

Reversible Heat Pump- Organic Rankine Cycle

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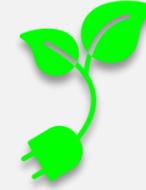
Architecture, Built Environment and Planning

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Paris Agreement

Limit global temperature rise to below 2°C
Pursue efforts to limit it to 1.5°C



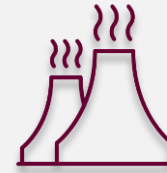
European Union 2018

Renewables target of **32%** by 2030



European Union 2018

Energy efficiency increase of **32.5%** by 2030



European Union 2018

Reduce emissions by at least **40%** by 2030

Role of Industry



European Commission 2018

Energy responsible for more than **75%** of EU's GHG emissions



Energy efficiency

A main strategic building block of European Commission's vision



Recovering industrial waste heat aids to improve the energy efficiency

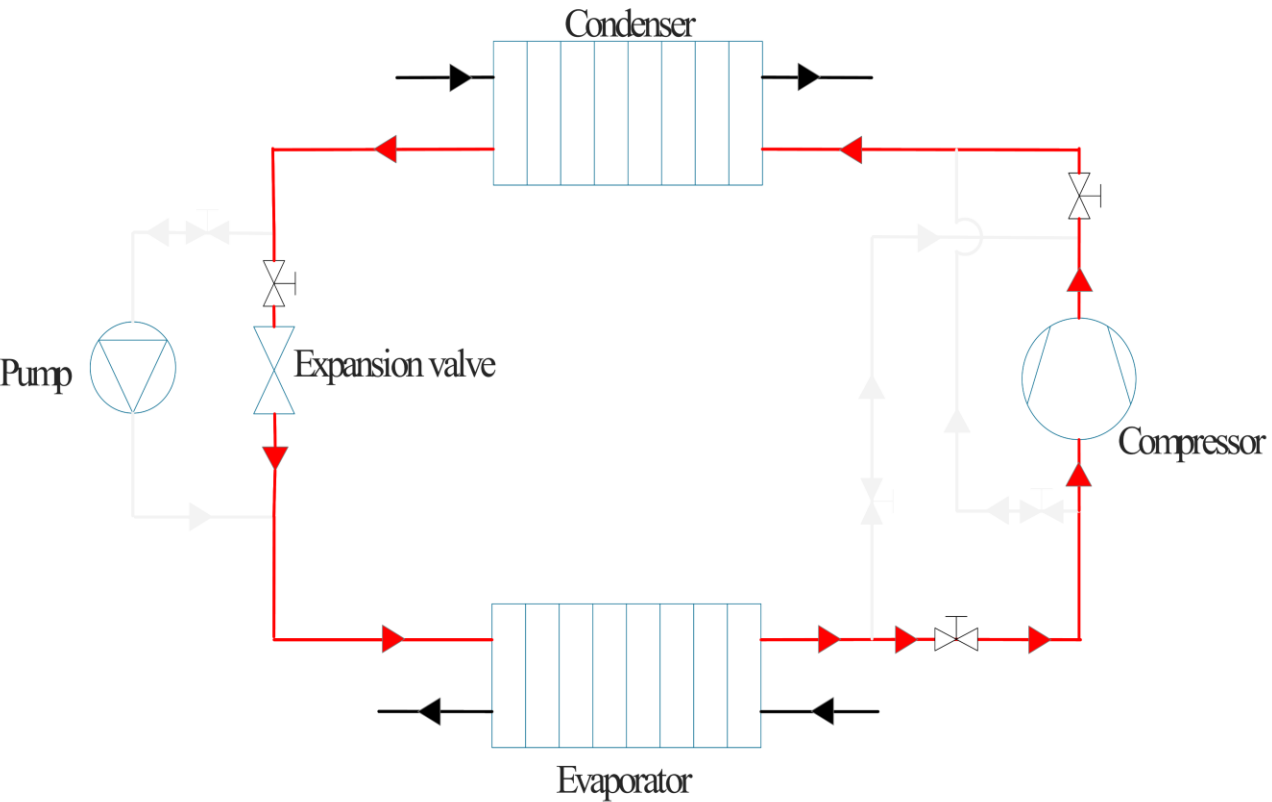


Total waste heat potential in EU is about **300 TWh/year**

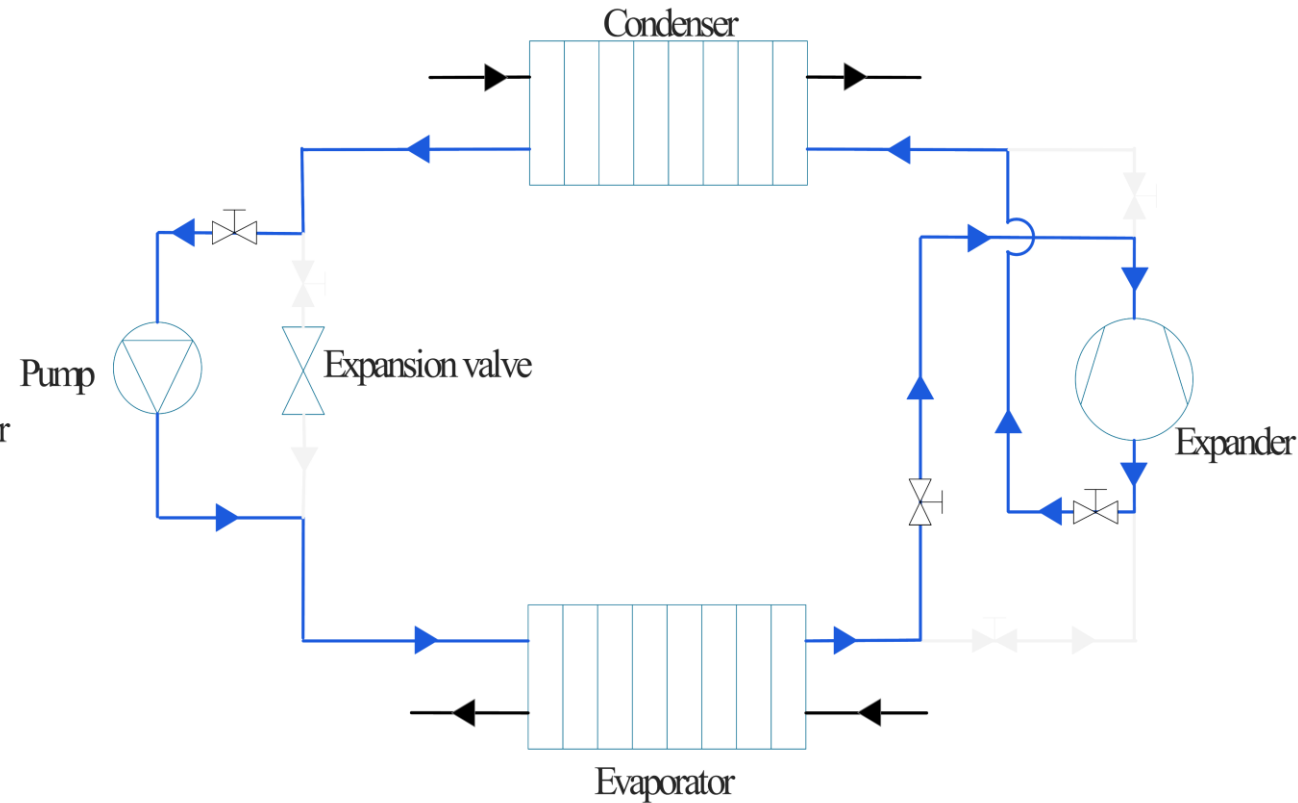


One third of waste heat corresponds to temperature below **200°C**

Research Challenge 3.4



Heat pump mode
(Volumetric machine acting as compressor)



Organic Rankine cycle mode
(Volumetric machine acting as expander)

Main aspects of the project



Heat pump mode

Temperature lift of 50 K (from 90 to 140 °C) in Heat pump mode.



ORC mode

Power generation in ORC mode utilizing waste heat



Volumetric machine

Identifying a suitable volumetric machine that can operate in both compressor and expander modes.



Refrigerant

Selection of a suitable low GWP and zero ODP refrigerant

Selection of a suitable volumetric machine



Copeland scroll compressor

η

Higher isentropic efficiency compared to piston, screw and roots expanders for small capacities (<5kW)



Reduced number of moving parts

Availability and reliability



Better handling of two phase conditions compared to other expanders

Selection of a suitable refrigerant



Low Global warming potential (GWP)



Zero Ozone depletion potential (ODP)

R245fa

Commonly used refrigerant in small scale ORC systems.

Very high GWP

To be phased out in near future

Must be replaced by a low GWP, zero ODP refrigerant.

R1233zd(E), R1234ze(Z), R1224yd(Z) most suitable drop in replacements for R245fa