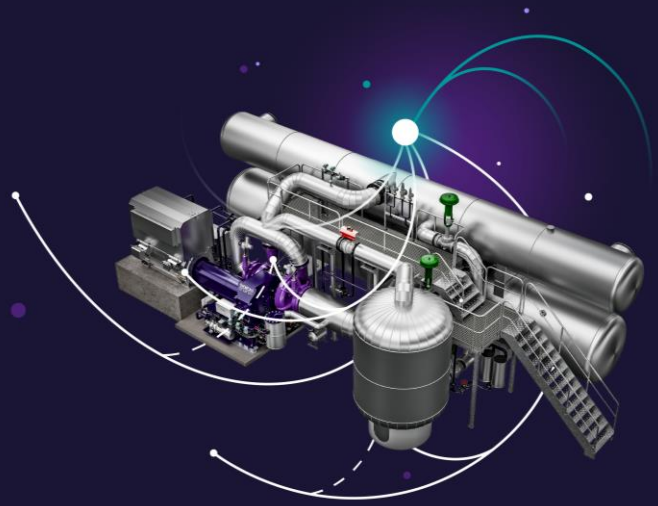
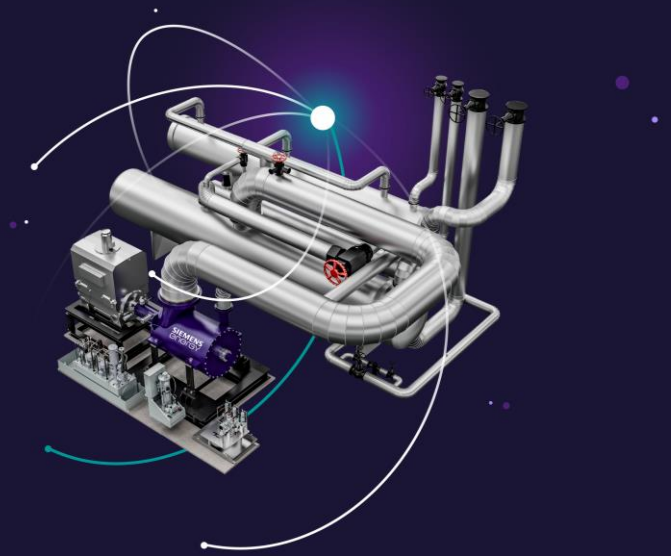
Industrial Heat Pump

Decarbonization of heat

2022

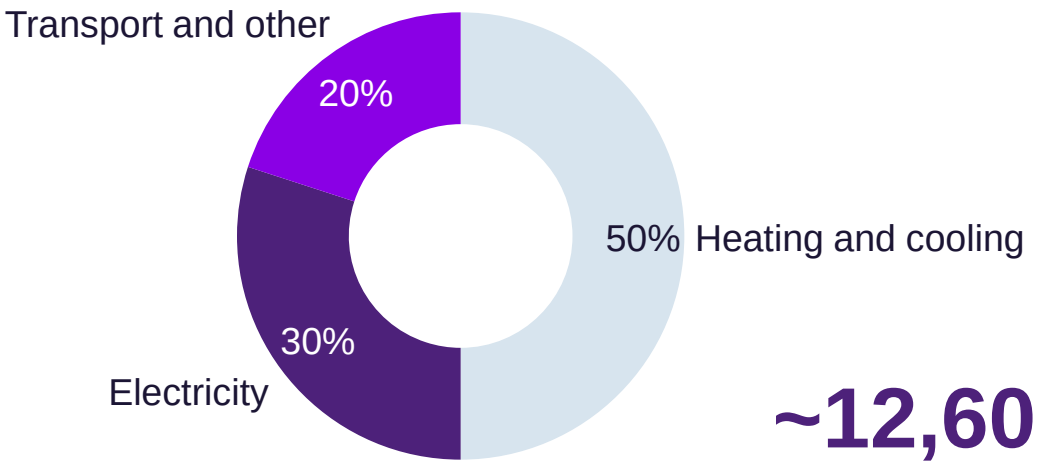




Decarbonized Energy Systems

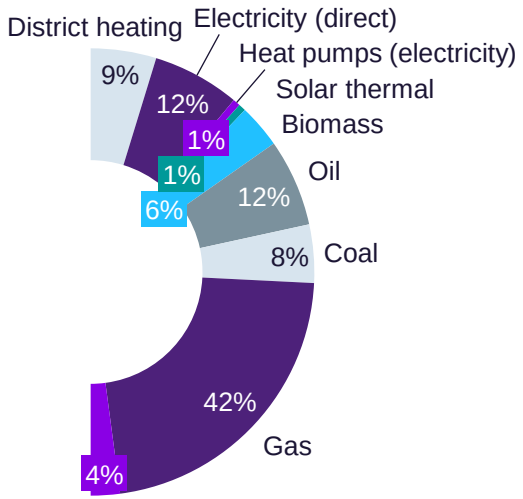
Today – Decarbonization is urgent
Heat in Europe is still largely produced from fossil sources

Final energy consumption EU28



~12,600
TWh *(2015)*

Heating and cooling in EU28 by carrier



~6,300
TWh *(2015)*

50%
of final energy use is heat → more than double comparing electricity

2/3 heat
is produced from fossil fuels → ~40% of energy related CO_2 emissions

Decarbonizing the heat sector requires

- Efficiency improvements (e.g., thermal insulation, use of waste heat)
- **Replacement of fossil fuels** with renewables or renewable power

Market Need for Large Scale Industrial Heat Pumps

Energy market

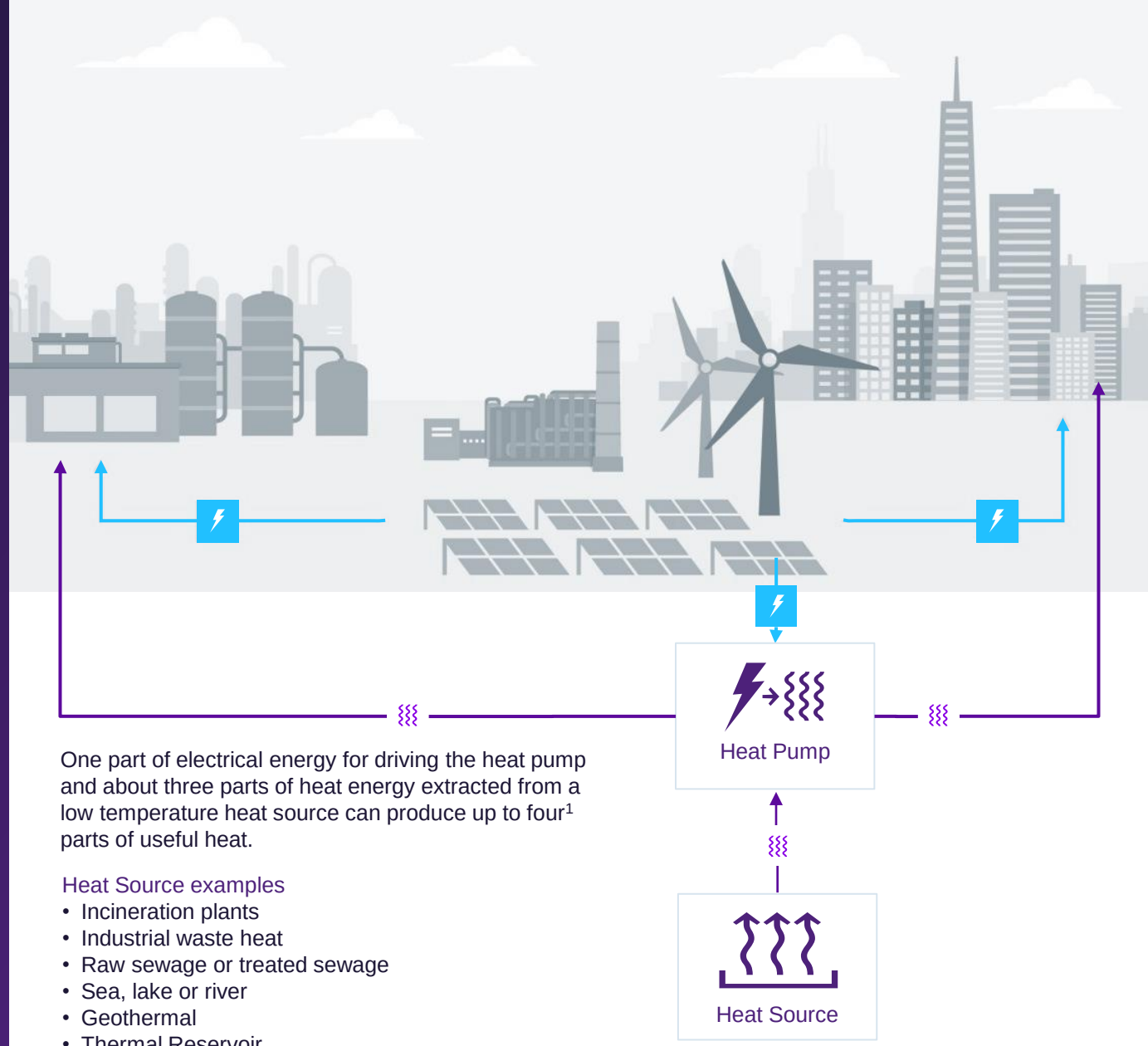
is changing with a continuous increase of renewable energy whilst heat from combustible applications becoming less.

This at the same time as the need for heat is increasing.

Electricity

from wind-, solar- and hydro power need to be converted into heat. Industrial scale heat pumps is both economic and environmentally friendly and will play an important role on the future energy market.

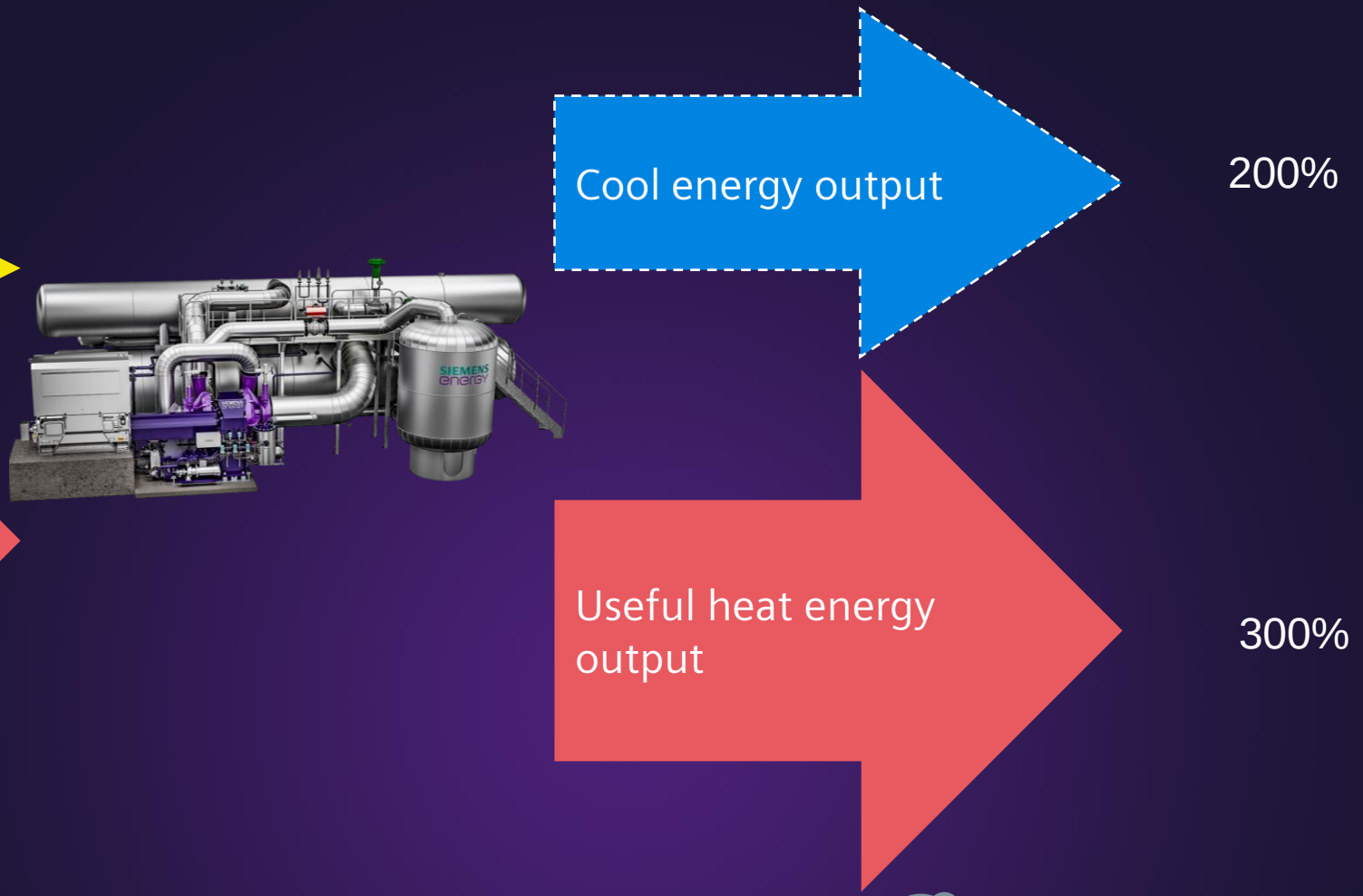
1 Note: Performance depends on specific site conditions



One part of electrical energy for driving the heat pump and about three parts of heat energy extracted from a low temperature heat source can produce up to four[1] parts of useful heat.

Heat Source examples
- Incineration plants
- Industrial waste heat
- Raw sewage or treated sewage
- Sea, lake or river
- Geothermal
- Thermal Reservoir
- Server Hall

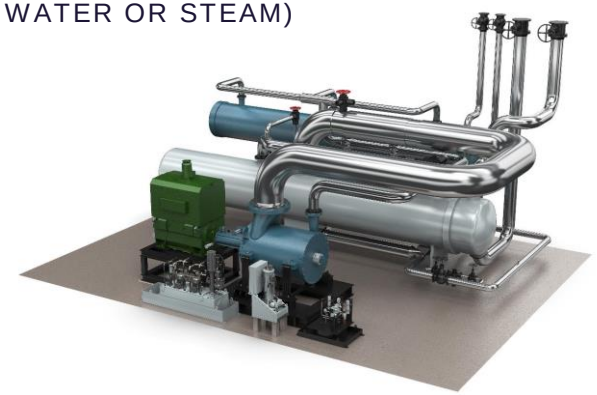
An introduction to heat pumps
What is the benefit of a heat pump?



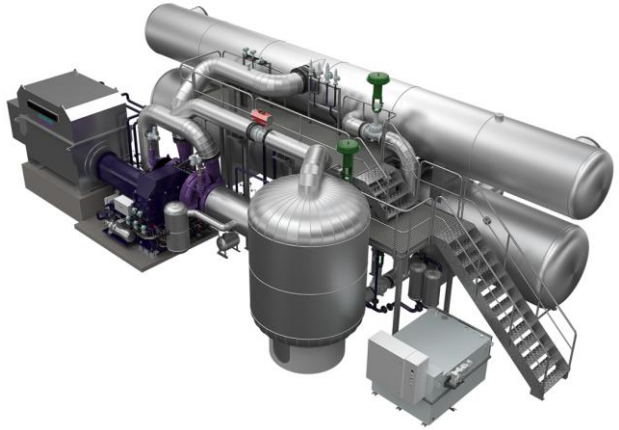
Industrial scale Heat Pumps from Siemens Energy
address both district heating and industry applications

TWO COMPLEMENTARY PRODUCT LINES …

SHP-STC-XX W/S
HIGH TEMPERATURE HEAT PUMP
5 – 70 MW, UP TO 150 °C (HOT WATER OR STEAM)



SHP-C600/C750
BASED ON PROVEN DESIGN (SINCE 1980_S)
15 – 45 MW, UP TO 100 °C (HOT WATER)



… TO SERVE THE NEEDS OF OUR CUSTOMERS

HEAT SUPPLY
~5 - 70MW_{th} per unit

TEMPERATURES
up to **150°C**

ENVIRONMENT FRIENDLY WORK MEDIUM
low **GWP** and **ODP**

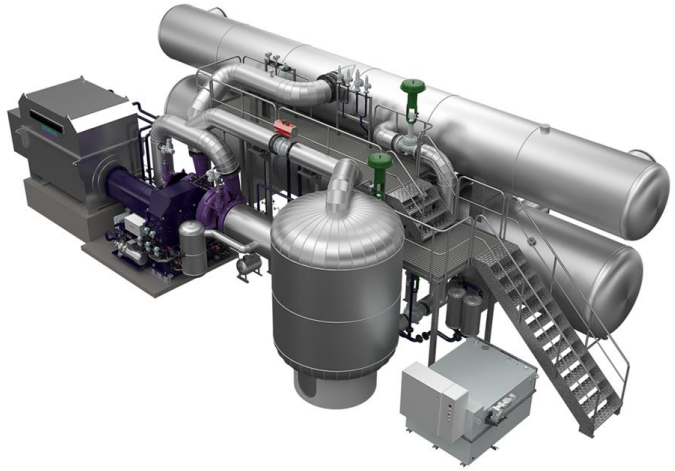
VARIOUS DRIVE CONCEPTS
electrical or **mechanical**

SCOPE OF SUPPLY
component up to **turnkey supply**

Industrial Heat pump SHP-C600/750, 15-45 MWth

The existing fleet has over the years truly proven the robustness of the heavy-duty industrial heat pump.

- Design based on the 50 deliveries, starting in mid 80s.
- 6 + Millions accumulated operation hours
- Continuously development by inhouse competence for high COP.
- Industrial design with High Reliability & Availability
- Operational flexibility for dynamic operation suited for the FCR requirement.
- Dynamic operation – Quick ramp rates, Down to 30 % load
- Modern Efficient and Environmentally Friendly Refrigerant R1234ze(E) with Low GWP.
- Flexible modularized design optimized for each customer.
- Turbo compressor module pre-assembled in workshop.



Heat Output 15-45 **MW_{th}**
Cooling Output 5-25 **MW_{th}**

District Heating Supply Temperature
up to 100°C

Modularized concept
Design flexibilty and secure high quality

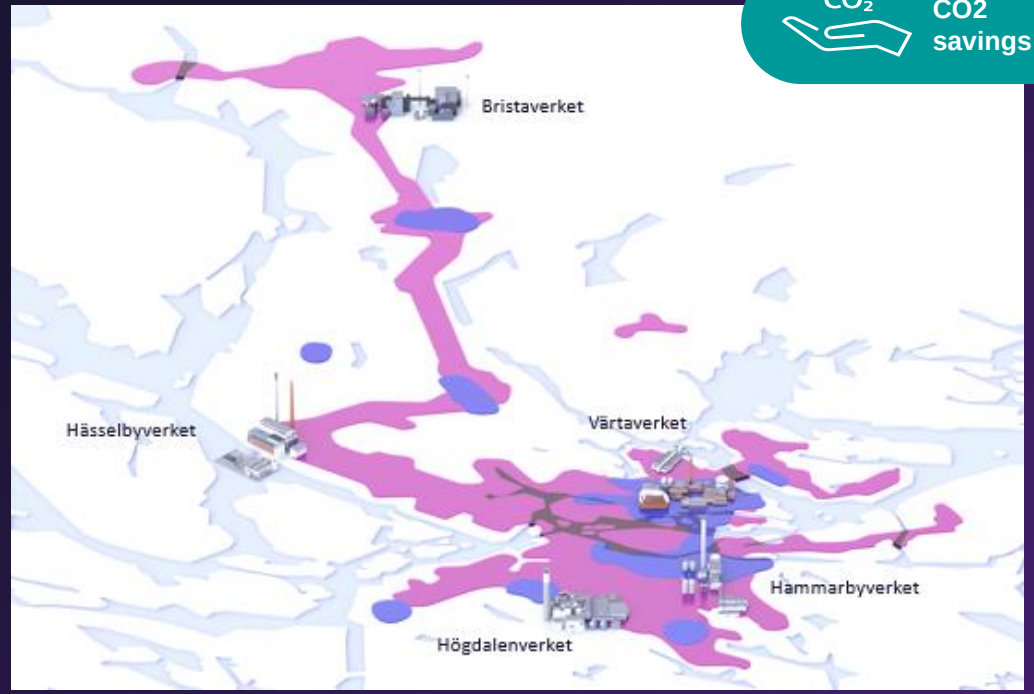
Dynamic operation, FCR
Load ramp, up 2 **MW_e**/60s down 2 **MW_e**/30s

Heat source flexible
Sea water
Sewage - Process water
Air from outdoor or building
Geothermal

REFERENCE EXERGI PROJECT, STOCKHOLM, SWEDEN | 2020

Siemens Energy is providing Stockholm with a climate neutral district heating and cooling supply

CO_2 CO2 savings



PROJECT TYPE

Heat & Green Municipalities

Combined heat and power | Heat pumps | Efficiency | CO_2-savings

Deep decarbonization

Customer Challenge/Driver

Carbon Neutral District Heating combined with District Cooling. Cooling operation flexibility during summer to operate with low heat demand for district heating.

Portfolio Elements

Low-temperature heat pump plant solution (from 20 MWth to 215 MWth) are located centralized and decentralized.

Scope

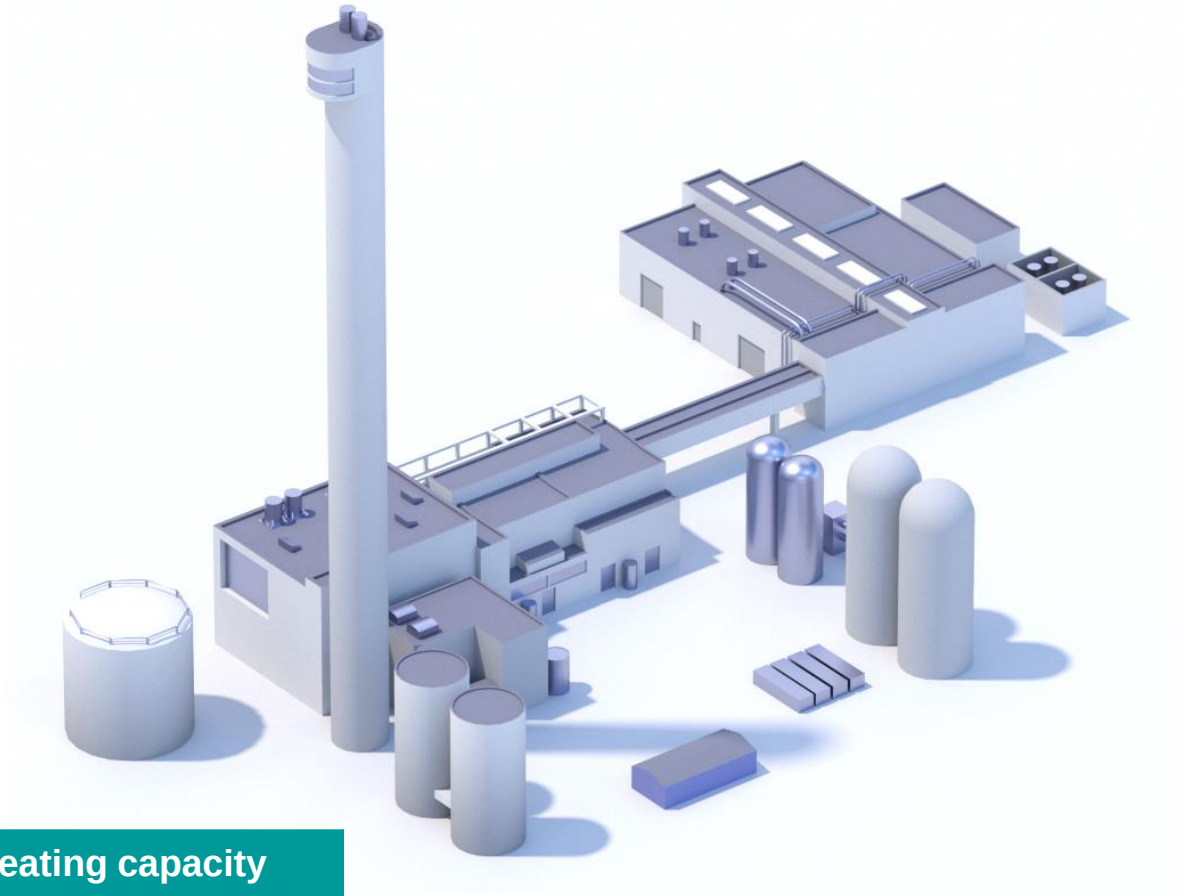
Heat Pumps optimized for each location and operational demand. Both Tube and Falling film evaporator to optimize performance to heat source temperature.

Customer Benefit

- Outstanding availability in operation since 1980s
- The compressor has been updated to meet new demands and increase efficiency
- Converted to new refrigerant
- Planned for operation for the next 20 years
- Reduced emissions compared to other heat power plants

Hammarbyverket

Heats 80,000 apartments
Energy from purified waste water
Heat and cooling generated simultaneously



Plant	Fuel	Operational	Heating capacity	
			MW	GWh
7 heat pumps	Waste water, electricity	1986-1991	215	900
2 boilers	Bio-oil	1986	200	140
Total			**415**	**1 040**

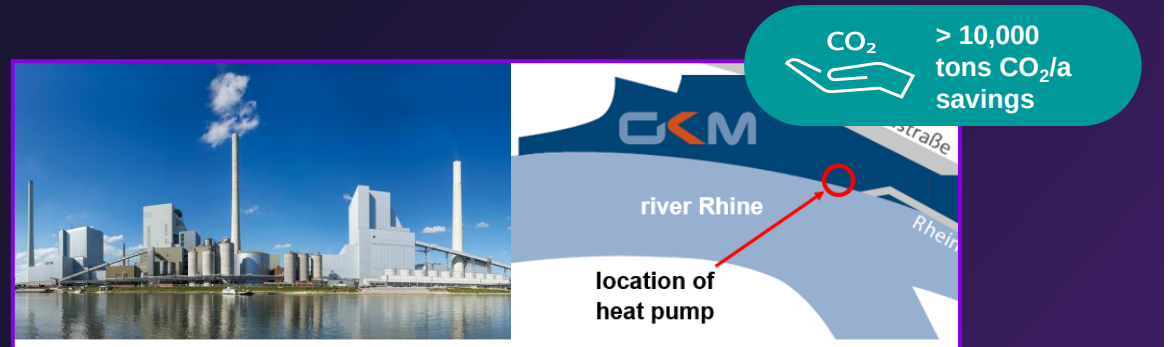
REFERENCE MVV & GKM MANNHEIM, GERMANY | 2021

Siemens Energy and MVV with GKM using a large-scale heat pump to do the first step towards green district heating

Press release

Seen on TV

Deep Decarbonization



Customer Challenge/Driver

Decrease the use of coal at GKM power plant by installation of a heat pump using the river as energy source. The new heat pump is the first step towards the goal of green district heating. MVV and the City of Mannheim is targeting to become CO_2 neutral in the district heating production by 2030.

Portfolio Elements

Low temperature heat pump SHP-C600 from Finspang (20 MW_{th}) enabling temperature levels up to 99 °C, compressor with gear, electrical motor, heat exchangers, storage tank & control system

Scope

Delivery of a complete heat pump SHP-C600 including full installation and commissioning

Customer Benefit

- Decrease the use of coal
- Use the river Rhine as heat source
- Provide 50 GWh/a heat for the district heating network
- More than 10,000 t of CO_2 emissions savings per year versus heat from a gas boiler at 2,500 full operating hours

PROJECT TYPE

Heat & Green Municipalities

Combined heat and power | Heat pumps | Efficiency | CO_2-savings

REFERENCE QWARK³ PROJECT, VATTENFALL, BERLIN | MARCH 2021

Vattenfall and Siemens Energy help advance a climate-friendly heating supply for Berlin with large scale heat pump

Press release

Deep Decarbonization

Customer Challenge/Driver

Utilize unused waste-heat of district cooling as heat source for district heating

Portfolio Elements

High-temperature heat pump (8 MW_{th}) enabling temperature levels from 85 to 120 °C

Scope

Our role: Provide new large scale heat pump technology
Partner: Vattenfall Wärme Berlin

Customer Benefit

- Avoid unused heat being dissipated into the environment
- Provide 55 GWh/a additional heat for the district heating network
- 6,500 t of CO_2 emissions savings
- 120,000 m³ of cooling water savings

PROJECT TYPE

Heat & Green Municipalities

Combined heat and power | Heat pumps | Efficiency | CO_2-savings

SHP-C600/C750 heat cycle, operation and main equipment

Evaporator
Cold liquid refrigerant heated to gas phase.

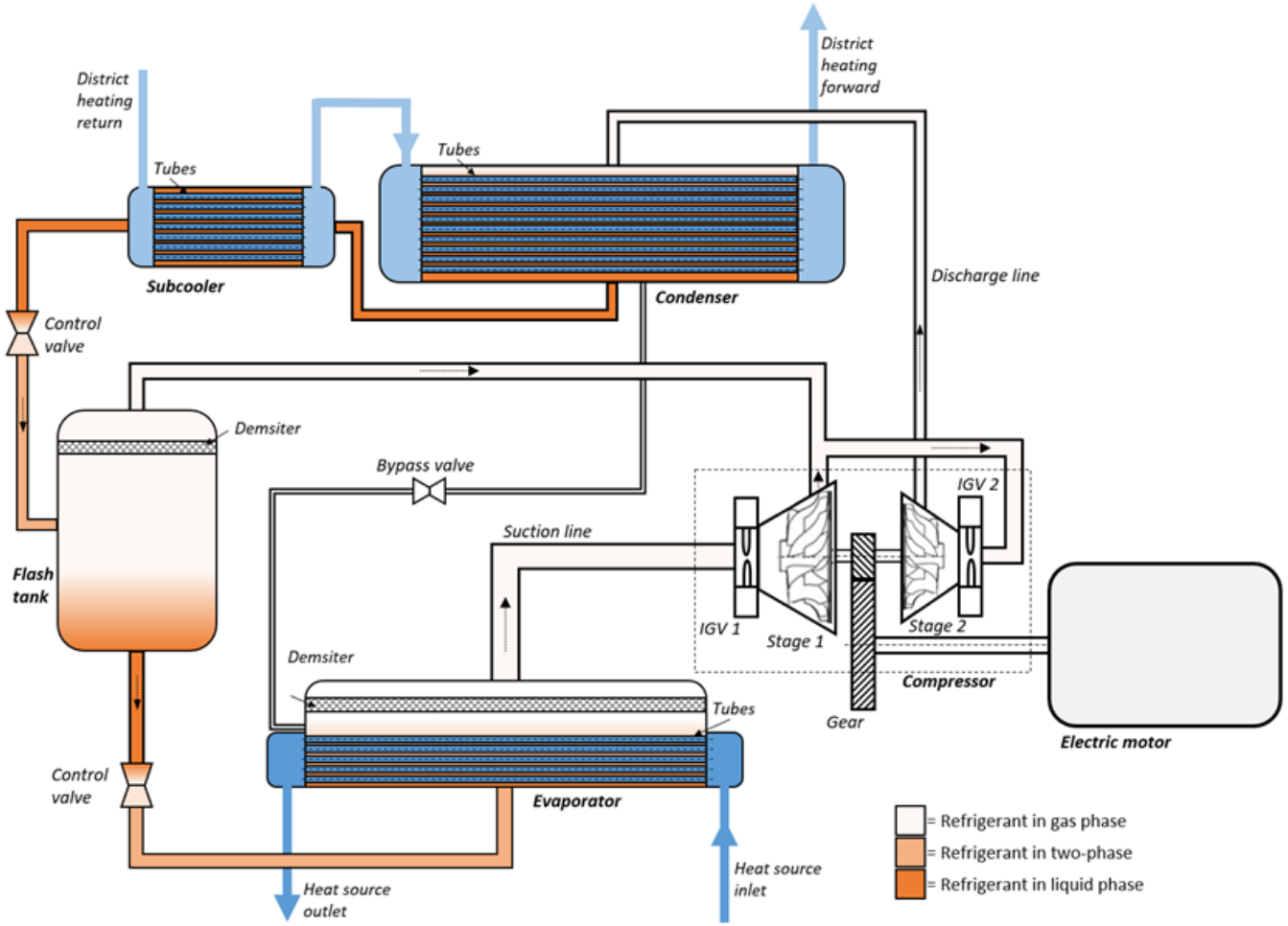
2-stage Compressor
Evaporated refrigerant pressure increased in two stages.

Condenser
Overheated gaseous refrigerant heat district heating water and condense to liquid.

HP Control Valve
Refrigerant expanded to mix phase.

Flash Tank
Separates gas from liquid refrigerant.

LP Control Valve
Refrigerant pressure and temperature reduced.



2020-12-18

Contact overview – Siemens Energy Heat Pumps

Henrik Örn
Business Owner SHP-C600

Engineering
Phone +46 (122) 81000
Mobile +46 702735447
E-mail henrik.orn@siemens-energy.com

Dr. Christian Hüttl
Business Owner SHP-STC-XX W/S

Industrial Heat Pump Solution
Phone +49 (9131) 17-38099
Mobile +49 (172) 5213738
E-mail christian.huettl@siemens-energy.com

Mats Flenhagen
Senior Sales Manager

Generation Sales
Phone +46 12282956
Mobile +46 702495485
E-mail mats.flenhagen@siemens-energy.com

Norbert Wenn
Senior Sales Manager

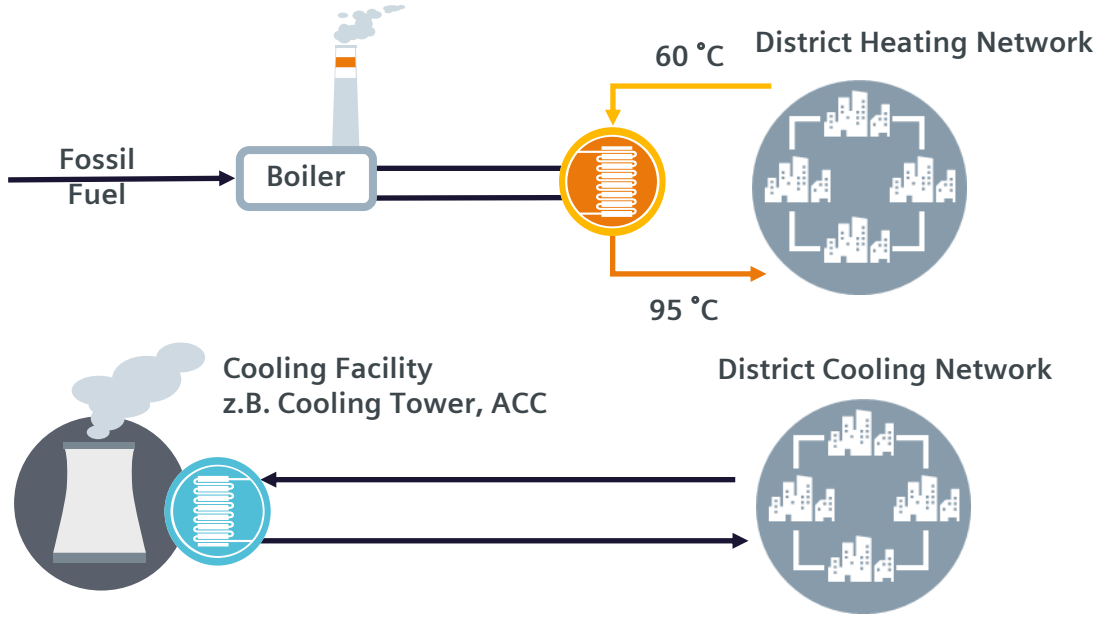
Generation Sales Europe
Phone
Mobile +49 (152) 22524749
E-mail norbert.wenn@siemens-energy.com

Tanja Zusann
Senior Consultant DES

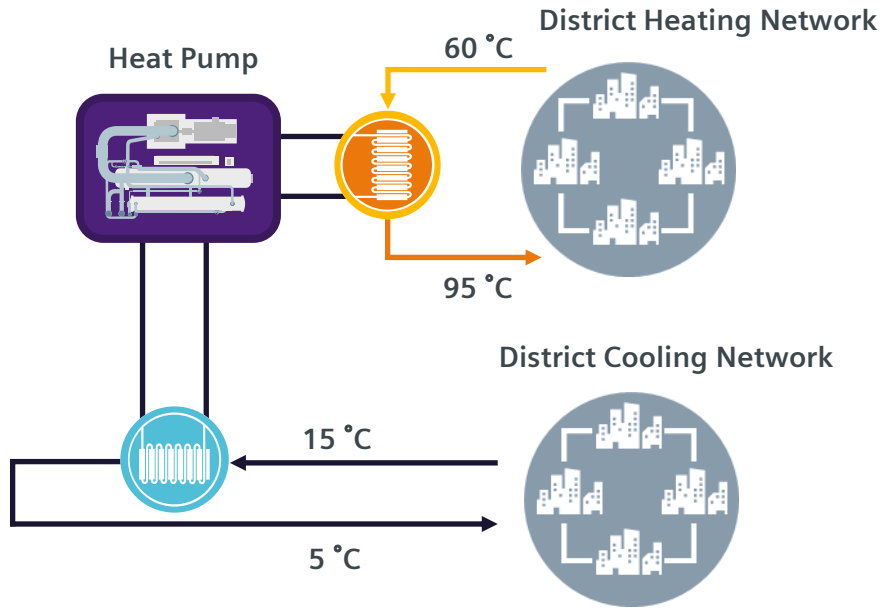
Generation Sales DES
Phone
Mobile +49 (172) 8338454
E-mail tanja.zusann@siemens-energy.com

Industrial Heat Pumps @ Industry
Production of useful heat to District Heating from District Cooling Network

SITUATION TODAY



IMPROVED SITUATION WITH HEAT PUMP

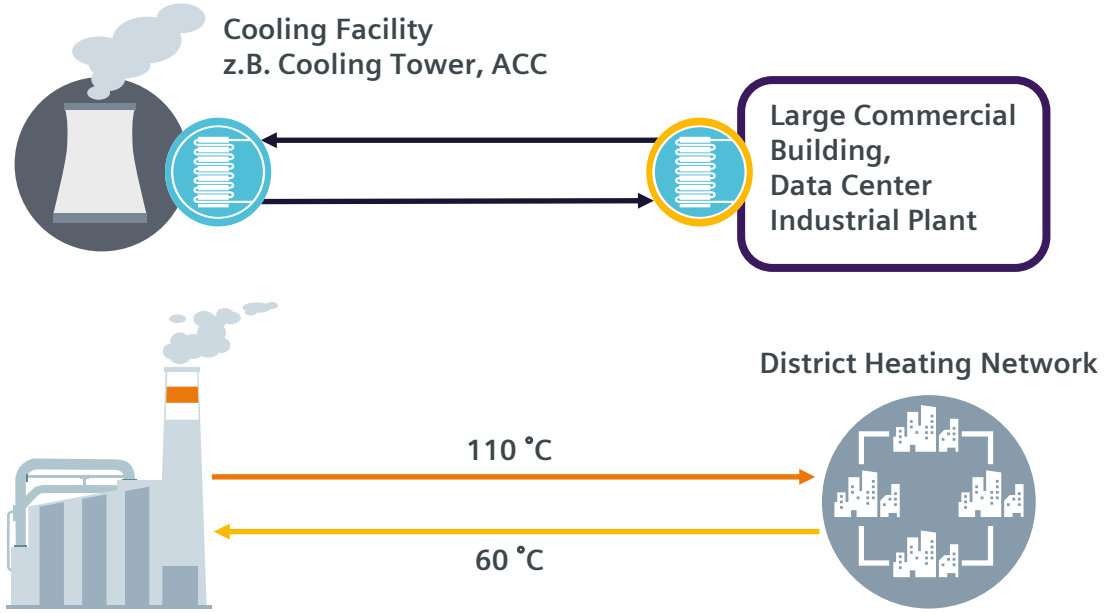


BENEFITS

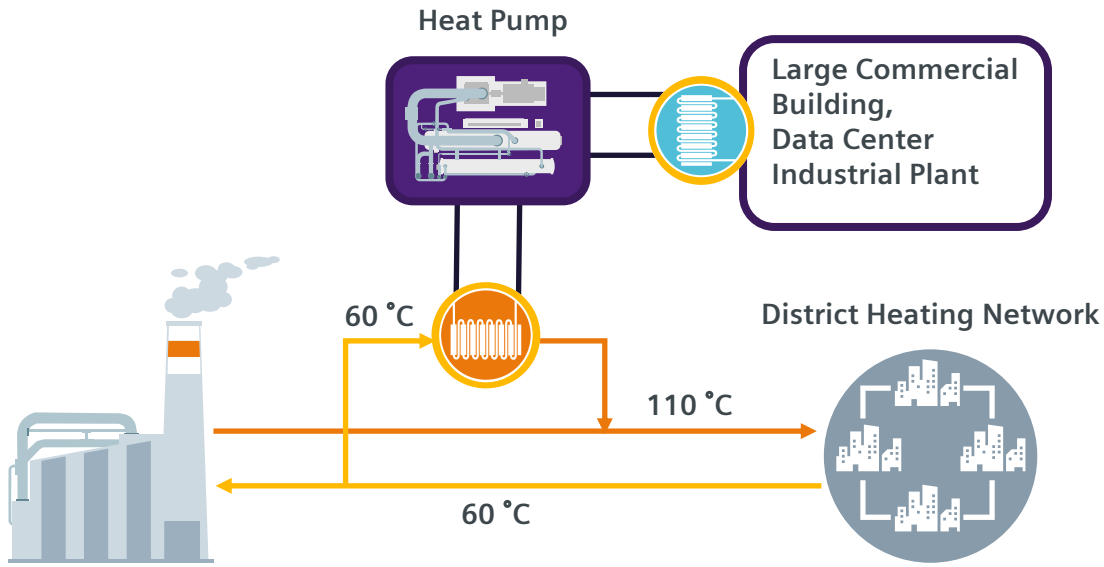
- District Heating heat supply with reduced CO2 emissions
- Less dependency on fossil fuels
- Use waste heat from Colling source
- Reduced cooling demand → no additional cooling facilities needed anymore → e.g. reduction of aux. consumption, make-up water

Industrial Heat Pumps @ District Heating & Industry
Integration of large cooling systems / utilization of new heat sources

SITUATION TODAY



IMPROVED SITUATION WITH HEAT PUMP

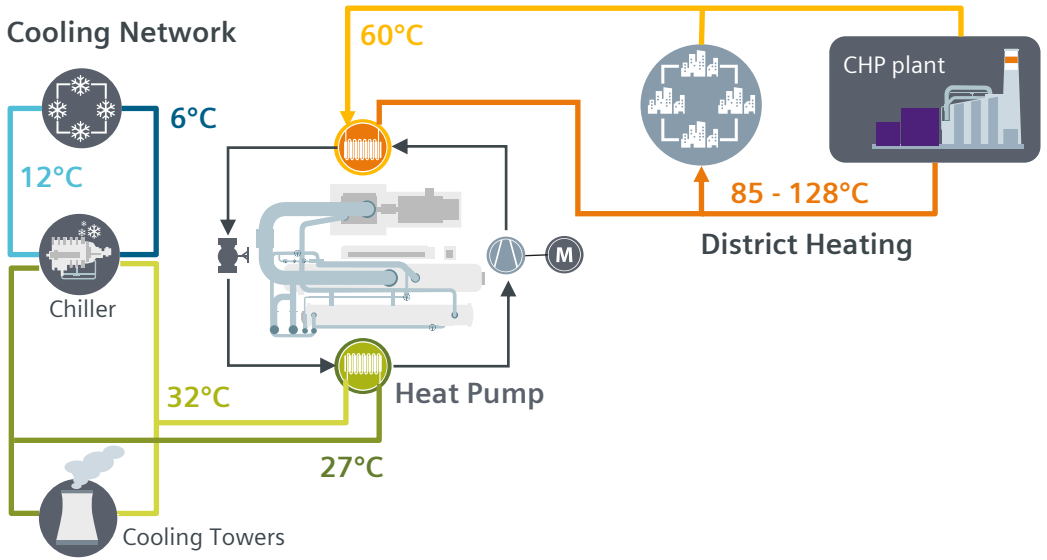


BENEFITS

- Waste heat from large commercial buildings, data centers and industry can be utilized for district heating → opening up new sources for district heating
- Combined-Heat-and-Power-and-Cooling → re-use of waste heat → reduced heat rejection to ambience
- no additional cooling facilities needed anymore → e.g. reduction of aux. consumption, make-up water
- “cooling” as additional product for heat pumps

Integration of Industrial Heat Pump – Project Example
Heating and cooling facility at Potsdamer Platz | Overview & key figures

OVERVIEW



BACKGROUND

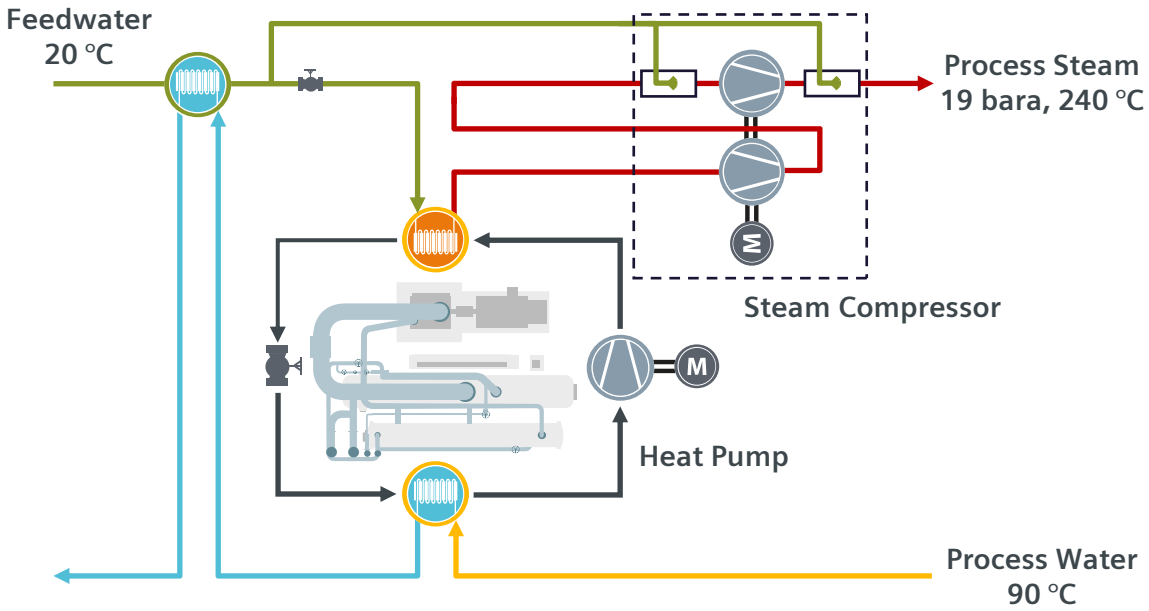
- Heat pump lifts the temperature level of cooling water from chillers to the temperature level of the district heating system
- Public funded project (BMWi) in cooperation with Vattenfall Wärme Berlin

KEY FIGURES

CAPACITY	1 Unit ~8 MWth,
AVERAGE COP	~3
REFRIGERANT	Hydro-(-chloro)-fluoro-olefin (H(C)FO)
ARRANGEMENT	Brownfield (integration in existing building)
HEAT SOURCE	Cooling water return from compression chillers to wet cell cooling tower (32 → 27 °C)
HEAT SINK	District heating (50 → 85 - 128°C)
COMPRESSOR	SIEMENS single shaft centrifugal vertically split radial compressor
LUBE & SEAL OIL SYSTEM	Combined lube and Seal Oil System
HEAT EXCHANGER	Semi-welded Plate Type Heat Exchangers (Evaporator, Condenser, Subcooler)
I&C SYSTEM	T3000 compact

Integration of Industrial Heat Pump – Project Example
Process Steam Production in chemical plant | Overview & key figures

OVERVIEW



BACKGROUND

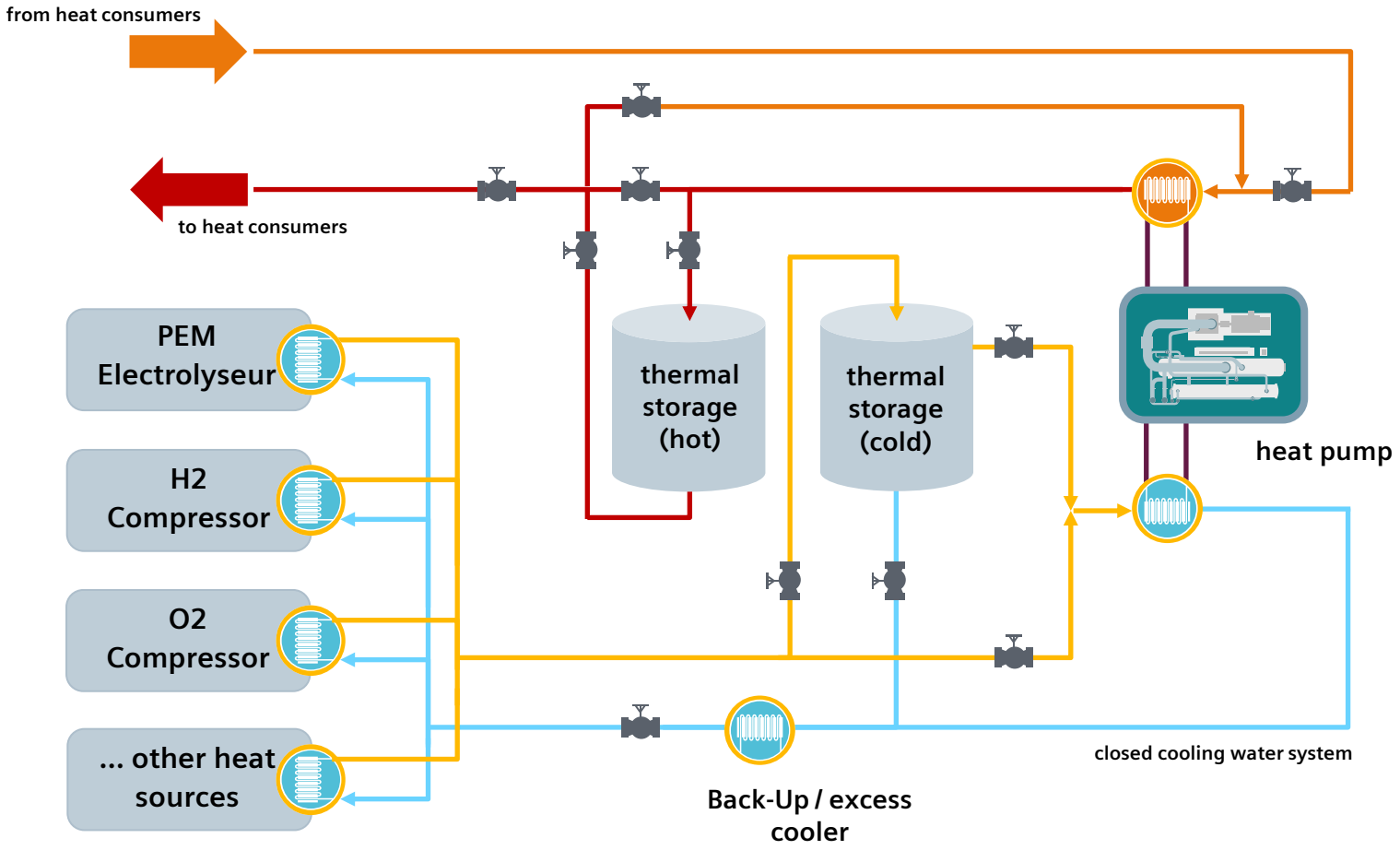
- High temperature heat pump utilizes waste heat from process water of reactors to produce saturated steam from feedwater
- Saturated steam is fed to steam compressor (multi-stage intercooled / attemporated)
- Final adjustment of steam parameters by attemporation

KEY FIGURES

CAPACITY	36 MWth HP & Steam Compressor = 50 MWth
AVERAGE COP	~ 2.5 (incl. steam compression)
REFRIGERANT	Hydro-(-chloro)-fluoro-olefin (H(C)FO)
ARRANGEMENT	Brownfield (integration in existing building)
HEAT SOURCE	Process water return from reactors (90 → 70 °C)
HEAT SINK	Process Steam (20 °C → 19 bara, 240 °C)
COMPRESSOR	SIEMENS geared type radial compressor
LUBE & SEAL OIL SYSTEM	Combined lube and Seal Oil System
HEAT EXCHANGER	Shell & Tube Heat Exchangers (Evaporator, Condenser, Subcooler)
I&C SYSTEM	T3000 compact

Concept – Waste Heat Utilization for Electrolysers
Heat Pump for cooling & supply of process heat (hot water)

PROCESS FLOW SCHEME



PRINCIPLE

- Heat Pump absorbs the heat from the H2 production and lifts it to higher temperature level e.g. for process heating (hot water or steam)

CHALLENGES

- Heat demand and waste heat from H2 production may timewise not be congruent
- Fluctuating heat from H2 production (esp. when driven be renewable electricity)

CONCEPT

- Decoupling of waste heat production and heat demand by thermal storage
- Optimized sizing of heat pump by integrating a thermal waste heat storage for electrolyzers