EGTEI

UNECE-Expert Group on Techno-Economic Issues

LCP > 500 MWth

Refineries

Glass production

LCP $\geq$ 500 MWth

- A good example concerning technical discussions which can be promoted within EGTEI
- Synthesis of the Dutch comments and of EGTEI answers

1. The cost figures in the report are within ranges of Dutch figures.
2. The NOx reduction effect of the options is lower than usual.
   If this is put in the RAINS model, the effect will be: higher NO_x reduction costs or/and higher remaining NO_x emissions.

EGTEI comment : EGTEI proposals have to be compared with the current RAINS hypotheses.

EGTEI current proposals :

Control Technology Description	Technology	Abatement efficiency %
HC existing plant	MP	30
BC existing plant	MP	30
HF existing plant	MP	20
Gas existing plant	MP	40
HC new plant	MP	40
BC new plant	MP	40
HF new plant	MP	30
Gas new plant	MP	50
HC existing plant	MP + SCR	82.5
BC existing plant	MP + SCR	82.5
HF existing plant	MP + SCR	80
Gas existing plant	MP + SCR	85
HC new plant	MP + SCR	91
BC new plant	MP + SCR	91
HF new plant	MP + SCR	89.5
Gas new plant	MP + SCR	92.5

The RAINS model proposes often very efficient primary measures (between 50 and 65%) which does not seem realistic as an average especially concerning existing plants (liquid fuels for example).

Secondary measures in the RAINS model increase only slightly the overall performance level (between 15 and 30% for existing plants) which is not realistic at all and lead to very high abatement costs.

On the contrary, EGTEI has tried to set up a logical and realistic approach proposing simple and low cost primary measures which can be combined with secondary measures.

The overall efficiency proposed by EGTEI is for example often higher and never lower concerning existing plants than the current RAINS hypotheses (best overall efficiency 80% for all fuels).

RAINS Sector/Technology	Technology abbreviation	Removal efficiency, %
Power plant sector (PP):		
Brown Coal - Combustion modification (CM) – existing plant	**PBCCM**	**65**
Brown Coal - Selective catalytic reduction (SCR) – new plant	**PBCSCR**	**80**
Brown Coal - CM + SCR – existing plant	**PBCCSC**	**80**
Hard Coal - CM – existing plant	**PHCCM**	**50**
Hard Coal - SCR – new plant	**PHCSCR**	**80**
Hard Coal - CM + SCR – existing plant	**PHCCSC**	**80**
Oil and Gas - CM – existing plant	**POGCM**	**65**
Oil and Gas - SCR – new plant	**POGSCR**	**80**
Oil and Gas - CM + SCR – existing plant	**POGCSC**	**80**

Concerning new plants, there are only slight differences :

Fuel	RAINS overall performance level	EGTEI proposal
BC	93	91
HC	90	91
HF	93	89,5
Gas	93	92,5

which can be easily understood, as the efficiency cannot be for example the same for liquid and gaseous fuels.

3. Upgrading of the SO2 removal efficiency of existing FGD installation is a missing option.
(EGTEI comment : it will have to be considered after implementing in the RAINS model an option allowing to combine the use of low sulphur fuels and scrubbings)

4. Non combustion dust emission from coal storage or fly ash handling at combustion locations looks missing. (EGTEI comment : agreed, but difficult to implement at the moment)

5. The removal effect is missing of particulates from a wet FGD after a deduster
(EGTEI comment : EGTEI has tried to take this aspect into account considering that no additional cost has to be considered from 45 mg/Nm3 to 20 mg/Nm3 if a wet FGD has already been installed (see page 40 – 3.4.3.1))

6. It looks there are no data on gas turbine power plants in this document. Because this is the main new technology, they should be added. To use this in the RAINS model a country could specify the percentage of the gas used in a conventional power plant and in a gas turbine power plant.

(EGTEI comment : the current approach using a specific and identified fuel may be used but EGTEI will examine this technology in the future in order to better take it into account – question to IIASA : will this distinction be possible in the future ?)

7. The data does not give a good overview of the emission reduction options in the total calculation period of RAINS. At this moment, only conventional reduction options are in the report. For use in the RAINS model additional options should be added as well. For the period after 2010 options, which are now in the demonstration phase, are relevant. In addition, improved conventional options with a higher efficiency (and higher cost) should be formulated.

(EGTEI comment : emerging (future) technological options will need to be addressed at a later stage. EGTEI begins with the current state of the art as it is not yet fully accurately described in the RAINS model.

Another group deal with emerging technologies. Its final report will be soon available on the EU DG environment web-site and may be used to improve some modelling aspects.)

8. Total options for NOx reduction in France in 2010 reduce emissions from about 116 kton to 53 kton. A reduction of 55%. This is strange, one would expect a reduction possibility above 80%. If all plants directly use SCR with an efficiency of 80% (which technically can be implemented at almost all places) emissions would be reduced with at least 80% (also MP can be used).

This part of the document is just given to show how the EGTEI approach could be used.

The French power plant sector is very specific (electricity is mainly produced in France by nuclear plants).

Some French plants have low operating hours or will be closed in the near future.

The result is that the Nox emission level can reasonnably be lowered in 2010 only by 54% according to the climate policy scenario.

The situation is different the following years :

2015 (71%),

2020 (84%),

2025 (86,5%)

etc...

Illustrating that the approach but also the control strategy have to be discussed in depth............

Example of difficulties encountered: the refinery sector

- Approach:

a full set of data provided by EGTEI concerning SOx, NOx and dust,

sector representatives do not agree with the investment cost concerning SCR for boilers and furnaces

First set of data: EUROGLAS Hombourg

Euroglas Hombourg - new plant, no retrofit

Fuel : Natural Gas

Capacity: 59 MWth

SCR

Gas flow rate = 60 000 Nm^3/h
Raw gas temperature = 400°C

Abatement efficiency: 75%
Catalyst volume: 5 m^3 (calculated)
Investissement: 1300 kEuros

Clean gas temperature = 370°C

Raw gas concentration: 2000 mg/Nm^3

remark: high concentration because of thermal NOx formation and also NOx formation caused by the presence of nitrogen in the raw material.

Clean gas concentration: 500 mg/Nm^3

Cost per ton of NOx abated: 709 Euros/t NOx abated

Second set of data: Refinery in the Netherlands

Refinery in the Netherlands - new plant, no retrofit

Fuel : Oil

Capacity: 115 MWth

SCR

Abatement efficiency: ?
Catalyst volume: ?
Investissement: 7000 kEuros

Raw gas concentration:
?

Clean gas concentration:
?

Cost per ton of NOx abated: 3200 Euros/t NOx abated (derived from the Cost-Effectiveness curve of CONCAWE paper)

EGTEI proposals for heavy fuel oil combustion

EGTEI Heavy fuel oil

Fuel : Heavy fuel oil

SCR

Capacity: 50 MWth

Abatement efficiency: 85%
Catalyst volume: 7 m³ (calculated)
Investissement: 4150 kEuros (1st case)
2000 kEuros (2nd case)

Raw gas concentration:
420 mg/Nm³

Clean gas concentration:
65 mg/Nm³

Cost per ton of NOx abated: 5321 Euros/t NOx abated (1st case)
Cost per ton of NOx abated: 2868 Euros/t NOx abated (2nd case)

EGTEI proposals for natural gas combustion

EGTEI Natural Gas

Fuel : Gas

Capacity: 50 MWth

SCR

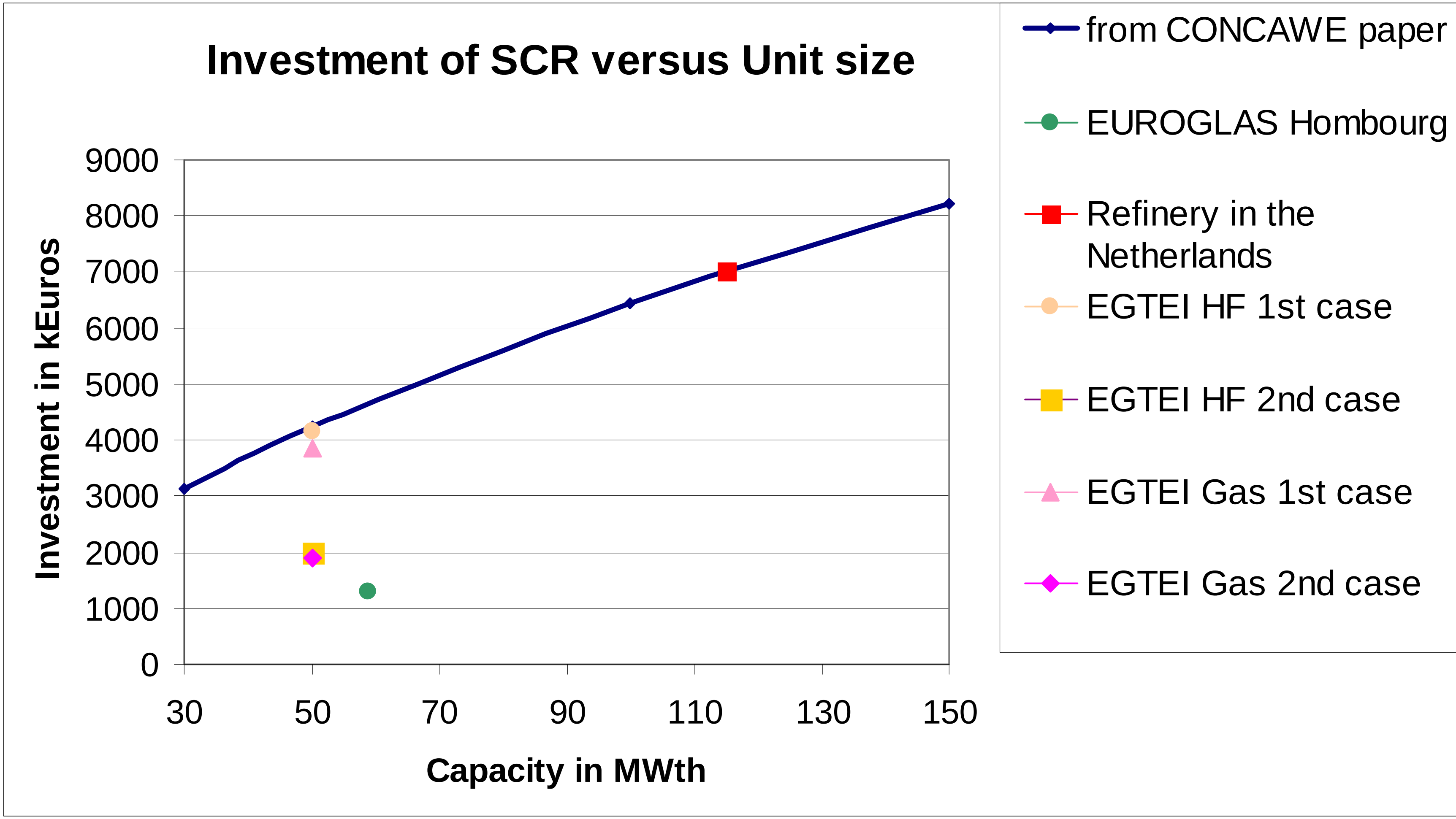
Abatement efficiency: 85%
Catalyst volume: 7 m³ (calculated)
Investissement: 3850 kEuros (1st case)
1900 kEuros (2nd case)

Raw gas concentration: 100 mg/Nm³

Clean gas concentration: 15 mg/Nm³

Cost per ton of NOx abated: 20949 Euros/t NOx abated (1st case)
Cost per ton of NOx abated: 11314 Euros/t NOx abated (2nd case)

Investment of SCR vs Size of Combustion Unit



➡ Which data can be taken into account ?

Procedures to be set up to agree on the incorporation of EGTEI proposals in RAINS

- Illustration with the glass sector

  - Approach finalized in July 2003

  - Information by IIASA in January 2004 that changes in RAINS may only be introduced if input data are collected for all parties...

Recall concerning the glass sector (1)

① Pollutants: SOx, NOx and dust

② Emission factors in kg/tonne of glass

EGTEI	SO_2	NOx	Dust
Gas	2,05	9,55	0,853
Liquid fuels	14,35	9,55	0,853

Recall concerning the glass sector (2)

③ Technical options

		Emission factors	EGTEI	Efficiency	Total efficiency
Sector	Polluant	Unit	Value	%	%
Glass	Dust unabated	kg/t of glass melted	0,725	0,00%	0,00%
	Dust abated	kg/t of glass melted	0,029	96,00%	96,00%
	NOx brut	kg/t of glass melted	8,12	0,00%	0,00%
	NOx MP	kg/t of glass melted	2,9	64,29%	64,29%
	NOx MS	kg/t of glass melted	1,45	50,00%	82,14%
	SO2 gas unabated	kg/t of glass melted	1,74	0,00%	0,00%
	SO2 gas dry scrubbing	kg/t of glass melted	0,87	50,00%	50,00%
	SO2 liquid fuels unabated	kg/t of glass melted	12,2	0,00%	0,00%
	SO2 liquid fuels low S content	kg/t of glass melted	5,2	57,38%	57,38%
	SO2 liquid fuels dry scrubbing	kg/t of glass melted	4,1	21,15%	66,39%

Recall concerning the glass sector (3)

④ Economical assessment

		Technical option	EGTEI Cost in euros	
Sector	Polluant		per tonne of pollutant avoided	Per activity unit
glass	Dust	Dedusting	5204	3,62
	NOx	PM	218	1,15
	NOx	SM	1952	2,83
	SO2	Dry scrubbing liquid fuels	983	1,02
	SO2	Dry scrubbing gas	1384	1,20

Recall concerning the glass sector (4)

⑤ Use of this tool during the bilateral consultation

Definition of a control strategy

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
Sox HF NOC	55,66	20,40	0,00	0	0	0	0	0	0
Sox HF LSF	44,34	79,60	45,96	0	0	0	0	0	0
Sox HF LSF + dry scrubber	0,00	0,00	54,04	100	100	100	100	100	100
Sox gas NOC	80,89	50,57	42,89	42,89	21,44	0	0	0	0
Sox gas dry scrubber	19,11	49,43	57,11	57,11	78,56	100	100	100	100
NOx NOC	13,51	0,00	0,00	0,00	0	0	0	0	0
NOx PM	86,49	84,27	43,72	43,72	40	40	40	40	40
NOx PM + SM	0,00	15,73	56,28	56,28	60	60	60	60	60
Dust NOC	80,89	50,57	42,89	42,89	21,44	0	0	0	0
Deduster	19,11	49,43	57,11	57,11	78,56	100	100	100	100

Recall concerning the glass sector (5)

⑥ Emission level assessments

Recalculated unabated emissions in kt

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2	38,55	44,93	42,55	45,33	46,47	45,53	46,66	47,83	49,03
NOx	47,58	52,42	57,26	62,11	63,67	65,26	66,89	68,56	70,28
Poussière	4,25	4,68	5,11	5,55	5,69	5,83	5,97	6,12	6,28

CLE scenario in kt

Année	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2	29,61	25,59	18,50	18,26	17,83	16,73	17,15	17,58	18,02
NOx	21,12	17,25	14,71	15,96	15,93	16,33	16,74	17,16	17,59
Dust	3,47	2,46	2,31	2,51	1,40	0,23	0,24	0,24	0,25

Lowest achievable emission level in kt

Année	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2	29,61	25,59	18,50	16,54	16,96	16,73	17,15	17,58	18,02
NOx	21,12	17,25	14,71	11,12	11,40	11,68	11,98	12,28	12,58
Dust	3,47	2,46	2,31	0,22	0,23	0,23	0,24	0,24	0,25

Recall concerning the glass sector (6)

⑦ Costs assessments

Yearly cost in Meuros between NOC and CLE

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2 liquid fuels low S content	4,71	10,05	11,34	12,00	12,30	11,82	12,11	12,42	12,73
SO2 liquid fuels scrubbing	0,00	0,00	1,69	3,31	3,39	3,26	3,34	3,42	3,51
SO2 gas scrubbing	0,74	1,94	2,87	3,17	4,47	6,07	6,22	6,37	6,53
NOx	5,77	19,40	55,15	59,82	64,78	66,40	68,06	69,76	71,51
Dust	4,06	11,56	14,59	15,83	22,32	29,12	29,85	30,60	31,36
All pollutants	15,27	42,96	83,97	90,83	103,87	113,41	116,25	119,15	122,13
Per tonne of glass in euros	3,07	7,83	14,00	13,96	15,58	16,60	16,60	16,60	16,60

Yearly cost in Meuros between CLE and LAEL

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2 liquid fuels low S content				0,00	0,00	0,00	0,00	0,00	0,00
SO2 liquid fuels scrubbing				0,00	0,00	0,00	0,00	0,00	0,00
SO2 gas scrubbing				2,37	1,21	0,00	0,00	0,00	0,00
NOx				39,71	37,24	38,17	39,13	40,10	41,11
Dust				11,89	6,09	0,00	0,00	0,00	0,00
All pollutants				53,97	44,55	38,17	39,13	40,10	41,11
Per tonne of glass in euros				8,30	6,68	5,59	5,59	5,59	5,59

New user friendly framework

Input data per year	Germany	France
Gas consumption for the sector [TJ]	42469	28974
Liquid fuel consumption for the sector [TJ]	10450	18148
Amount of glass melted for the whole sector [t]	8693103	5902466
E_{NOx} Emission of NOx [t]	18113	14285
E_{SOx} Emission of SO2 [t]	14537	12416
E_{dust} Emission of dust [t]	397	2309

Application rates NOx - 2000		
Technology	**Germany**	**France**
None	**0**	**0**
Primary measures	**100**	**100**
Primary and secondary measures	**56,3**	**33,09**

Differences between EGTEI and IIASA assessments – Case of France

Difference **In kt**

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2	9,91	11,34	11,28	12,09	12,40	12,35	12,66	12,98	13,30
NOx	7,38	8,09	8,94	9,71	9,95	10,24	10,49	10,75	11,02
Dust	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03

%

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030
SO2	251%	241%	267%	271%	271%	281%	281%	281%	281%
NOx	659%	636%	695%	702%	702%	721%	721%	721%	721%
Dust	15%	15%	15%	15%	15%	15%	15%	15%	15%

Discussion between EGTEI and IIASA (1)

- Data collection

- Changes in RAINS

(Austrian study – Presented in December 2004)

- Pb with the unabated emission factor
  - in the Austrian study : 600 mg/Nm^3 instead of 250 mg/Nm^3 (EGTEI)
- the investment cost
  - (6 000 000 ATS or 436 000 euros) for a container glass furnace of 350 t/day may be underestimated in the Austrian study.
  - To check this aspect, the BREF document about the glass industry may be examined.

    Table 4.3 page 134 (Berkeens reference) indicates that the investment cost for an EP installed on a 300 t/day container glass furnace is 1 420 000 euros.
  - Italian container glass furnace of 325 t/day.

  Investment cost in 1997 for an EP was 1 100 000 euros.

  . EGTEI proposal (furnace of 170 t/day – Investment cost for the deduster : 900 000 euros)

Discussion between EGTEI and IIASA (2)

- As a conclusion, EGTEI does not see clearly why the Austrian study should be considered with more confidence than the EGTEI proposals.

- A procedure may be usefull to discuss EGTEI proposals and RAINS changes...... and how to collect for all parties the relevant input data (6 per year for this specific sector)