

OST
Eastern Switzerland
University of Applied Sciences

IES | Institute for
Energy Systems



2024

Arne
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Decarbonizing industry with Stirling-cycle steam generating heat pumps

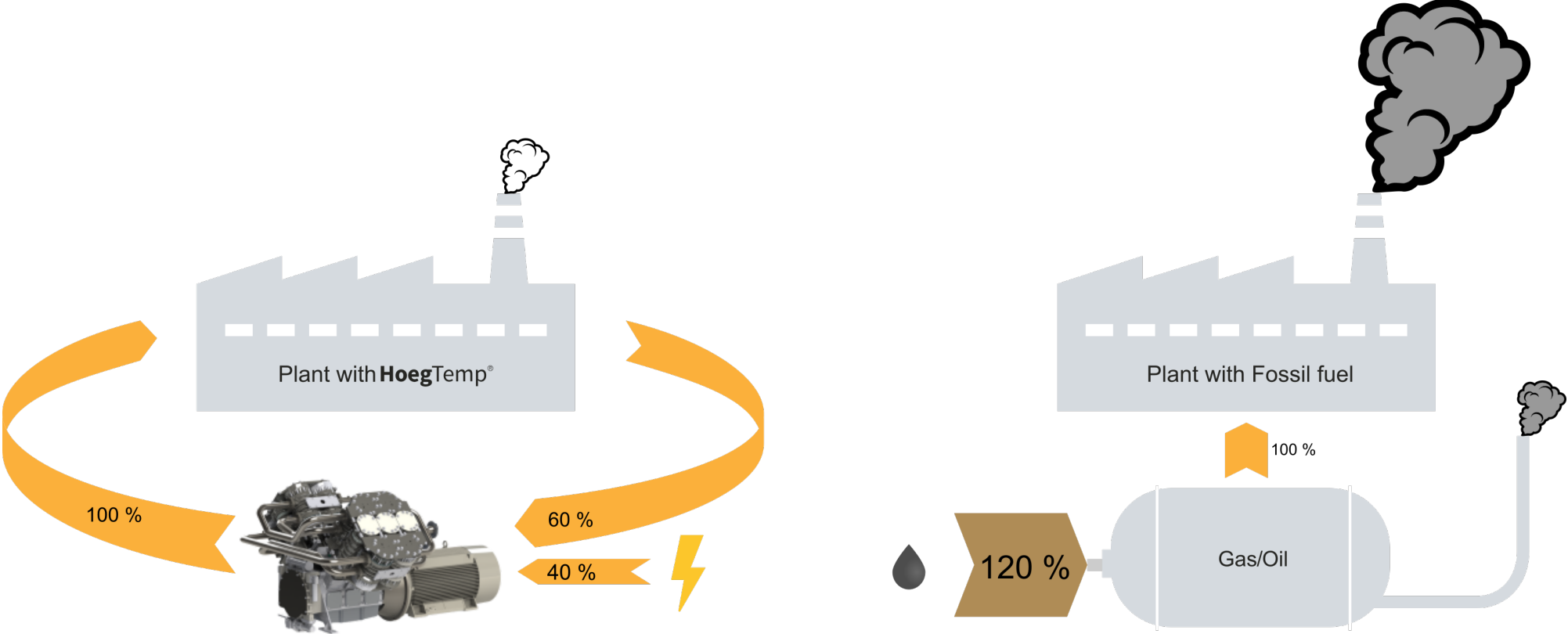


enerin
ENERGY ENGINEERING

Decarbonizing industry with stirling-cycle steam generating heat pumps

Steam generating heat pumps, OST Webinar, 18 March 2024

Heat Pumps vs Boilers



50-70% Energy saved

Reduced Strain on Energy System

20-50% RoI for customers



HoegTemp[®]

ENGINEERING BY ENERIN

Stirling cycle

High COP at high temperature lifts

Robust to varying operating conditions

R-704 Helium

Inert, non-toxic, zero ODP, zero GWP

Steam or hot water up to 200°C

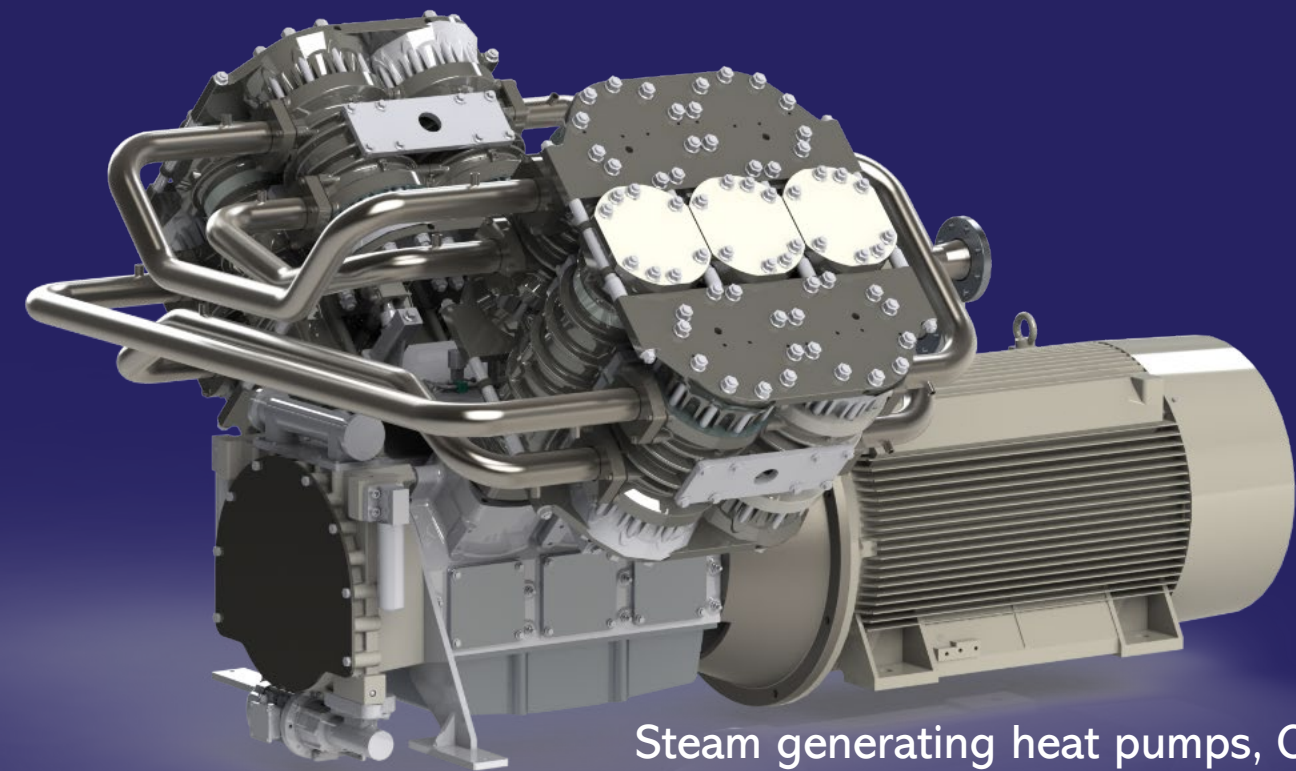
Any source temperature

Simple integration:

Power, steam line and water circuit

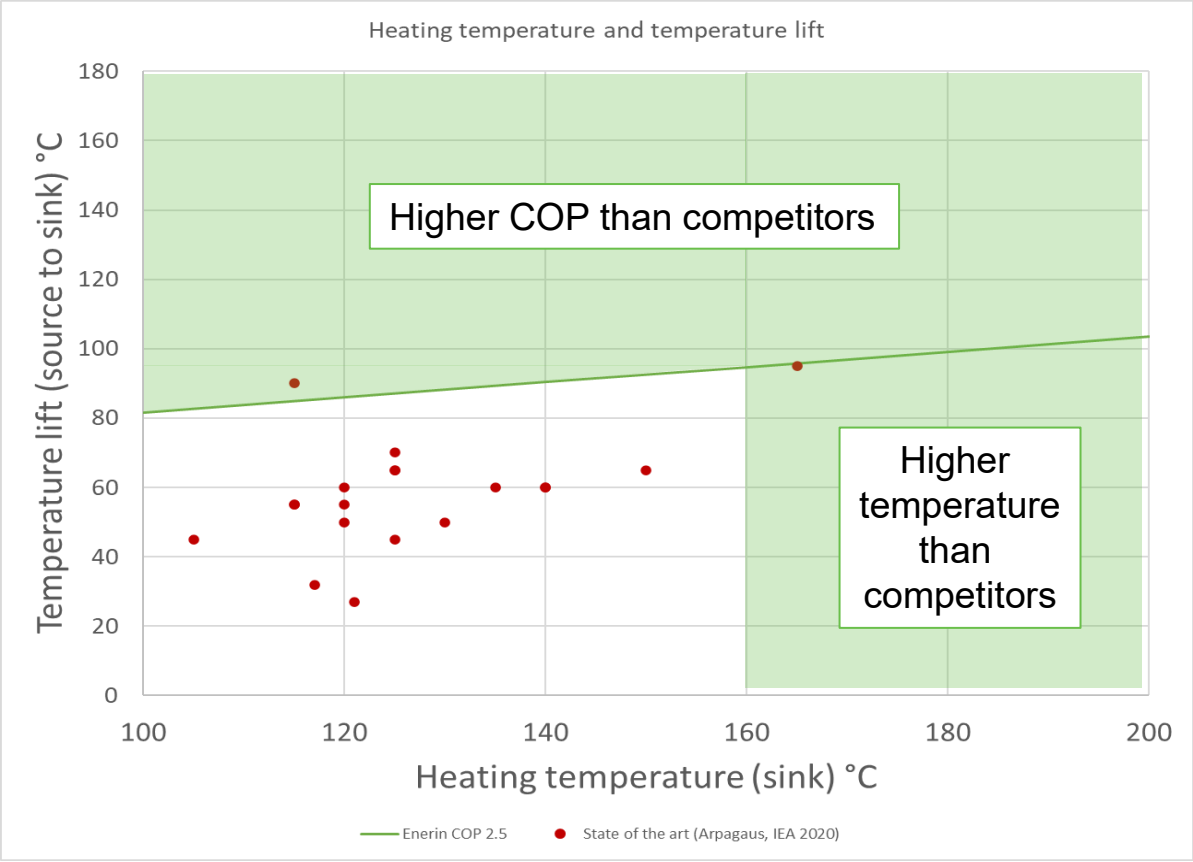
Fast control response

Power control similar to boilers



Steam generating heat pumps, OST Webinar, 18 March 2024

HoegTemp Best Solution for:



High Temp
> 120°C

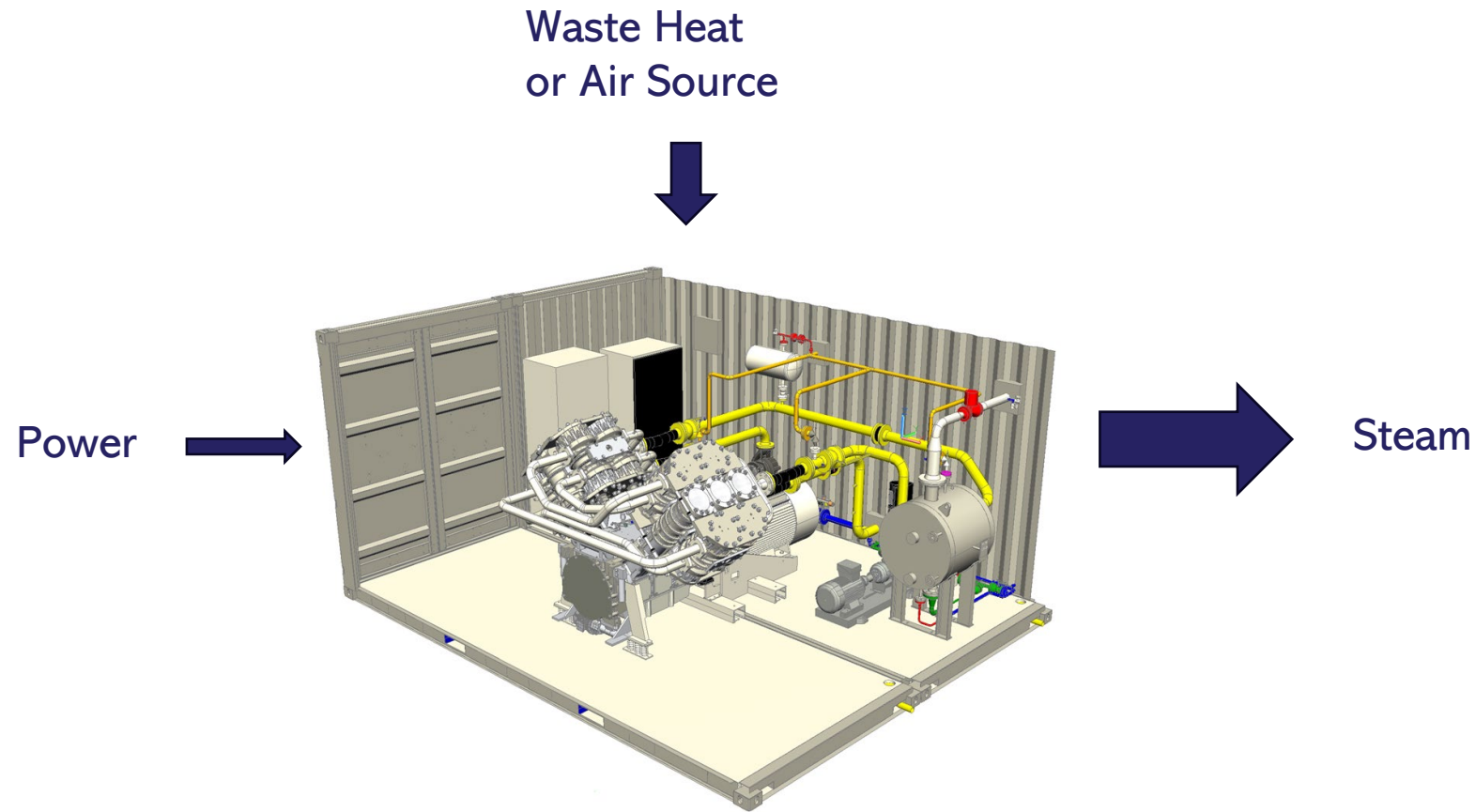
High Lift
> 80°C

Varying Conditions

Heating & Cooling
-10° to 200°C

Waste Heat
& Air

Simple Integration - Future Proof



One process - one Refrigerant

-10°C to +200°C

Adapts to future changes in plant conditions

Standard interface

Power - water/air - steam

Identical modules for all installations

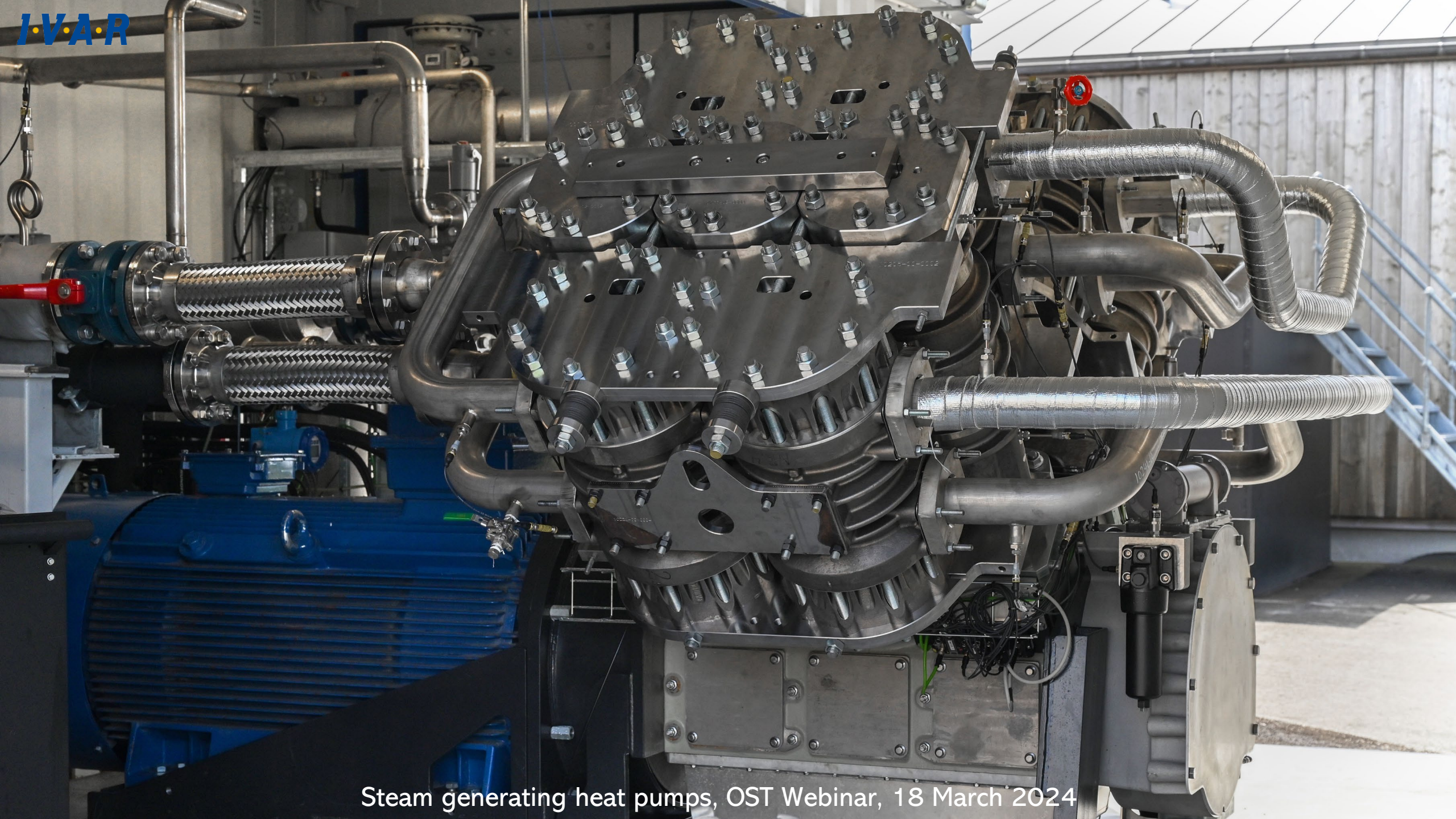
IVAR Biogas plant

Steam for CO₂ capture unit

Cooling of waste heat

August 2023

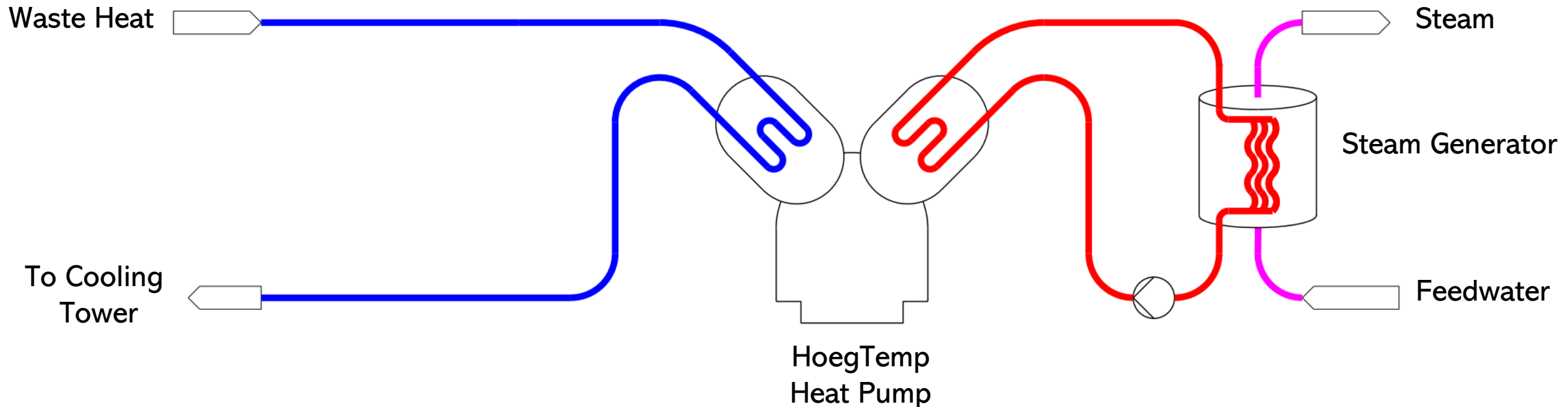




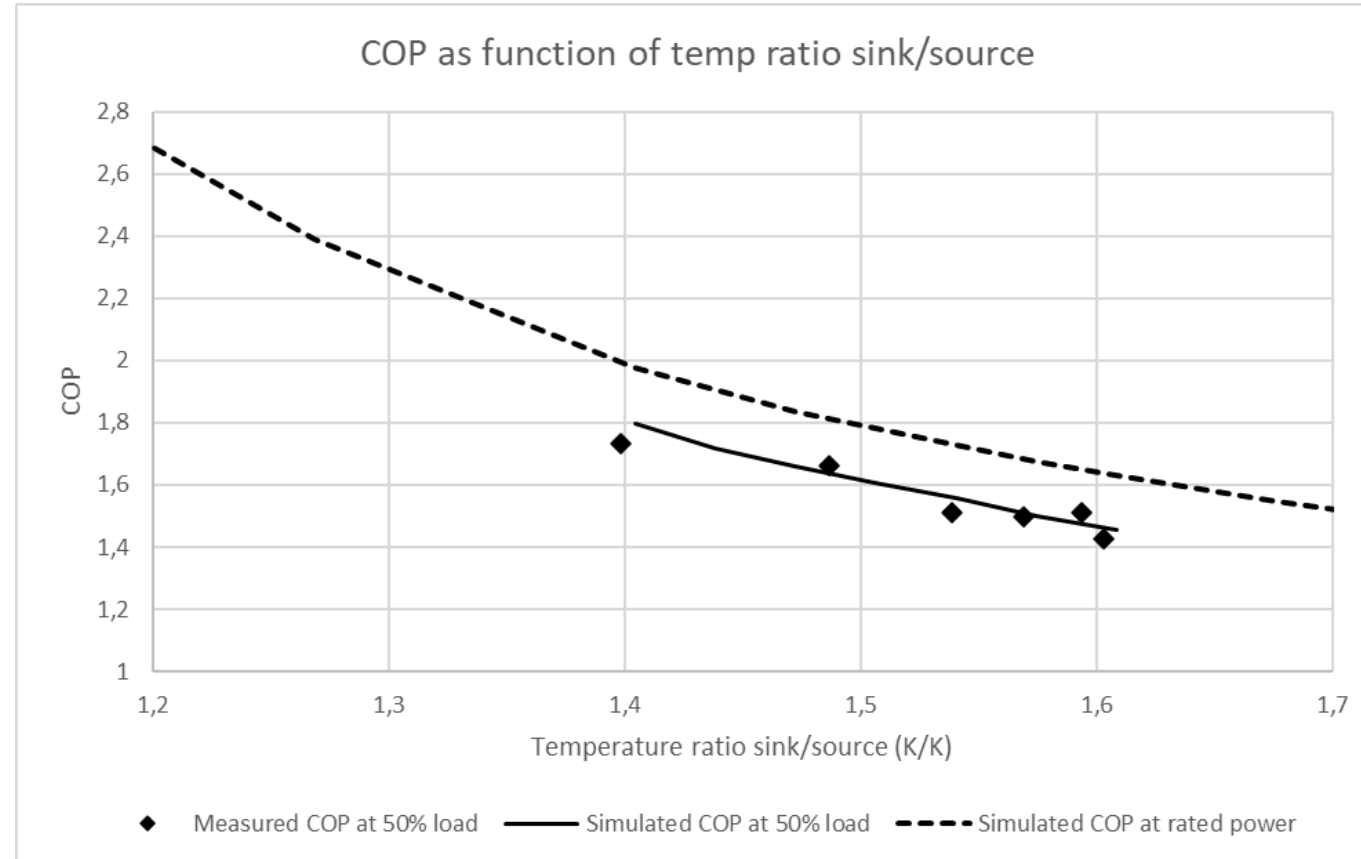


2-13 bar_G Steam from Cooling

Steady steam demand - variable pressure for R&D reasons
 low-glide, seasonal heat source 15°-40°C



COP as function of temperature ratio



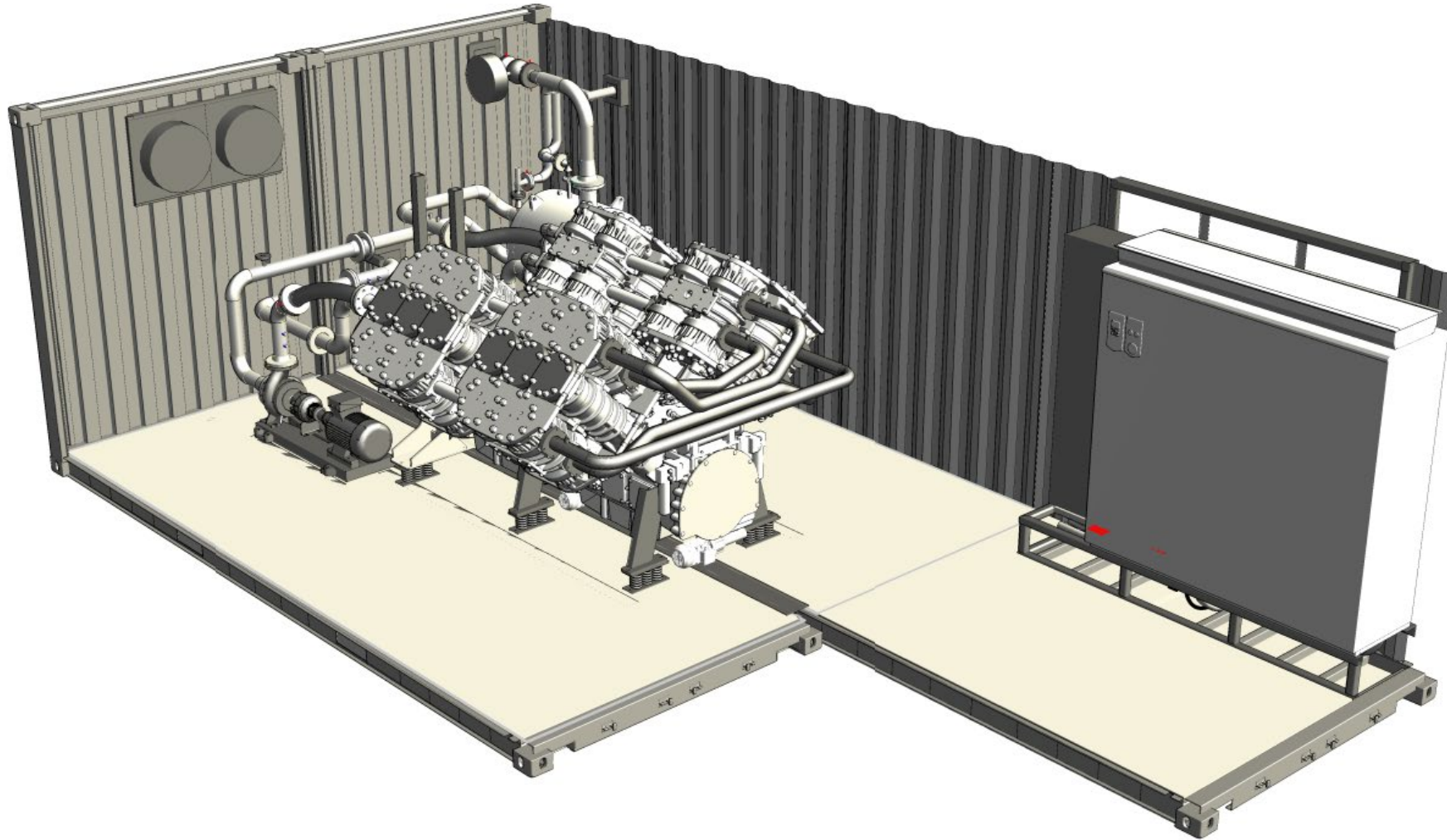
Stirling cycle characterized by temperature ratio - not by absolute temperatures

$$\text{Temperature ratio} = \frac{T_{\text{sink}}}{T_{\text{source}}} \qquad \text{ex: } \frac{473\text{K}}{294\text{K}} = 1.6\text{ K/K}$$

GE Healthcare

800 kW steam for pharmaceutical production
from waste heat/cooling system
2024

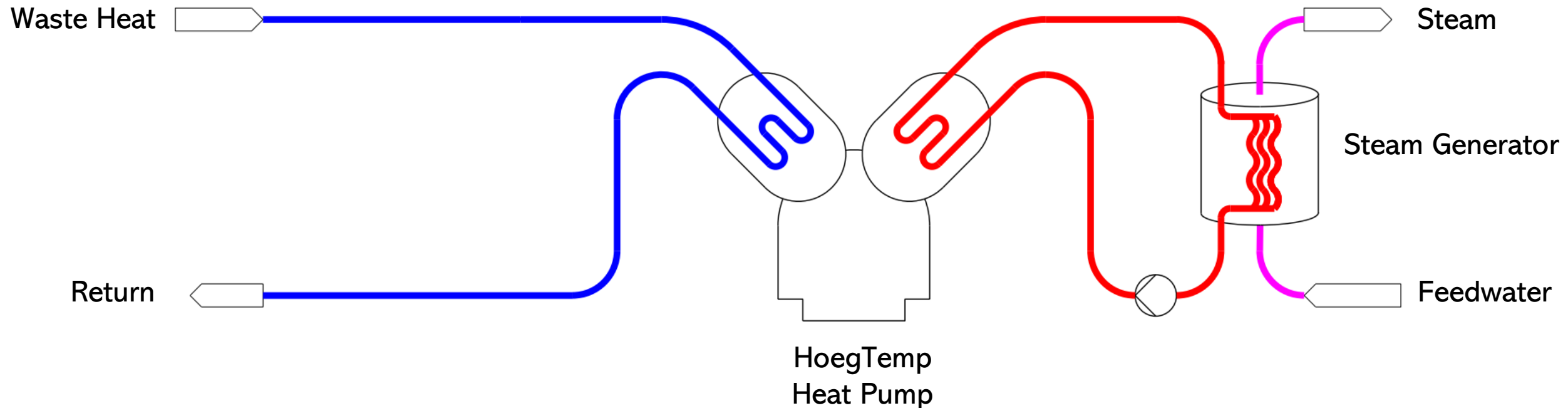
800 kW 2 bar_G steam



2 bar_G Steam from Cooling Circuit

Constant steam demand - stable 15°C heat source

Expected COP 1.9-2.0



Pelagia Måløy

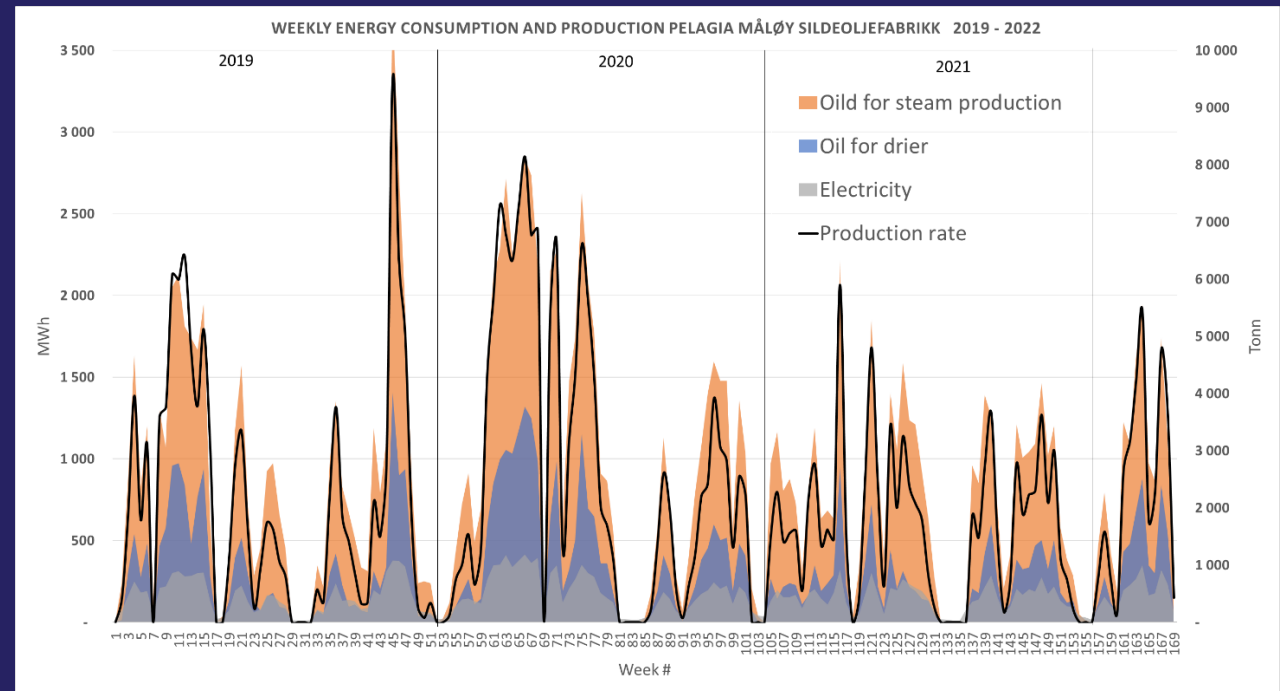
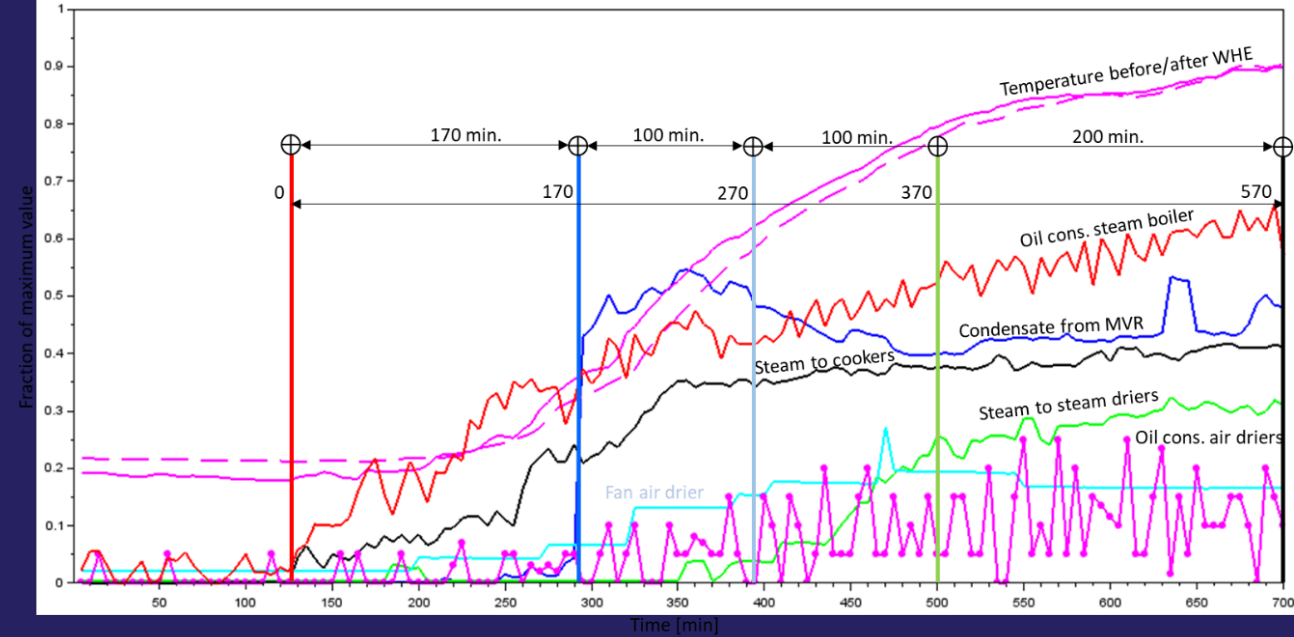
1.6 MW steam 8 barG

Sources: waste heat and sea water

2024-2025

Heat Consumption

- Variable Feestock availability
- Variable heat consumption
- Varying steam pressure and heat sources
- Ramp up
- Production tail



Pinch analysis

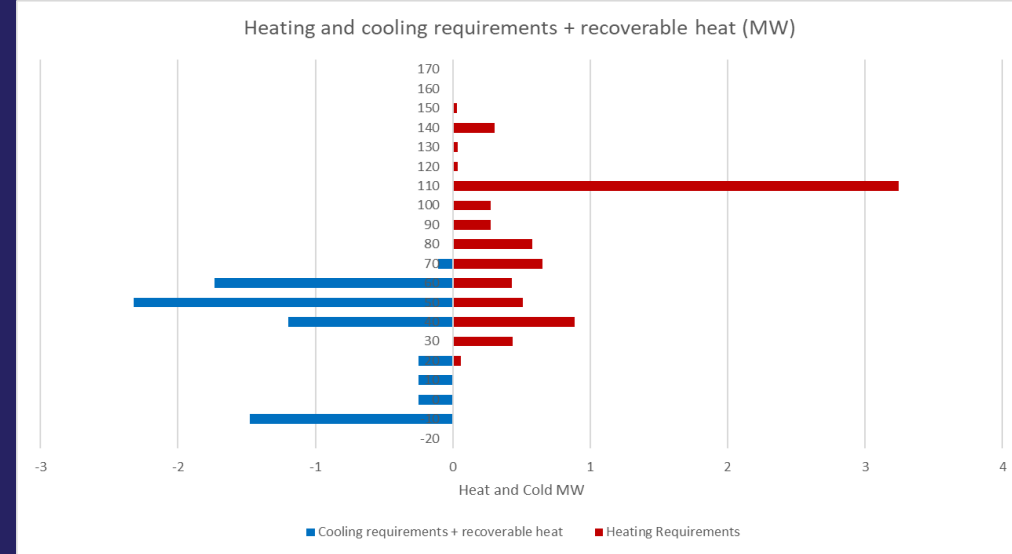
Dashboard for plant simulation and dynamic pinch analysis

Use historic data, statistic data, prognosis or real-time data

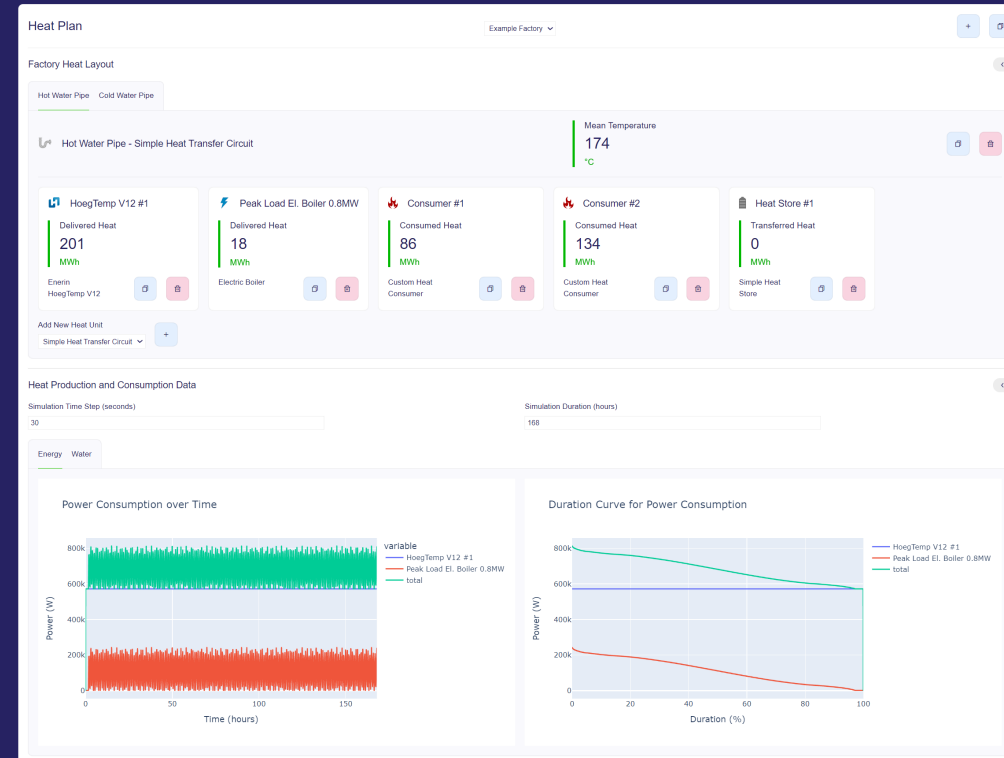
Evaluate existing systems and new solutions and heat pumps

Energy result and RoI with different energy price scenarios

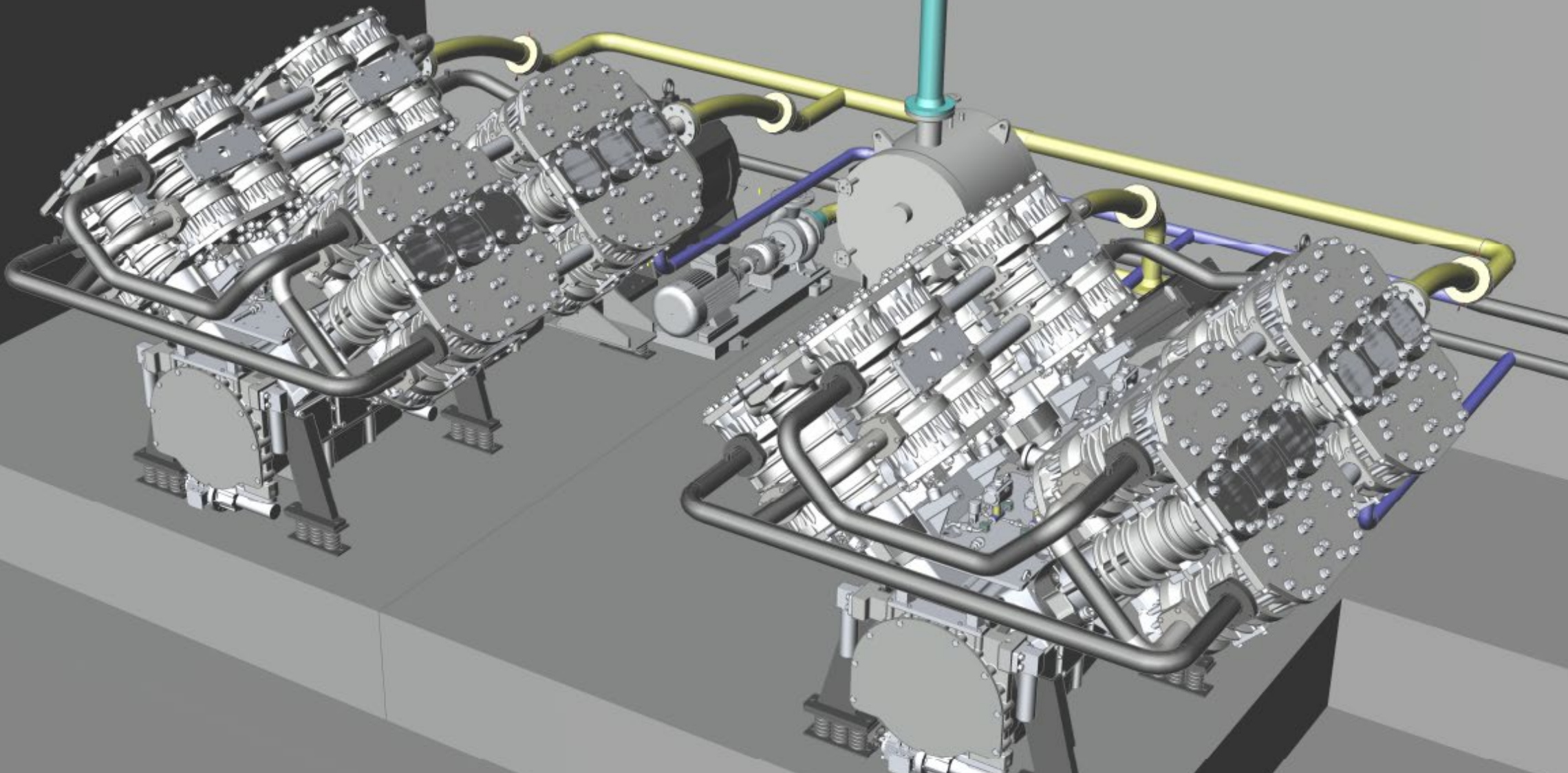
Steam generating heat pumps, OST Webinar, 18 March 2024



Virtual Factory Heating



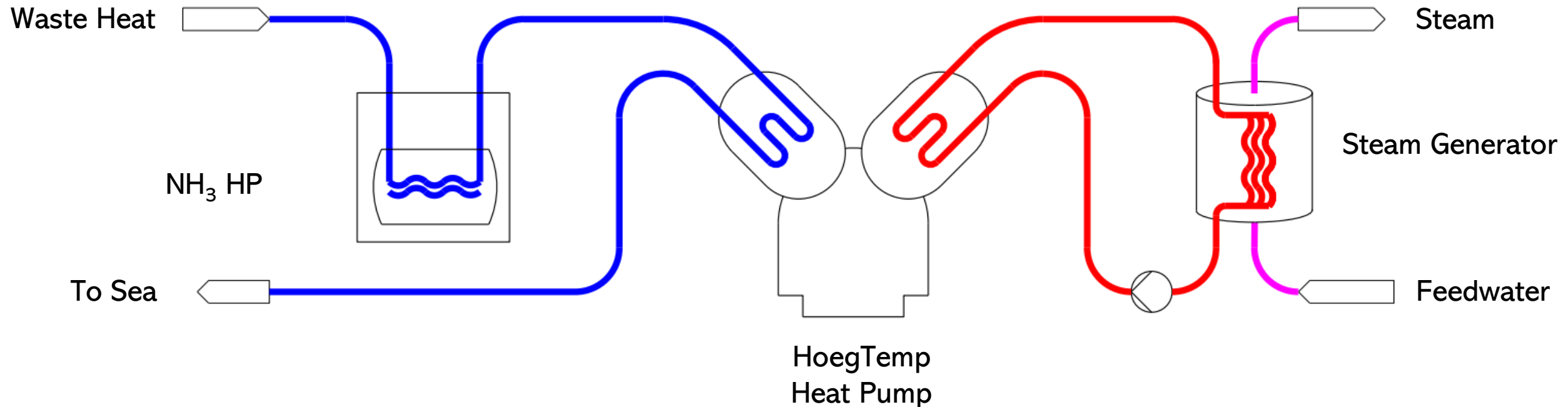
1.6 MW 8 bar Steam



5-8 bar_G Steam from Waste Heat

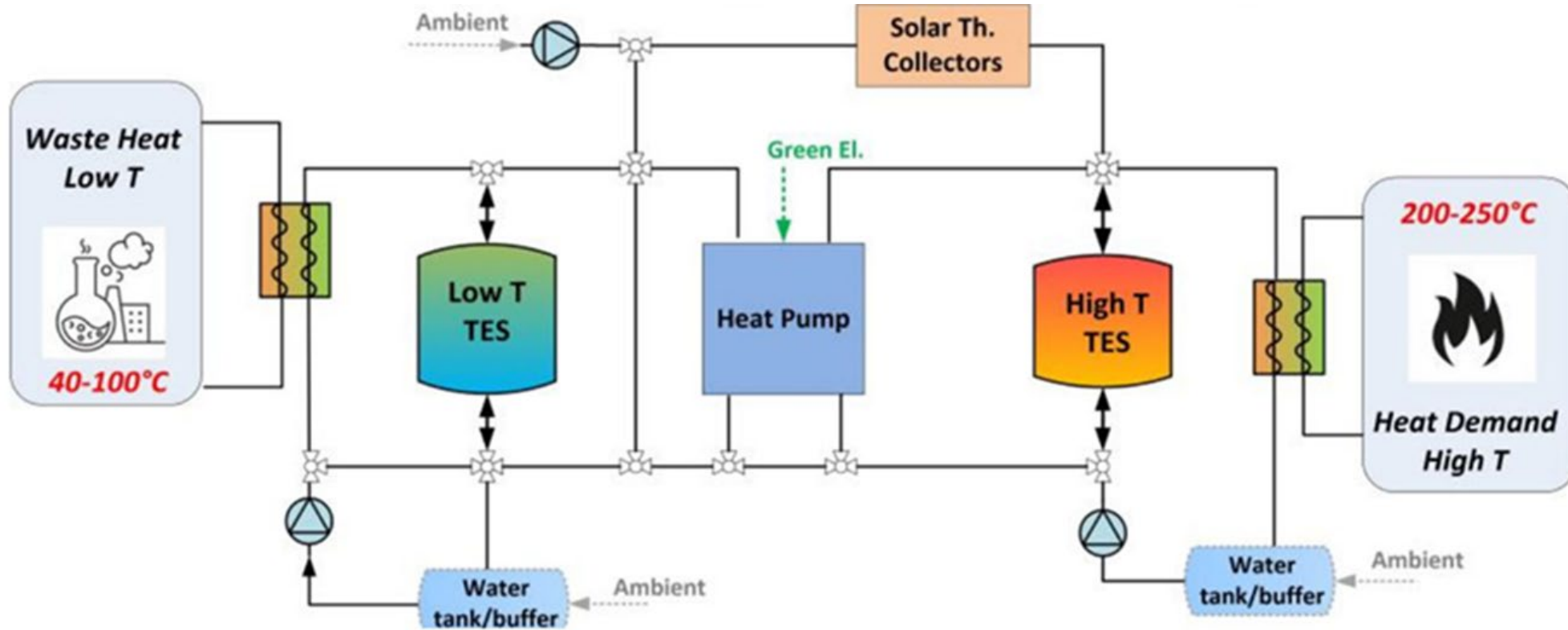
Variable steam demand - variable, high-glide heat source 5°-90°C

Expected COP 1.5-2.5 (1.8 typical)



Susheat EU Project

Integration of 250°C heat pump with Thermal Energy Storage 2026



Technology to Decarbonize Industry Today

Steam generating heat pumps, OST Webinar, 18 March 2024

7 AFFORDABLE AND
CLEAN ENERGY



8 DECENT WORK AND
ECONOMIC GROWTH



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



11 SUSTAINABLE CITIES
AND COMMUNITIES



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



13 CLIMATE
ACTION



17 PARTNERSHIPS
FOR THE GOALS

