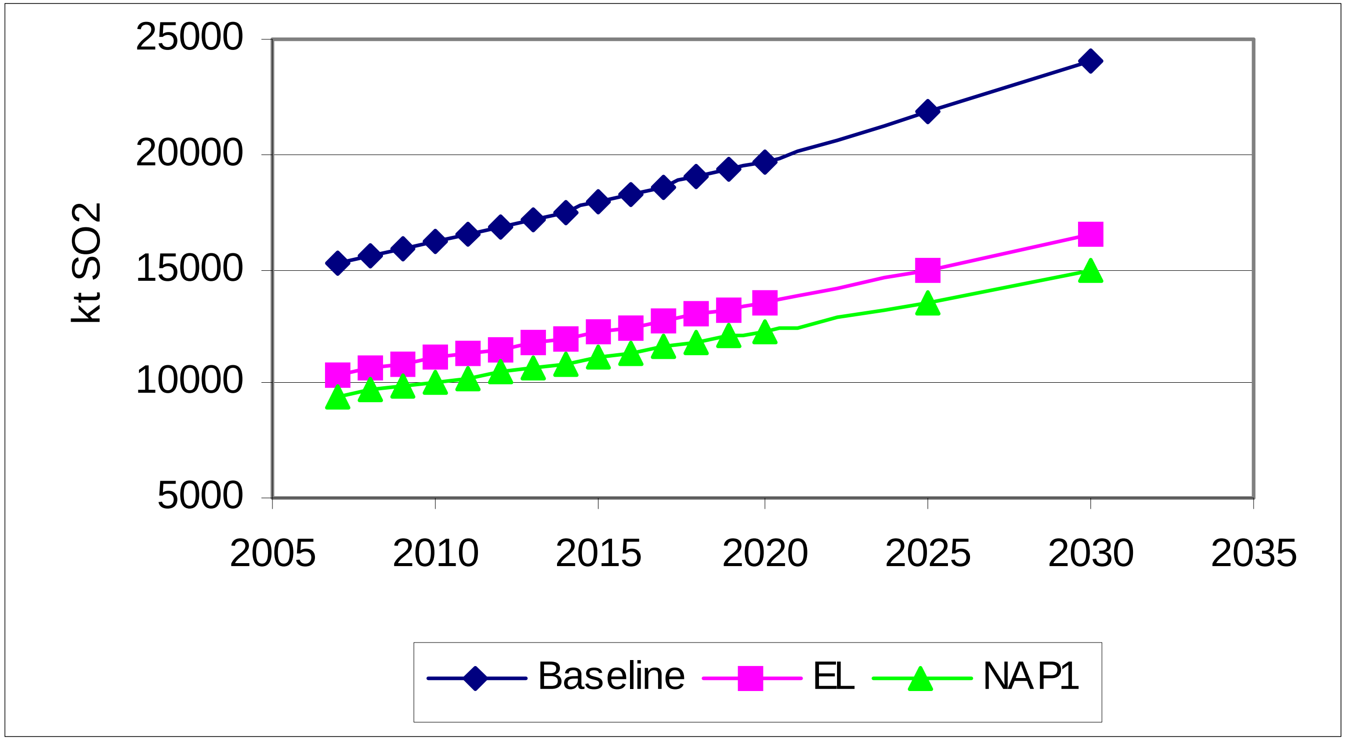


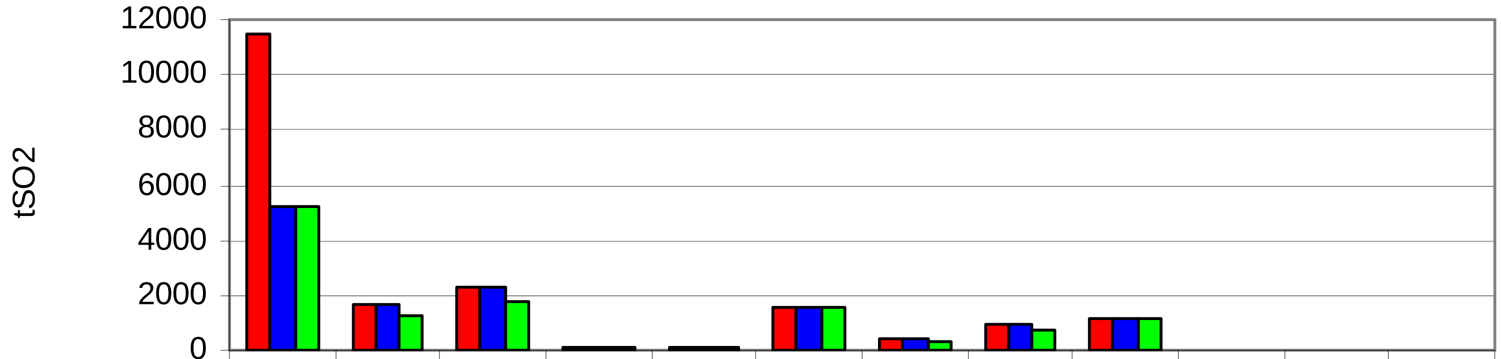
Energy chains of industrial CHP
ES
Useful heat demand in industry
useful
FU electricity
FU heat
final
Industrial CHP
generation
Alt a
without trading
Alt s
allowance sale
Alt p
Allowance purchase
trade
Baseline
EL of pollutants
NAP
fuelmix
primary
Brown coal
NG
biomass

1st question- Will new EU legislation bring additional decrease of emission?

2st question- Will EU ETS bring additional decrease of emission?

The SO_2 decrease has been achieved by this two type of policy





	CHM	Spol	SYN	PET	OMGD	DEZA	HEX	LOV	KAU	IVAX	LON	NG
Baseline	11426	1692	2288	72	84	1575	463	925	1194	1.15	0.11	0.99
EL ZZL	5221	1692	2288	72	57	1575	463	925	1194	1.15	0.11	0.99
NAP	5221	1301	1776	72	57	1575	356	709	1194	1.15	0.11	0.99

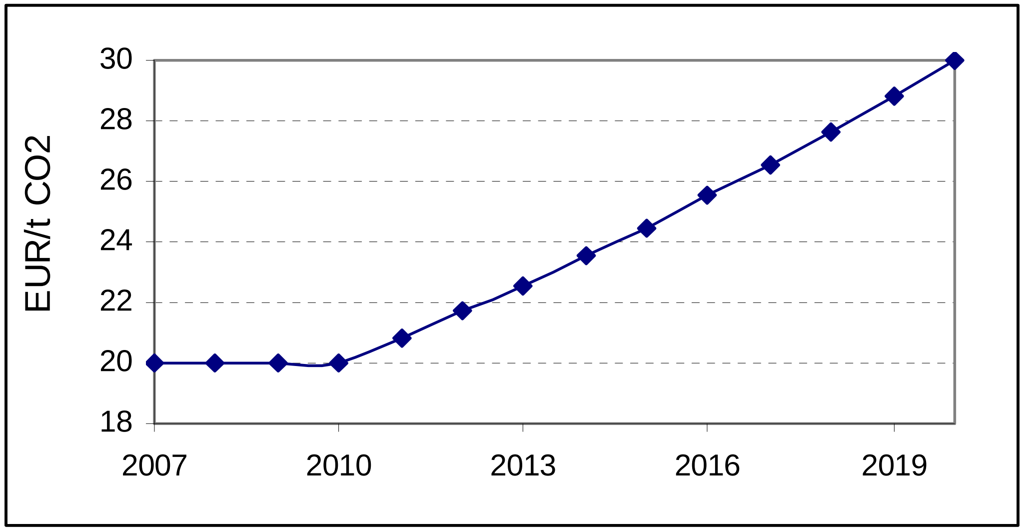
Only small decrease is achievable by these policy measures

Emission trading and impact on CO2 emission level

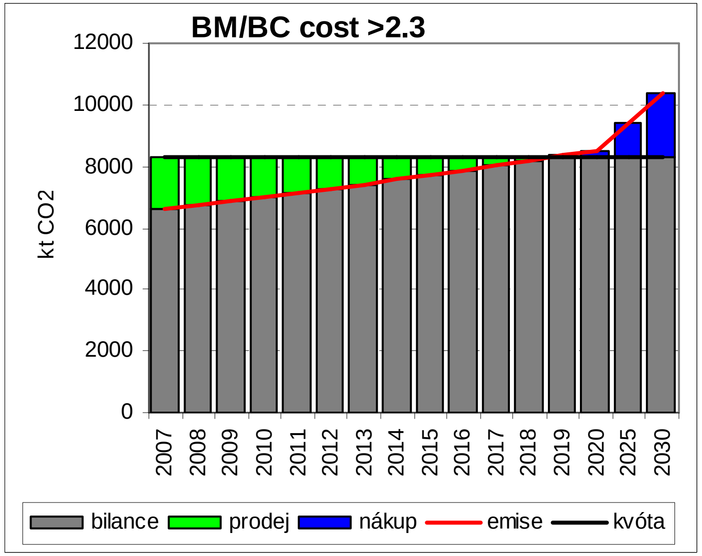
Three factors determining the CO2 emission balance

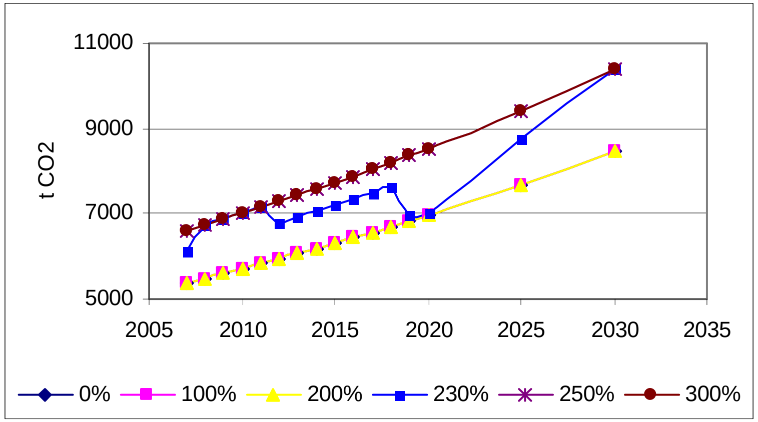
- Emission allowance allocation on individual CHP – NAP of CR
- Allowance price on international/domestic emission market
- Fuel cost relation biomass/coal as main fuel
- Final energy/ heat growth rate

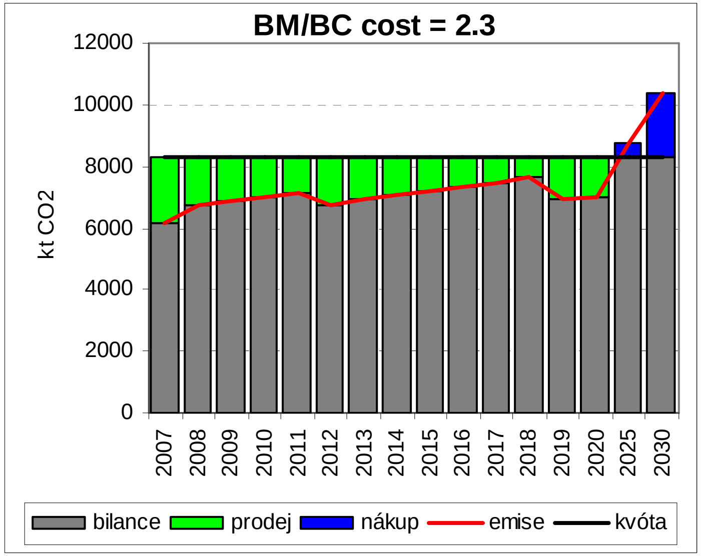
Applied CO2 market cost

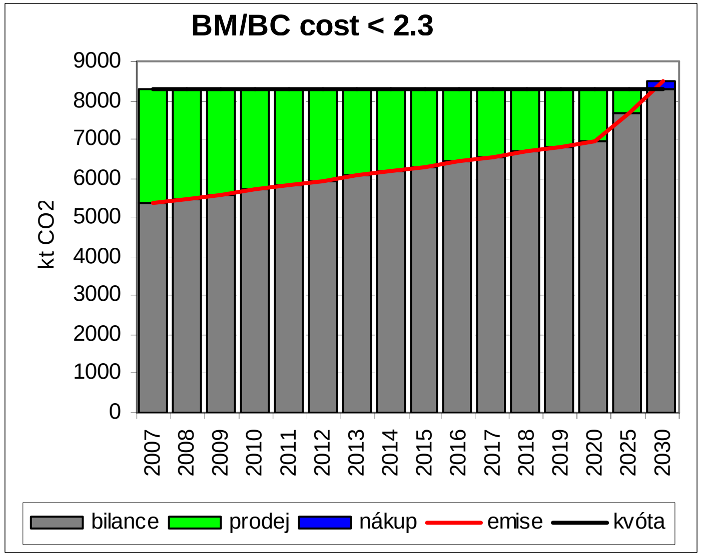


Impact of BM/BC cost on ET and CO2 balance









Application on Czech electricity sector

- Based on 2006 data
- 95 % of Czech el. consumption
- 81 % of el. production in CZ
- Energy Island
- All big heat and nuclear Power Plants
- Aggregated Water PPs – constant production
- Extraction limits of brown coal
- Biomass only as a co-combustion in brown coal PPs (up to 30 %)
- 10 new available technologies
- Desing of energy chain very similar as in the previous Case Study

Scenarios

- Current Legislation (CL):
  - Current payment for SO_2, NO_x, PM and VOC until 2030[1]
  - EU ETS: partly grantfathering for current PPs until 2020

    auctioning for new PPs and after 2020 for all

€2007/tCO2:

2006	2007	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028	2030
15.8	2.0	17.1	19.4	22.2	23.6	25.1	26.3	27.2	28.4	29.7	31.1	32.6	33.8

- Environmental Tax Reform (ETR):

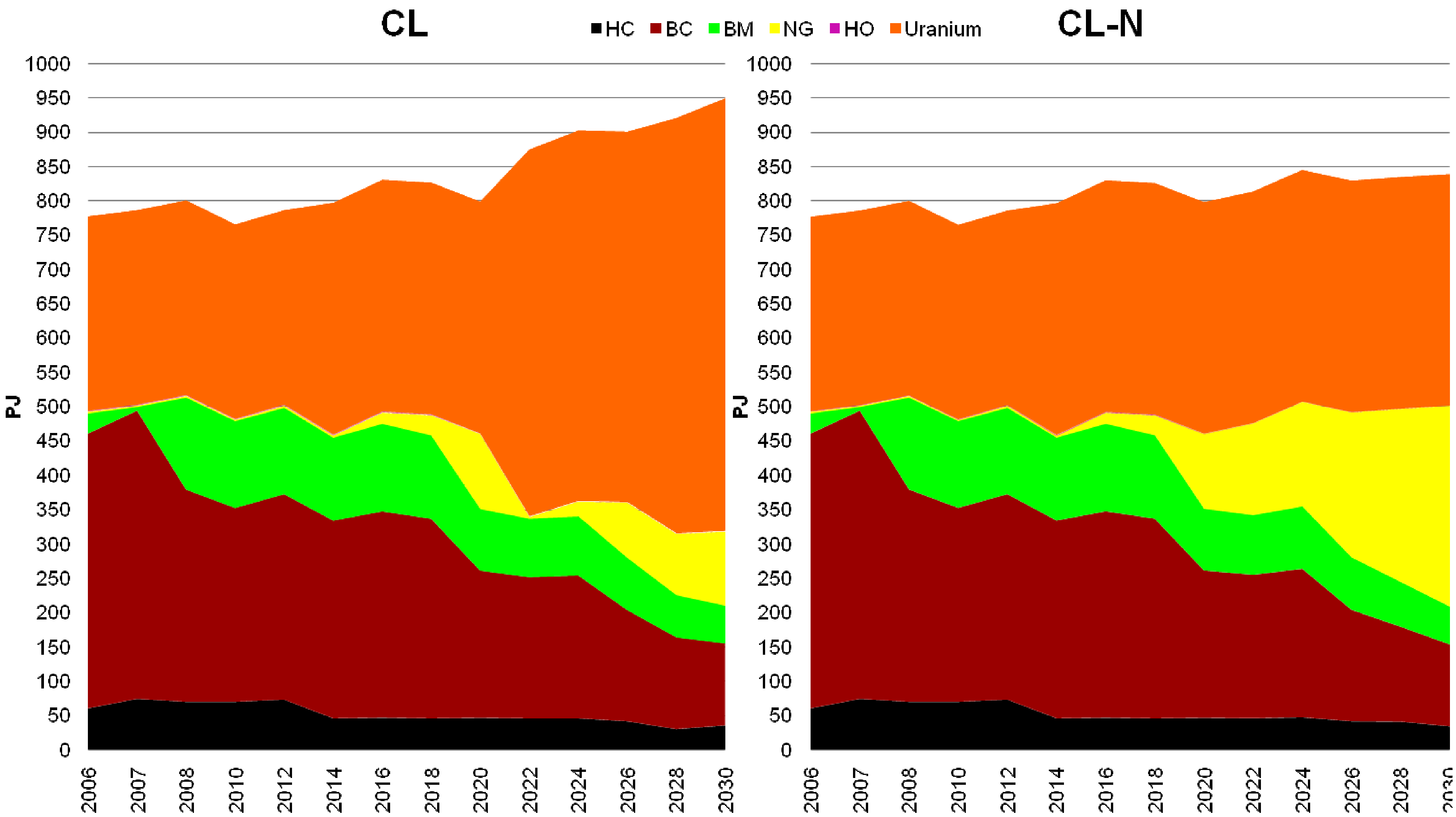
  Payments for polutants in nominal values CZK[1]

	2006- 2009	2010-2015	2016	2017	2018	2019	2020	2021-2030
PM	3 000	4 200	6 300	8 400	10 500	12 600	14 700	29 400
SO2	1 000	1 400	2 100	2 800	3 500	4 200	4 900	9 800
NOx	800	1 100	1 700	2 200	2 800	3 300	3 900	7 800
VOC	2 000	2 800	4 200	5 600	7 000	8 400	9 800	19 600

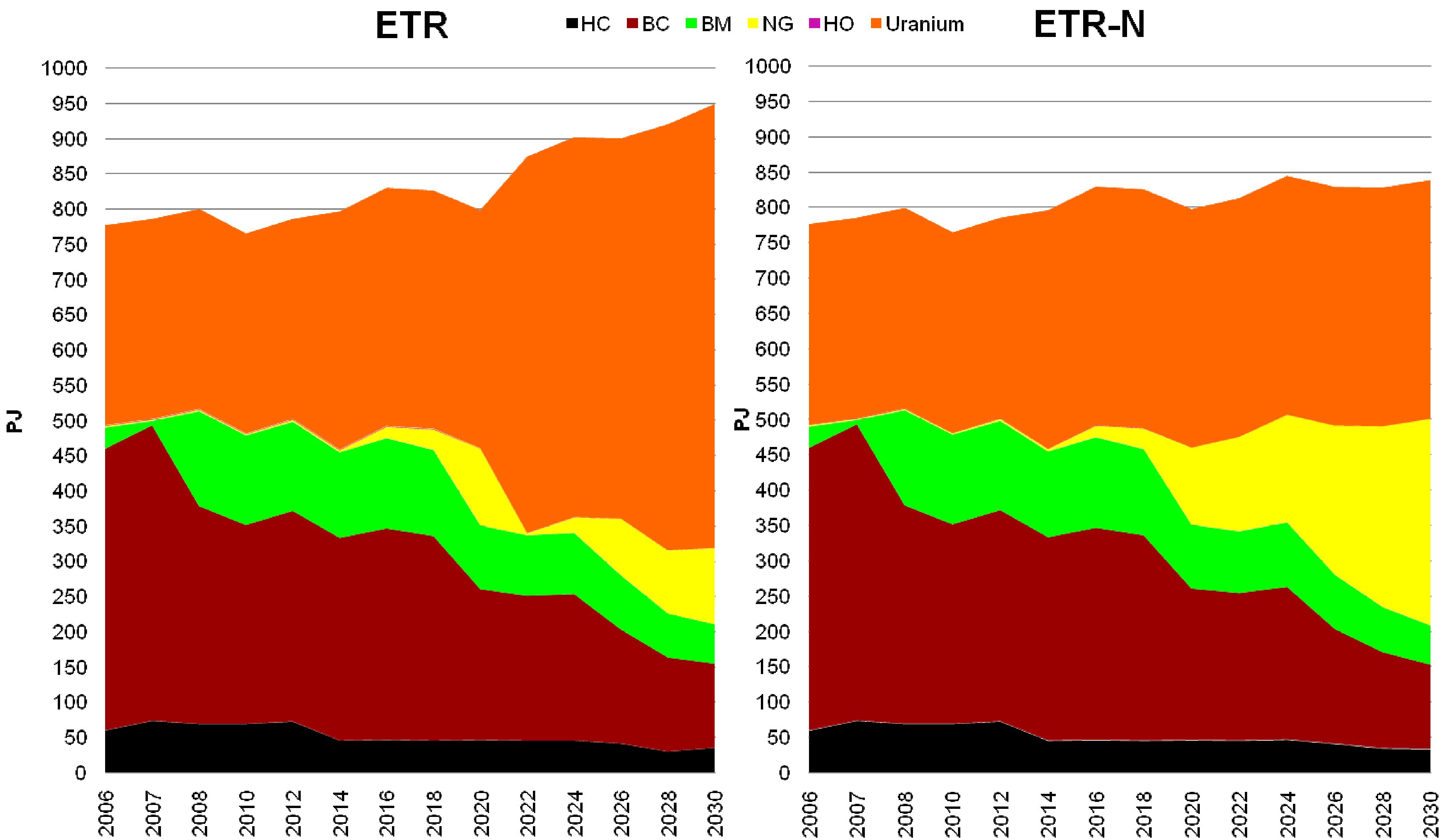
  - EU ETS on the same way as in CL
- Current Legislation without new Nuclear PP(CL-N)
- Environmental Tax Reform without new Nuclear (ETR-N)

[1]In the model used real €2007 with constant exchange rate 25 CZK/€

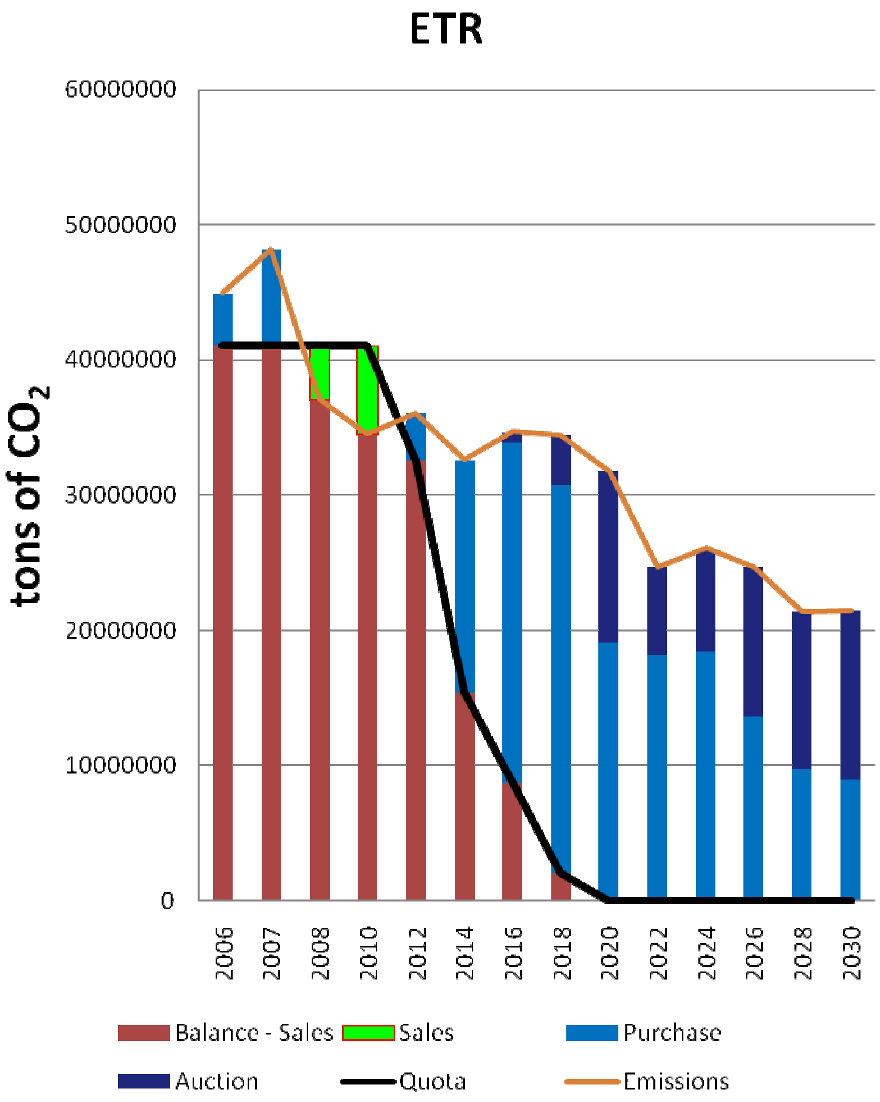
Results – fuelmix (1)

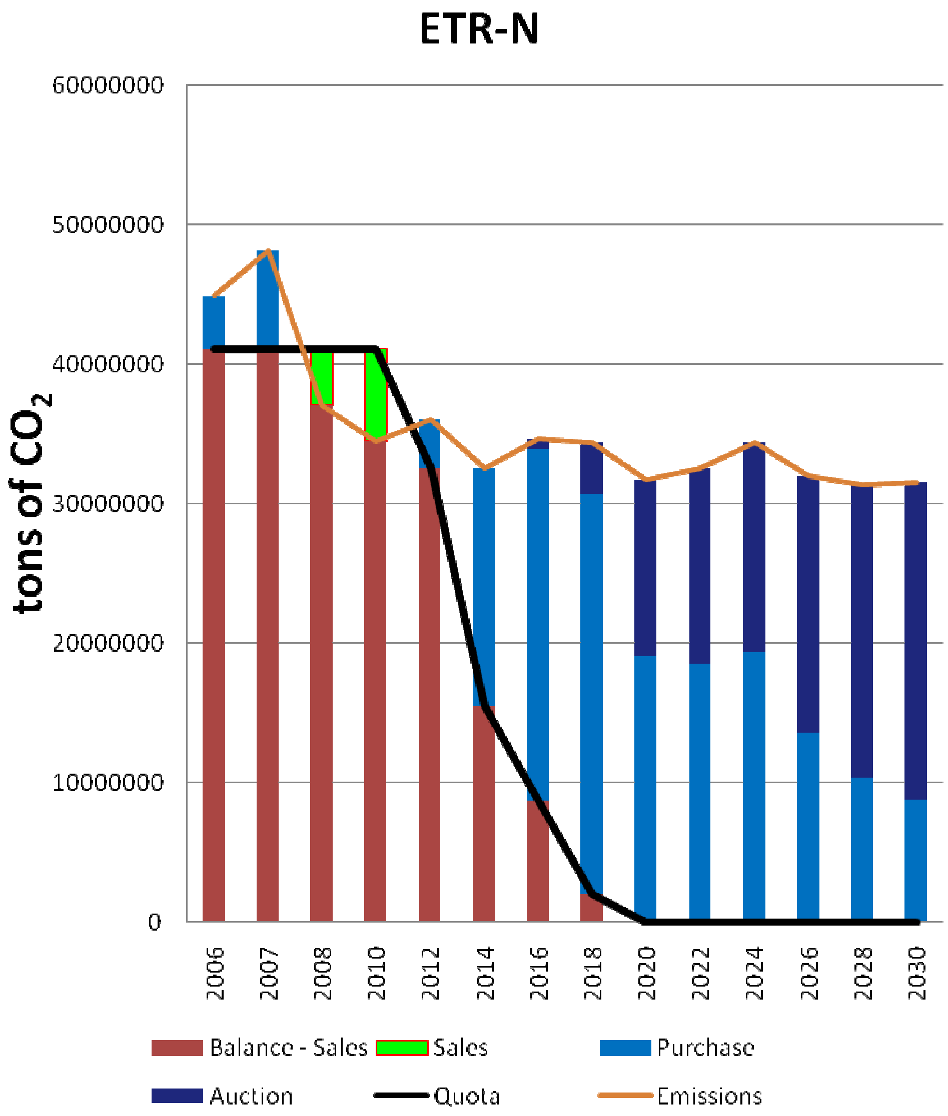


Results – fuelmix (2)

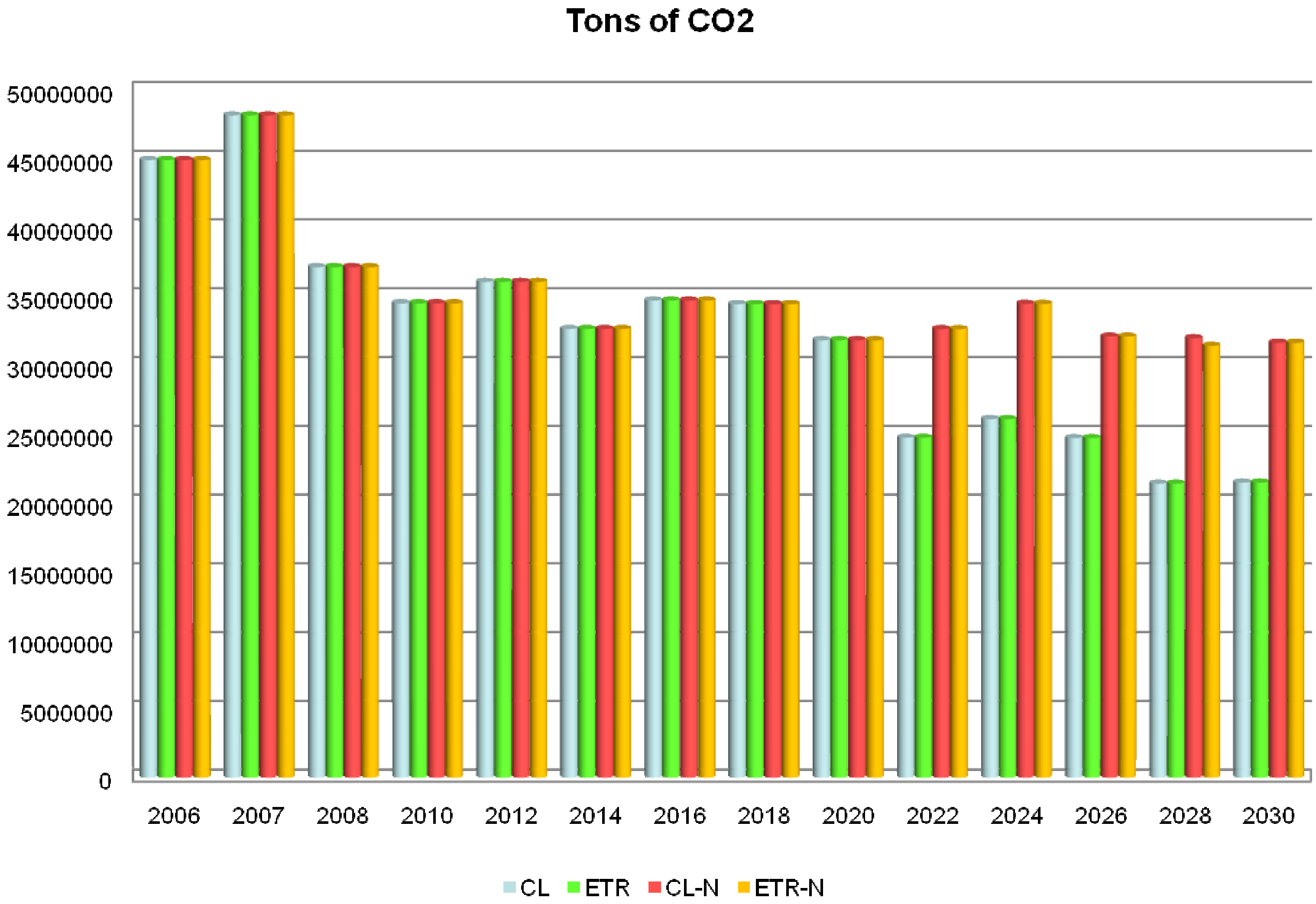


Results – CO2 trade





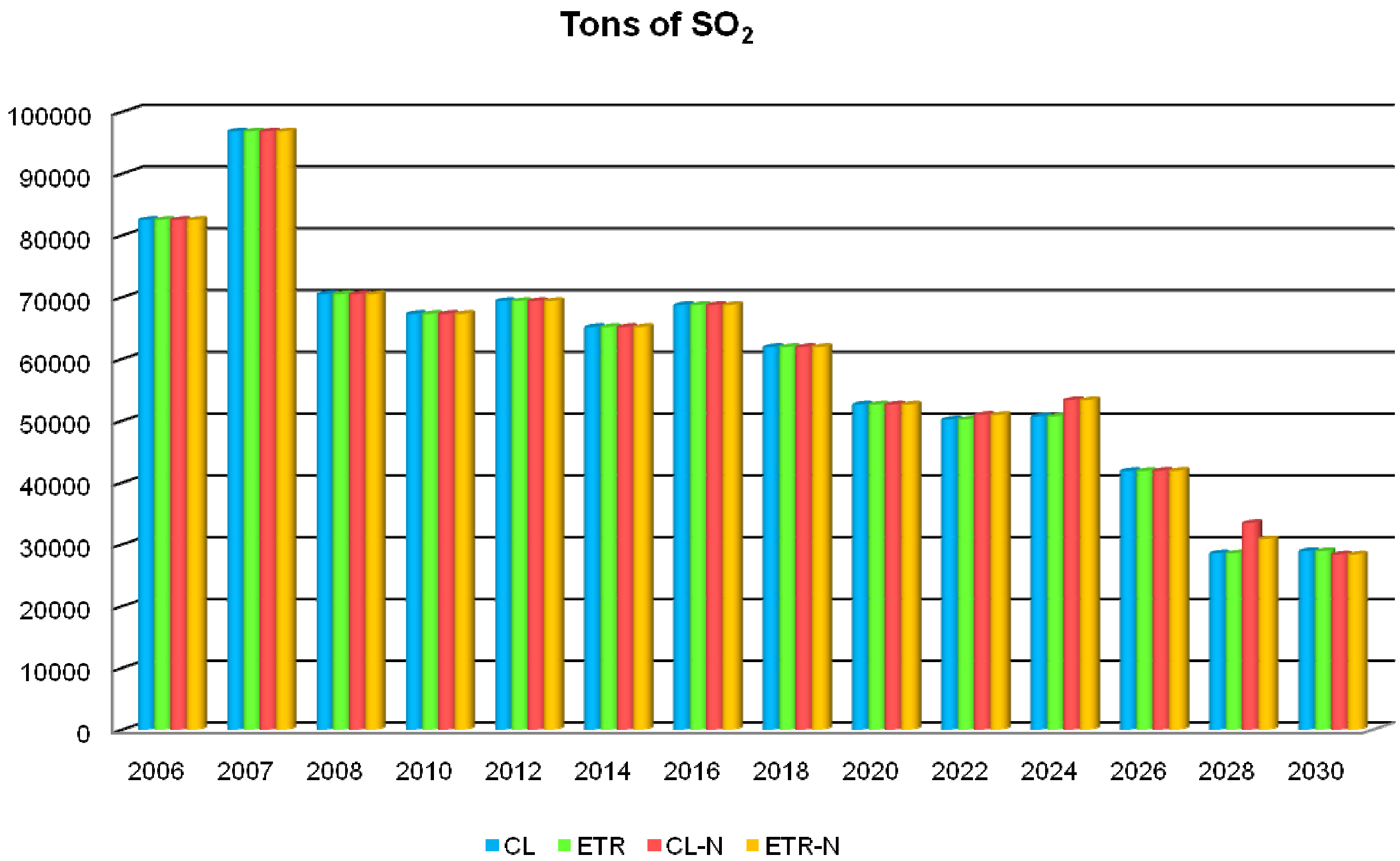
Results – CO_2(1)



Results – CO_2 (2)

	CL	ETR	CL-N	ETR-N	ETR-N/CL-N
2006	100%	100%	100%	100%	100%
2007	100%	100%	100%	100%	100%
2008	100%	100%	100%	100%	100%
2010	100%	100%	100%	100%	100%
2012	100%	100%	100%	100%	100%
2014	100%	100%	**90.698%**	**90.698%**	100%
2016	100%	100%	**93.161%**	**93.161%**	100%
2018	100%	100%	100%	100%	100%
2020	100%	100%	100%	100%	100%
2022	100%	100%	**131.969%**	**131.951%**	**99.9864%**
2024	100%	100%	**132.186%**	**132.186%**	100%
2026	100%	100%	**129.908%**	**129.908%**	100%
2028	100%	**95.51%**	**142.721%**	**140.289%**	**98.2957%**
2030	100%	100%	**149.786%**	**149.786%**	100%
Total	**100%**	**99.7811%**	**108.2440%**	**108.1245%**	**99.8896%**

Results – SO_2(1)



Results – SO_2(2)

	CL	ETR	CL-N	ETR-N	ETR-N/CL-N
2006	100%	100%	100%	100%	100%
2007	100%	100%	100%	100%	100%
2008	100%	100%	100%	100%	100%
2010	100%	100%	100%	100%	100%
2012	100%	100%	100%	100%	100%
2014	100%	100%	100%	100%	100%
2016	100%	100%	100%	100%	100%
2018	100%	100%	100%	100%	100%
2020	100%	100%	100%	100%	100%
2022	100%	100%	**101.52066%**	**101.477479%**	**99.957466%**
2024	100%	100%	**105.18136%**	**105.181364%**	100%
2026	100%	100%	**100.0873%**	**100.087302%**	100%
2028	100%	100%	**117.21785%**	**107.981973%**	**92.120756%**
2030	100%	100%	**98.10523%**	**98.105231%**	100%
Total	100%	100%	100.93314%	100.614947%	99.684750%

Summary

•In our presentation the impact of MESSAGE model as ingeneering oriented one enable to simulate Impact of different measures on the pollutents and GHG emission levels.

•In our presentation the impact of enviromental legislation (emission Concentration limits) as well as impact of ETS and CO2 emission auctioning was demonstrated.

•Impact of ETR was demenstratied for electric sector

•The model enables the sensitivity analysisi in order to analyse the robustness of energy system on the impact of large scele of Environmental and energy policies (share of RES, energy import constarains etc.)