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Profitable CO_2 capture for urban biomass CHP plants

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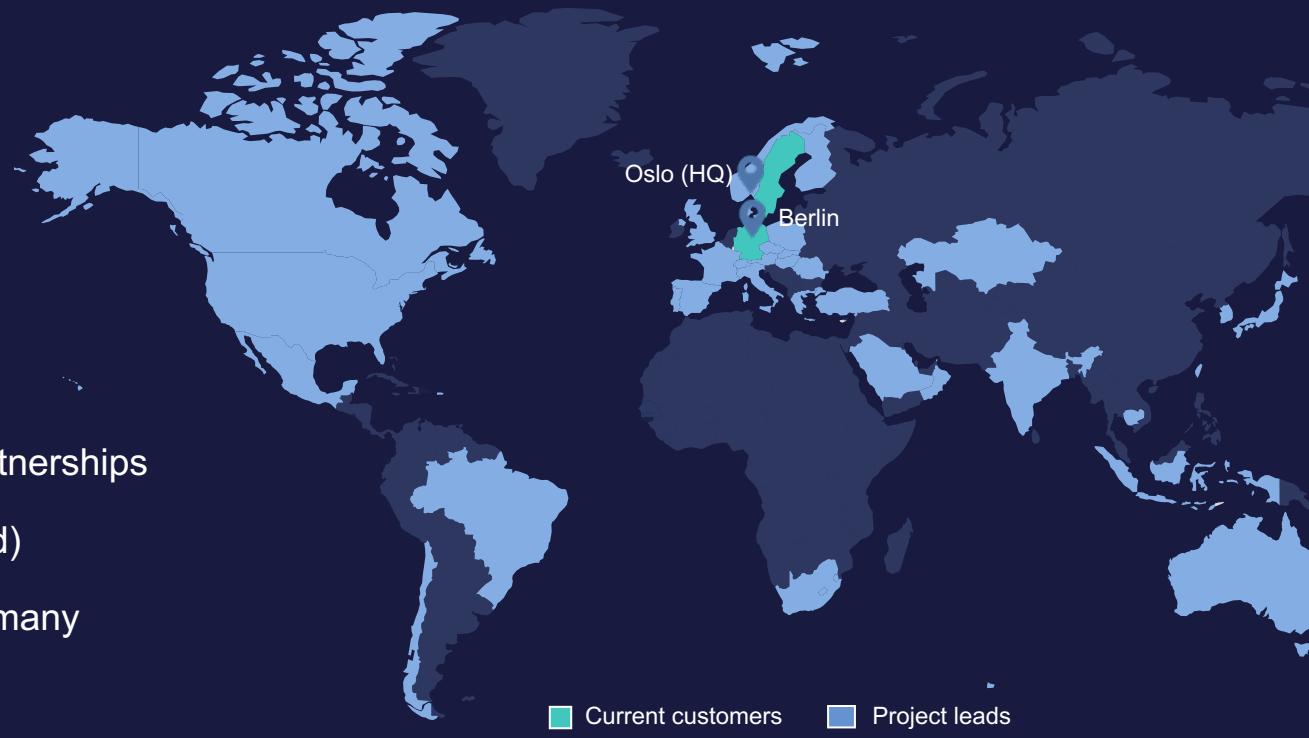
Capsol at a glance

Accelerating the world's transition to a carbon-negative future

- CO_2 capture technology developer and licensor
- Highly competitive carbon capture technology – safe, flexible and cost-efficient
- Based on potassium carbonate as a solvent and applicable to all CO_2-intensive industries worldwide
- Proven solution with 4 000+ operational hours
- Licensing directly to emitters or through global cooperation and partnerships
- Strong patent protection (11 patent families filed, of which 8 granted)
- Headquarter in Oslo/Norway – office recently opened in Berlin/Germany



Initiated	Euronext Growth	Invested	Capture plant efficiency	Capture plant uptime
2003	**CAPSL**	**NOK ~500m**	**90-95%**	**>99%**

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HPC as a solvent

Proven

HPC as an absorbent is thoroughly documented and used in hundreds of existing plants across the world.

Widely available

Potassium carbonate is commonly used in the food industry

Safe

No hazard to environment or people

Low cost

Significantly less expensive than amines

Non-carcinogenic

Captured CO_2 is totally free of degraded (potentially carcinogenic) amines

Oxygen resistant

No oxidative degradation and solvent losses

No vapour pressure

No solvent in absorber clean gas outlet

Focusing on large industries with high CCS potential together with leading partners

Cement

- Largest industrial emitter
- Hard to abate emissions with few or no other alternatives than CCS

Biomass / Bio-Energy CCS

- Increasing need for carbon removal as the world lags path to net zero
- BECCS is considered the most viable carbon removal option

Gas turbines

- Natural gas expected to be the longest-lasting hydrocarbon-based energy production
- CapsolGT® has the potential to significantly reduce capture cost, increasing the CCS opportunity

Energy-from-Waste

- High potential impact by adding CCS to solution that already reduces emissions
- Strong growth outlook for the EfW industry

- Will expand into other industries
- The company has partnered with industry leaders enabling efficient delivery, cost reductions and increased market share

CATACARB
Proven CO_2 Capture Technology

Sumitomo SHI FW

Hitachi Zosen INOVA

SIEMENS energy

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Carbon capture technologies to support all industries based on Hot Potassium Carbonate (HPC)

CapsolGo®
demonstration units

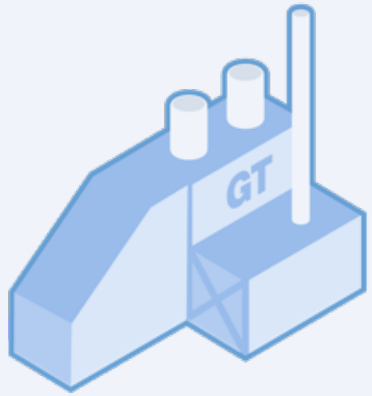
700 tonnes CO_2/year

Mobile carbon capture demonstration unit with an all-inclusive package. Two units currently in operation in Germany.

CapsolEoP ®
(End-of-Pipe)

100 000+ tonnes CO_2/year

A full capture system for large-scale CO_2 emitting industries. First large-scale license agreement for BECCS (bio-energy carbon capture and storage) project in Sweden.



CapsolGT®
for gas turbines

12 000 to 400 000+ tonnes CO_2/year

A carbon capture solution for simple-cycle gas turbines, enabling additional electricity generation. Applicable also when turbines are used for other industrial applications.

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First large-scale project won with Stockholm Exergi

Europe's first large-scale negative emissions plant

- Stockholm Exergi provides power, district heating and cooling.
- The plant will make Stockholm the first carbon neutral capital and is supported with EUR 180 million from the EU Innovation Fund

Capsol Technologies selected as the preferred solution

- Highly competitive economics and ease of EoP retrofit
- Proven technology and safety of HPC compared to amines
- Opportunity to recover heat from the carbon capture process for district heating

800 000
tonnes of CO_2 per year (full-scale deployment)

2026
operations planned to start

EUR 180 million
support from the EU Innovation Fund

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Proven traction with BECCS in Europe and the US

Awarded licensing agreement in Europe's first large-scale negative emissions plant

Stockholm Exergi, Sweden

800 000

tonnes of CO_2 per year
(full-scale deployment)

Capsol awarded technology licensing agreement for CapsolEoP™

Biomass plant, Sweden

~170 000

tonnes of CO_2 per year
(full-scale deployment)

Capsol awarded Front End Engineering Design (FEED) study with Norconsult

United States

~100 000

tonnes of CO_2 per year
(full-scale deployment)

Capsol executed feasibility study in 2022 and awarded pre-FEED study in 2023

Germany

~200 000

tonnes of CO_2 per year
(full-scale deployment)

Capsol awarded CapsolGo® demonstration campaign

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A creative and counterintuitive technology solution

HPC for post combustion CO_2 capture

"The compression problem"

Problem statement:

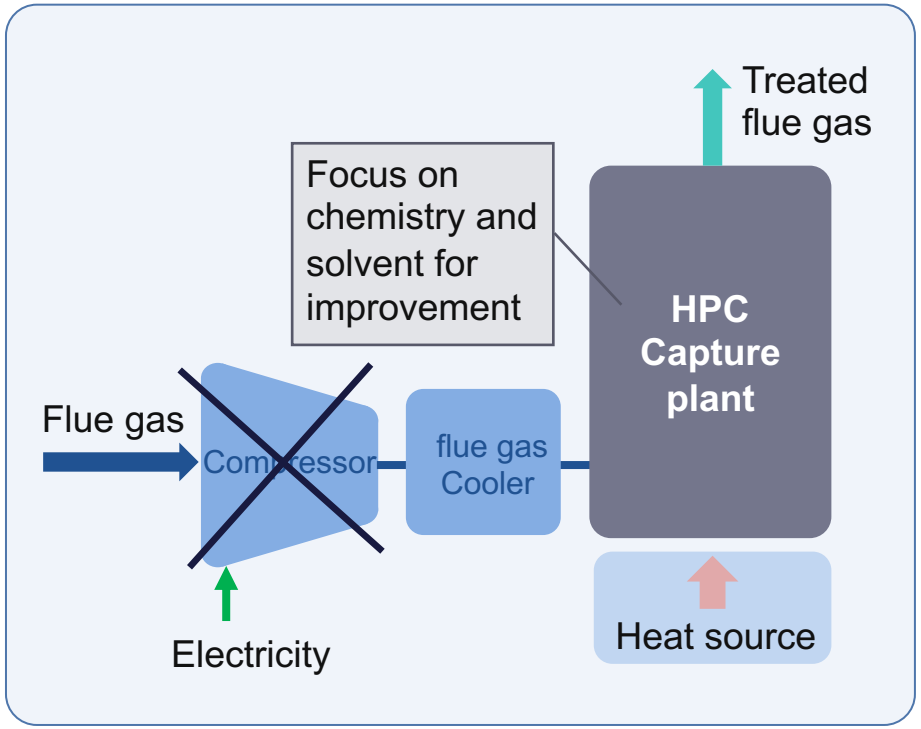
- Traditional HPC CO_2 capture does not work under ambient pressure conditions. Driving forces are too low. You need to compress flue gas to increase CO_2 partial pressure
- Flue gas compression requires large machines that use large amount of energy

Resulting in:

- Traditional HPC CO_2 capture for flue gases is considered too energy intensive

Conventional solutions:

- **Add more promoters**
- **Find new and more effective promoters that will make HPC work at ambient pressure**
- **Choose a different solvent**



The conventional solutions see the flue gas compression as a problem and will try to avoid it.

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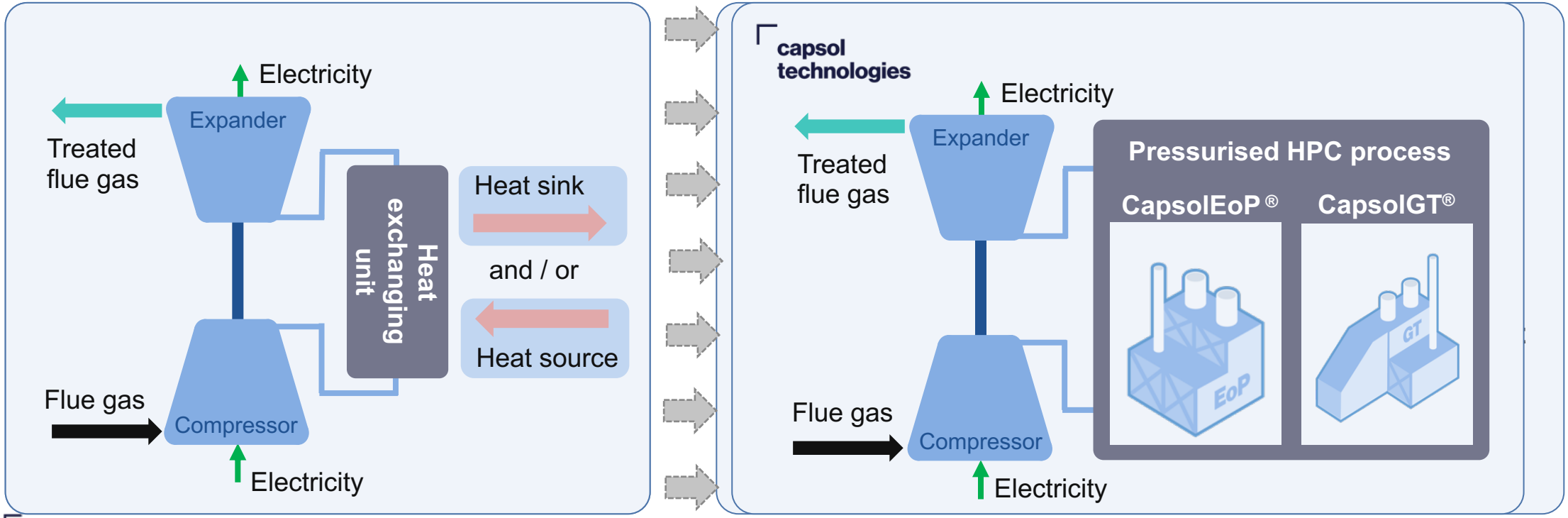
HPC for post combustion CO_2 capture

The creative and "counterintuitive" solution

- The counterintuitive solution is to look at the compression as an advantage for the capture process - not a disadvantage.
  - *It is not a problem, it is a solution*

- Adding an expander + tailoring the process to the conditions of the HPC absorption section creates a flexible combined heat engine / heat pump and a chemical absorption plant in one installation.



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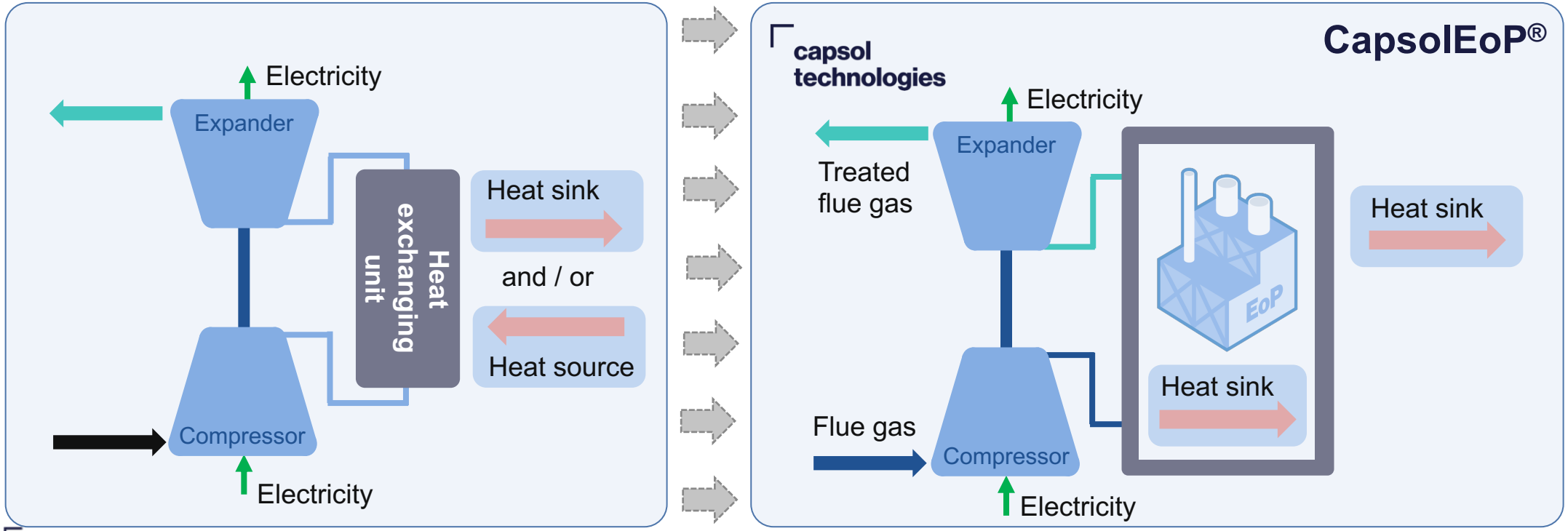
CapsolEoP®

Efficient heat pumping and CO_2 capture. Using electricity to efficiently generate heat for internal HPC CO_2 capture process. Can be configured to deliver additional heat to ex. district heating.

CapsolEoP® – End of Pipe CO_2 Capture plant

- Capsol EoP® is not just a chemical absorption plant with a different solvent
- The CapsolEoP® is a **chemical absorption plant with an integrated heat pump** where the HPC absorption process acts as a heat sink as well as a possible heat source.



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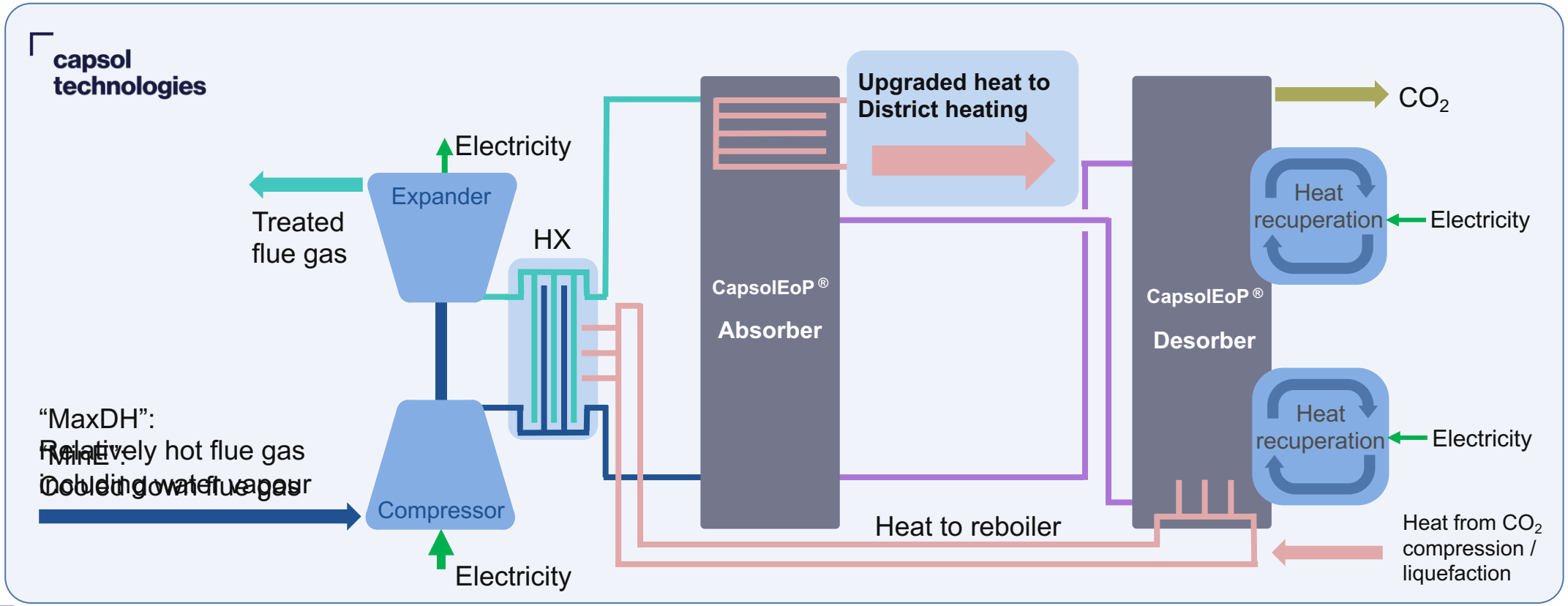
CapsolEoP® – Efficient heat pump and CO_2 capture plant

Delivering heat to district heating

- CapsolEoP® optimised for delivering maximum district heating is both a CO_2 capture plant and a very effective heat pump



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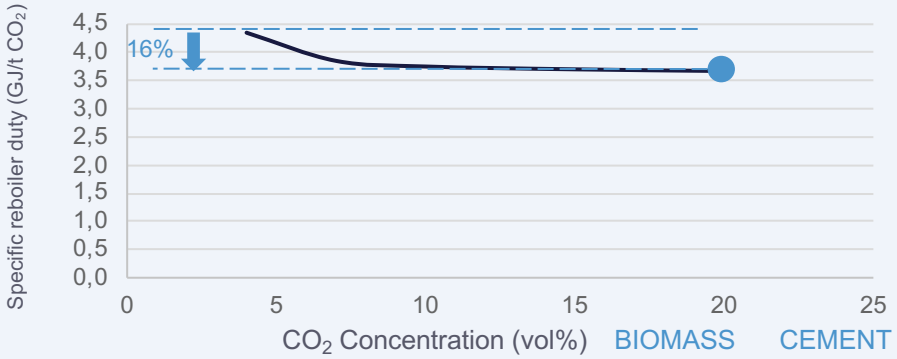
CapsolEoP® for biomass – superior energy efficiency

Traditional post combustion absorption

- Energy requirement is predominantly heat
- Heat consumption is a weak function of CO_2 concentration

Energy use as a function of CO_2 concentration (MEA)



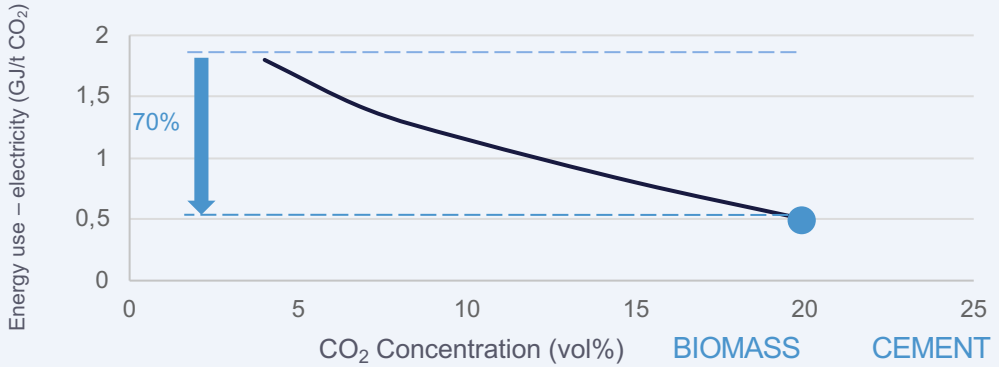
**Energy use is the main operational cost of CO_2 capture*

- The amount of heat needed is normally not available as waste heat from a biomass plant, i.e., live steam from needs to be extracted from the turbine

CapsolEoP® based on HPC

- Energy requirement is mostly electricity to pressurise flue gas
- Electricity consumption is a strong function of CO_2 concentration

Energy use as a function of CO_2 concentration (CapsolEoP®)



**Energy use is the main operational cost of CO_2 capture*

- Does not need additional heat, but can utilise what is available to further reduce total energy use

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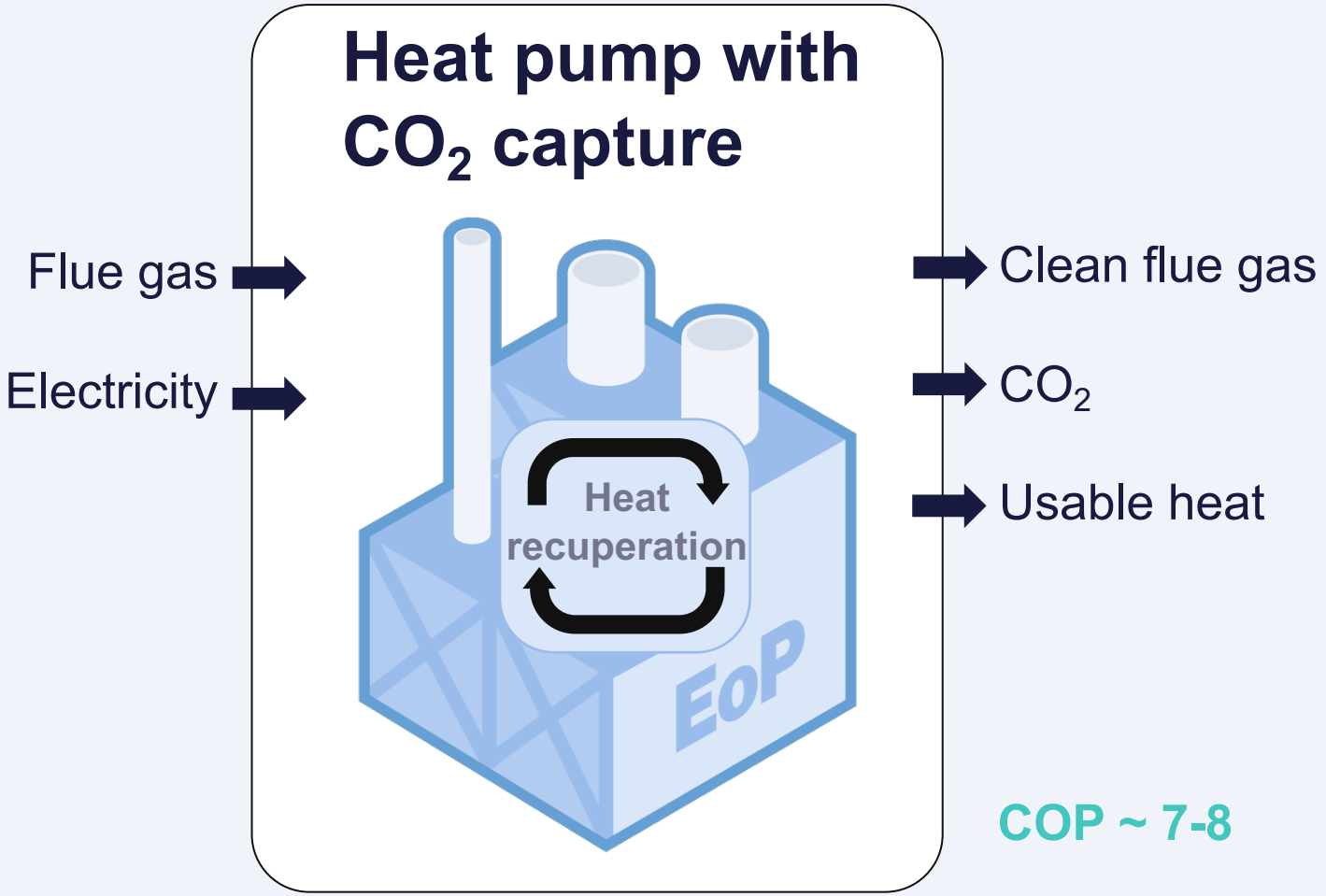
CapsolEoP®



Efficient heat pumping and CO_2 capture. Using electricity to efficiently generate heat for internal HPC CO_2 capture process. Can be configured to deliver additional heat to ex. district heating.

COP ~ 7-8

COP = coefficient of performance

Biomass power plant case example

- European site
- 20 MW electric power – 90% capture rate – approx. 160 000 tonnes/year CO_2

Parameter	MinE configuration	MaxDH configuration
Cooling before compressor	30°C	55°C
Power demand*	5-6 MW	6-7 MW
Specific power demand	0,9 GJ/tonne CO_2	1,2 GJ/tonne CO_2
District heat generation	4-5 MW	18-20 MW
Cost of investment and energy	20-25 EUR/tonne CO_2	5-10 EUR/tonne CO_2
Energetic cost and revenue	5-10 EUR/tonne CO_2	-10 EUR/tonne CO_2

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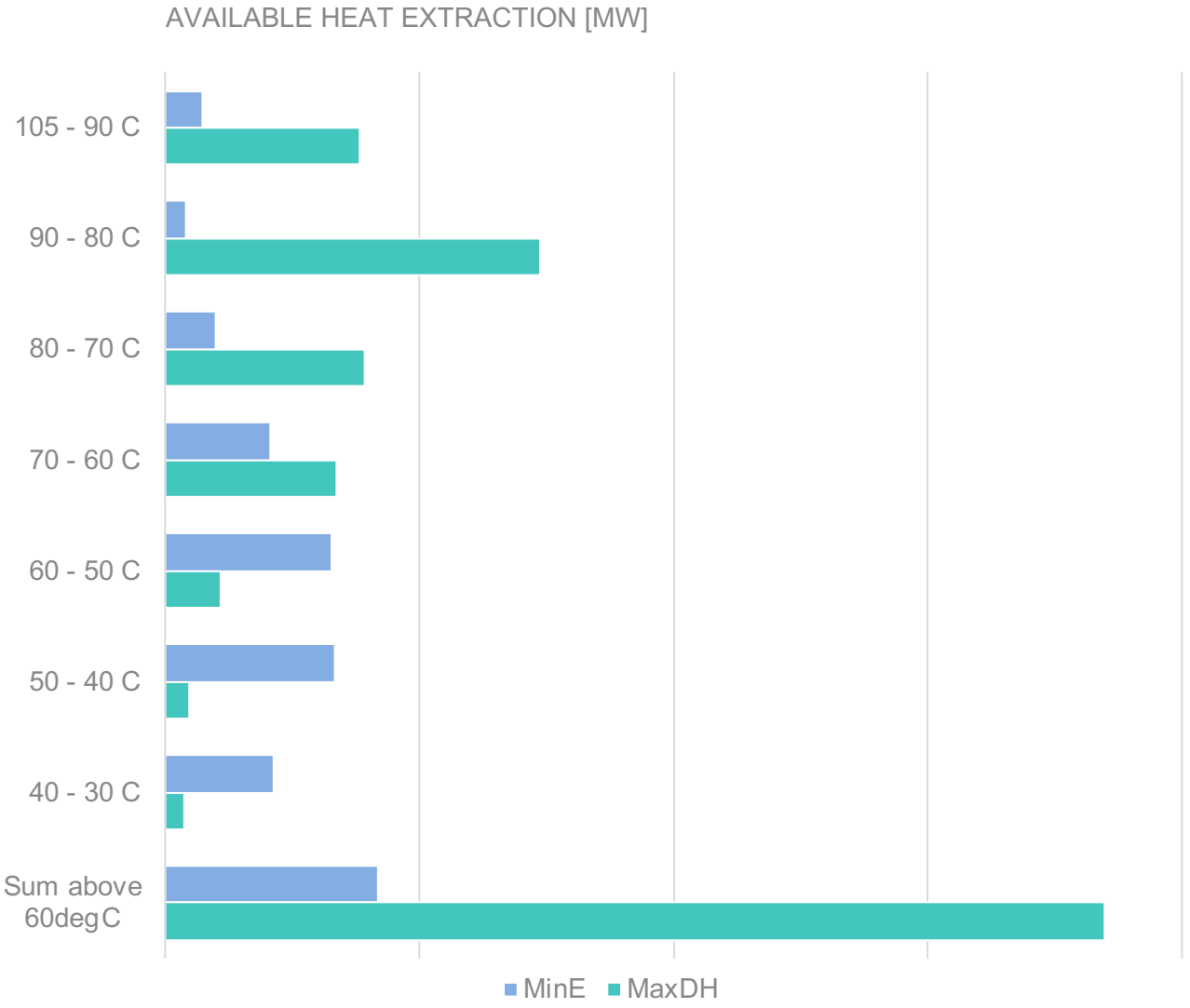
*) without compression

Biomass CHP case example

- In the “MaxDH“ configuration, an additional 1,5 MW of electricity would yield an additional 14 MW of available heat above 60°C
- → COP = 9,0
- Both configurations can be chosen operationally as required, e.g., MinE in summer and MaxDH in winter
- Only marginal additional cooling water demand



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CHP = combined heat and power COP = coefficient of performance

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CapsolGo® News

A 1 tpd containerised demonstration unit

4th CapsolGo® campaign awarded in Germany

- CapsolGo® demonstration campaign at EEW's Energy-from-Waste (EfW) plant in Hannover, Germany
- All-inclusive service with a testing and validation program, providing EEW with valuable data and information on CapsolEoP® (End-of-Pipe) capture technology
- EEW's 17 sites in Germany, Luxembourg and the Netherlands processing 5 million tonnes of waste per year. Approximately half of it consists of biogenic waste and half of fossil components
- EEW's plants generate process steam for industrial plants, district heating and environmentally sustainable power

5
months contract

280 000
tonnes of CO_2 per year (full-scale deployment)

Q4 2023
expected start-up of demonstration campaign

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HPC summary

- Hot Potassium Carbonate (HPC) is the most environmentally friendly CO_2 capture solvent in urban settings.
- Increased district heating sales largely offset capture costs and eliminate the usual cooling demand increase.
- Heat pump-based solvent regeneration allows fast and simple retrofitting of existing plants without steam extraction.

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Thank you

Capsol Technologies in the CCUS value chain

	Carbon capture technology	EPC[1]	Operations and maintenance	Liquefaction & intermediate storage	Transport	Storage
CO_2 emission/ plant	• Technology licensed out globally directly or through partners (re-sale) • Sales engineering	• Client selects independent provider or via Capsol partnerships • Competitive bidding is important for client to reduce overall cost • Capsol supports client through both the EPC tendering process and actual EPC work	• Client selects independent provider or operates themselves • Capsol offers support and expertise, in addition to optimized technical solutions during lifetime of projects	• Client selects independent provider • Capsol integrate energy waste from liquefaction to reduce energy consumption in the capture plant	• Clients selects independent provider • Capsol can provide independent advice to client	• Client selects independent provider • Capsol can provide independent advice to client

Supporting client through the value chain, but client remains free to choose providers

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[1] Engineering, procurement and construction