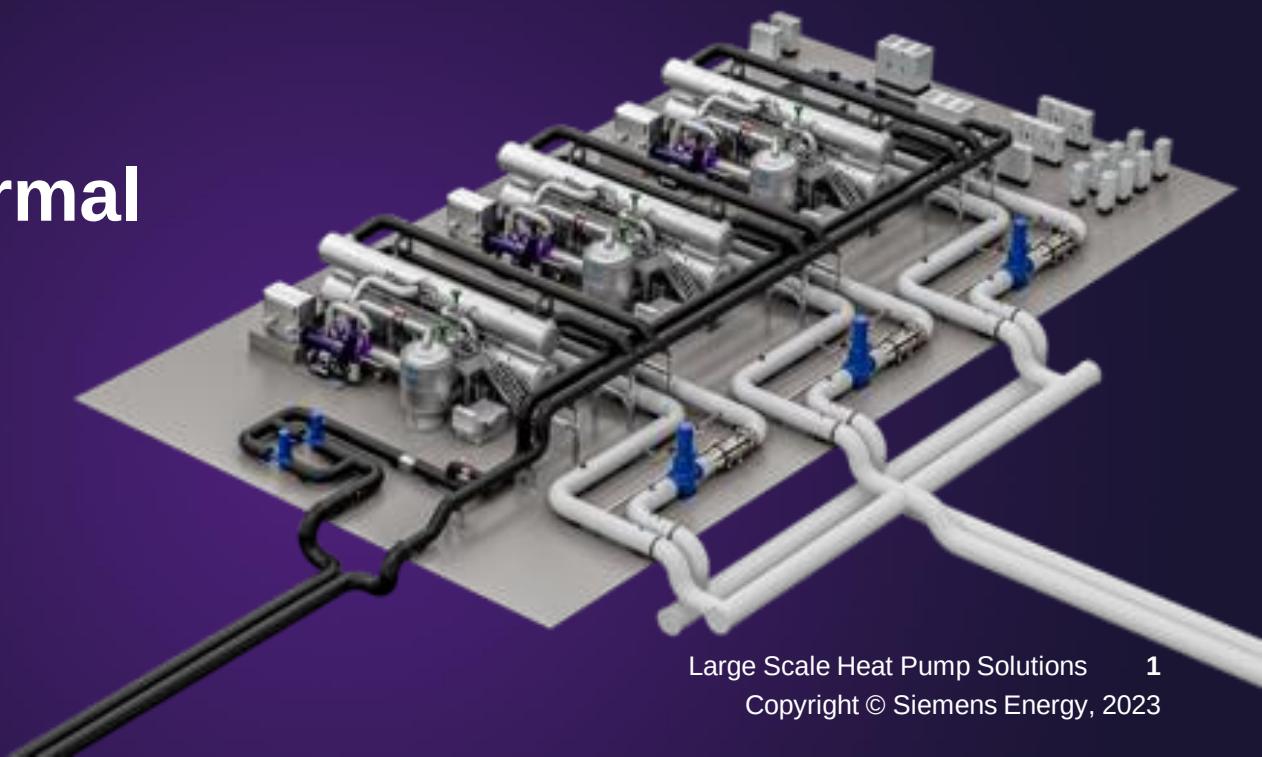
A Perfect Pairing

Unleashing the Power of Geothermal Energy with Heat Pumps

Ulrich Reinhardt | SE EU M&BD RT E
May 2023



Decarbonization of heating sector is essential to meeting global emissions targets and requires usage of Renewable Heat

~50%

of global final energy consumption is heat[1]

76%

from non-renewable sources[1]

40+%

of global energy related carbon emissions[1]

e.g., IEA analysis[1]

Use of Renewable Heat is key!

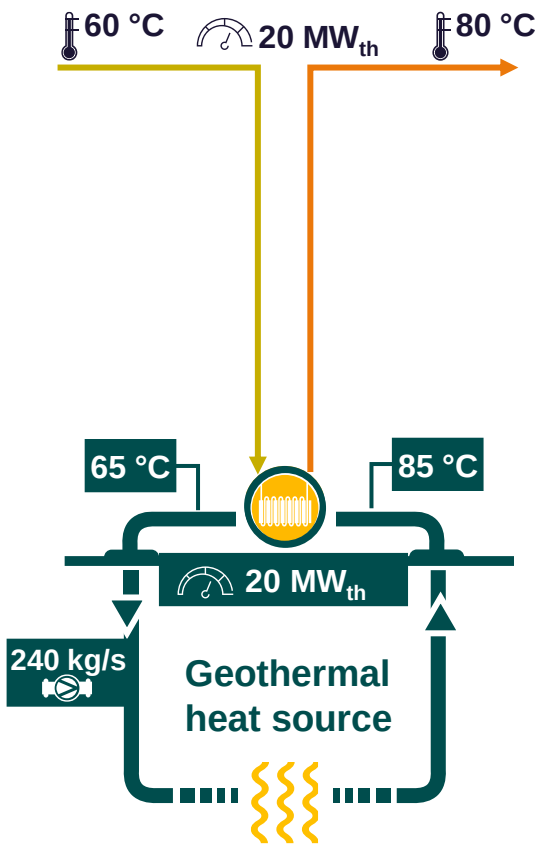
- **Thermal use of Modern Bioenergy**
- **Solar Thermal**
- **Geo-thermal**
- **Thermal use of Renewable Electricity**

my focus

[1]IEA (2021), *Renewables 2021*, IEA, Paris https://www.iea.org/reports/renewables-2021

Heat Pumps @ geothermal applications

IDEALIZED SKETCH



HEAT OFFTAKE CHALLENGES

Challenge:
District heating network requires higher feed temperature

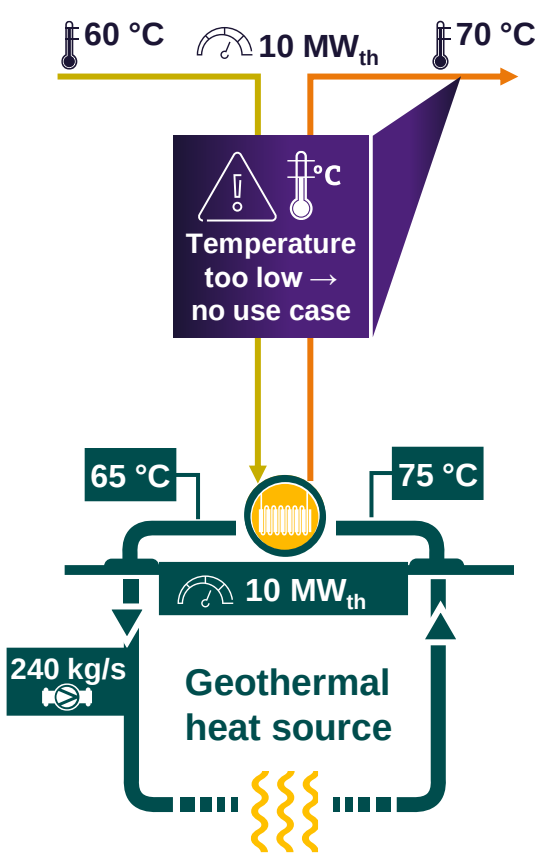
Challenge:
District heating network requires higher heat output

Challenge:
Geothermal heat source does not offer steam raising capabilities (only sensible heat) but heat offtake requires steam (latent)

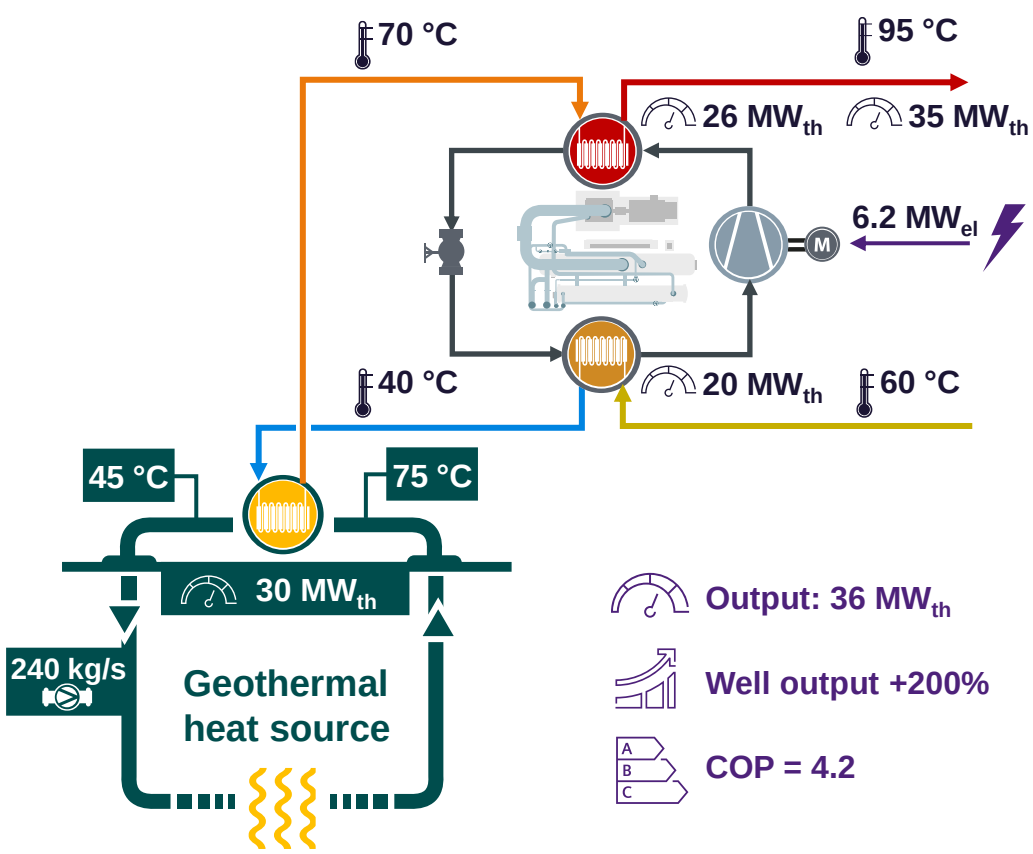
→ **All three challenges can be met with heat pumps**

Heat Pumps @ geothermal applications
Temperature increase of insufficient source

WITHOUT HEAT PUMP



WITH HEAT PUMP



Output: 36 MW_{th}

Well output +200%

COP = 4.2

CONCLUSION

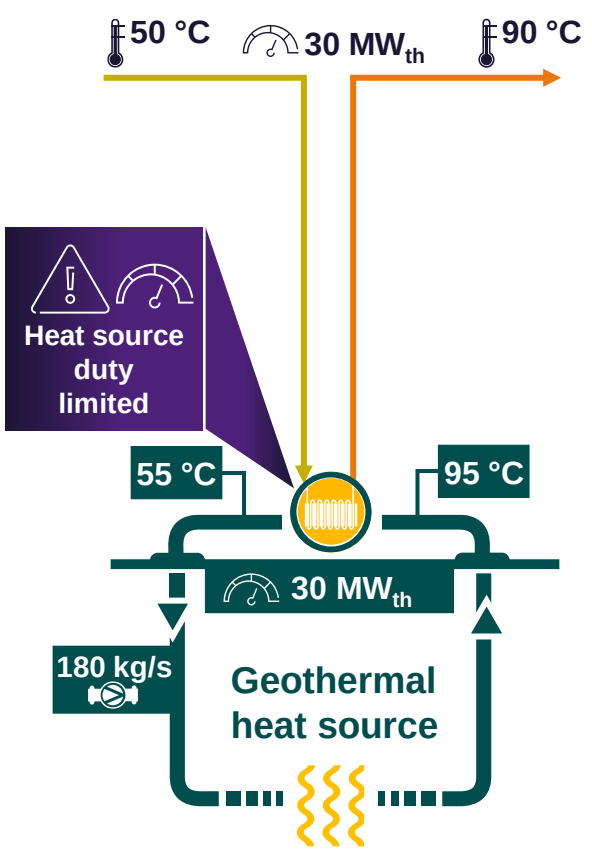
Without heat pump the temperature of geothermal source is too low

With heat pump the heat can be lifted to the desired temperature to assess the source

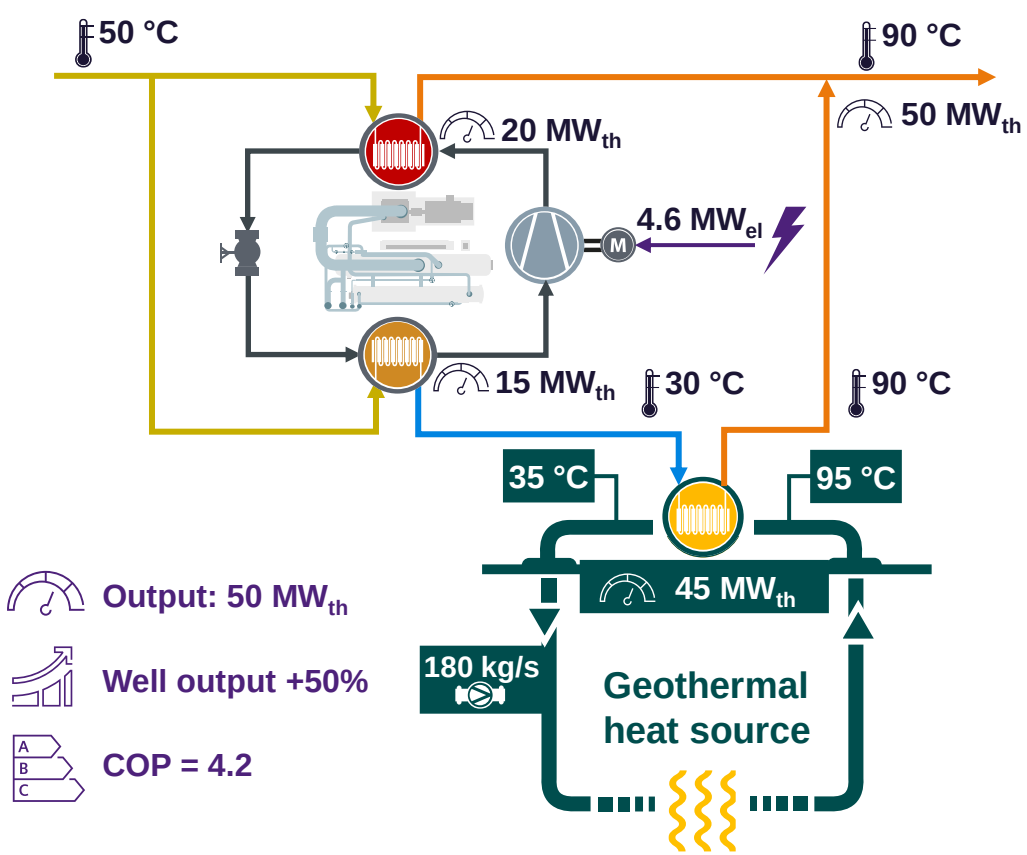
With heat pump the temperature spread can be increased → higher thermal power output

Heat Pumps @ geothermal applications
Capacity extension of geothermal source

WITHOUT HEAT PUMP



WITH HEAT PUMP

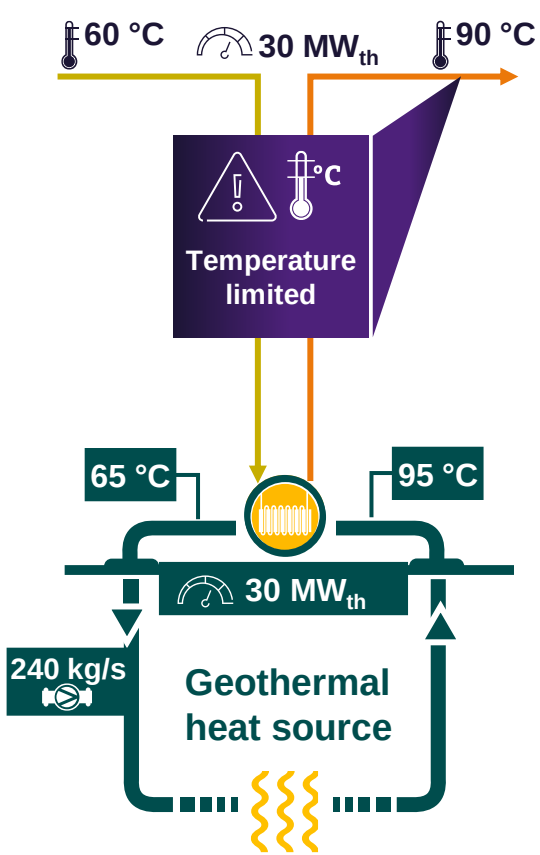


CONCLUSION

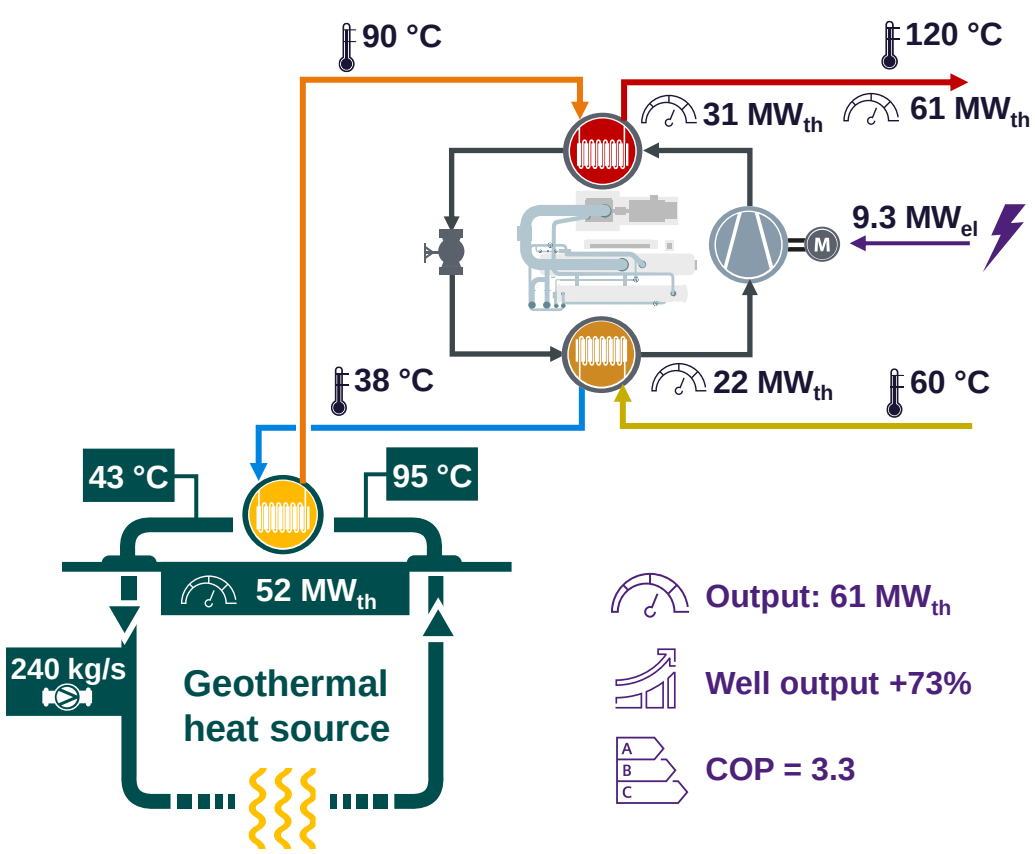
- Without heat pump the temperature spread at the geothermal source is limited
- Heat pump enables lower return temperatures at the geothermal heat source
- With lower return temperatures the thermal power output can be increased with same flow rate at the well

Heat Pumps @ geothermal applications
Temperature increase (and capacity extension)

WITHOUT HEAT PUMP



WITH HEAT PUMP



Output: 61 MW_{th}

Well output +73%

COP = 3.3

CONCLUSION

Without heat pump the temperature in the heating network is limited to the temperature at the well

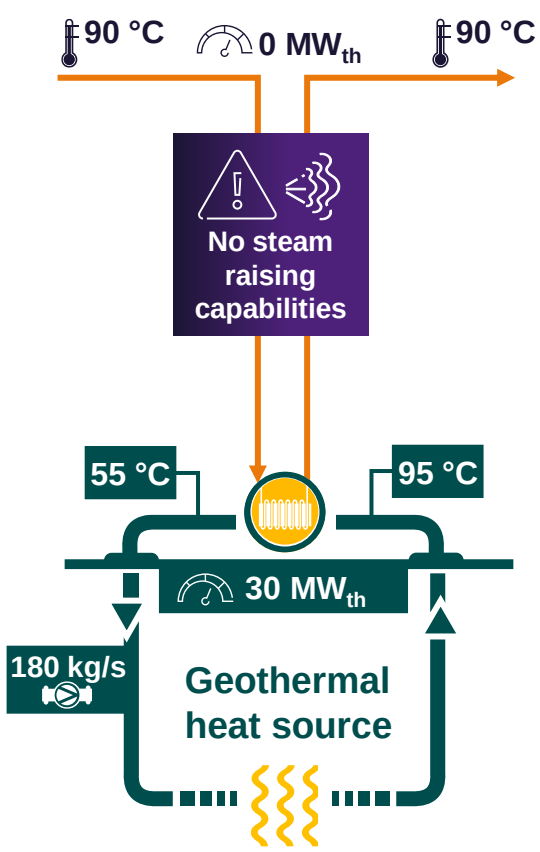
Topping temperature: Integrating a heat pump allow to stable enhance temperature level

With heat pump the temperature spread can be increased → higher thermal power output

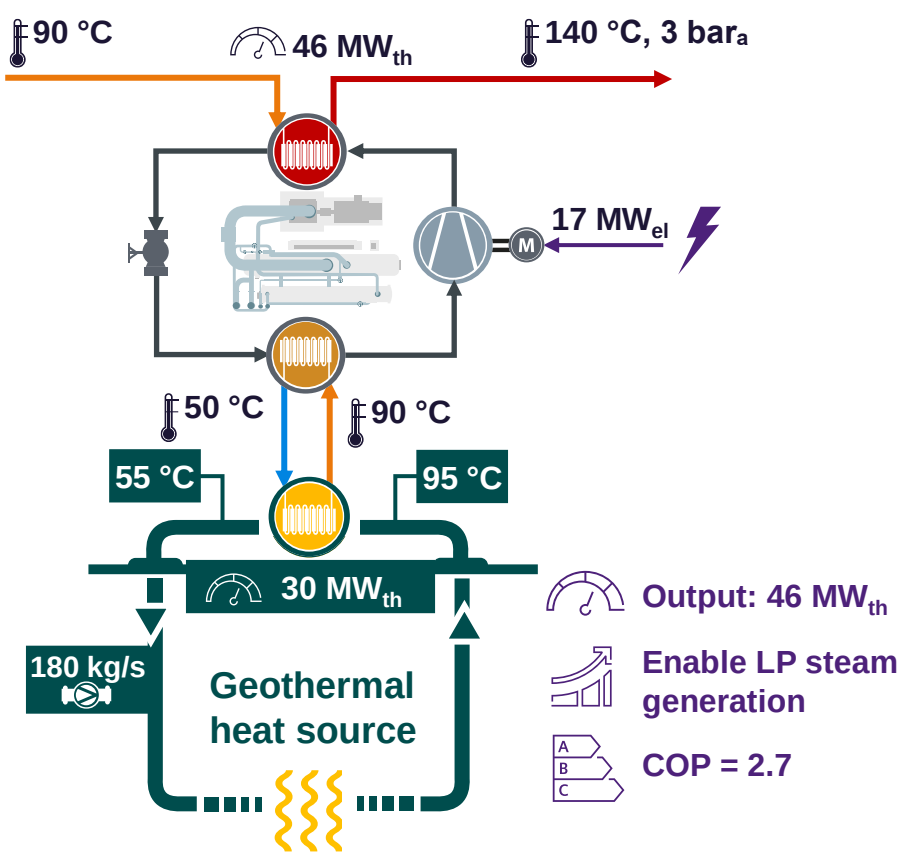
Heat Pumps @ geothermal applications
Steam generation - LP steam with HP

SIEMENS energy

WITHOUT HEAT PUMP



WITH HEAT PUMP



CONCLUSION

- w/o heat pump the temperature at the geothermal source does not allow for steam generation
- High temperature heat pump enables steam generation
- Geothermal capacity can be utilized for steam generation

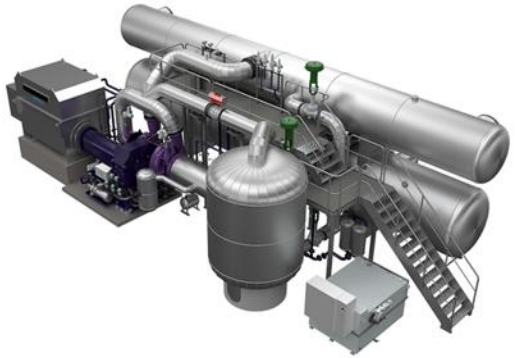
Industrial scale heat pumps from Siemens Energy
Address both district heating and industry applications

Two complementary product lines …

SHP-STC-XX W/S
High **T**emperature **H**eat **P**ump
8 – 70 MW_{th}, Up to 150 °C (hot water OR steam up to 3.7 bara)

1st reference: Potsdamer Platz
- 8 MW thermal output
- Customer: Vattenfall Wärme Berlin
- Expected PAC 06/2023

SHP-C600 / C750
Based on PROVEN design (since 1980s)
15 – 45 MW_{th}, up to ~ 110 °C (hot water)



Latest reference: Reallabor GKM
- 20 MW thermal output
- Customer: GKM Mannheim
- Expected PAC 09/2023

… to serve the needs of our customers

Heat supply
~8 – 70 MW_{th} per unit

Temperatures
up to **150°C** directly from heat pump

Environment friendly work medium
low **GWP[1]** and **ODP[2]**

Various drive concepts
Electrical or **mechanical**

Combination with steam compression
→ **higher temperatures** and **pressures > 3.7 bara (**process steam production **up to 55 bara**, **270°C**)

Scope of supply
Component up to **turnkey supply**

[1] GWP = Global Warming Potential
[2] ODP = Ozone Depletion Potential
[3] PAC = Provisional Acceptance Certificate

REFERENCE MVV & GKM MANNHEIM, GERMANY

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

PROJECT TYPE

Heat & Green Municipalities

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

May 2023

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

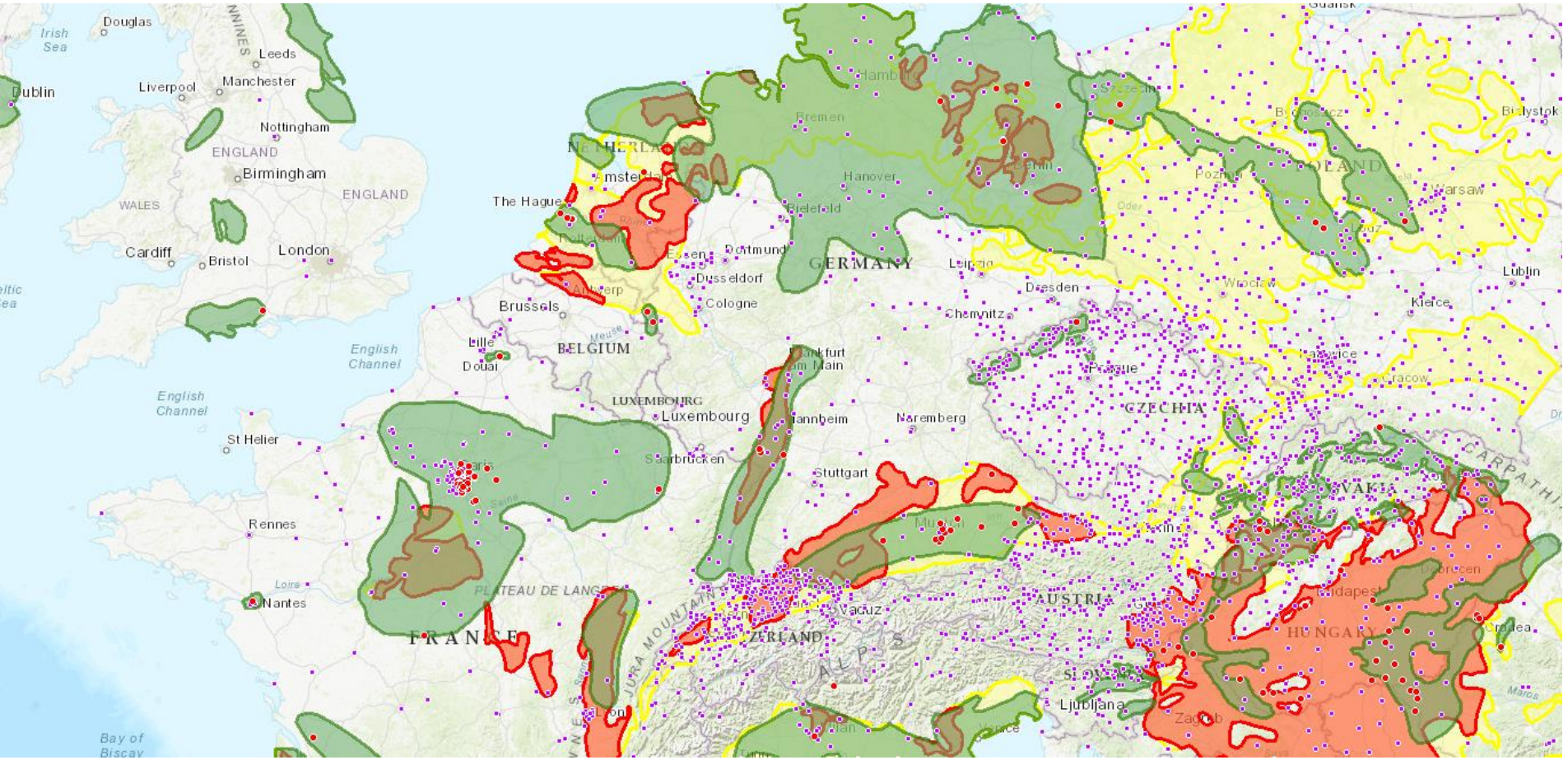
Scope

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

District Heating & Geothermal Potential in Central Europe



- Cities with district heating
- Cities with geothermal district heating
- Hot sedimentary aquifer
- Neogene basin
- Other potential reservoir

Heat Pumps to secure and expand geothermal heat supply potential

Source: GEODH Geothermal District Heating Map via https://map.mbfsz.gov.hu/geo_DH/ , last visited in May 10, 2023

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Thank you for your attention