INSTITUTE FOR CHEMICAL PROCESSING OF COAL

1955-2015

7th Clean Coal Technologies Conference

18th May 2015

Advanced CO_2 Capture Pilot Plant at Tauron's coal-fired Power Plant in Jaworzno

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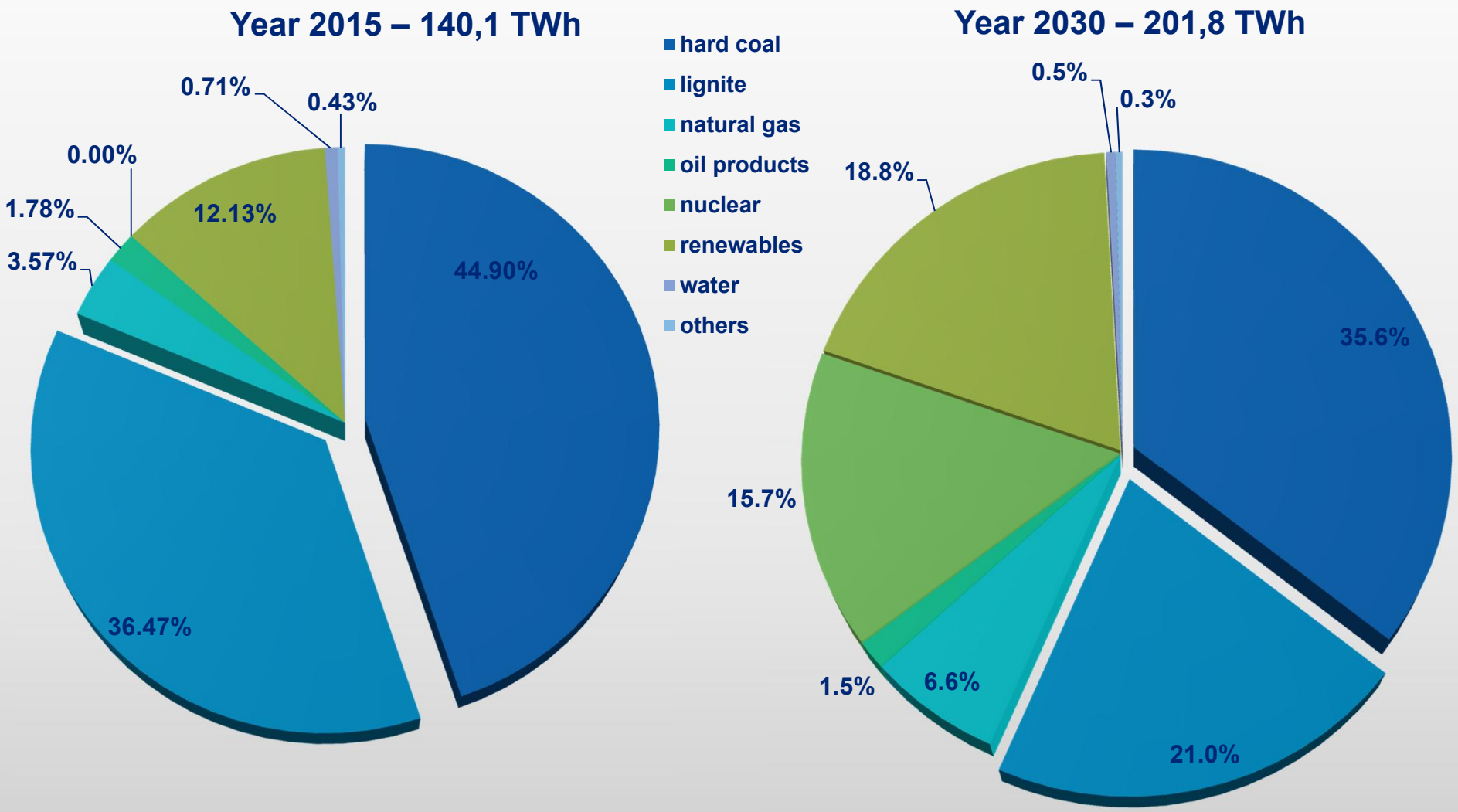
Fuel mix in power generation - Poland

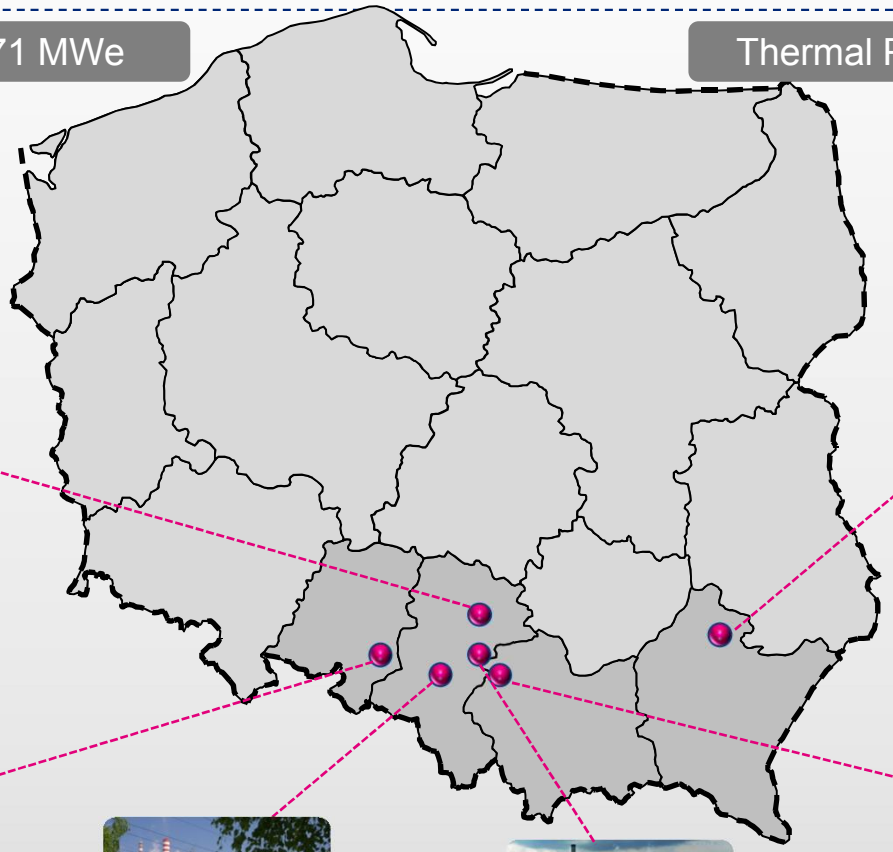


* „Energy Policy of Poland until 2030" (Ministry of Economy2009)

About TAURON Group – electric facilities

Electric Power– 4 671 MWe

Thermal Power– 1 667,1 MWt



Łagisza Power Plant

- 850 MWe
- 343,4 MWt

Stalowa Wola Power Plant

- 330 MWe
- 465,9 MWt

Blachownia Power Plant

- 165 MWe
- 256 MWt

Siersza Power Plant

- 666 MWe
- 36,5 MWt

Łaziska Power Plant

- 1 155 MWe
- 196 MWt

Jaworzno Power Plant

- 1 535 MWe
- 369,3 MWt

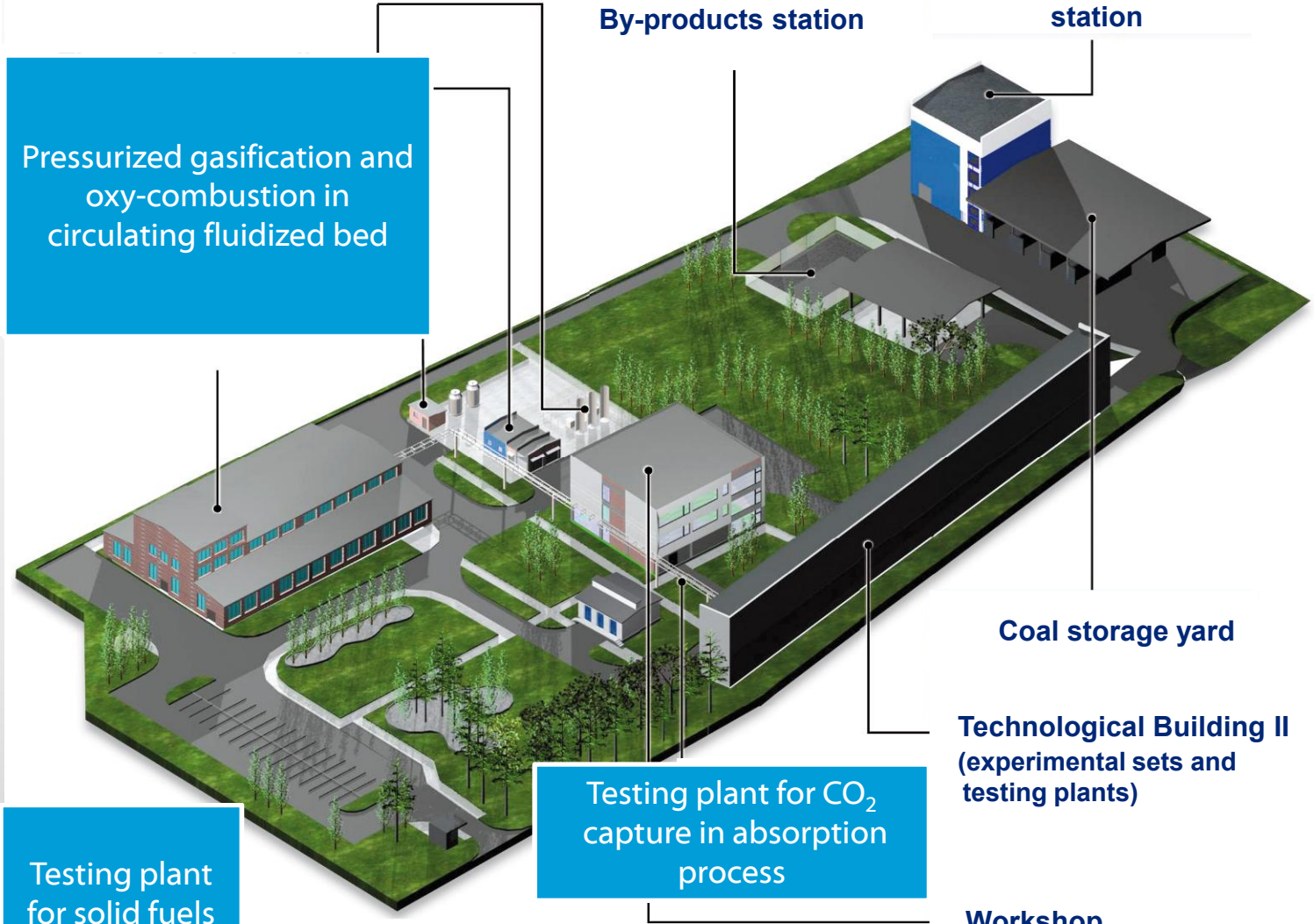
CCT
CENTRUM CZYSTYCH TECHNOLOGII WĘGLOWYCH
GIG

Clean Coal Technology Centre in Zabrze (Upper Silesia, Poland)

Zabrze

Pressurized gasification and oxy-combustion in circulating fluidized bed

Testing plant for solid fuels gasification



By-products station

Coal preparation station

Coal storage yard

Technological Building II
(experimental sets and testing plants)

Testing plant for CO_2 capture in absorption process

Workshop

General information

- **Project name:**
  Development of a technology for highly efficient zero-emission coal-fired power units integrated with CO_2 capture.

- **Objective:**
  The main purpose of the project was to demonstrate the post combustion pilot plant proces in conjunction with coal-fired power plant.

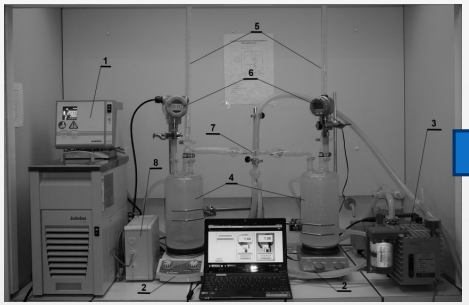
- **Principal:**
  National Research and Development Center (Poland)

- **Project duration:**
  1.04.2010 – 30.11.2015 (67 months)

- **Executors:**
  TAURON Polish Energy, TAURON Production, Institute for Chemical Processing of Coal (**ICPC**)

ICPC CO_2 capture process scale-up strategy

Experimental apparatus of CO_2 absorption kinetics and equilibriums in amine blends (2010)



Poster sesion
Monday 17.00-18.30

Lab stand for CO_2 capture process – 5 m^3/h (2011)

PDU for CO_2 capture process – 100 m^3/h (2012-ICPC Zabrze)

Post-combustion capture sesion
Monday 15.30-16.50

The Mobile Pilot Plant – 200 m^3/h (2013-Tauron Power Plant)

Pilot plant deployment - Jaworzno Power Plant – 04.2014

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The Pilot Plant commissioning–05.2014 Jaworzno Power Plant (TAURON)

Column diameter:	300 mm
Column height:	15,0 m
Number of devices:	40
Measurements:	180 points
Solvent:	amines solution
Solvent stream:	up to1600 dm^3/h
Gas stream:	up to 200 m^3_n/h
Tested gas:	Flue gas from hard–coal boiler

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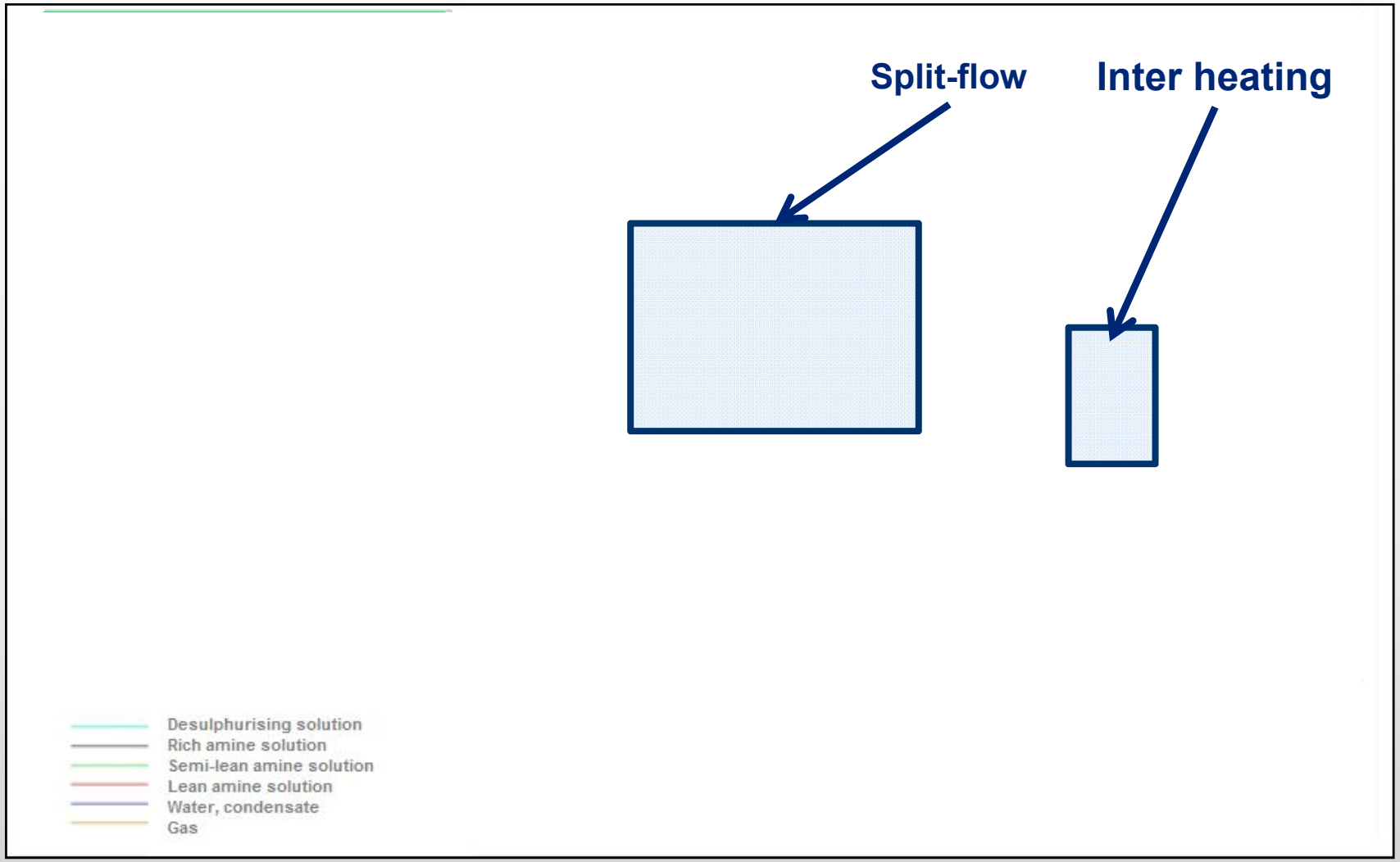
The Pilot Plant simplified flow diagram



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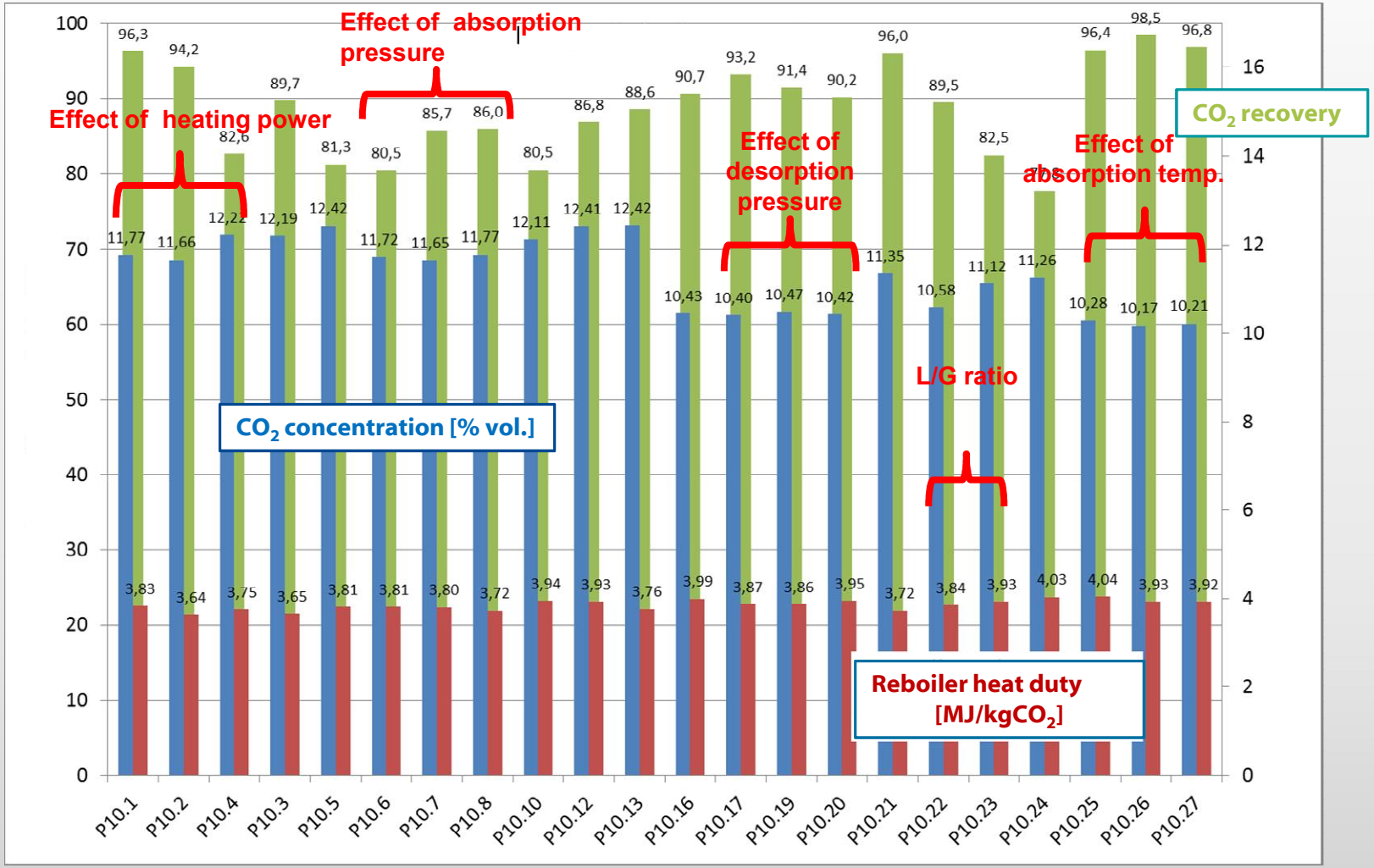
Results and discussion
Nomenclature

Parameter	Description	Unit
CO_2 recovery	Amount of CO_2 captured divided by amount of CO_2 in flue gas Typical values: 80 – 90	%
Reboiler heat duty	Energy delivered to the process divided by amount of CO_2 captured Typical values: 3 – 6	$\frac{\mathrm{MJ}}{\mathrm{kg}_{\mathrm{CO_2}}}$

Results and discussion– selected campaign



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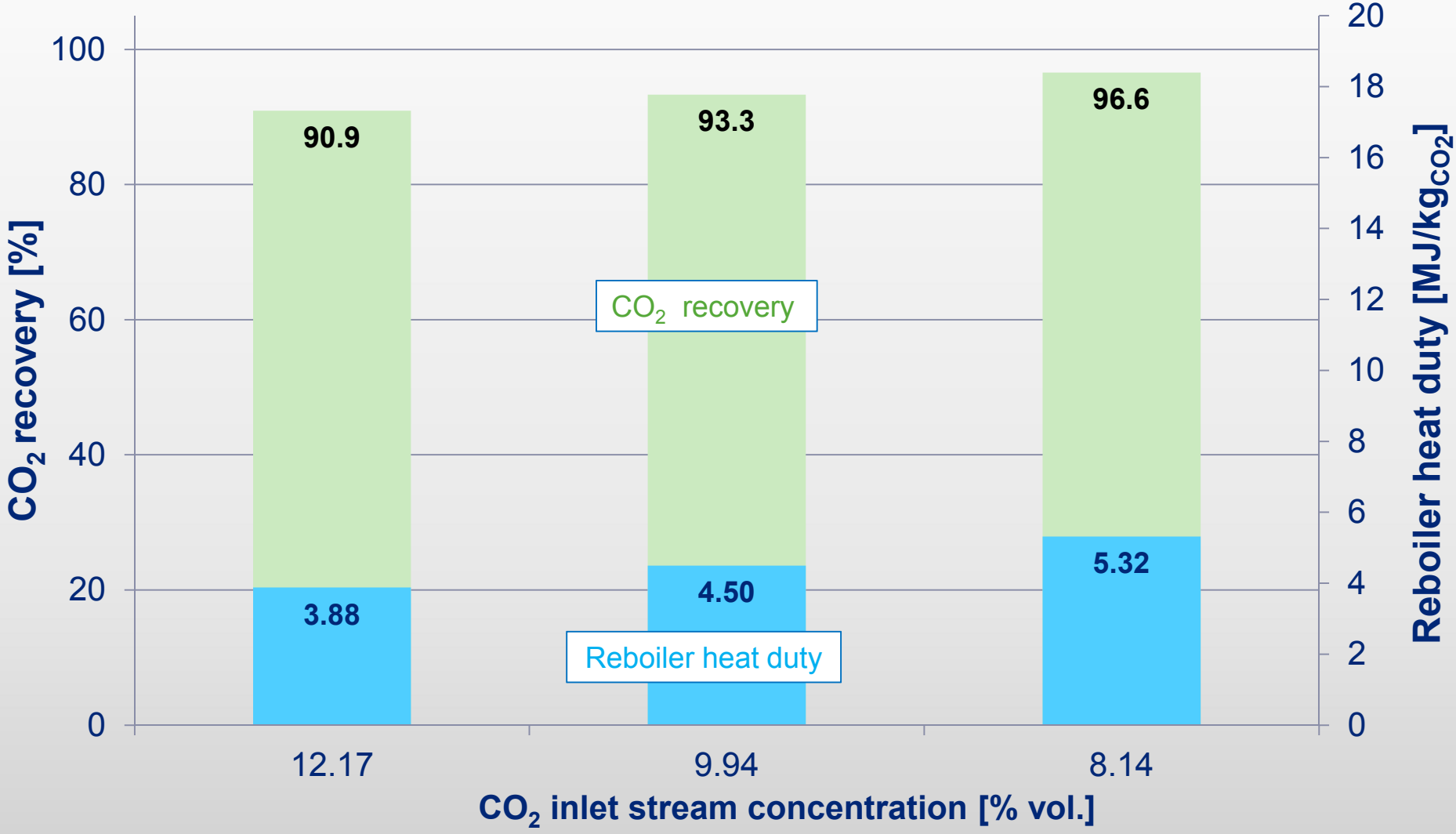
Effect of CO_2 inlet stream concentration on CO_2 recovery and reboiler heat duty



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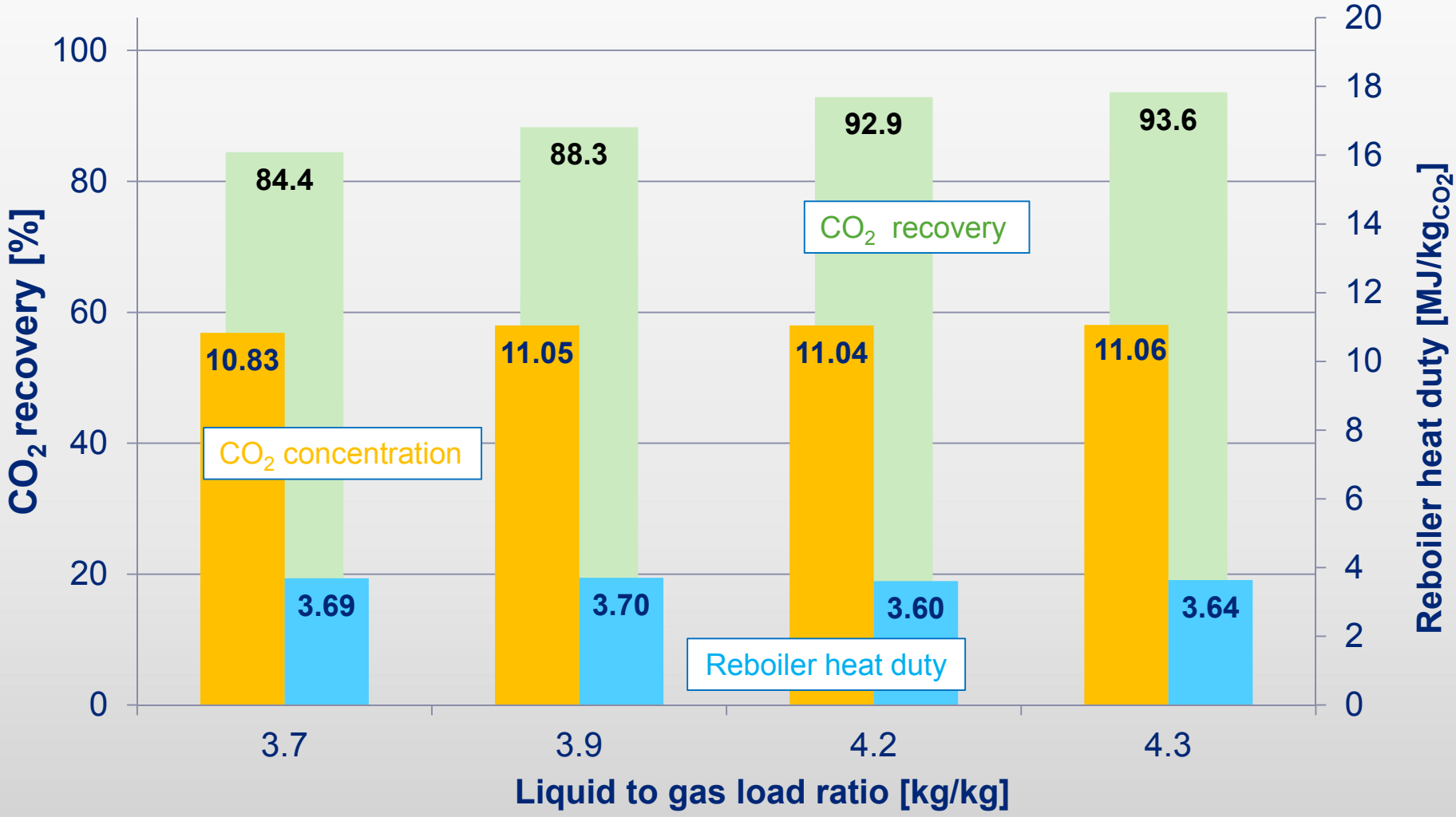
Effect of L/G absorber load ratio on CO_2 recovery and reboiler heat duty



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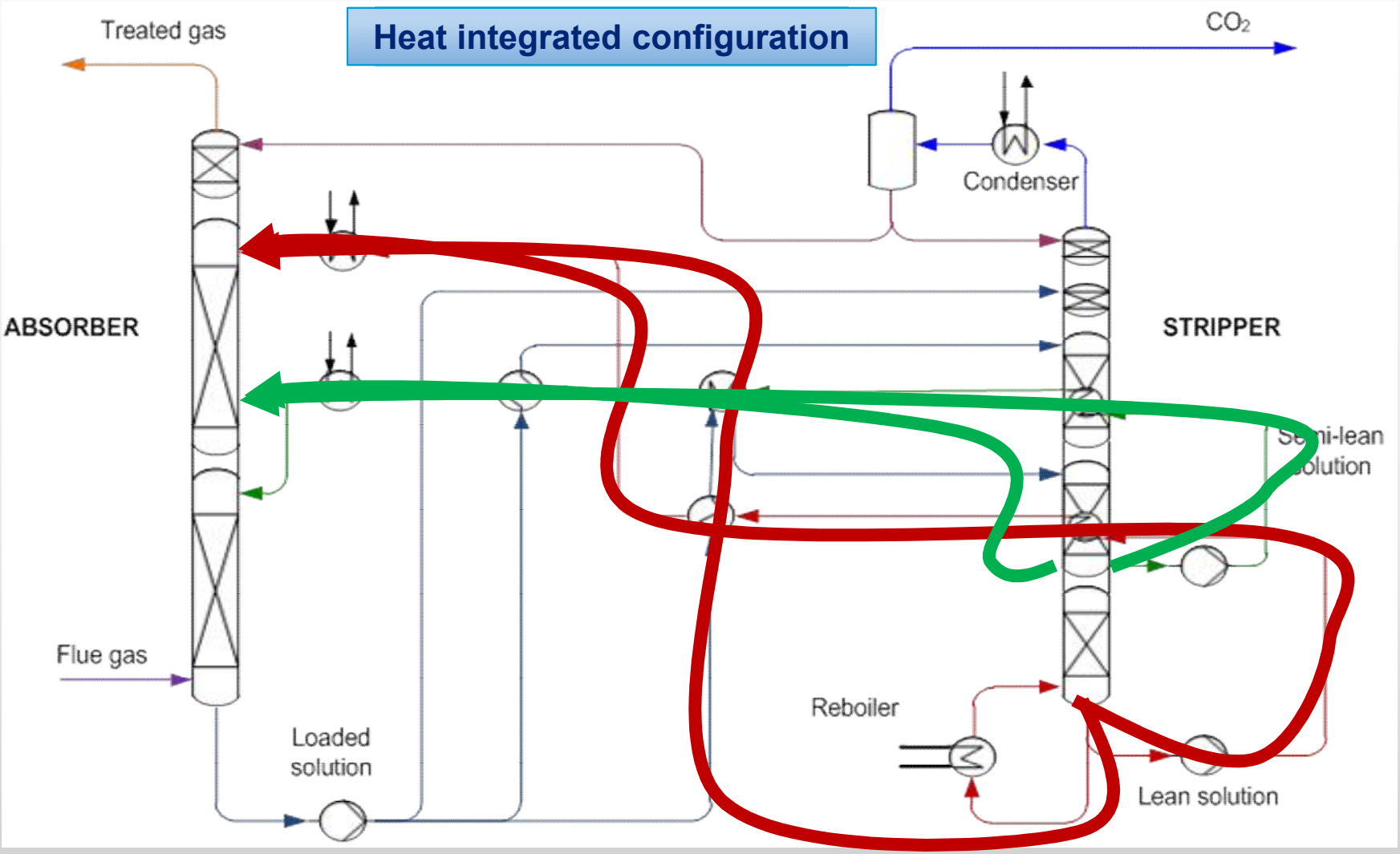
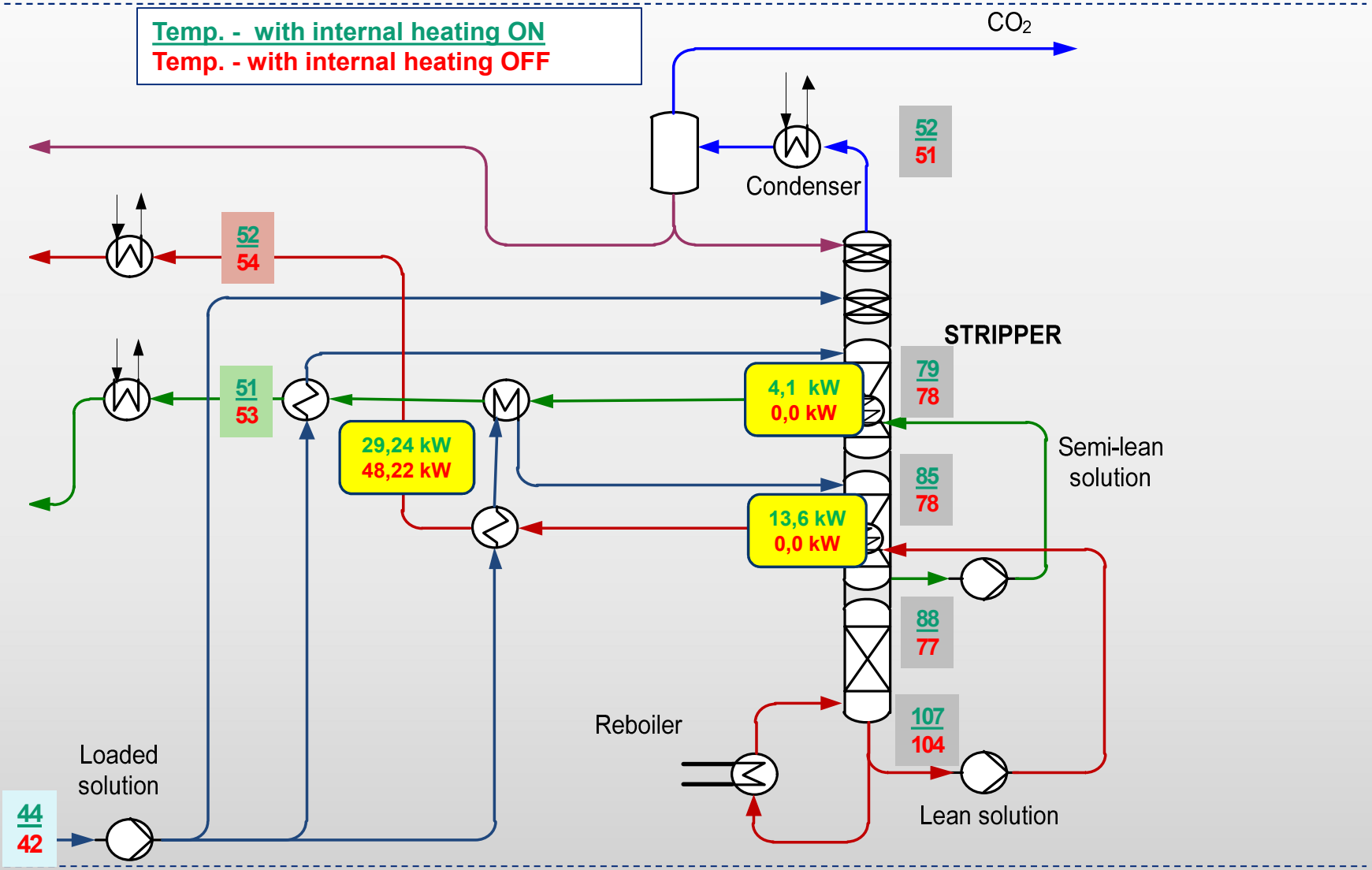
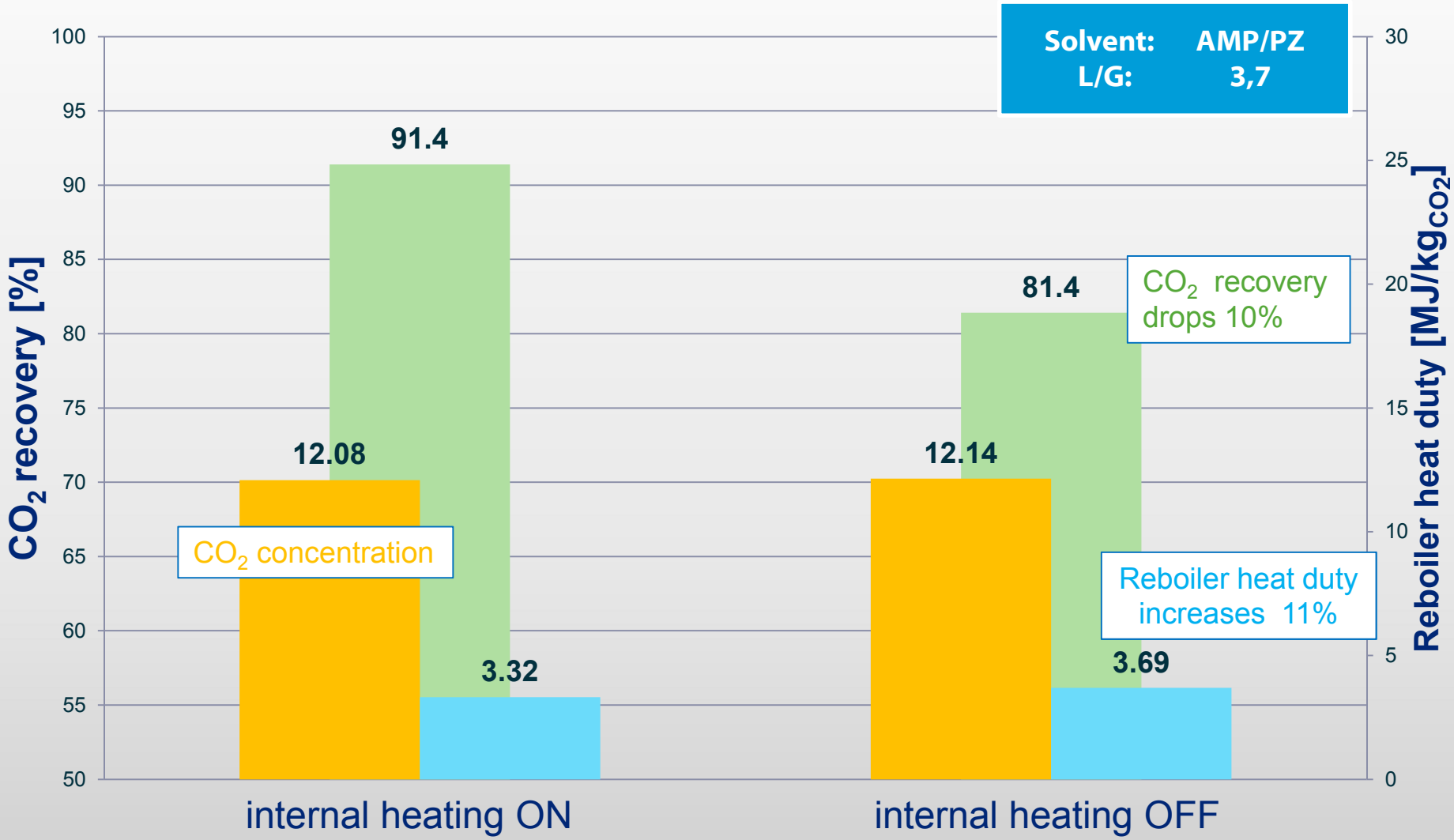
Standard versus advanced configuration



Results - stripper internal heating temperature profile



Effect of regenerator internal heating on CO_2 recovery and reboiler heat duty



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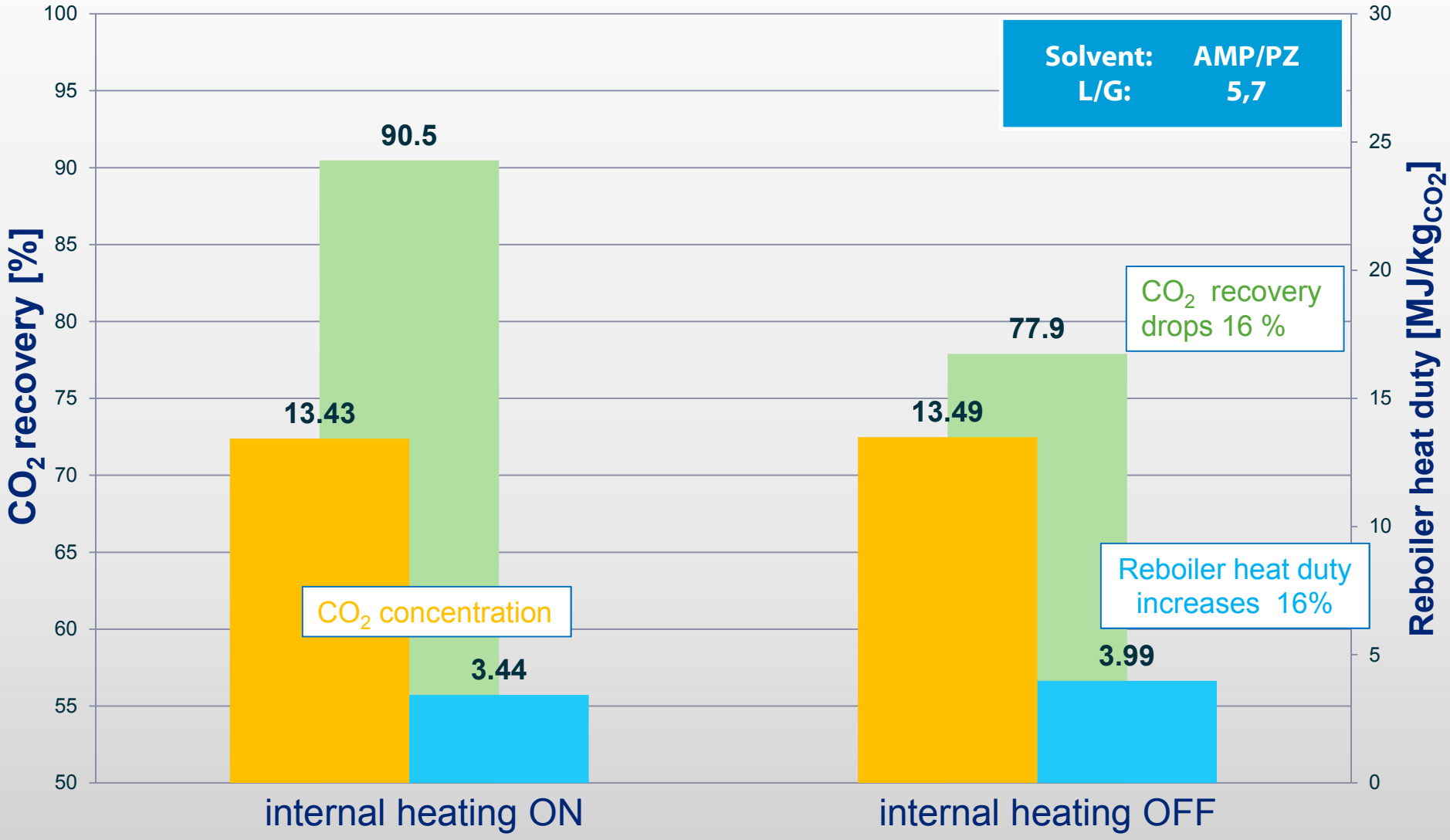
Results - Effect of stripper internal heating on CO_2 recovery and reboiler heat duty



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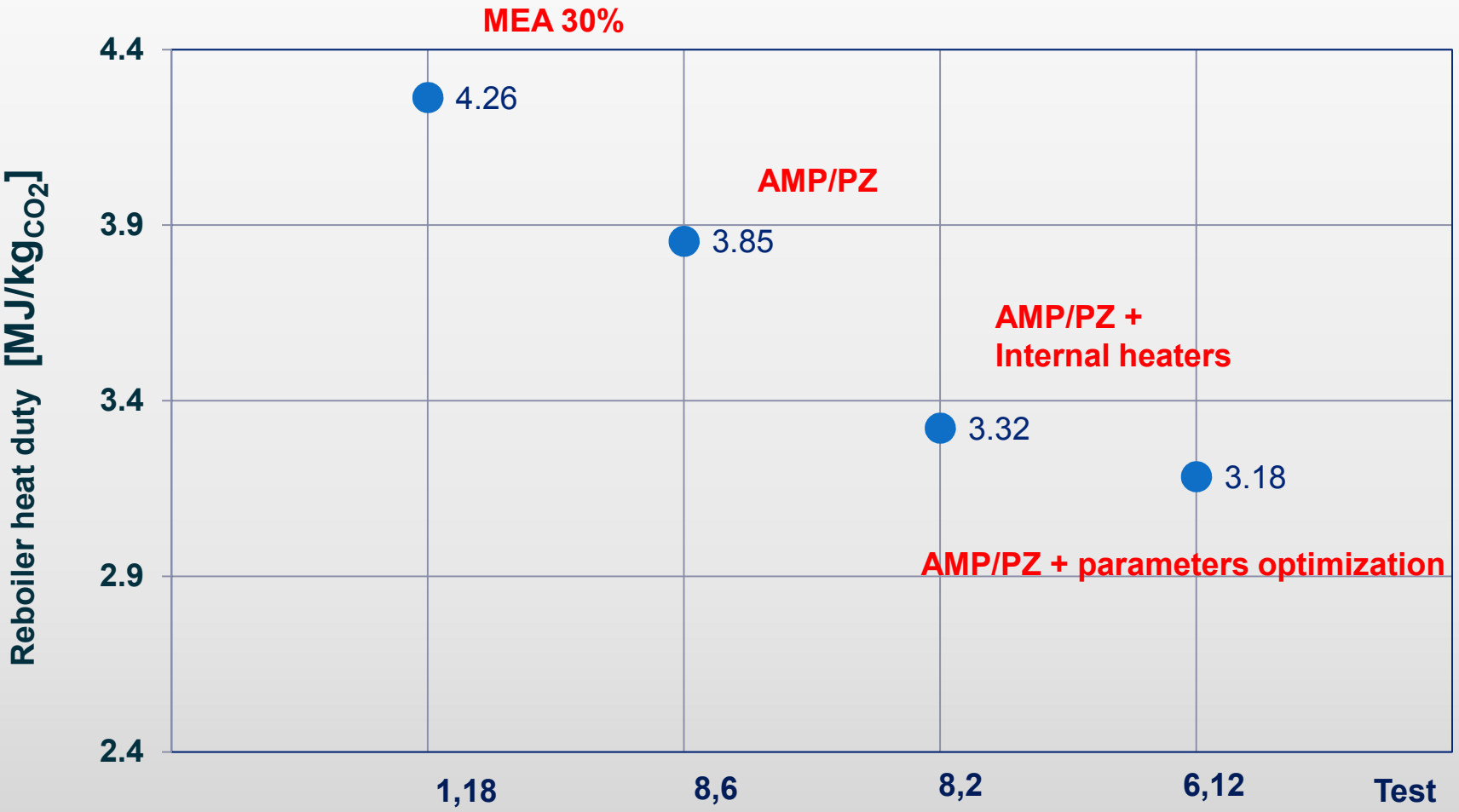
Results - Stripper internal heating influence matrix

Internal heat integration influence tests				
Campaigns	Solvent	L/G (Configuration)	Lean loading reduction [molCO_2/mol amine]	Heat duty reduction [%]
J1	MEA	5,7 (Split-flow)	0,025	11,2
J5	AMP/PZ	5,7 (Split-flow)	0,050	14,0
J8	AMP/PZ	4,0 (Split-flow)	0,054	16,0
J10	AMP/PZ	3,17 (Standard)	0,031	11,6
J13	Multicomponent	4,0 (Split-flow)	0,051	16,0

Results – ICPC reboiler heat duty reduction road map (2011-2014)



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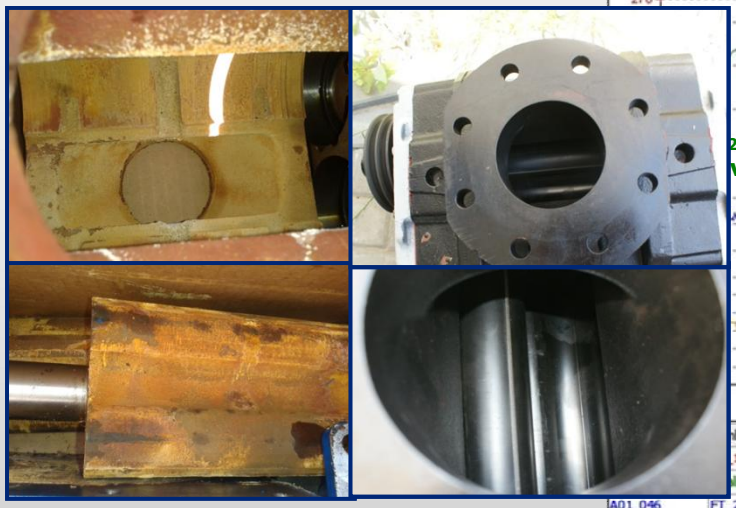
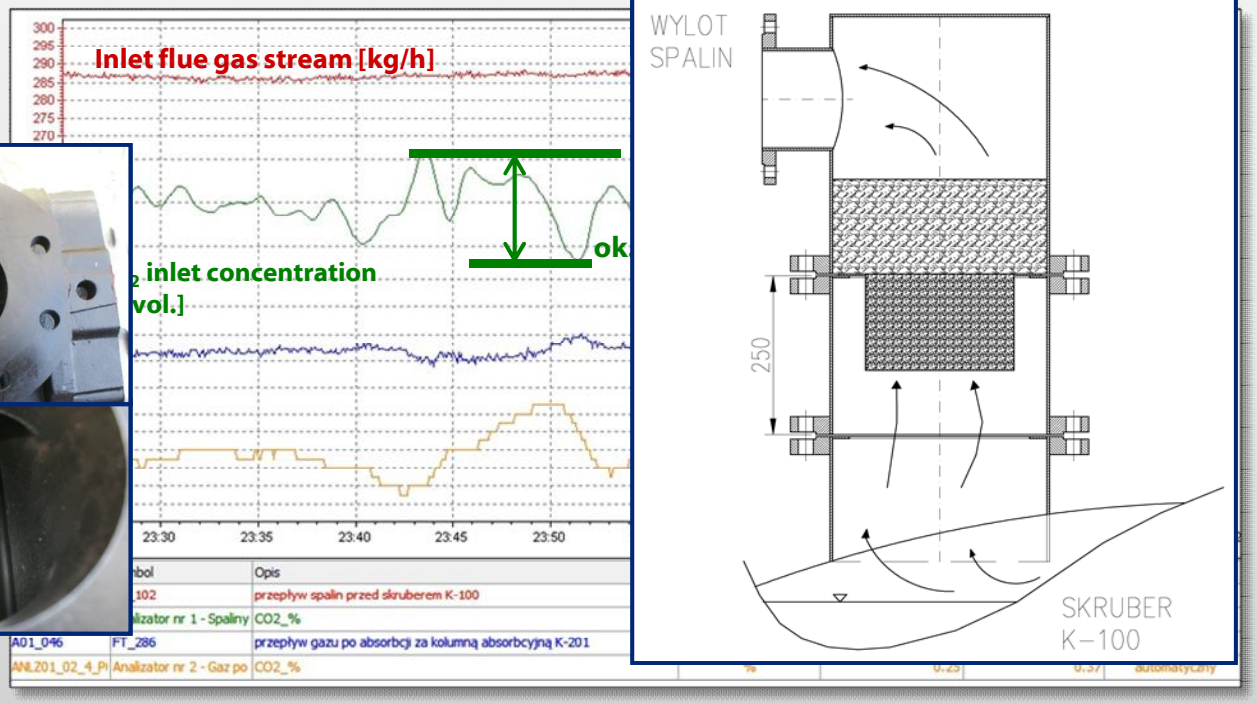
Results - The Pilot Plant operational difficulties

- CO_2 concentration fluctuations in inlet flue gas stream
- Inlet flue gases pipeline drainage
- Additional Venturi scrubber demister due to flue gases moisture
- Rapid corrosion in blower





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Results - Economic anaylsis

The full chain CCS demonstration plant, captures and stores the CO_2 from 250MW (175 tonnes of CO_2/h) of net electricity generation, with 100km CO_2 pipeline, solvent: 30 wt% MEA, CO_2 recovery: ca. 90%

Standard configuration	Advanced configuration
CAPEX: PLN 978.2 M	CAPEX: PLN 1000.3 M
OPEX: PLN 159.7M / year	OPEX: PLN 155.7M / year

How long will it take an advanced CCS plant to pay for itself?

CAPEX difference (PLN 22.1M) will be paid in less then 6 years!

The Pilot Plant research summary

- The pilot plant campaigns successfully demonstrated reliable operation allowing the removal of over 55 000 kg of CO_2 from real flue gas (1400h).
- The energy requirement for solvent regeneration was found about 3,2 MJ/kg$_{CO2}$ with 90% CO_2 removal efficiency .
- Experimental data was presented to verify effectiveness of the modifications which were up to this time presented mainly through modelling.
- Presented modifications resulted in an increase of CO_2 recovery ranging from 10% to 16% while reducing the reboiler heat duty by about 15%.

Parameter	Value
Number of campaigns	23
Number of tests	300
Operation time	1400 h
CO_2 removed	approx. 55 000 kg

TASK No. 1 – „Advanced technologies for energy generation: Development of a technology for highly efficient zero-emission coal-fired power units integrated with CO_2 capture”

Project co-financed by the National Centre of Research and Development in the framework of Contract SP/E/1/67484/10, dated 05 May 2010r.

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”A journey of a thousand miles begins with a single step”

Thank you for attention

- Chinese philosopher Laozi (604 bc - 531 bc)