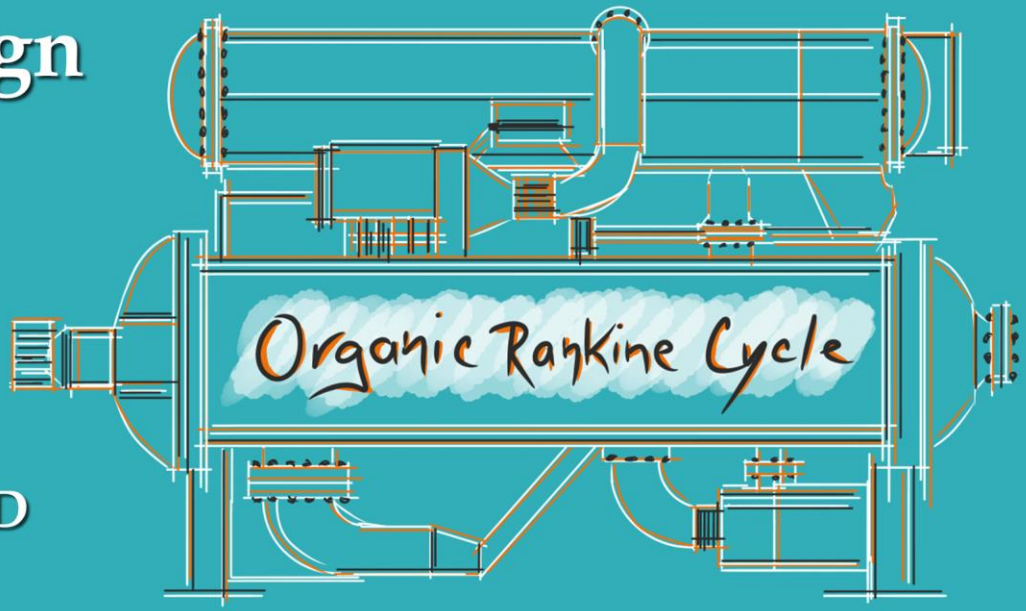
# New Cascade Design Technique for Higher Efficiency ORC Systems

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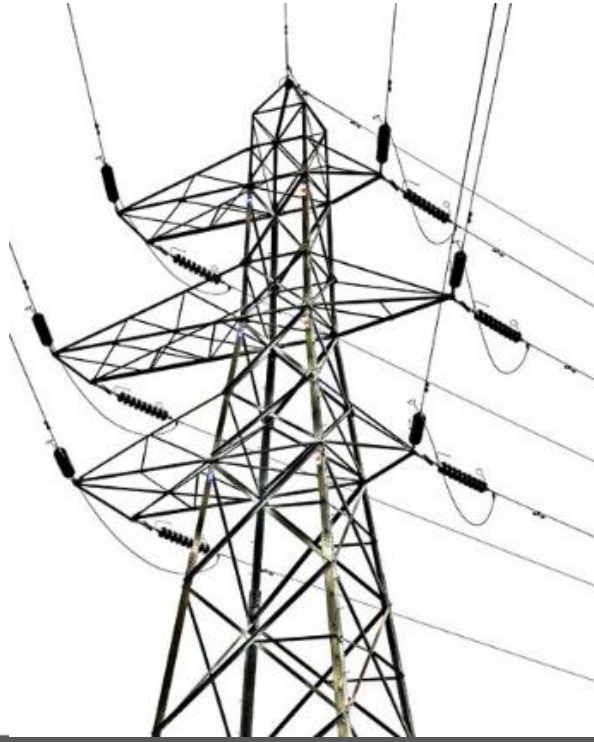
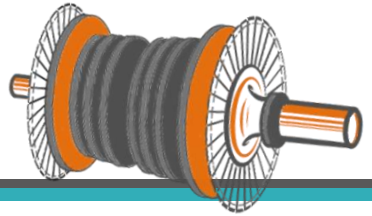
CRSNG NSERC

Young Energy Researchers Conference WSED 2020

# Outline

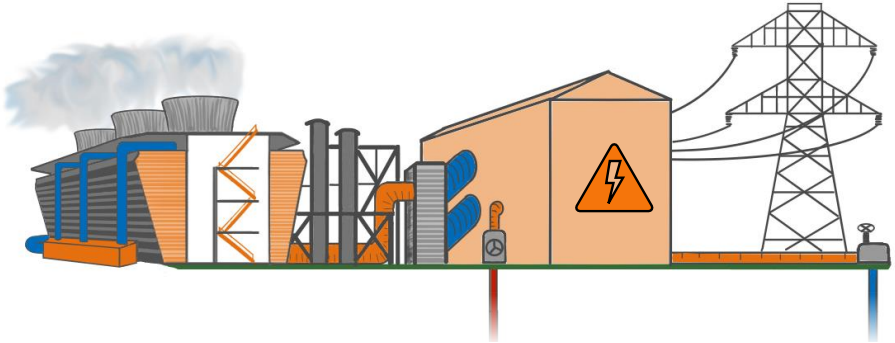
1. Introduction
2. Organic Rankine Cycle
3. Cascade design technique
4. Case study: geothermal power plant
5. Case study: cement plant
6. Conclusion



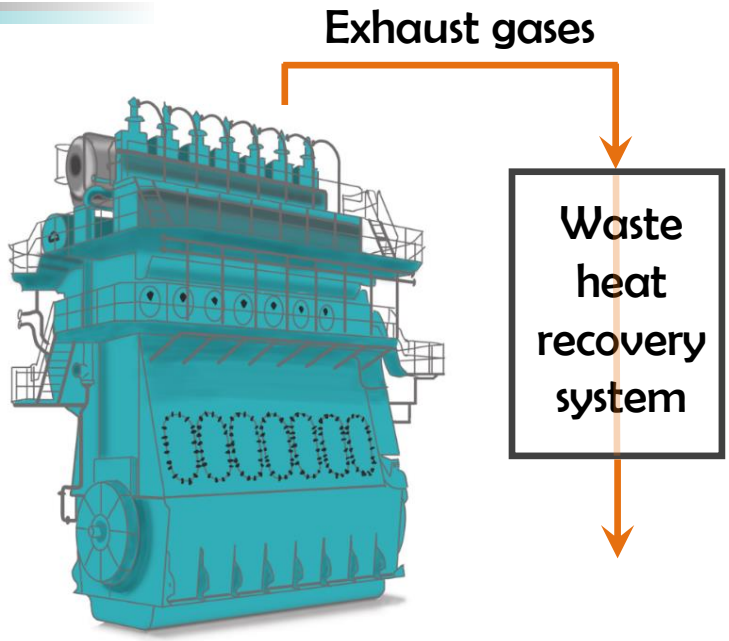


# Introduction

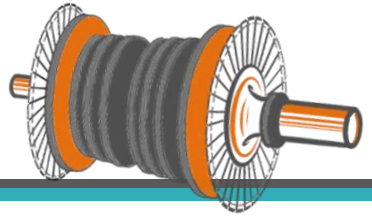
- Enormous amount of available heat
- ORC: attractive system for ***heat → power***
- Optimization for specific applications



*Binary geothermal power plants*

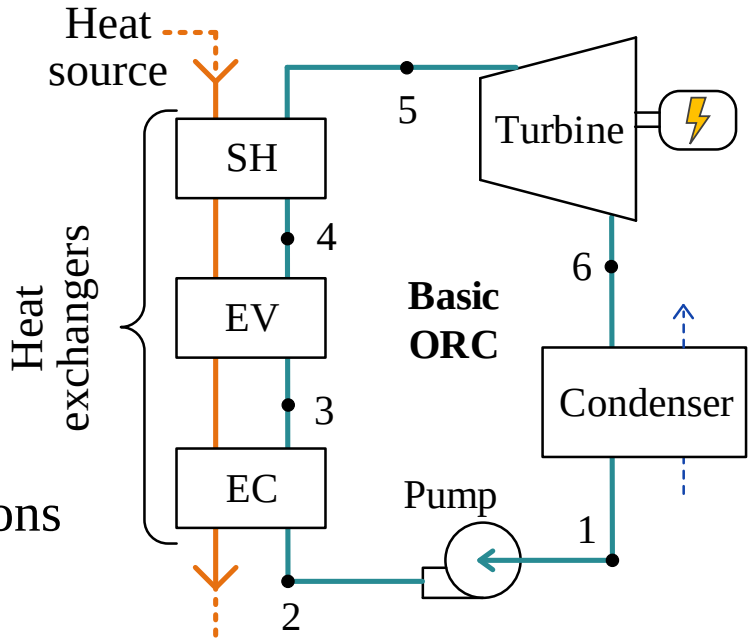



*Flue gases heat recovery systems*

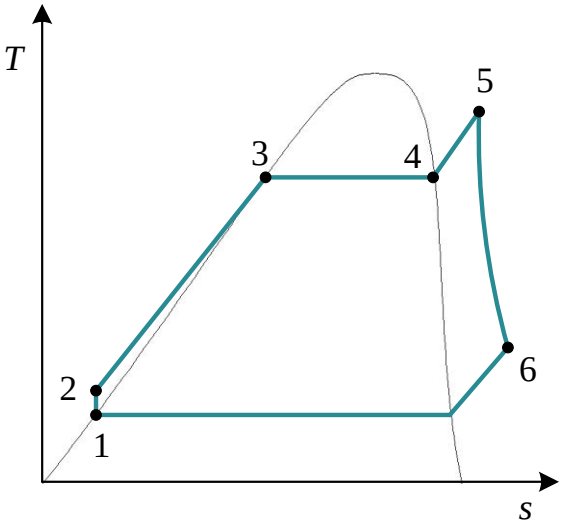


# Organic Rankine Cycle

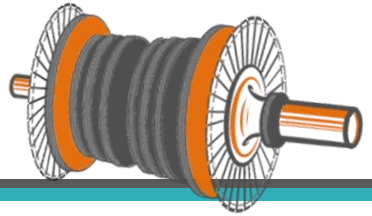
- Vapor cycle
- Organic fluid (R134a, isobutane,…)
- 4 basic evolutions
- Numerous variations and possibilities




*Cycle architecture*

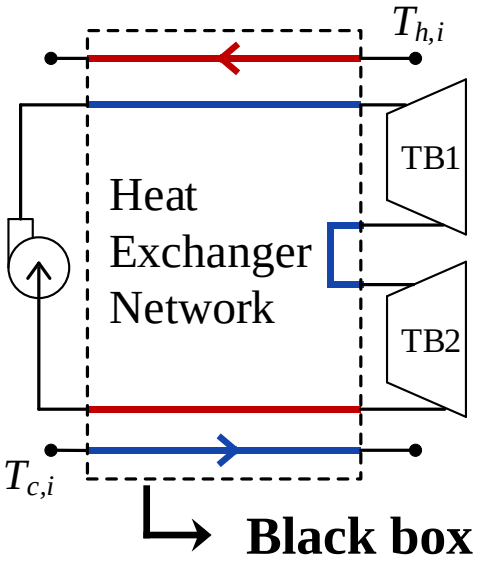


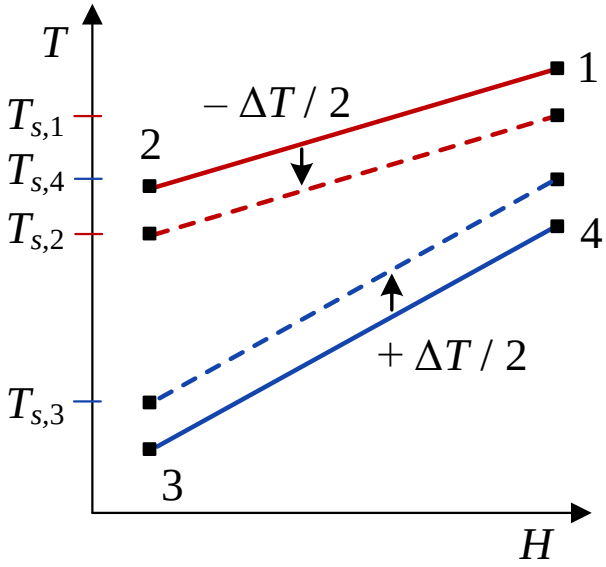

*Thermodynamic diagram (temperature vs. entropy)*

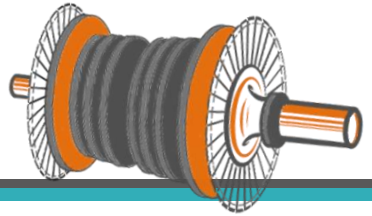


# Cascade design method

"Heatsep" method + Shifting technique + Heat cascade





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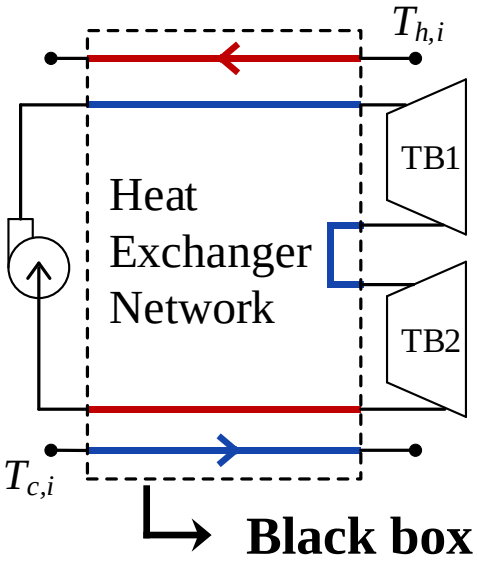
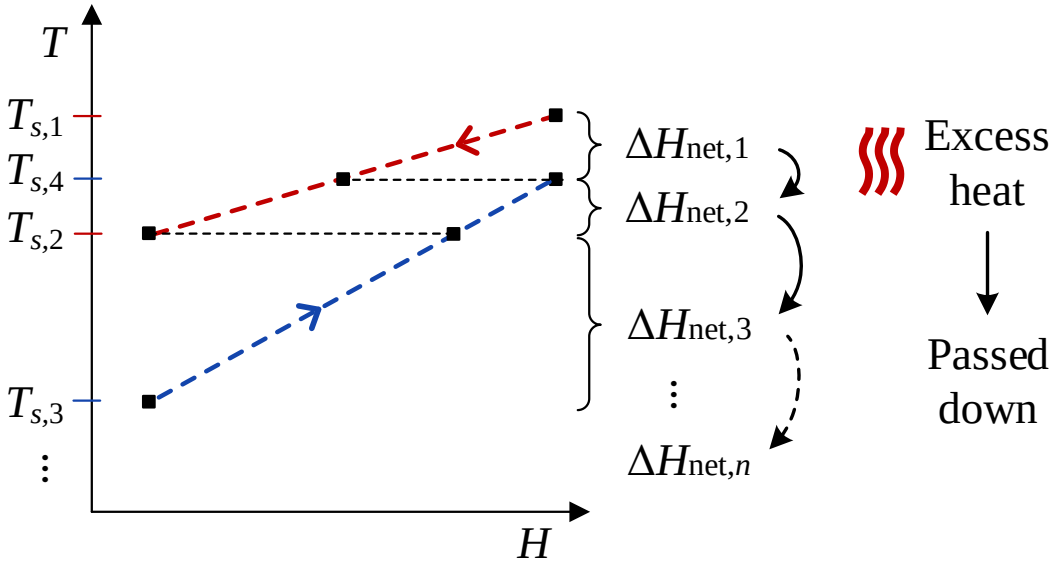
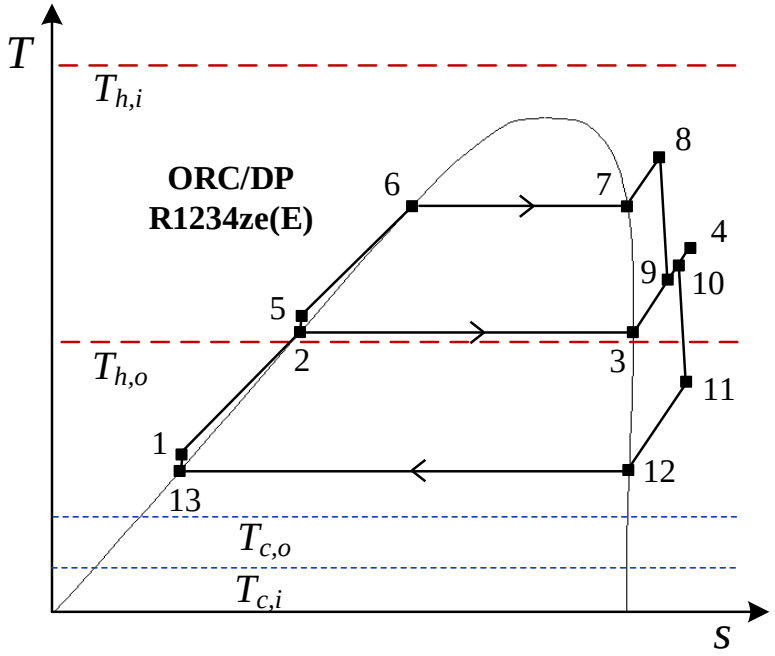


# Case study: geothermal power plant



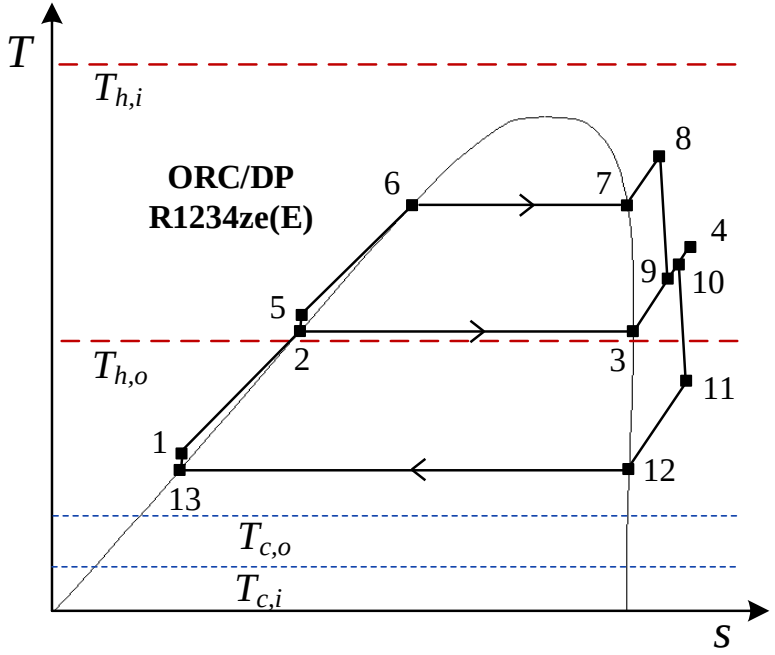

*T-s diagram of optimal results*

- Low-T° reservoir: T° hot = 120°C
- Northern climate: T° cold = 5°C
- Working fluid: R1234ze(E)

MATLAB + Particle Swarm Optimization

**40% increase in power using cascade method**

# Case study: geothermal power plant

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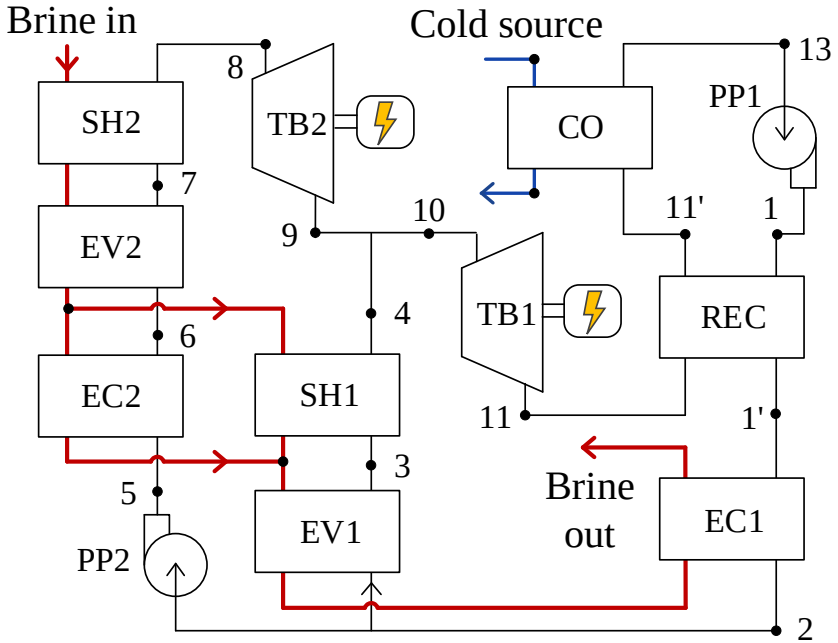
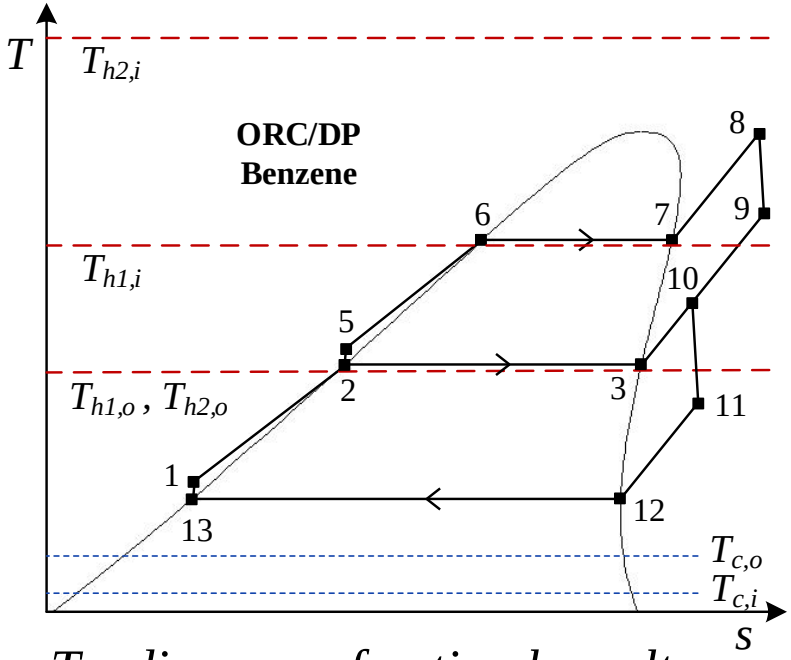



*Optimal equipment architecture*

# Case study: cement plant



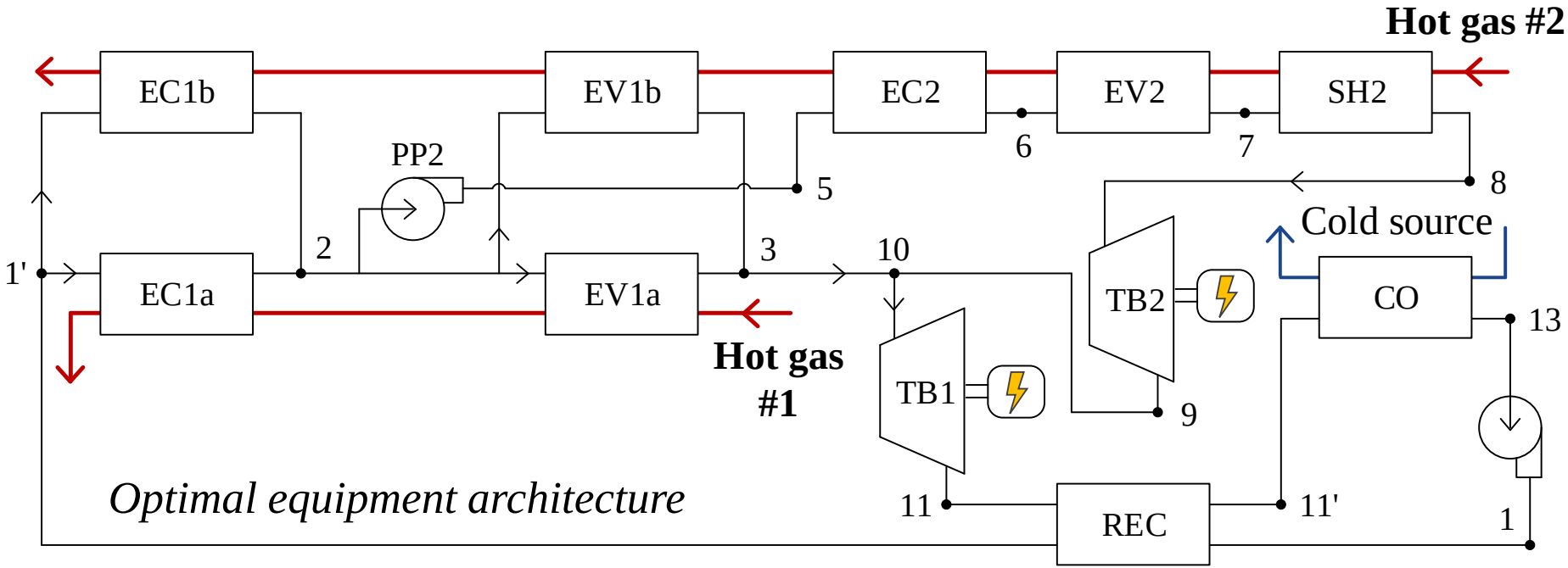

*T-s diagram of optimal results*

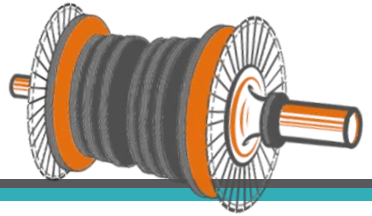
Waste heat: 2 gaseous sources

- T° hot #1 = 230°C
- T° hot #2 = 350°C
- T° cold = 40°C
- Working fluid: benzene
- Power: 3.3 MW

**Complex system that self-generates with cascade method**

# Case study: cement plant





# Conclusion

- Tremendous potential in recovering waste heat
- Cascade method: first step towards an automated design method for power cycles
  - ↳ Leaves greater freedom in the optimization
  - ↳ Generates designs with considerable performance increase
  - ↳ Easily handles complex systems
- Next steps: other power cycles & economic considerations

***Thank you! Vielen Dank!***