

Electrification & Industrial decarbonization

The power behind your mission

Agenda

- 14:00** **Arrival to Johnson Controls Denmark Aps** / Henrik Hartmann Thomsen
- 14:10** **Welcome and agenda** / Henrik Hartmann Thomsen, Sales and Product Portfolio Director
- 14:15** **Introduction to Johnson Controls and Sabroe campus** / Bente Klokkeholm, VP Manufacturing Operations
- 14:20** **EU policy and legislation** / Christina von Westernhagen, Director of Government Relations
- 14:30** **Why heat pumps?** / Per Skov and Morten Deding, Heat Pump Product Manager and Heat Pump Product Director
- 15:00** **Factory tour (safety video and practicalities)** / Henrik Hartmann Thomsen and Per Skov
- 16:30** **Group picture and departure** / All

At Johnson Controls, we build smarter, healthier and more sustainable tomorrows – for our customers, our communities and our planet

And we've been doing it since 1885.

Our Values

Integrity First
Purpose Led
One Team
Customer Driven
Future Focused



Johnson Controls at a glance



Nearly

140 Years

of innovation experience



100,000

experts globally



150 countries offering
a local service from
2000 locations



More than

9,200

active patents



4+ million

customers globally



\$78 million

in charitable contributions
in the past 5 years



Named in

40+

leading sustainability



More than

+35.2M

metric tonnes of CO₂e reduced
for our customers since 2000



+1.86 million

volunteer hours
in the past 5 years



We are in

90%

of the world's most
iconic buildings



Customers saved more than

\$7.2 billion

in energy and operational
savings since 2000



100% increase

in energy productivity since 2022


Sabroe Factory one-pager

Sabroe Factory produces quality solutions within chillers and heat pumps, which contribute to reducing CO2 emissions and optimizing energy utilization on our customers' plants worldwide.



 **26,000 sq.m.**
Production and warehouse

 **285**
217 blue and 68 white collar

 **1.254** Units shipped in
FY23

 **Certificates**
ISO 9001:2015
ISO 14001:2015
ISO 45001:2018
PED Modul H
PED Modul H/1
DNV – AoM certificate



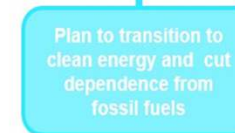
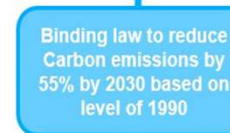
Policy and legislation

Christina von Westernhagen



EU Energy Performance of Buildings Directive

- 42% of energy consumed in the EU in 2021 was used in buildings
- +/- 80% of the energy used in EU households is for heating, cooling and hot water
- Over 1/3 of the EU's energy -related GHG emissions come from buildings



EU Energy performance of buildings add business opportunity

New legal requirements that have to be implemented at national level

Mandatory energy performance certificates (EPC) for buildings or building units that are offered for sale, should be stated in advertisements

EPC are mandatory for buildings that undergo major renovation, for buildings where a rental contract is renewed and all public buildings

Upgrade the 16% worst performing non-residential EU building stock from EPC label G to label F by 2027

National Energy and climate plans need to phase out fossil fuel-based heating by 2040

Mandatory Smart Readiness Indicator in non-res above 290 kW by 30 June 2027. JCI (Mariana Duarte) chairs the EU Commission's expert group.

BACS scope extended to non-res above 70 kW by 31 December 2029 and includes a new capability for monitoring of indoor environmental quality.

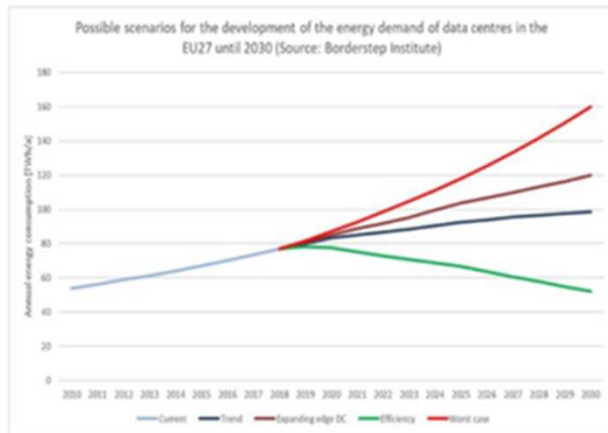
The annual target for renovation of the building stock is set to almost double, from 0.8% to 1.5% per year

9-14.5% energy reduction should be achieved by 2030 compared to what was projected for 2030 3 years ago

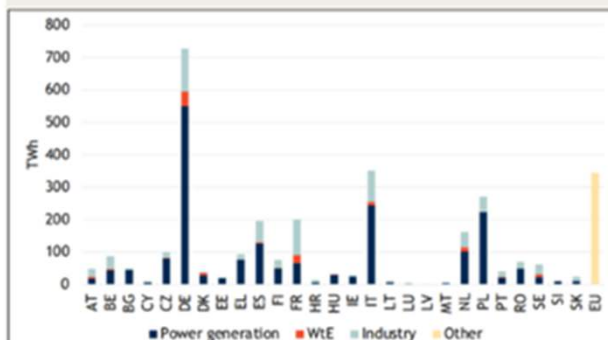
Two-year clock ticking for states to stand up implementation

Taxonomy requires building stock be 'green'

Possible scenarios for the development of the energy demand of data centers in the EU 27 until 2023



Waste heat potential in the EU27 (JRC, 2021)



Requirements for Data Center Owners when national legislation kicks in

Mandatory Reporting: Data center operators with a total rated power of at least 500 kilowatts (kW) have to publicly report their energy performance data annually.

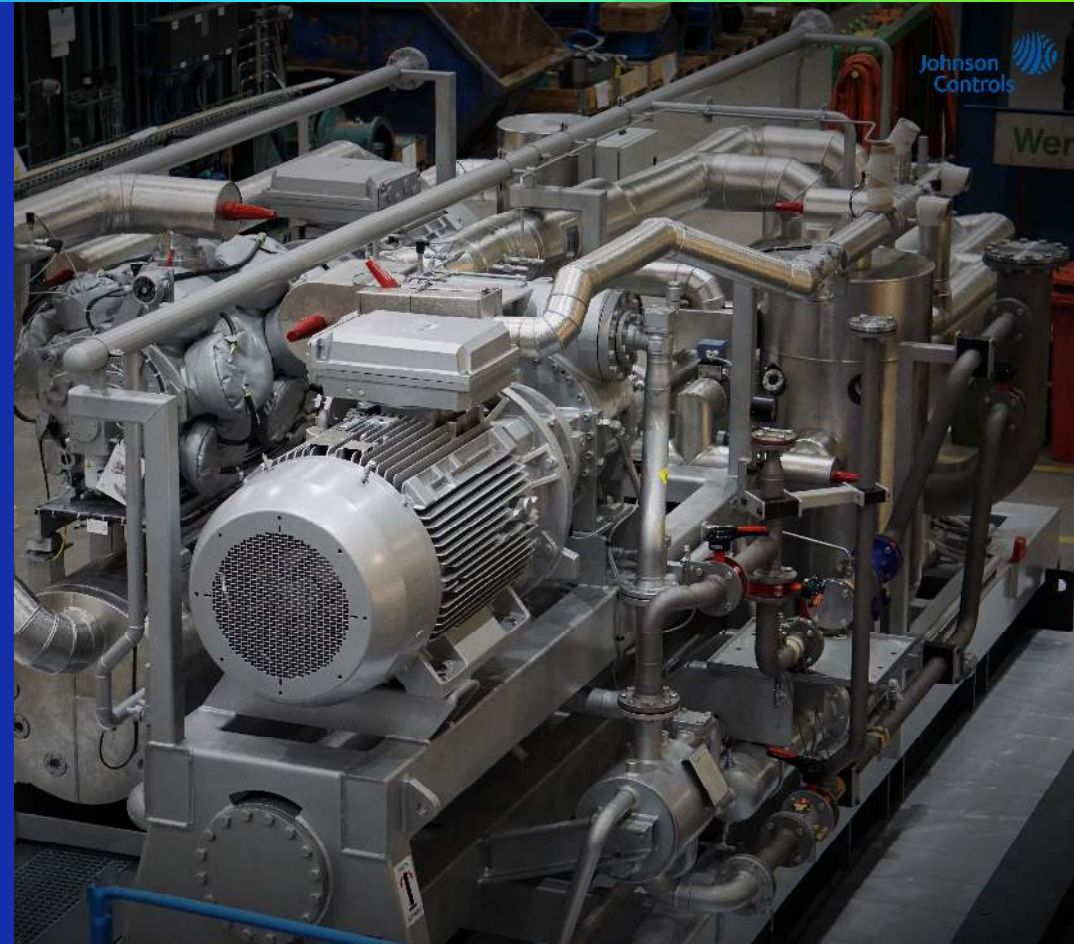
Waste Heat Utilization: Data centers with a total rated power exceeding 1 MW must utilize their waste heat for heating purposes or other energy recovery applications unless it is technically or economically unfeasible.

Renewable Energy Integration: Data centers should prioritize the use of renewable energy sources for their electricity consumption.

Optimizing Energy Consumption: Data center operators must implement energy efficiency measures to reduce their overall energy consumption. This includes optimizing cooling systems, using more efficient IT equipment, and adopting virtualization and server consolidation techniques.

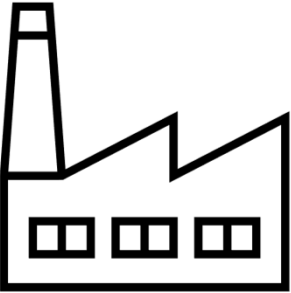
Why heat pumps

Per Skov & Morten Deding

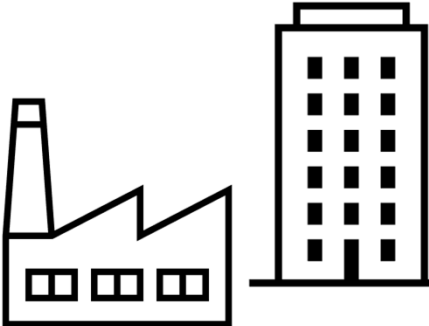
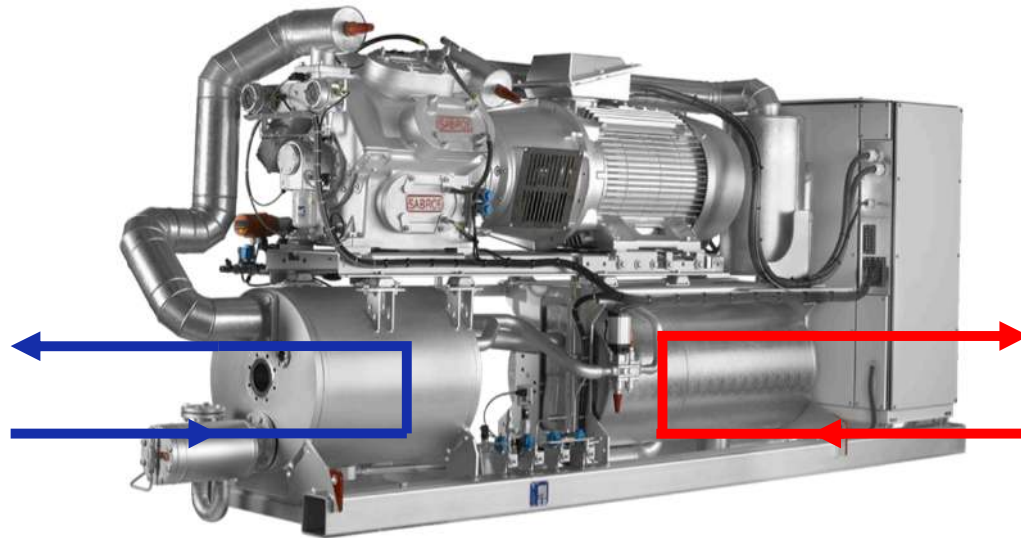


What is a heat pump?

A heat pump uses electricity to provide both cooling and heating



- Hospital
- Air
- Seawater
- Dairies
- Breweries
- District cooling
- Waste heat



- District heating
- Processes
- Dairies
- Campus
- Hospital
- Etc.

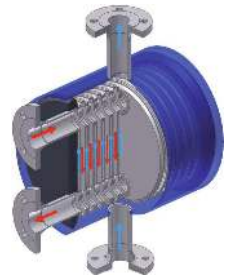
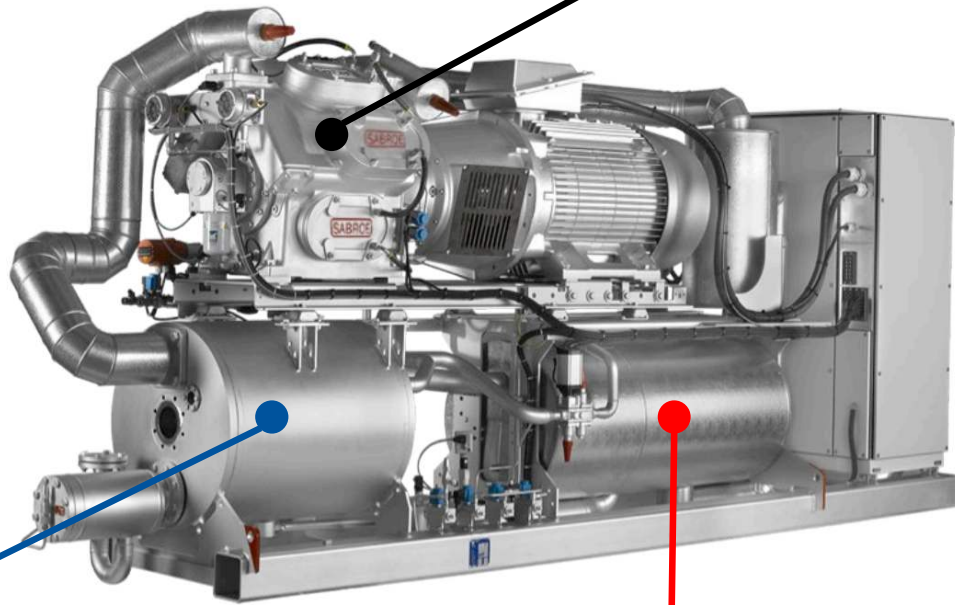
How does a heat pump work



Water (R718)	
Pressure	Boiling point
Atmospheric Pressure	100C – 212F

Low pressure.
 Phasechange at low temperature
 Cools a source during evaporates

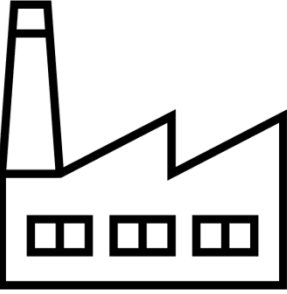
Compression of gas. Increases pressure and temperature



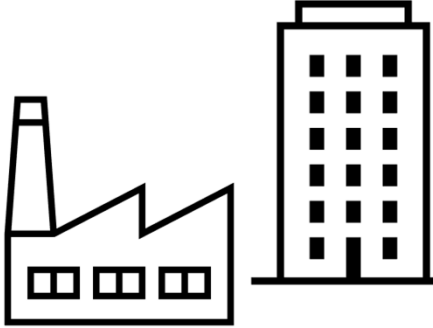
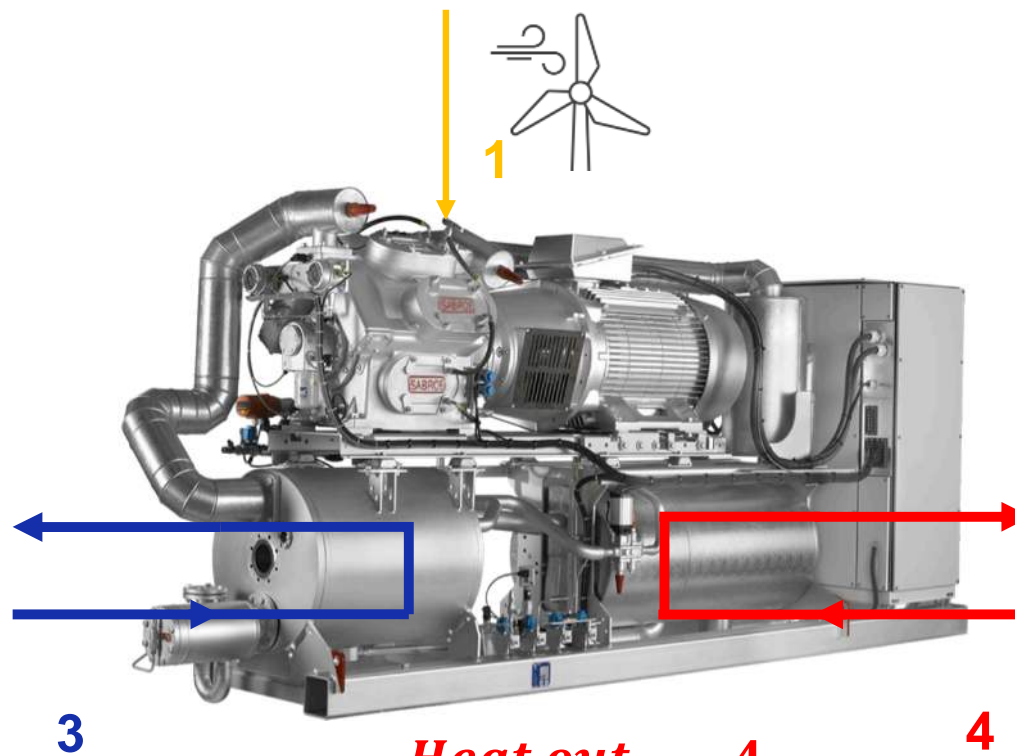
High pressure.
 Phase change at high temperature
 Heats up the sink during condensing

What is a heat pump?

A heat pump uses electricity to provide both cooling and heating



- Hospital
- Air
- Seawater
- Dairies
- Breweries
- District cooling
- Waste heat



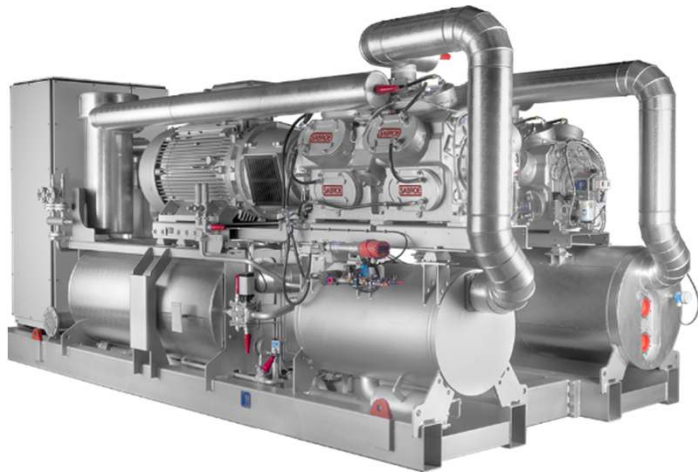
- District heating
- Processes
- Dairies
- Campus
- Hospital
- Etc.

$$\text{COP} = \frac{\text{Heat out}}{\text{Electricity}} = \frac{4}{1} = 4$$

Electrification of energy systems

The carbon neutral future is electric

Electrification Why?

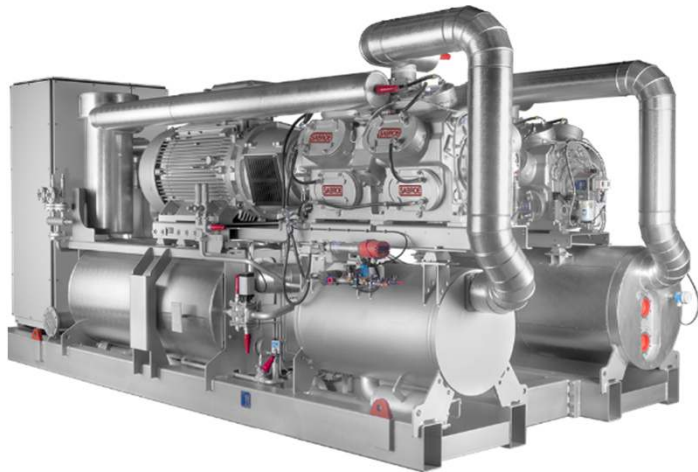


Electrification of energy systems

The carbon neutral future is electric

Electrification Why?

Heat pumps Why?



ELECTRIFICATION: Replacing technologies or processes that use fossil fuels with electrically-powered equivalents

CLEAN UP THE ENERGY WE USE: Electricity produced with an increasingly renewable energy for a truly clean energy system.

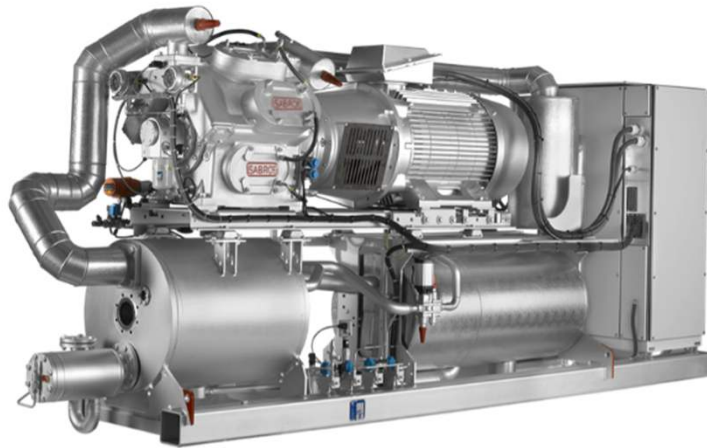
INCREASE EFFICIENCY: Energy because they are more efficient compared with other energy carriers.

TURN ENERGY SYSTEM INTO A SMART SYSTEMS: Electric appliances can be digitalized through smart technologies.

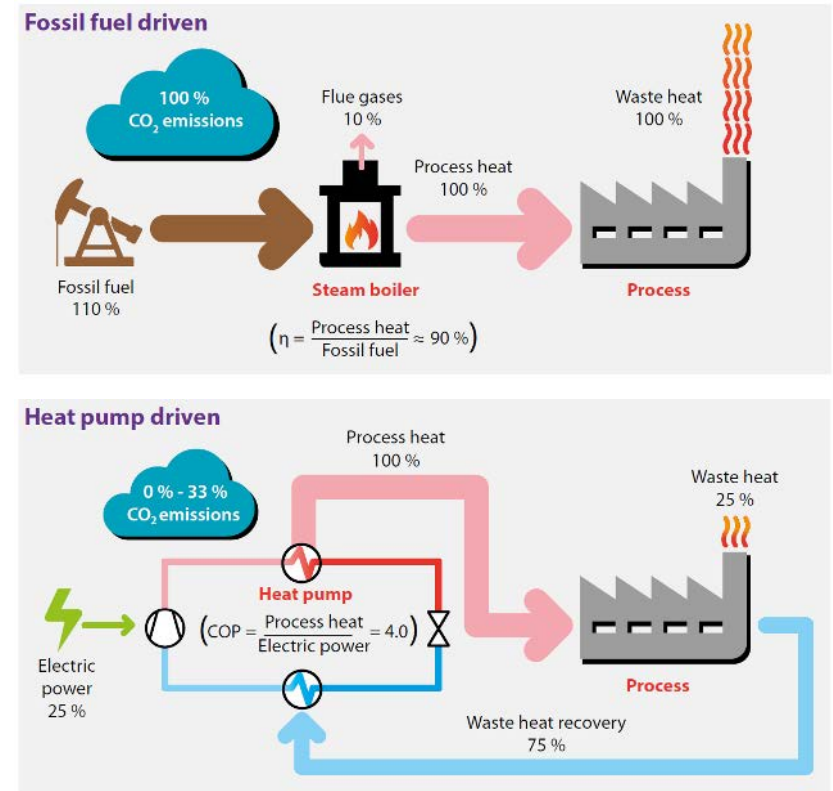
Electrification of energy systems

The carbon neutral future is electric

More waste heat available than the building heating demand in Europe



Heat pumps can be used to utilize waste heat or other sources at various temperature levels!



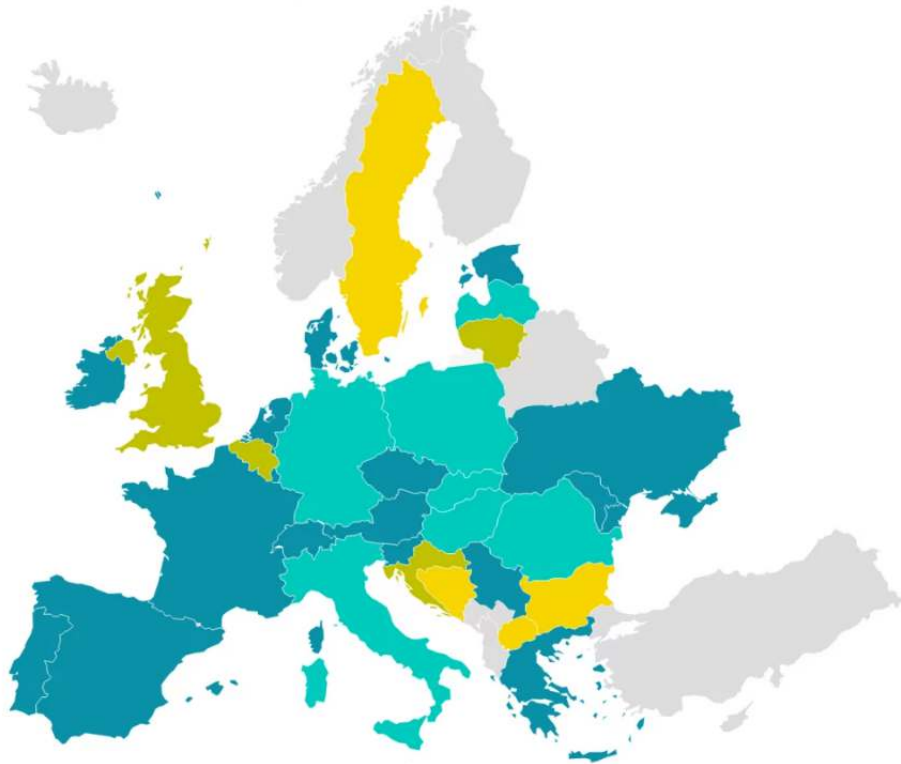
Source: Strengthening Industrial Heat Pump Innovation - Decarbonizing Industrial Heat

Electrical prices vs gas prices

Electricity to gas price ratio



■ <1.5 ■ 1.5-2.5 ■ 2.5-3.5 ■ >3.5



Electricity price is several times higher than that of gas, can lead to higher cost to operate a heat pump.

$$\text{COP} = \frac{\text{Heat out}}{\text{Electricity}} = \frac{4}{1} = 4$$

Applications can become limited due to higher COP needed.

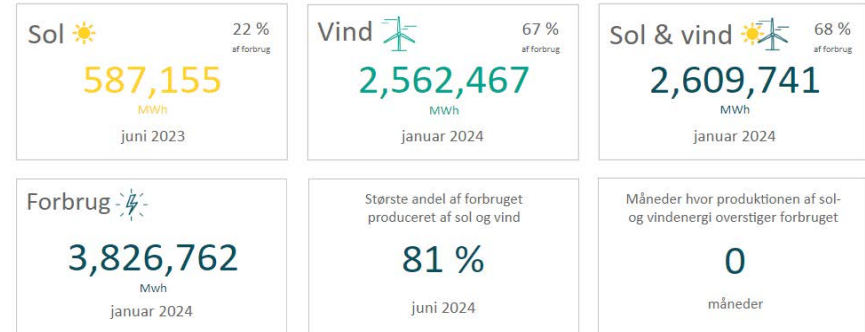
Lower electricity/gas ratio is needed achieve a fast return on investment and encourage people to buy a heat pump, electricity should be no more than double the price of gas

Renewable energy in Danish energy system

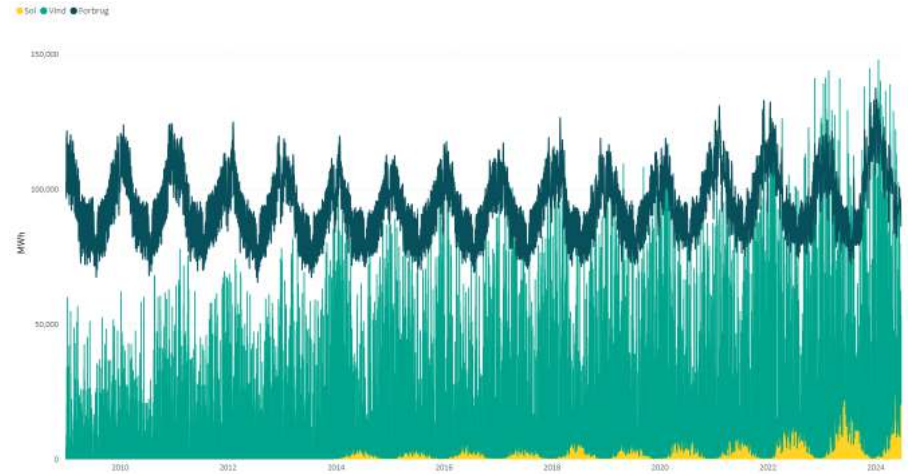
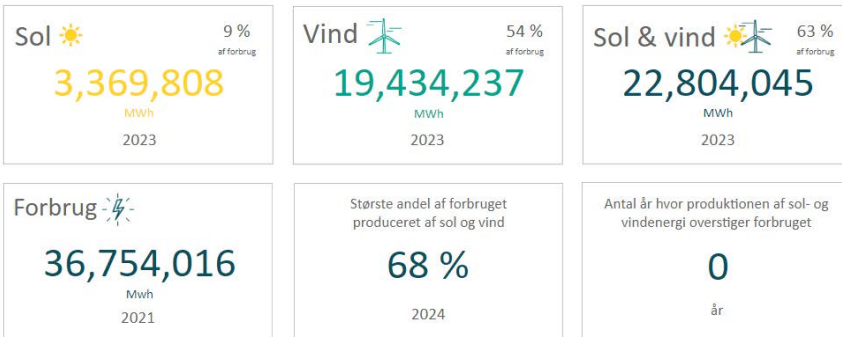
Day



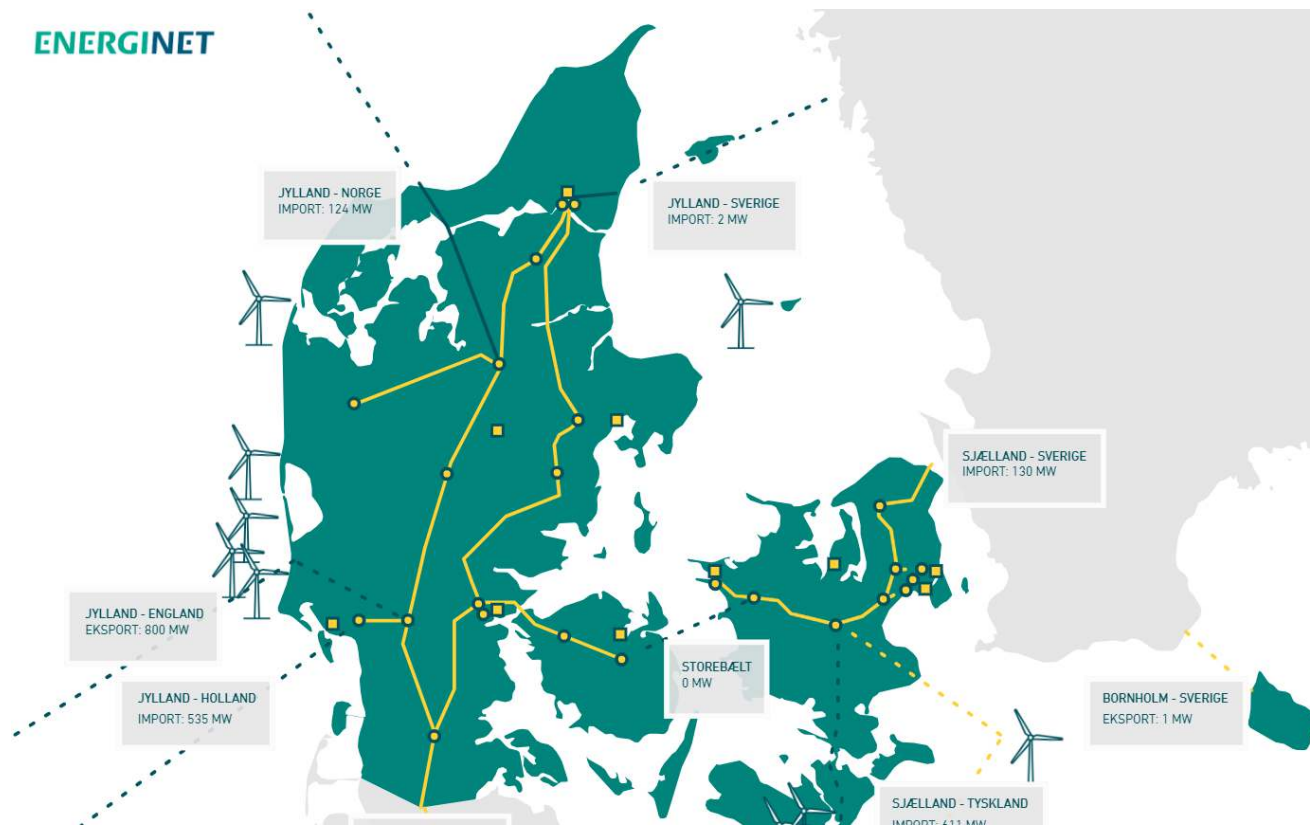
Month



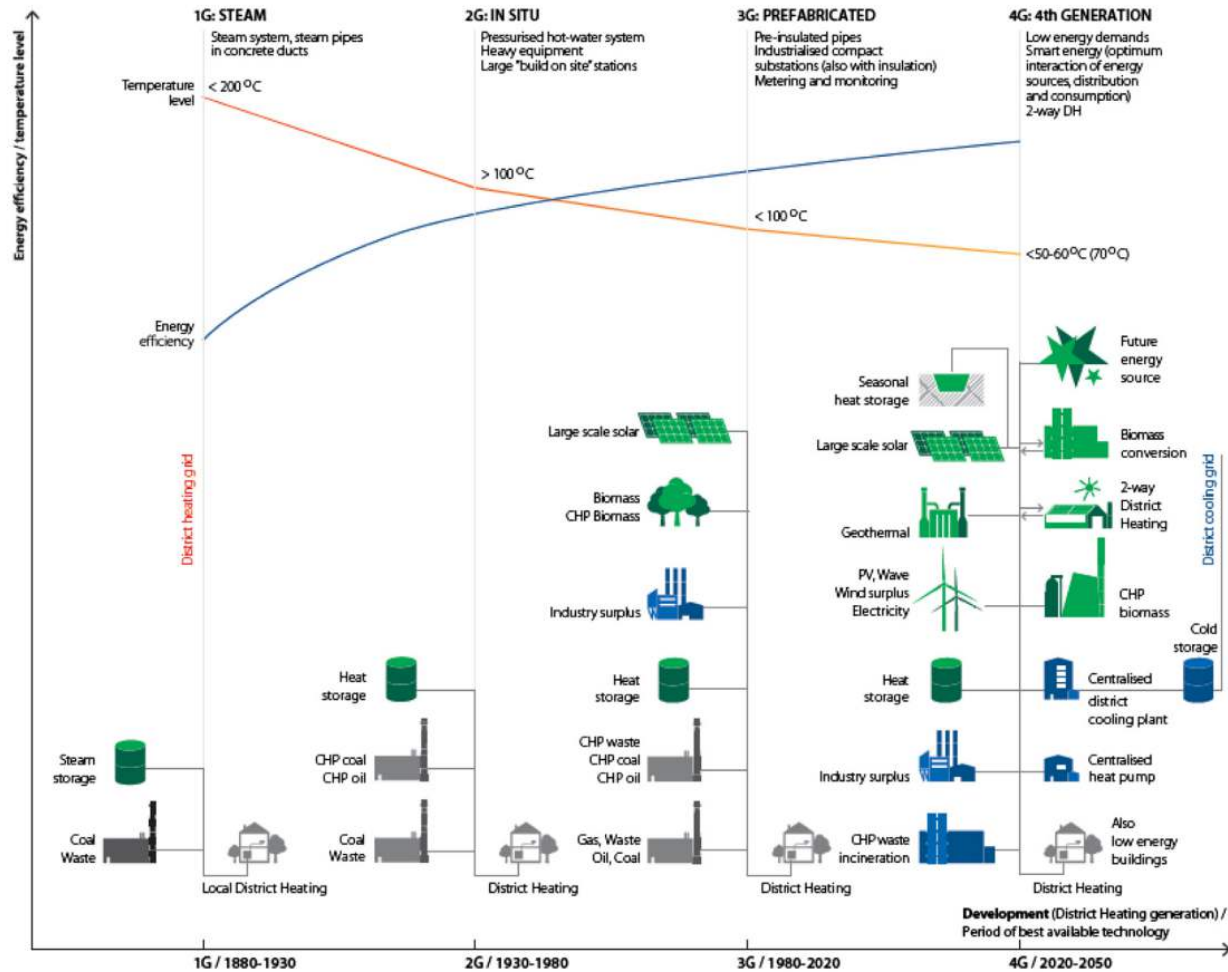
Year



- <https://energinet.dk/energisystemet-lige-nu/>

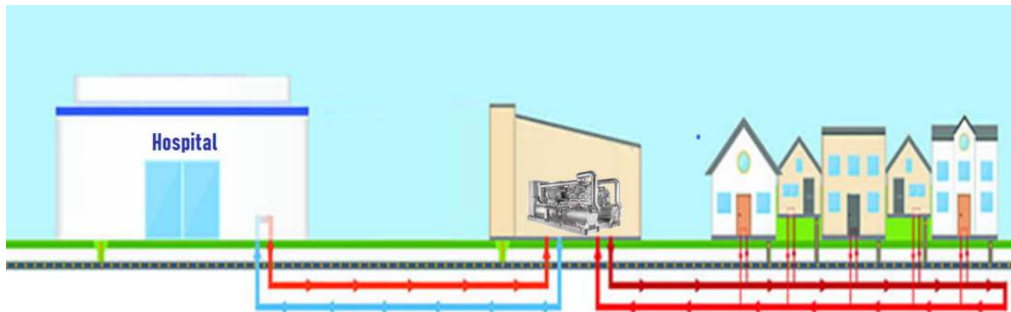


Development of energy system



Case: Hospitals

- Compressor: Reciprocating & screw
- Product: 4 x 2-stage heat pumps (recip & screw)
- Refrigerant: R717 (Ammonia)
- Source: Cooling for Hospital
- Supply: Heat for hospital and district heating
- Capacity: 7.8MW
- Temperature: Cooling: 18°C/12°C; Heating: 30°C/75°C
- COP: 4.3



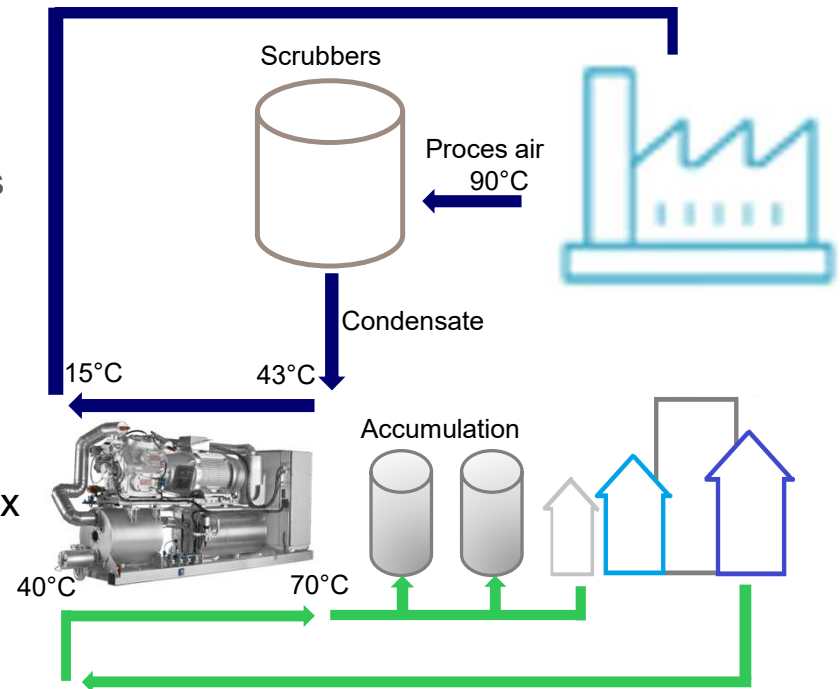
Waste heat to district heating

Covers 20% of total district heating production

- Compressor: Reciprocating
- Product: 8 x HeatPAC operating in series for COP optimization
- Refrigerant: R717 (Ammonia)
- Source: Waste heat from production of protein feed for animals
- Supply: District heating
- Capacity 12MW heat
- COP: 5.9
- Temperature: Cooling: 43°C/15°C; Heating: 40°C/70°C
- CO2-saving: 2.000 tons/year

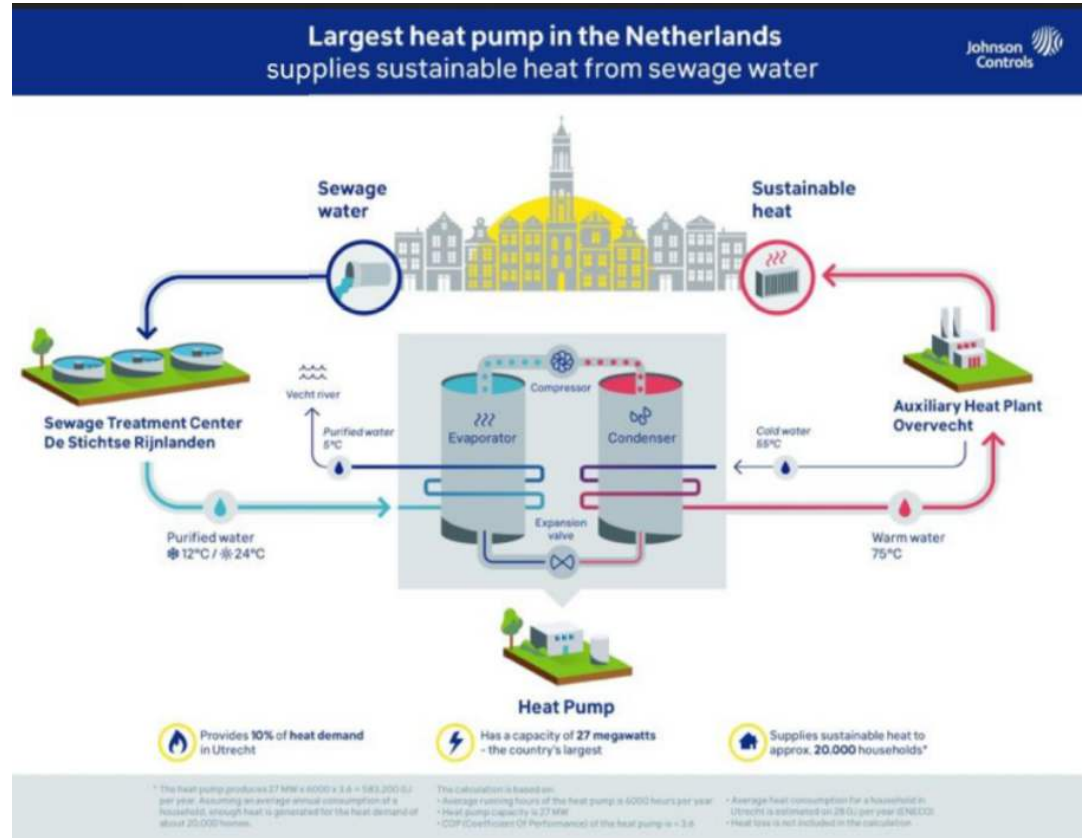
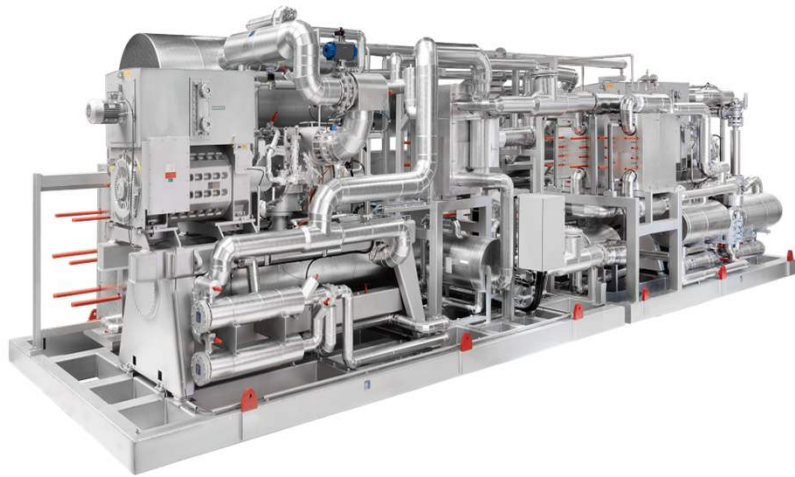


4 operating in series X



Spildevand Netherlands

Product: 4 x HicaHP 273S
 Heat capacity: 25MW
 Source: effluent water
 Supply: District heating



Factory tour



Products produced at the factory



SabroeRecip



SMC 100



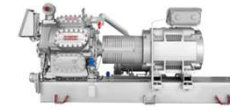
CMO 20-30



HPC 100



HPO 20



HPX 700



SabroeScrew



SAB screw small



SAB screw large



HP Screw 40



SabroeChill



ChillPAC



ComPAC



PAC recip



PAC screw



ChillPAC Air



SabroeFreeze



CAFP



SabroeHeat



HeatPAC



DualPAC



HicaHP



SabroeControl



UniSAB III



Chiller & Heat Pump Plant Control



Panels



Vibration monitoring



ISAC