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CO_2 The capture plant, Scale –Up challenges

Olav Falk-Pedersen

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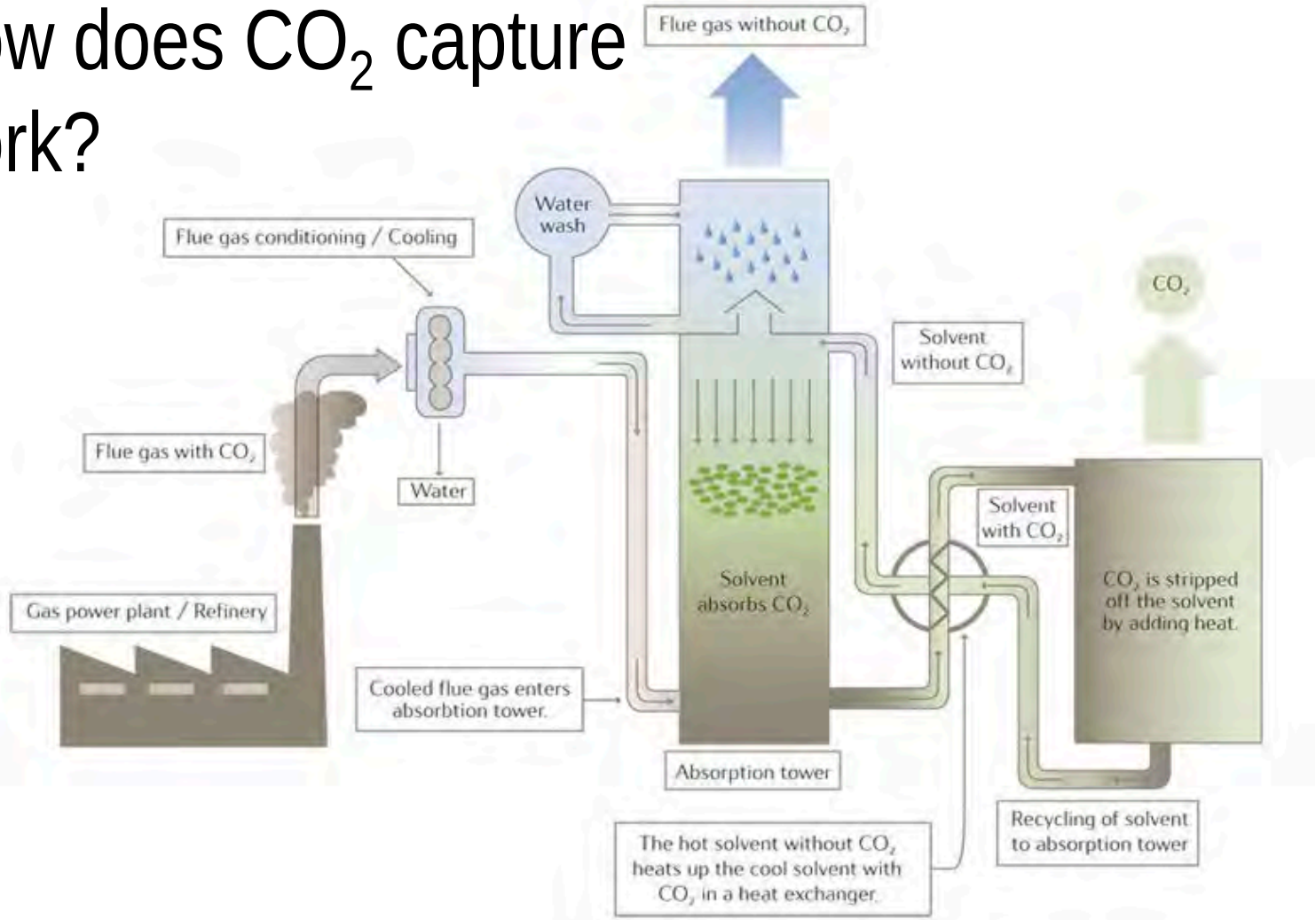
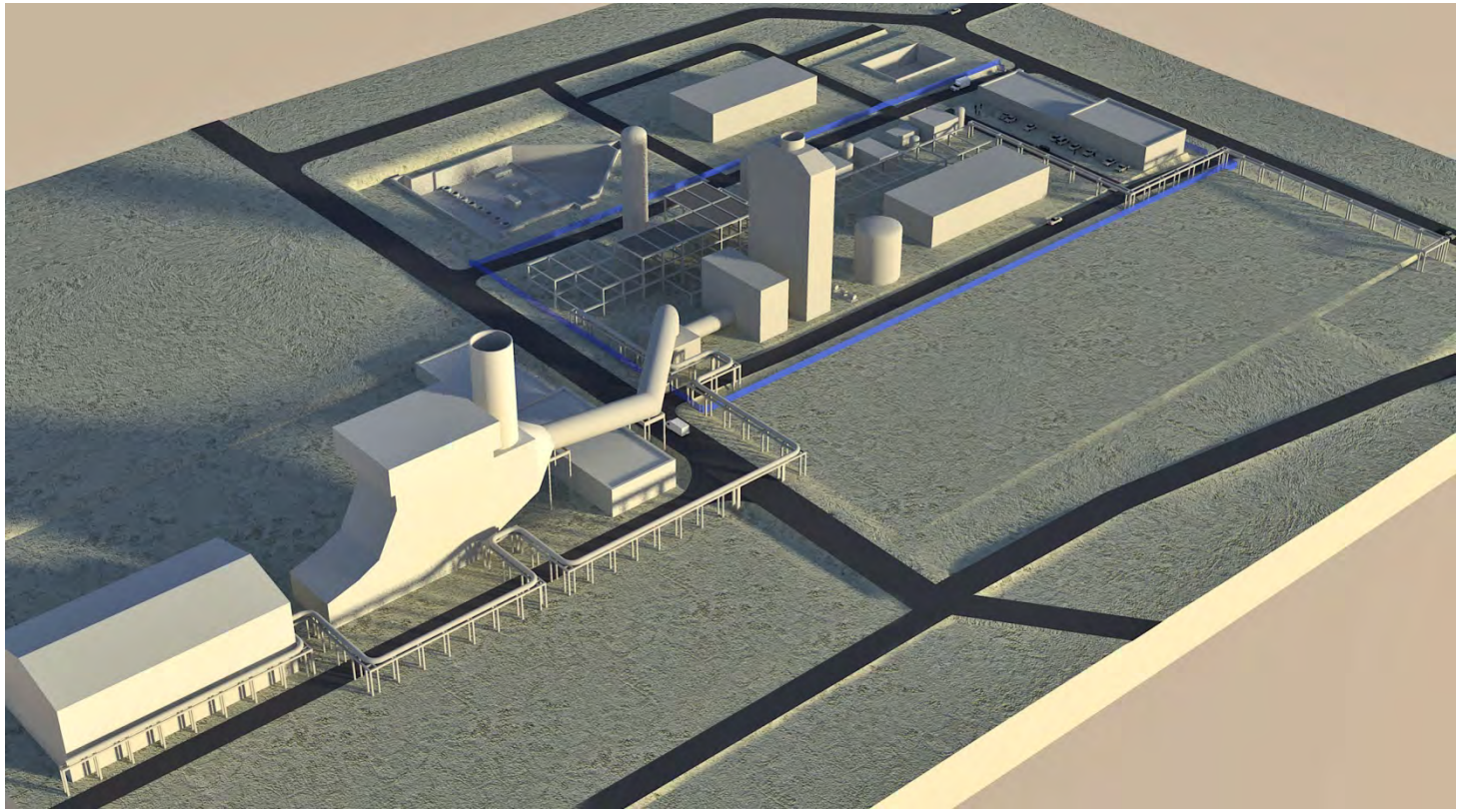
How does CO_2 capture work?



The capture plant



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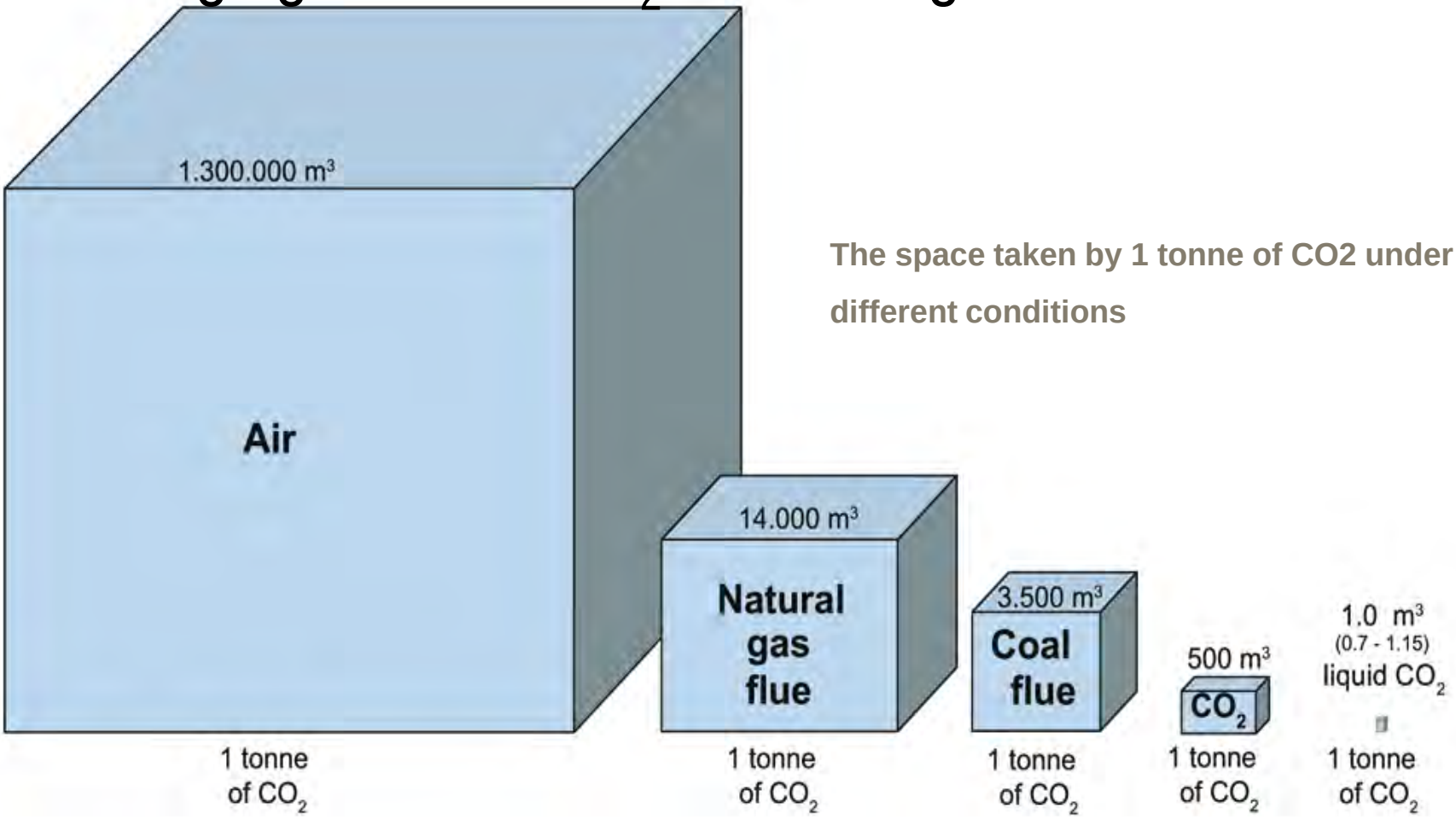
Challenging to catch CO_2 from flue gas



The space taken by 1 tonne of CO2 under different conditions

Illustration source: Freund, Kaarstad “Keeping the Lights on”, Universitetsforlaget, 2007

Gas turbine exhaust gas (420MW)

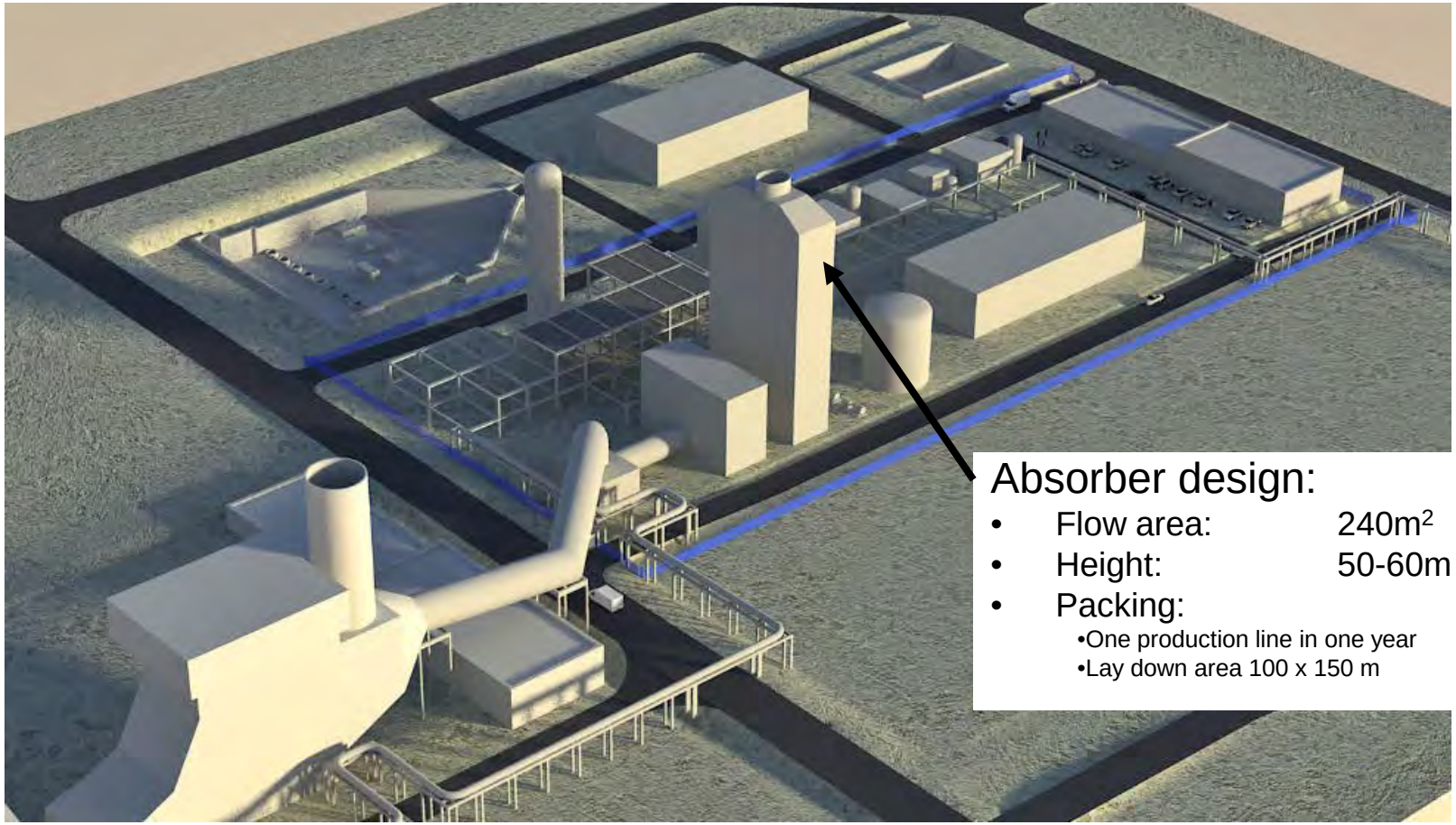
Temperature, °C	105
Pressure, barg	Atmospheric
Mass Flow Rate, kg/sec	694
Composition (mass% / vol%)	
Nitrogen	73.6 / 74.8
Oxygen	14.4 / 12.8
Carbon Dioxide	5.9 / 3.8
Water	4.9 / 7.7
Argon	1.2 / 0.9
NH_3	5 ppmv
SO_2	0.1 ppmv
Total NOx	2.0 ppmv

Large volume flow
Large absorber diameter

High degradation

High absorber
Special amines
High energy consumption

Low degradation



Absorber design:

- Flow area: 240m^2
- Height: 50-60m
- Packing:
  - One production line in one year
  - Lay down area 100 x 150 m

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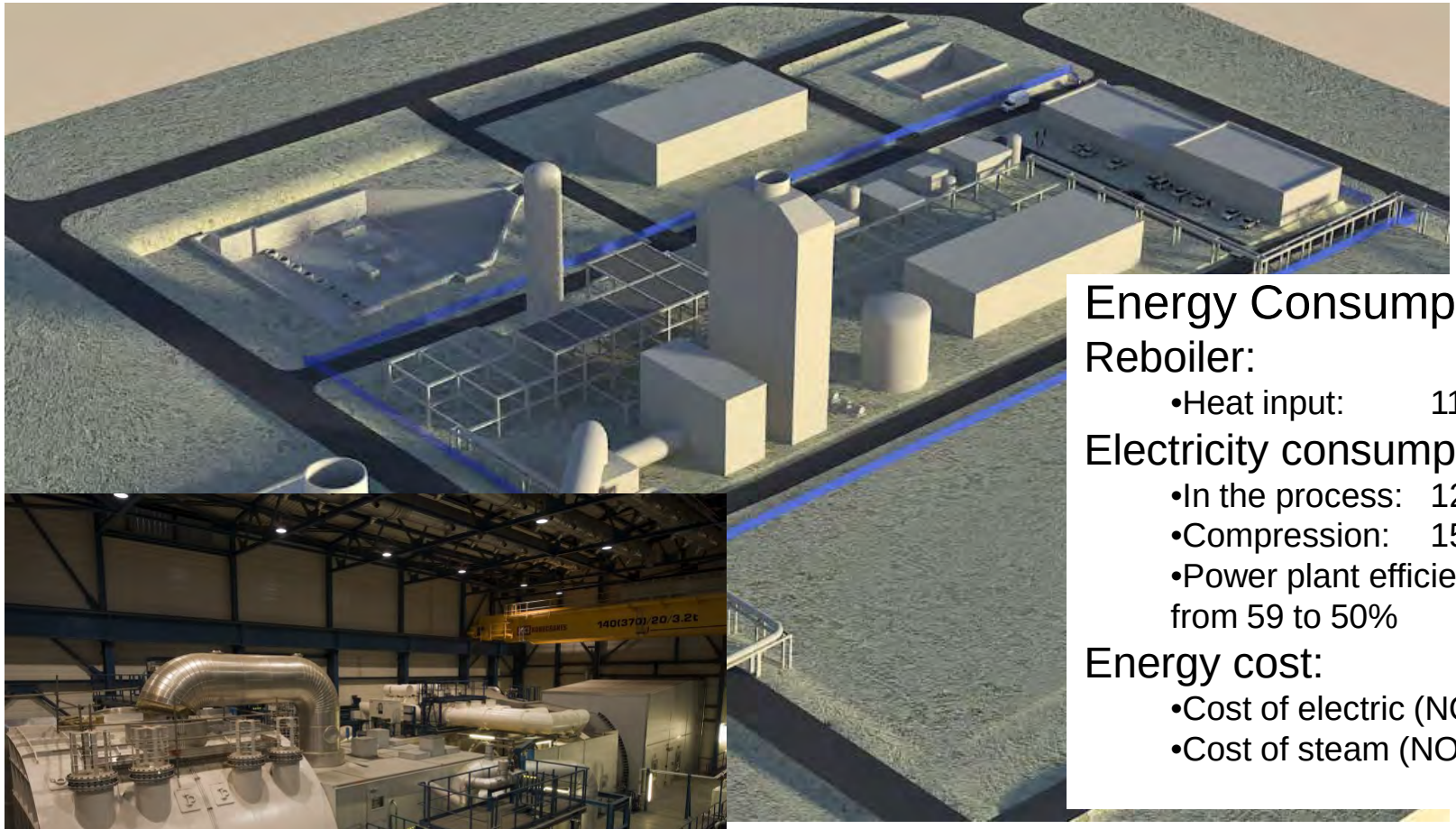

Energy Consumption

Reboiler:

- Heat input: 110-130 MW

Electricity consumption:

- In the process: 12-13 MW
- Compression: 15-17 MW
- Power plant efficiency reduced from 59 to 50%

Energy cost:

- Cost of electric (NOK/kWh)
- Cost of steam (NOK/ton)

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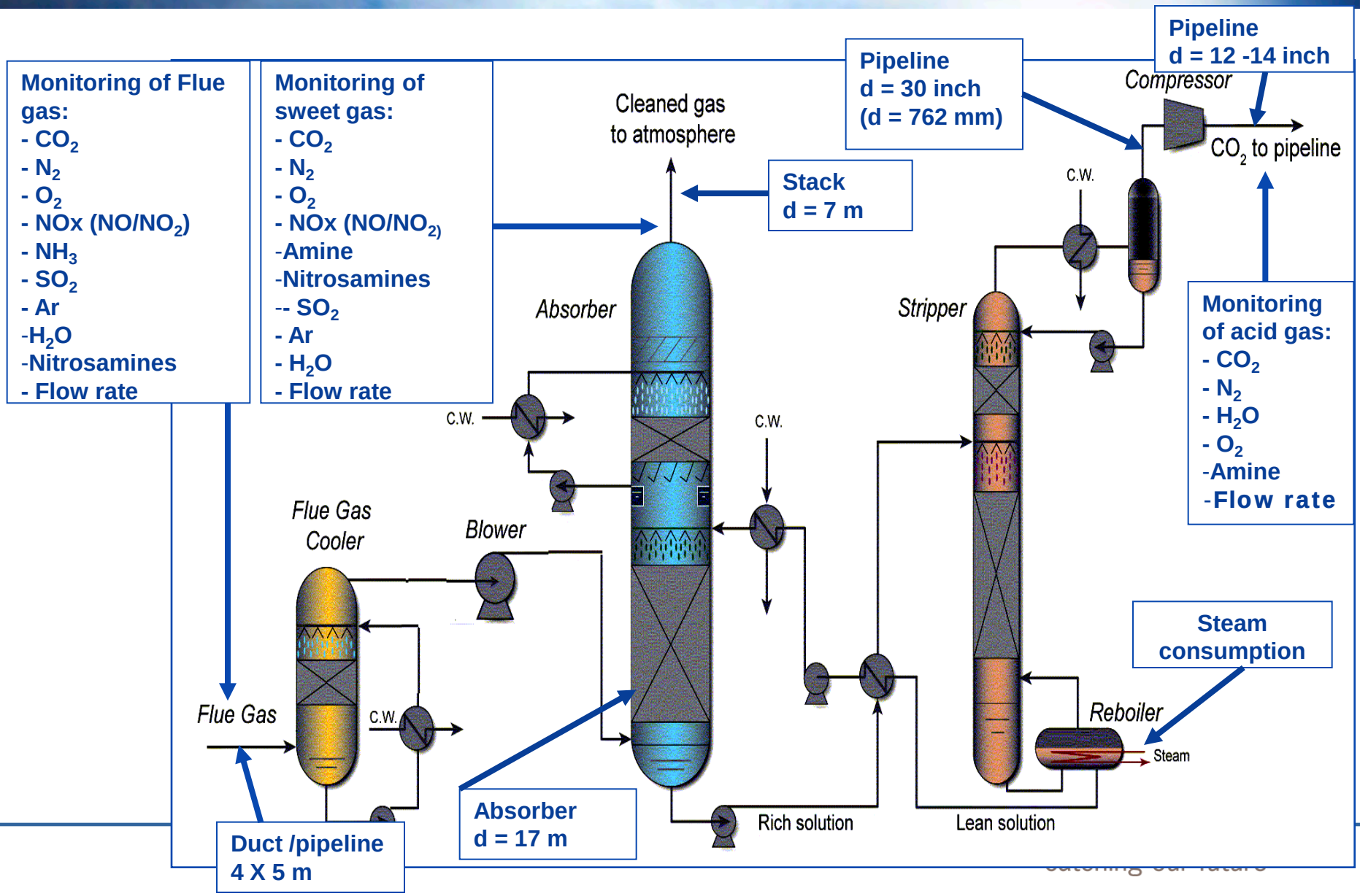
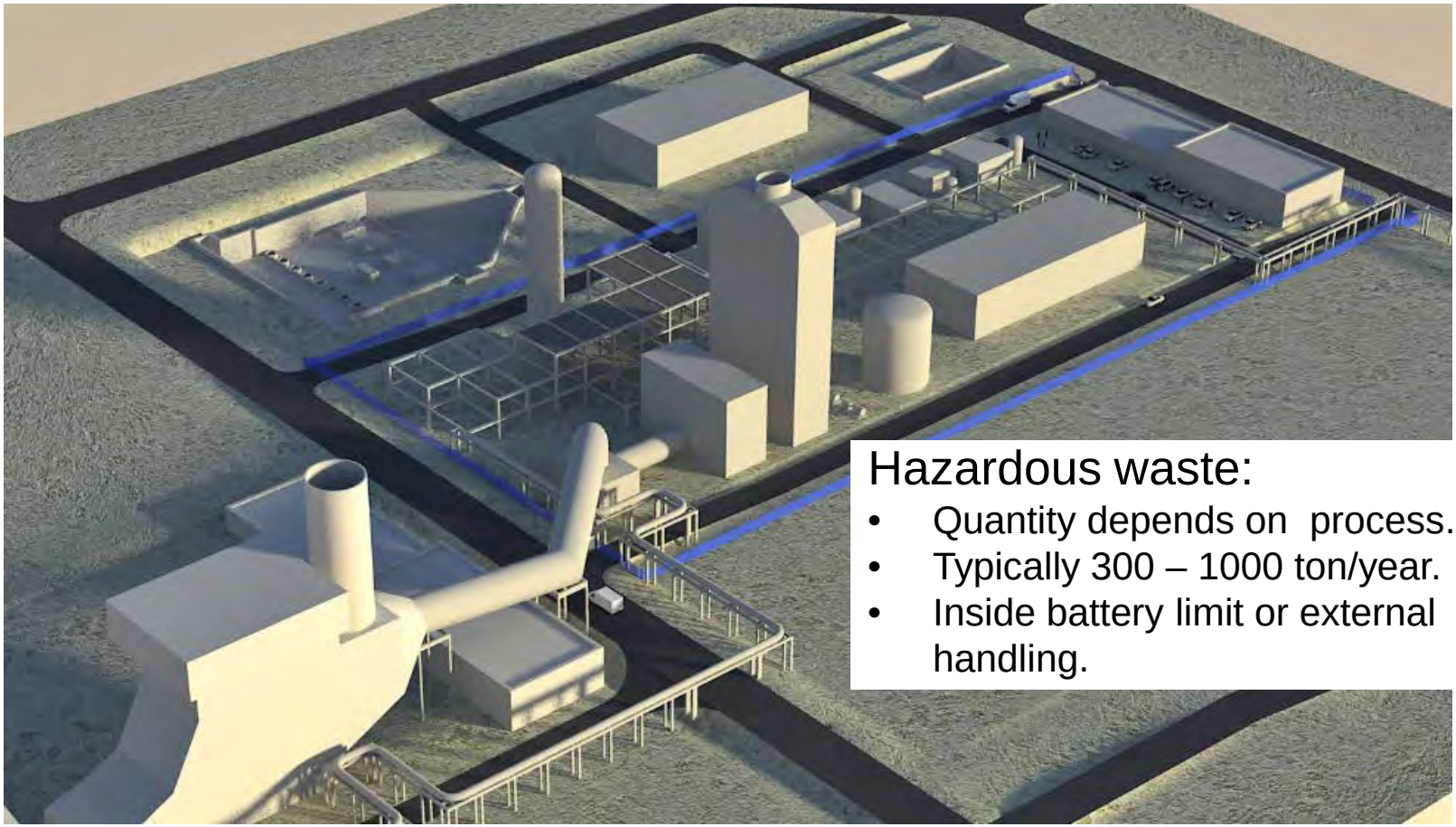
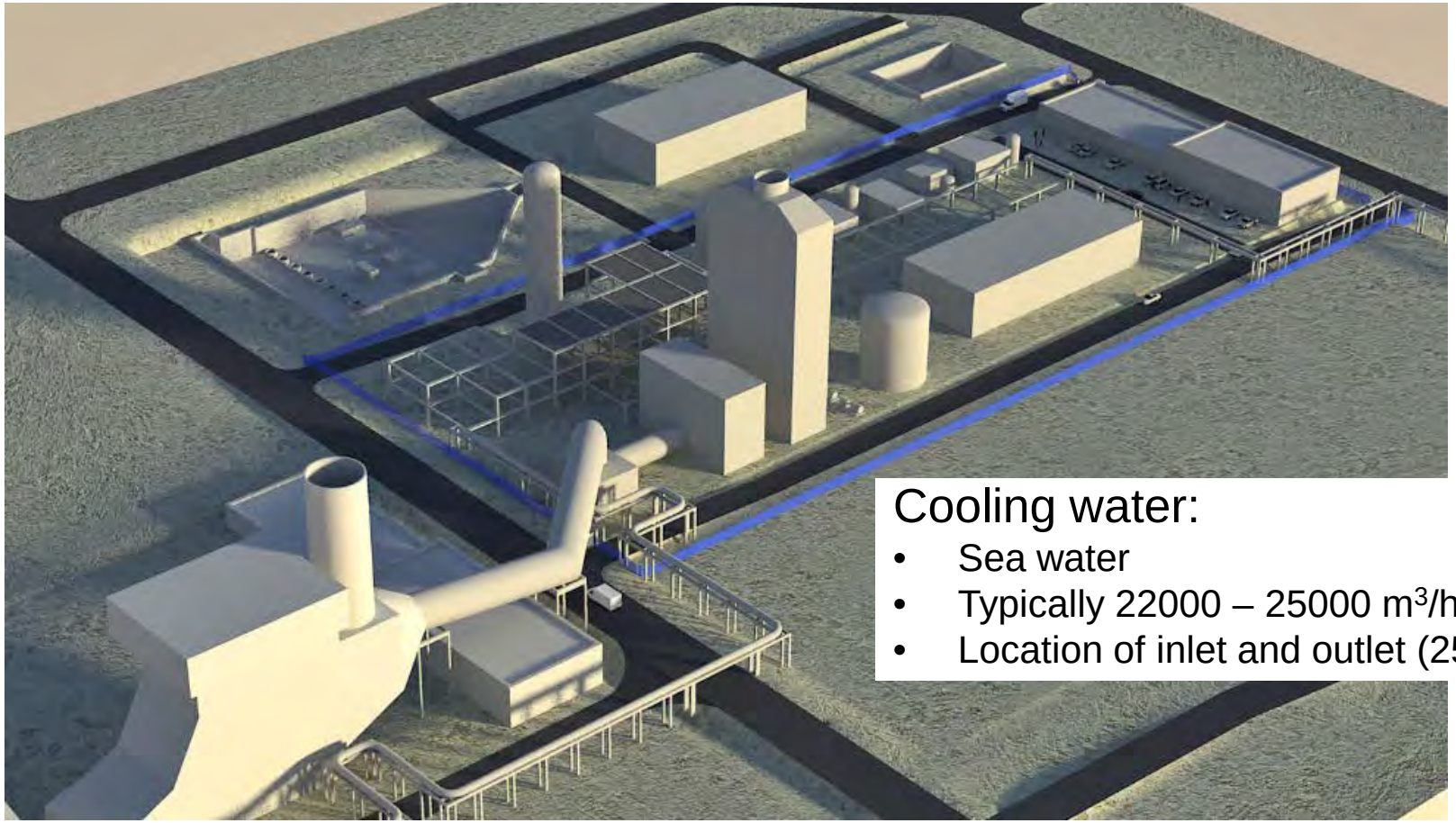




Hazardous waste:

- Quantity depends on process.
- Typically 300 – 1000 ton/year.
- Inside battery limit or external handling.



Cooling water:

- Sea water
- Typically 22000 – 25000 m^3/hour
- Location of inlet and outlet (255MW)

Inlet:

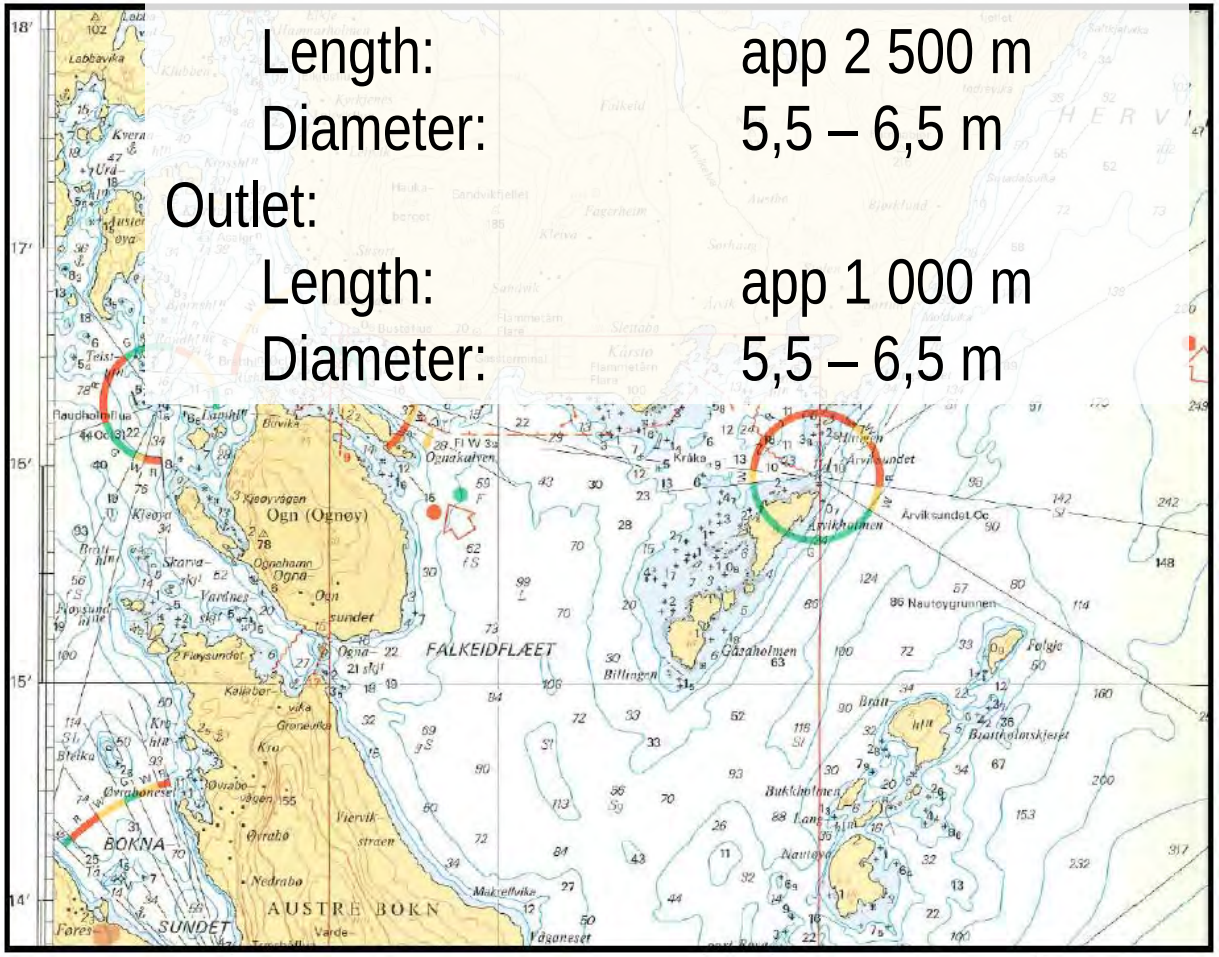
Length: app 2 500 m

Diameter: 5,5 – 6,5 m

Outlet:

Length: app 1 000 m

Diameter: 5,5 – 6,5 m



- Capacity of the fjord wrt. temperature and eutrofication
- Seasonal variations
- Interference with other cooling water discharge points
- Crossing of interests with anchoring of ships
- Disturbance of export gas pipes

Transport of rock material

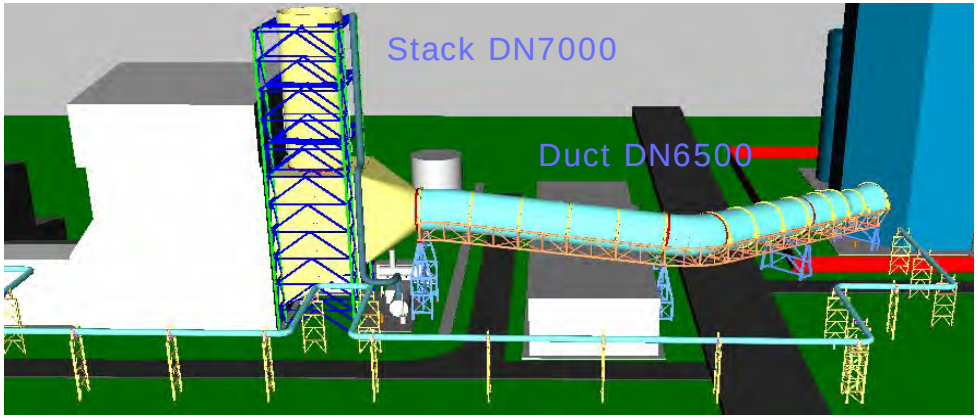
Activity	Volume (m^3)	Trucks loads
Inlet tunnel	90.000	18.000
Outlet tunnel	32.000	6.400
Site preparation	93.700	18.740
Total to external deposit	215.700	43.140
Backfilling	24.000	4.800
Total	239.700	47.940

Traffic safety

Noise

Dust

Connection to HRSG

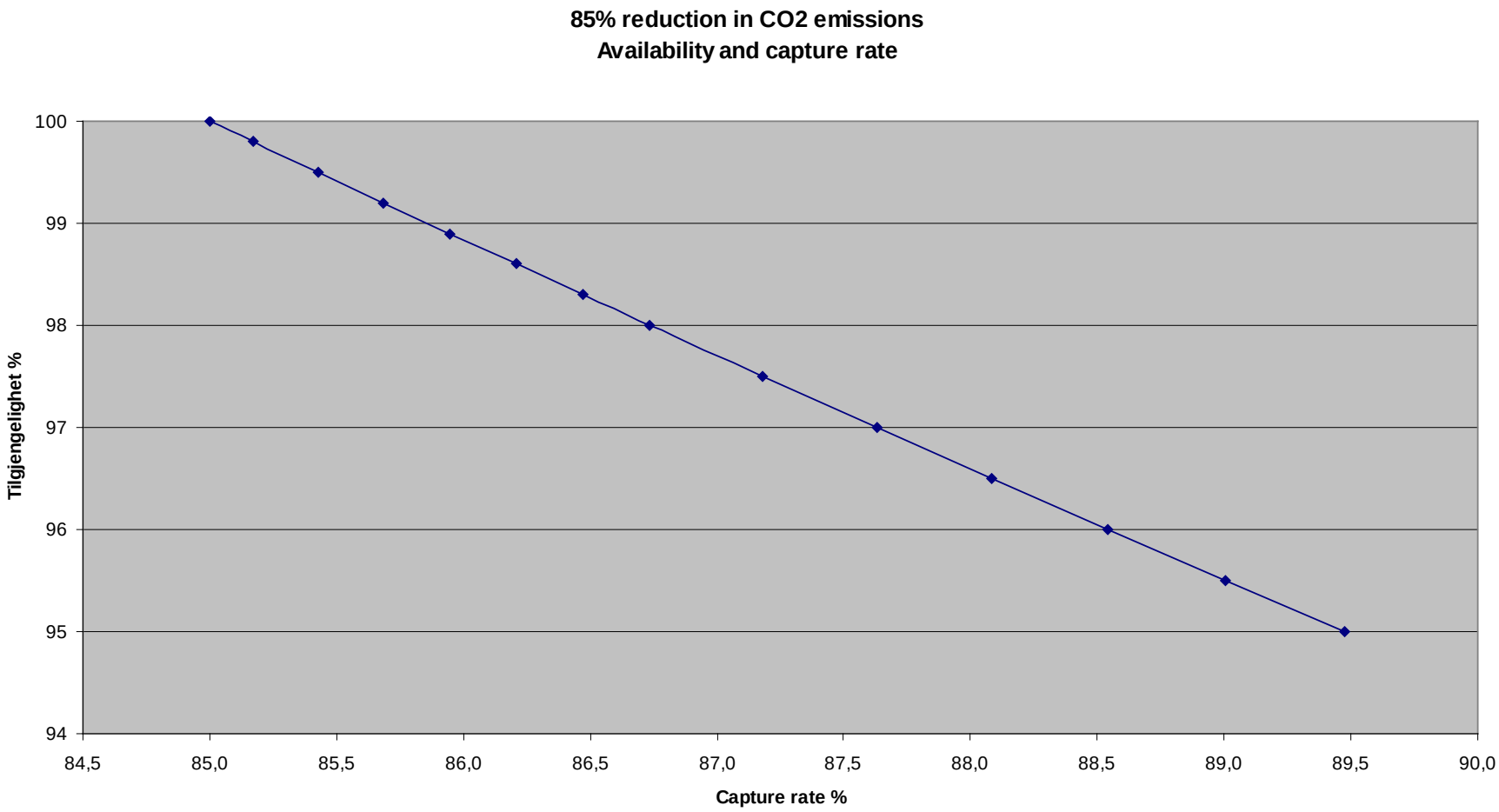


Very sensible for changes in operating pressure (typical numbers gas turbine outlet):

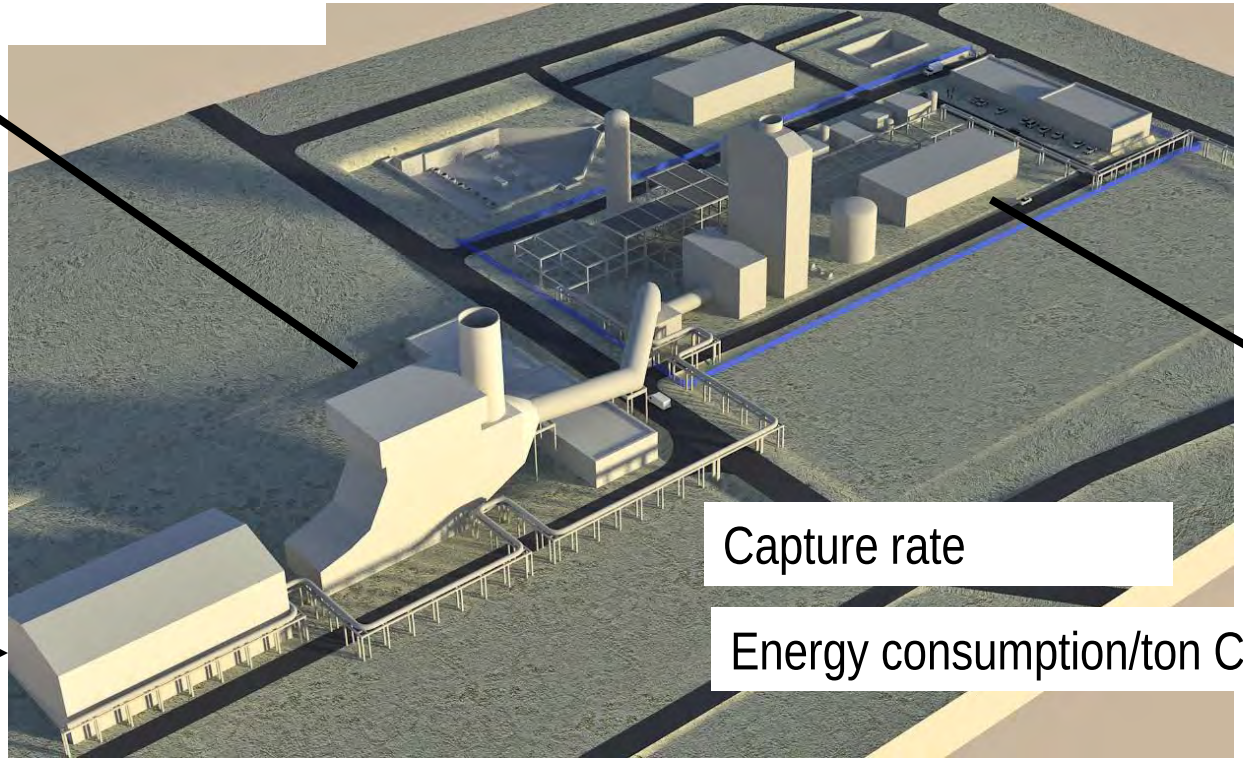
- Operating pressure approximately 46-47 mbar (g)
- The maximum pressure fluctuations in normal operation shuld be +/- 0,2 mbar.
- Increased back pressure at the gas turbine exhaust gas will reduce the gas turbine efficiency. The gas turbine will most likely shot down at an increase back pressure of approximately 13-20 mbar.
- The HRSG is not designed for vacuum.

Connection to HRSG

- Two proposed solutions:
  - 100% of the exhaust gas to be routed to the capture plant.
  - Less than 100% of the exhaust gas to be routed to the capture plant. Example:
    - Approximately 94% of the power plant flue gas routed to the CO2 capture plant.
    - 90% recovery in the CO2 capture plant
    - The overall CO2 recovery will meet the 85% overall recovery requirement


85% reduction in CO2 emissions
Availability and capture rate
Tilgjengelighet %
100
99
98
97
96
95
94
84,5
85,0
85,5
86,0
86,5
87,0
87,5
88,0
88,5
89,0
89,5
90,0
Capture rate %

Reduced production of electricity



Reduction in power production/ton of steam extracted
Electricity price

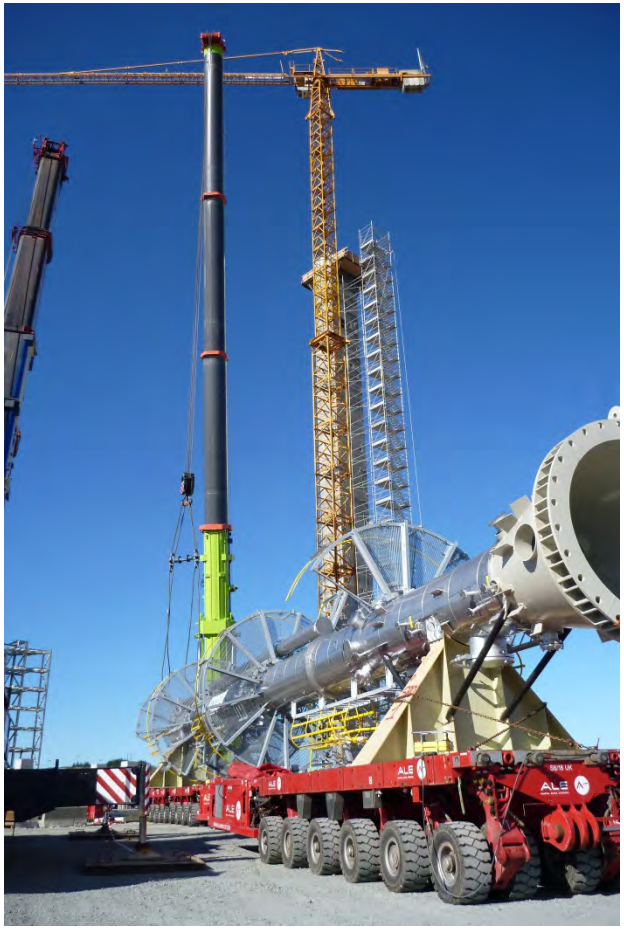
Construction philosophy

Area	Philosophy
Amine plant	Prefabricate modules Site-build of foundations Slip-form concrete structure
Chilled Ammonia plant	Stick-build at site Site-build of foundations Slip-form concrete structure
Utilities and infrastructure	Prefabricate modules Prefabricate concrete elements

Site

Fabrication of equipment

Installation of equipment



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Flue gas ducting

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App. 14.000 related to CO_2 capture
App. 1.000 relevant patents for an amine plant