EnergyVille

Influence of the Heat-Source Cost on Geothermal ORCs

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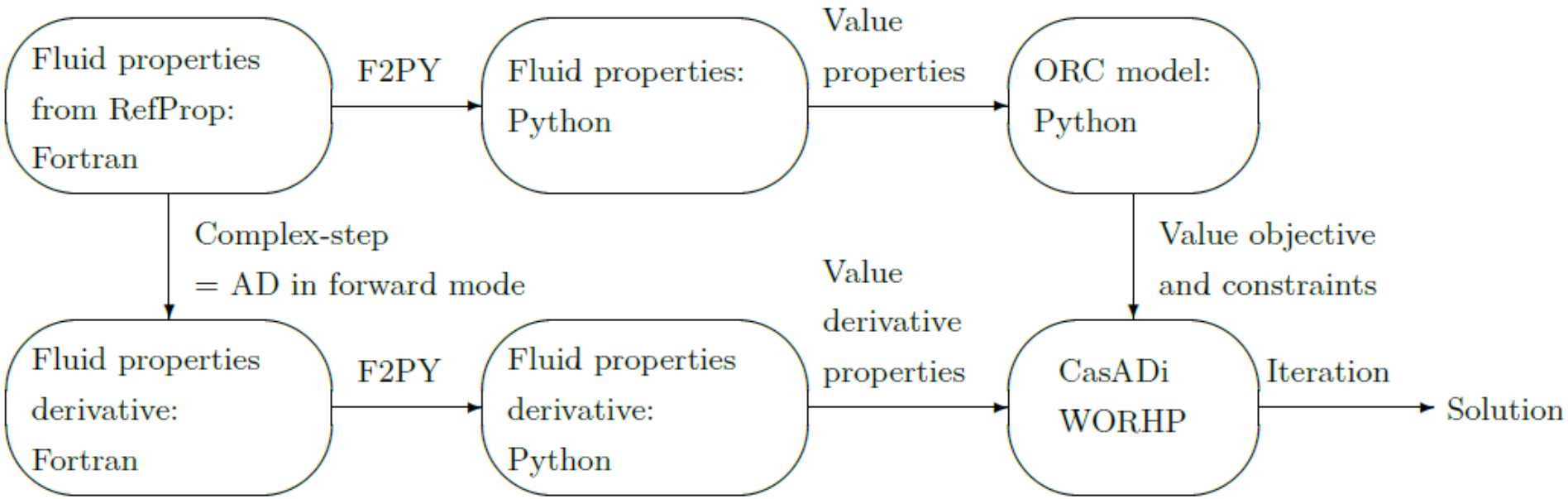
Introduction

- Low-temperature geothermal heat sources:
  - Low conversion efficiency
  - Often high cost of wells
  - ➔ Profitability?
- Economic system optimization
- Maps of economics and performance as a function of:
  - Heat-source temperature
  - Cost of wells
- Air cooling vs water cooling

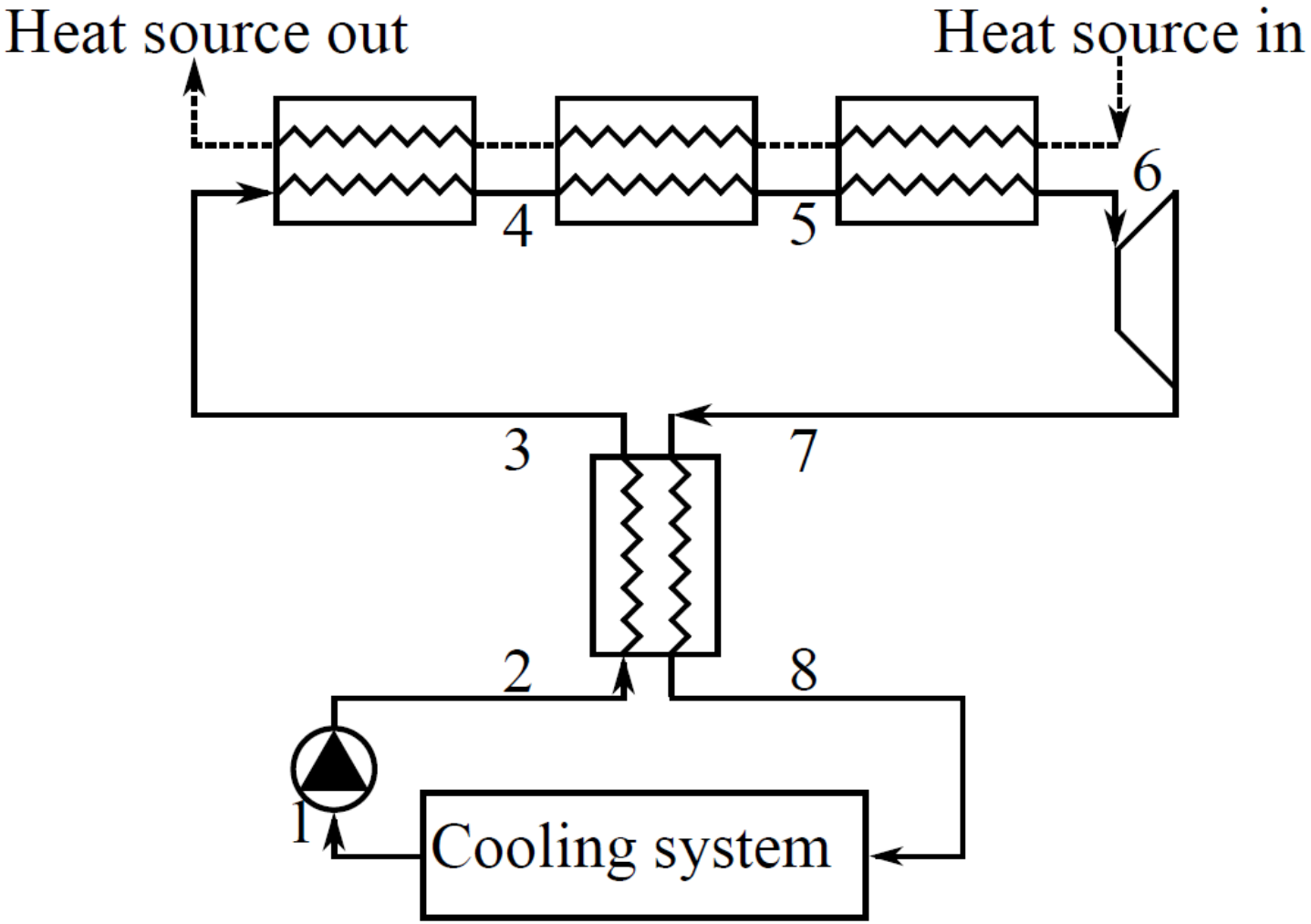
Optimization

- System optimization:
  - Configuration of cycle
  - Configuration of main components (HXs, cooling system, turbine)
  - ➔ Optimal SYSTEM
- Levelized Cost of Electricity (LCOE):
  - Fixed electricity price needed for break even at end of project
  - Minimization

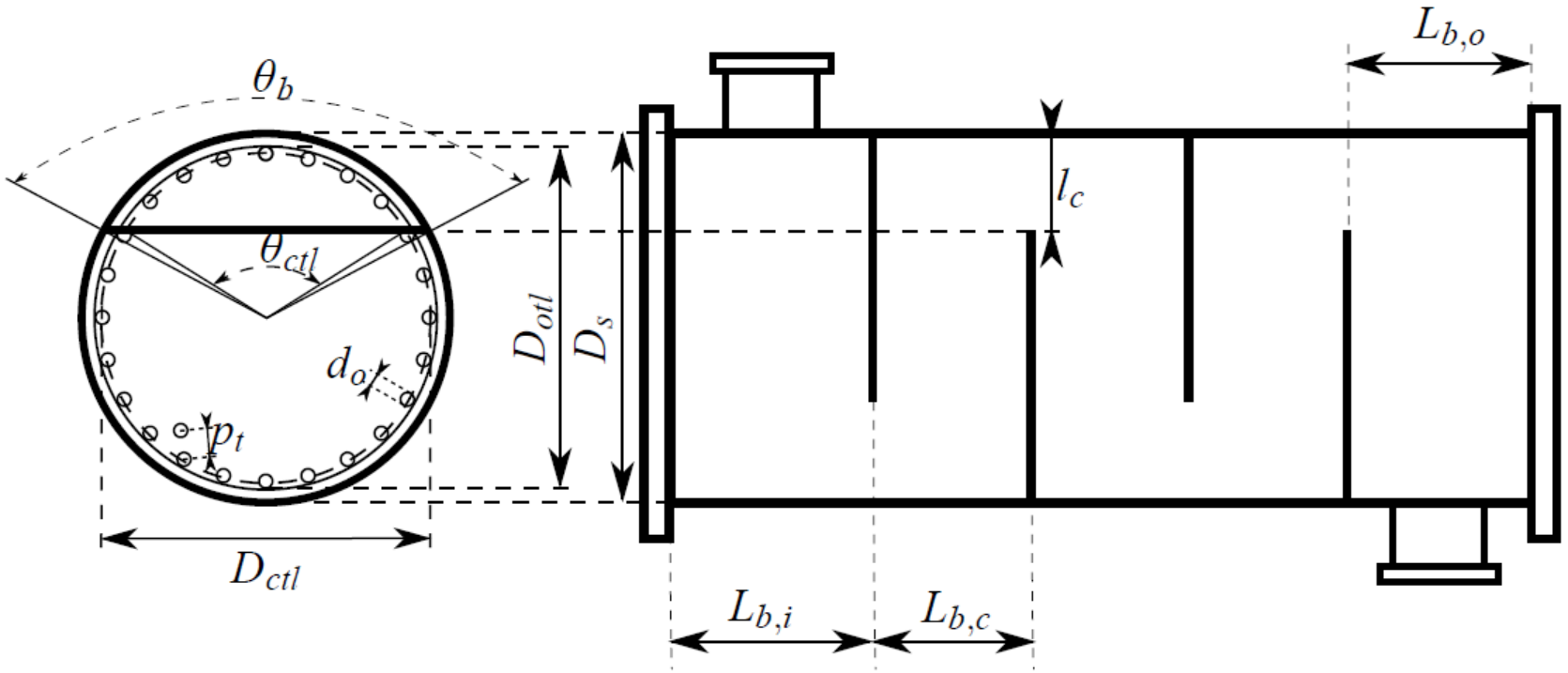
Optimization



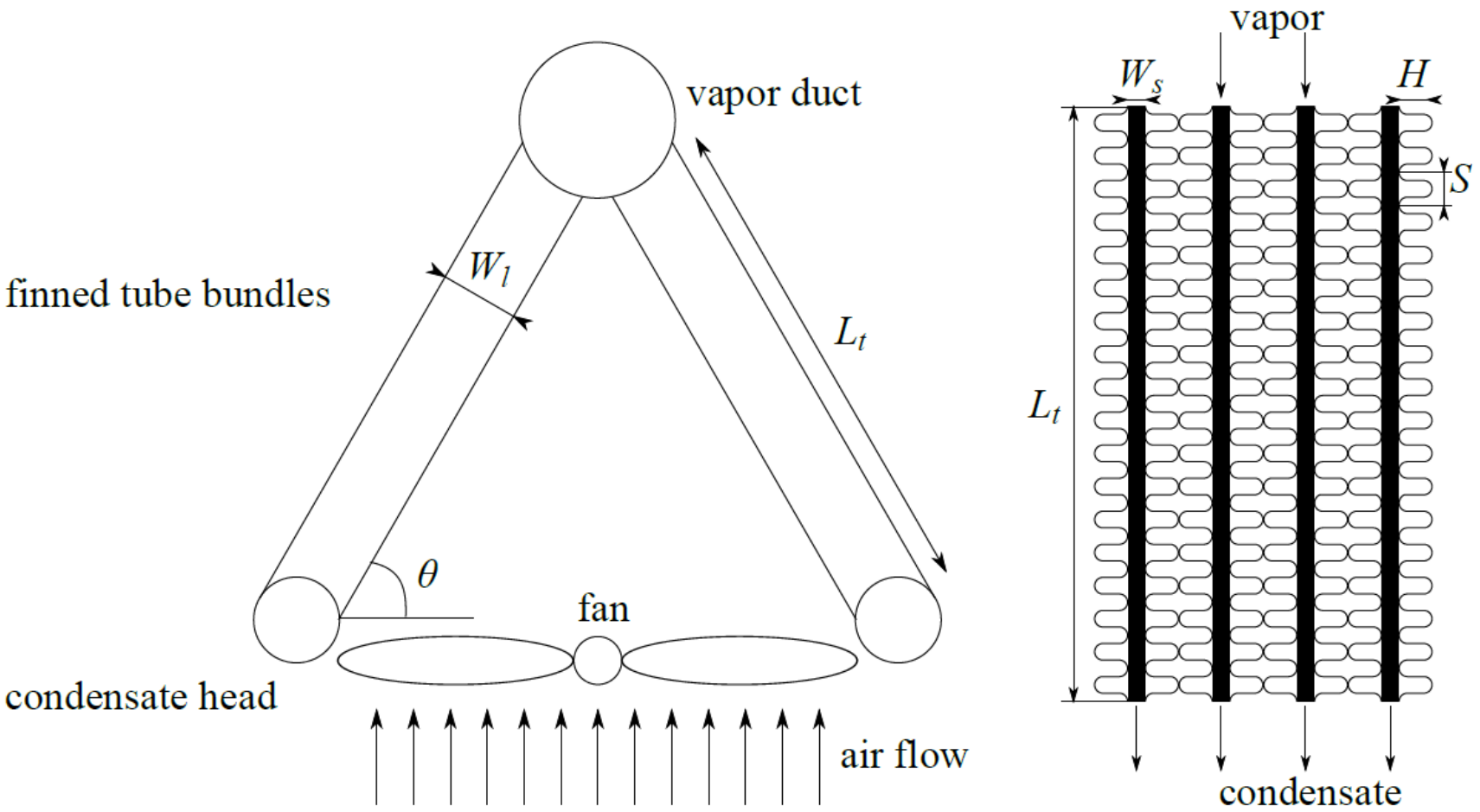
ORC



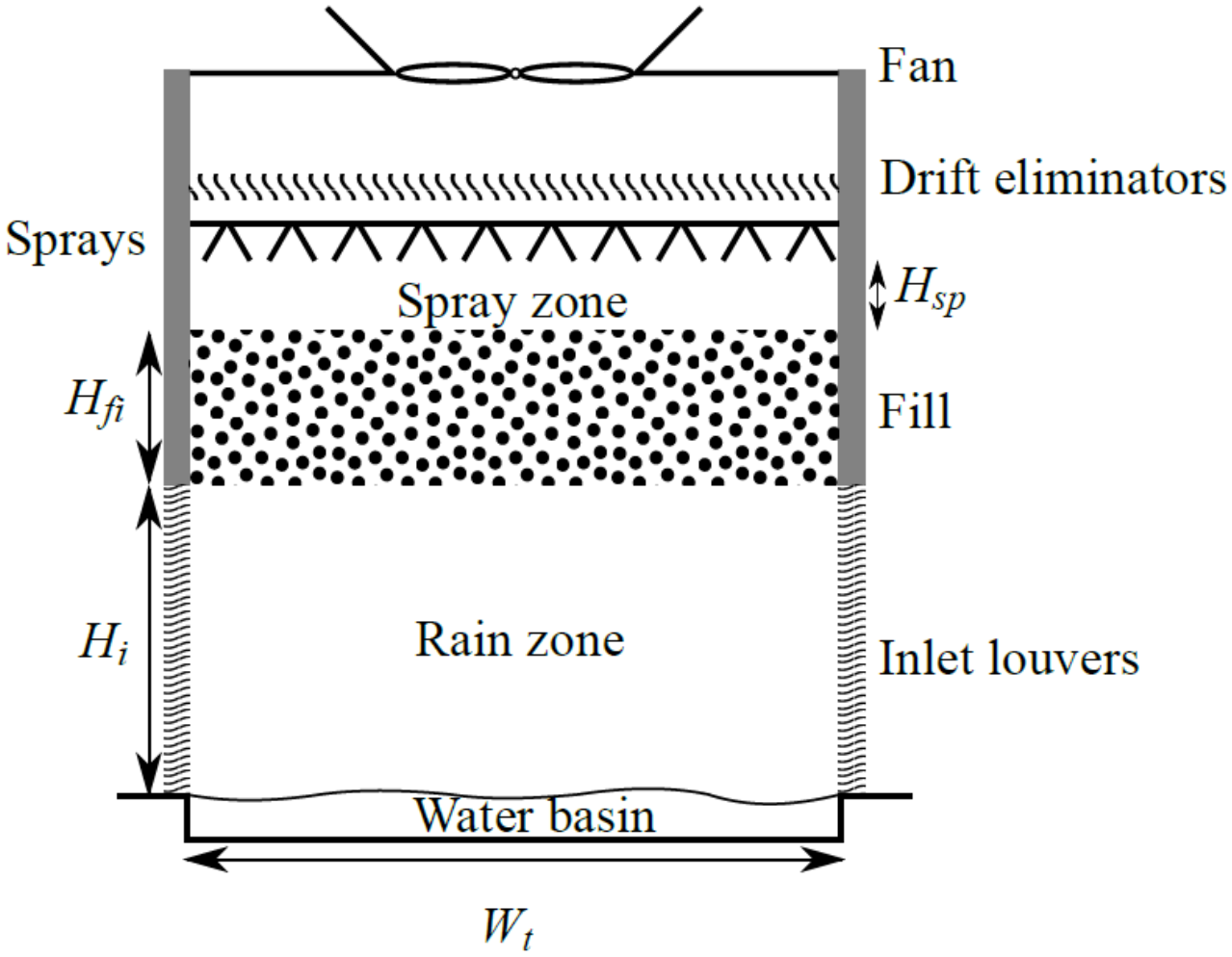
Shell-and-tube heat exchanger



Air-cooled condenser



Wet cooling tower



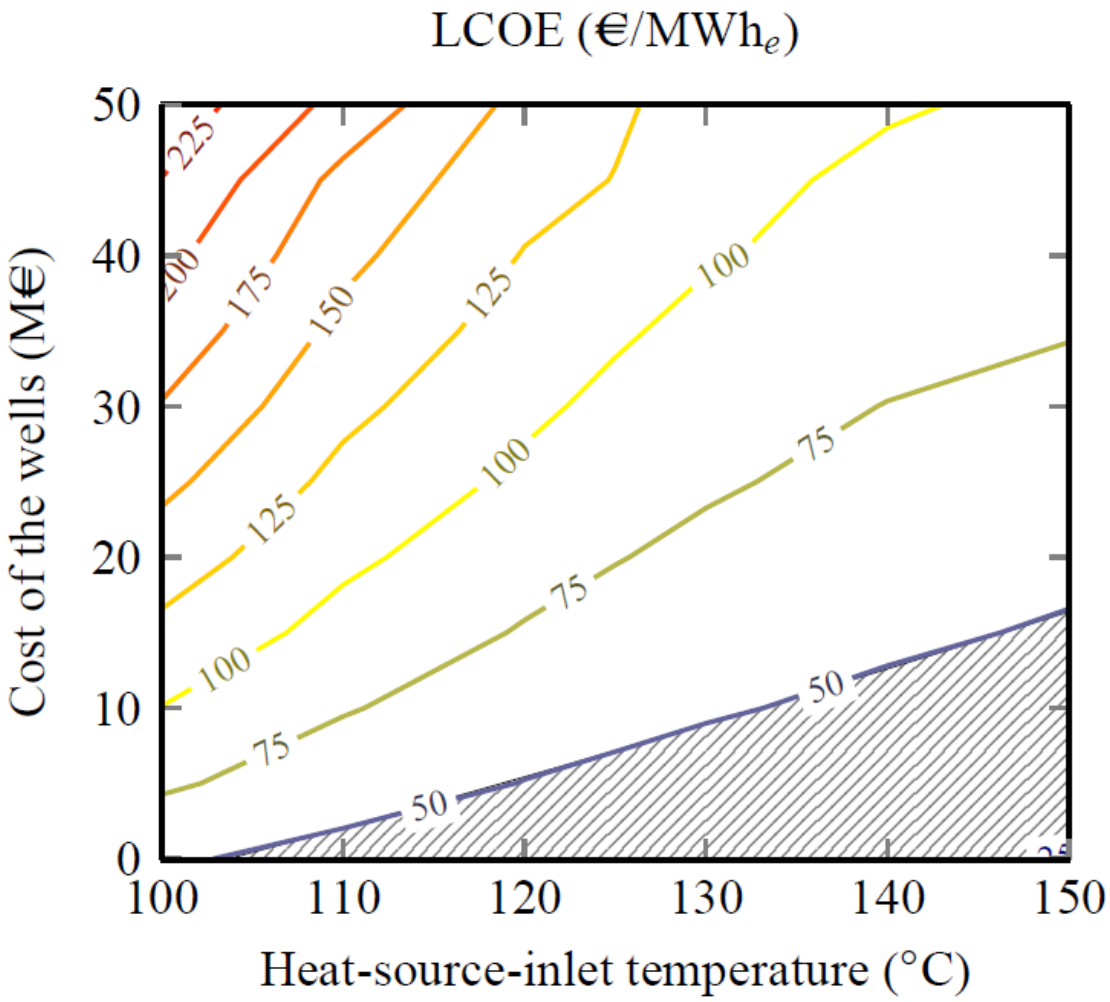
Reference parameters

Well parameters	
Brine-wellhead temperature	125°C
Brine production	194 kg/s
Well-pumps consumption	600 kW_e
Wells cost	27.5 M€

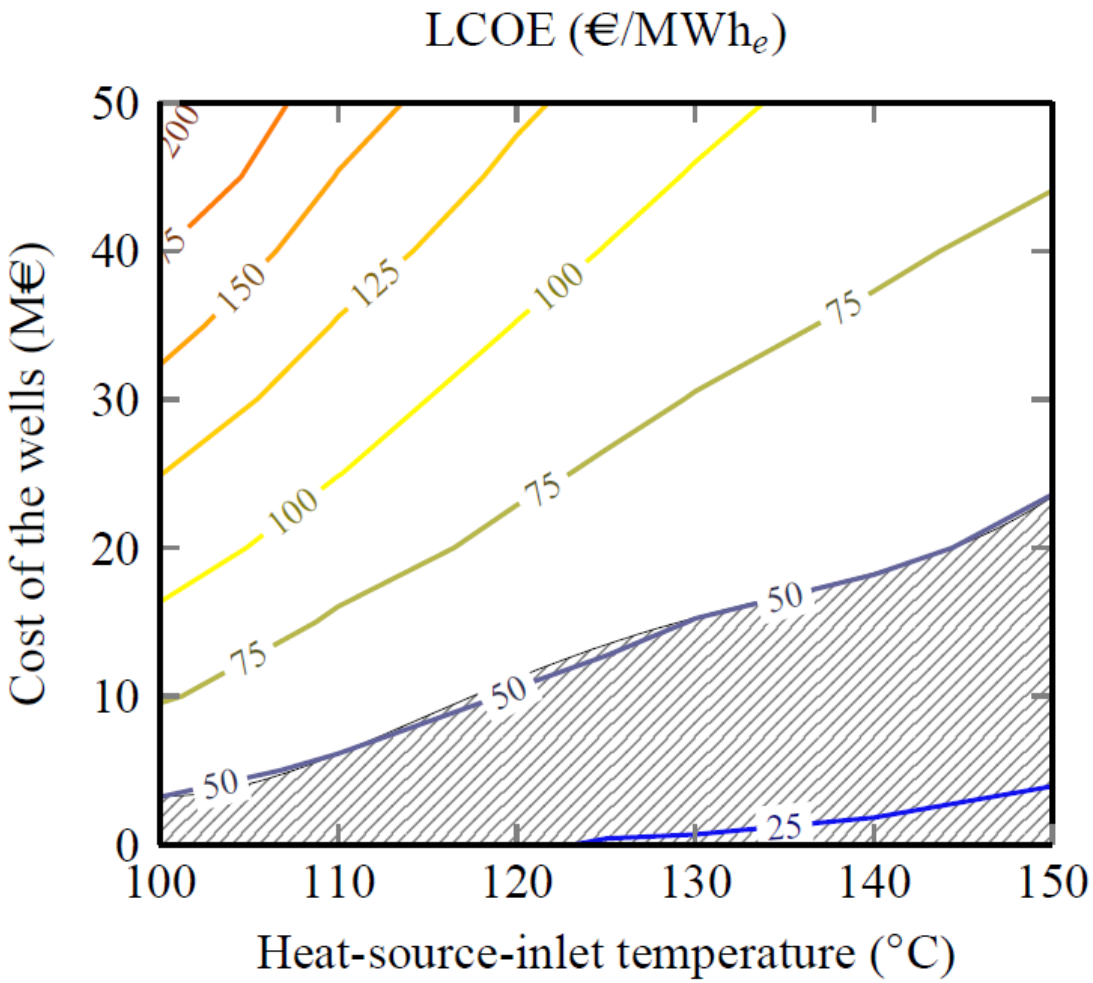
Economic parameters	
Lifetime plant	30 years
Discount rate	4 %/year
Water price	0.5 €/m^3

Environmental conditions	
Dry-bulb temperature	10.3°C
Wet-bulb temperature	8.6°C
Air pressure	1016 hPa

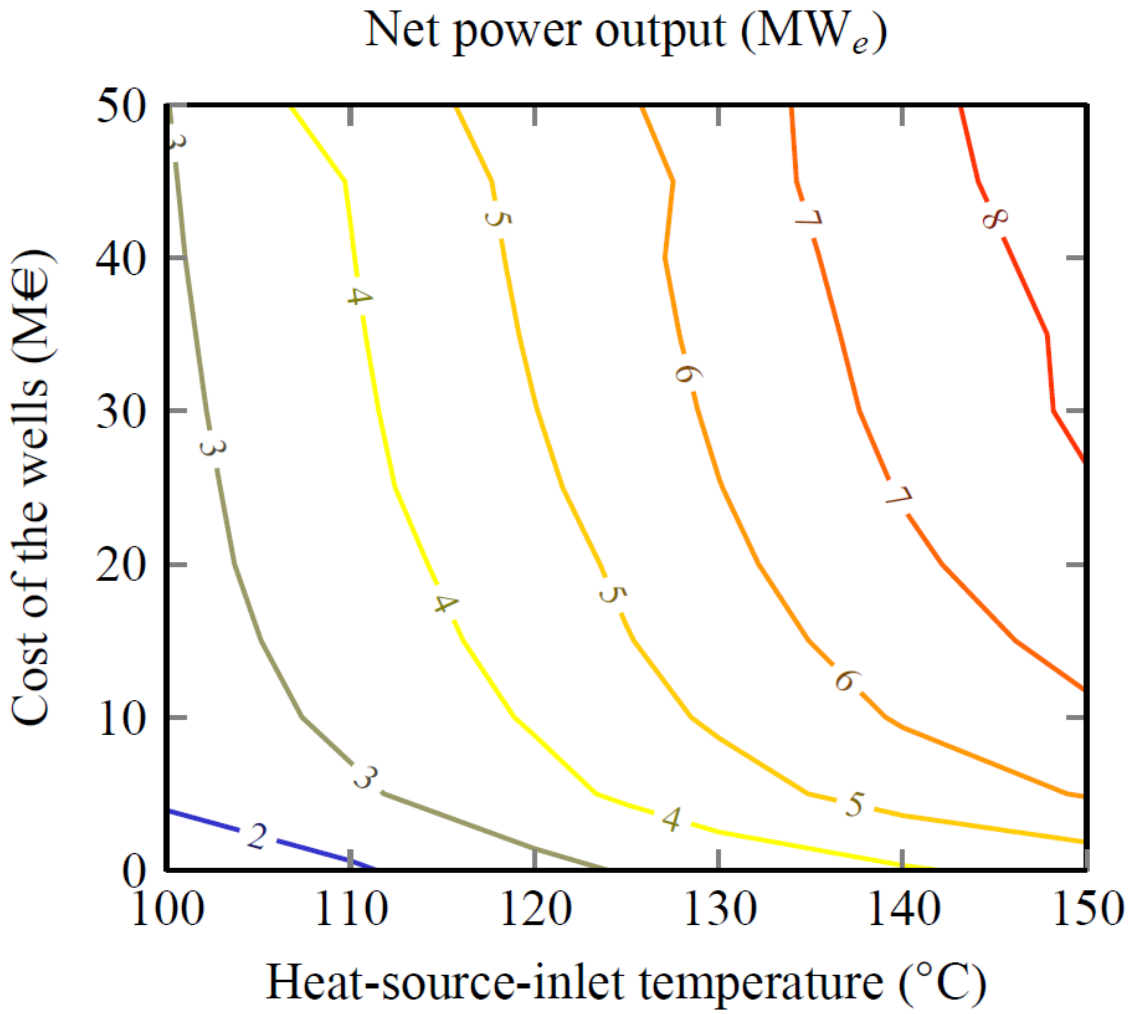
LCOE: air cooled



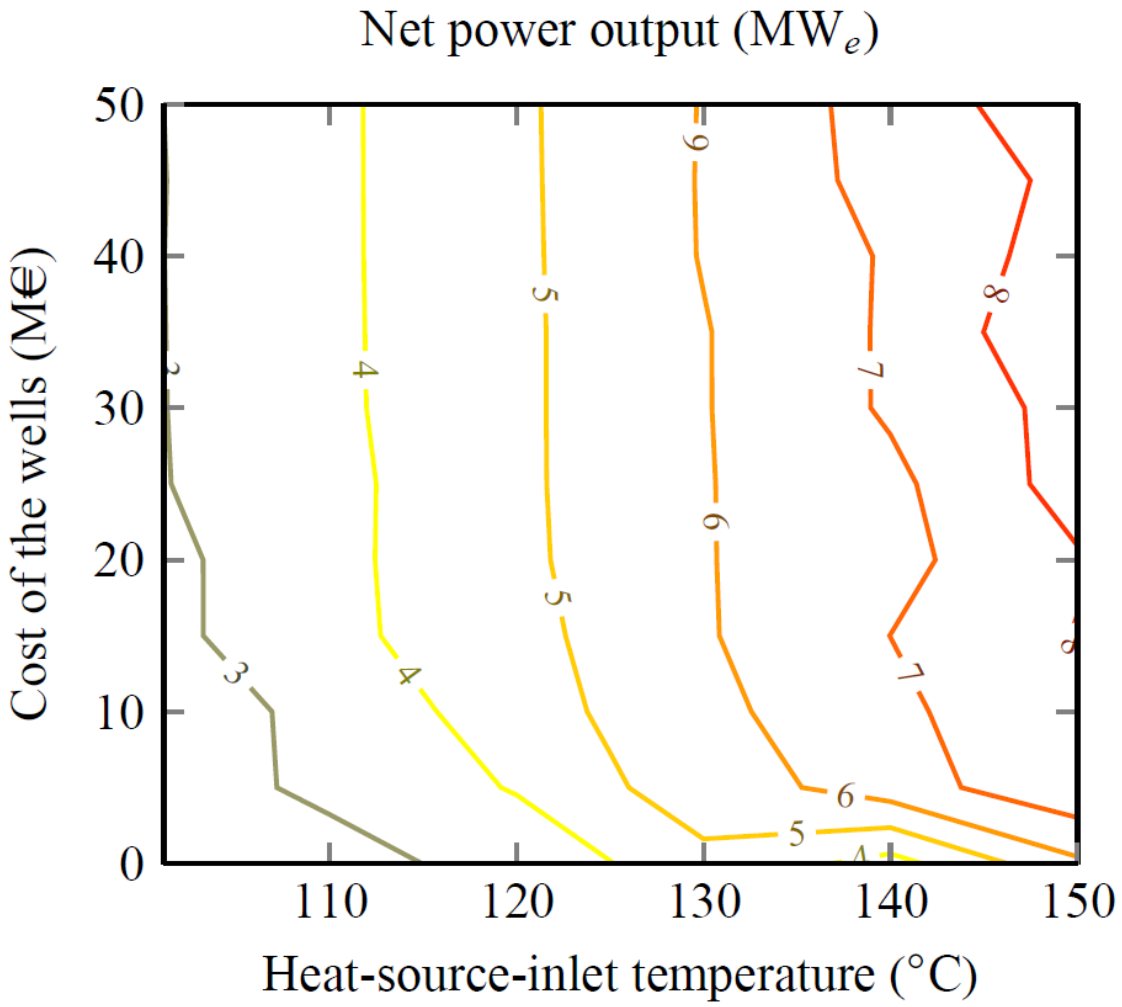
LCOE: water cooled



Net power output: air cooled



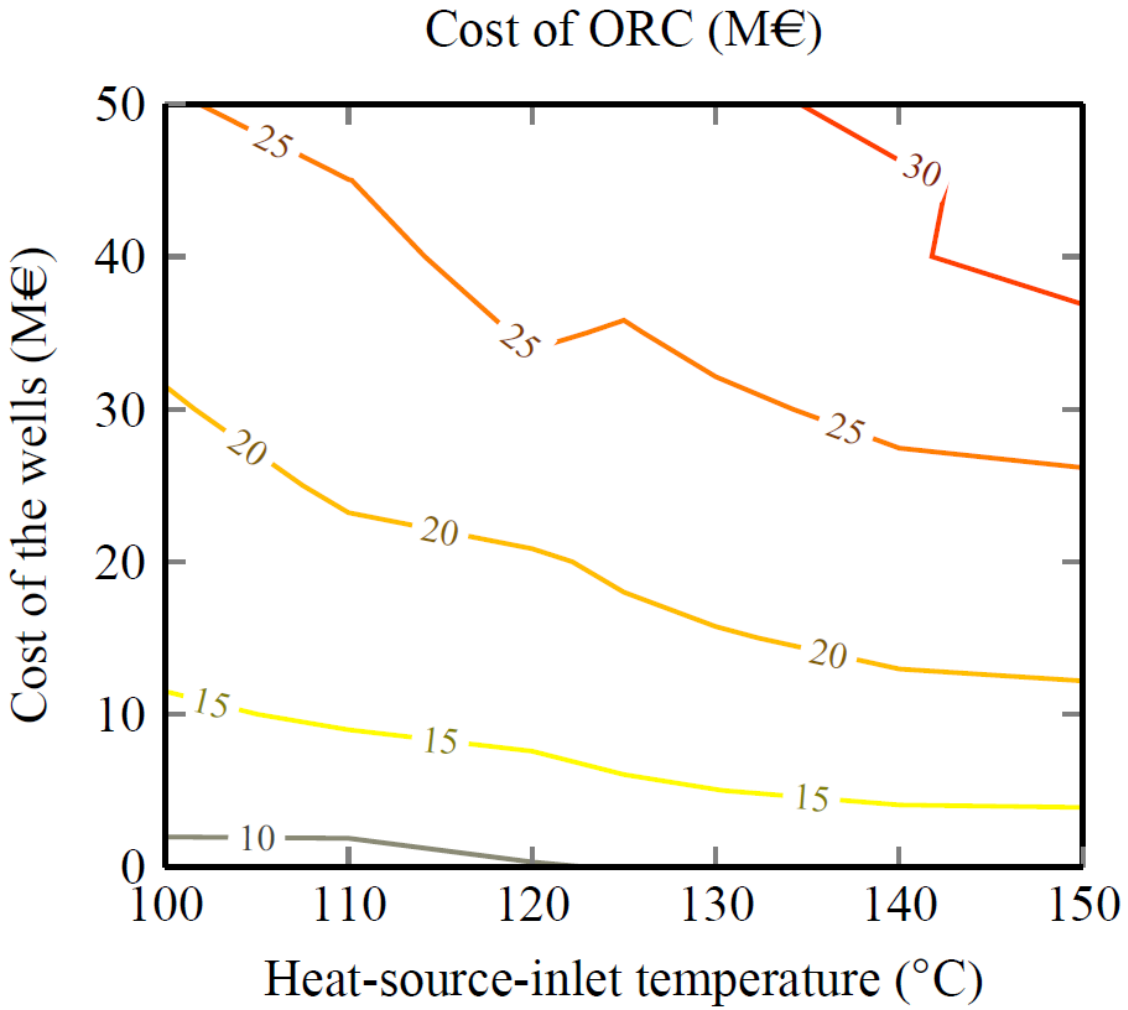
Net power output: water cooled



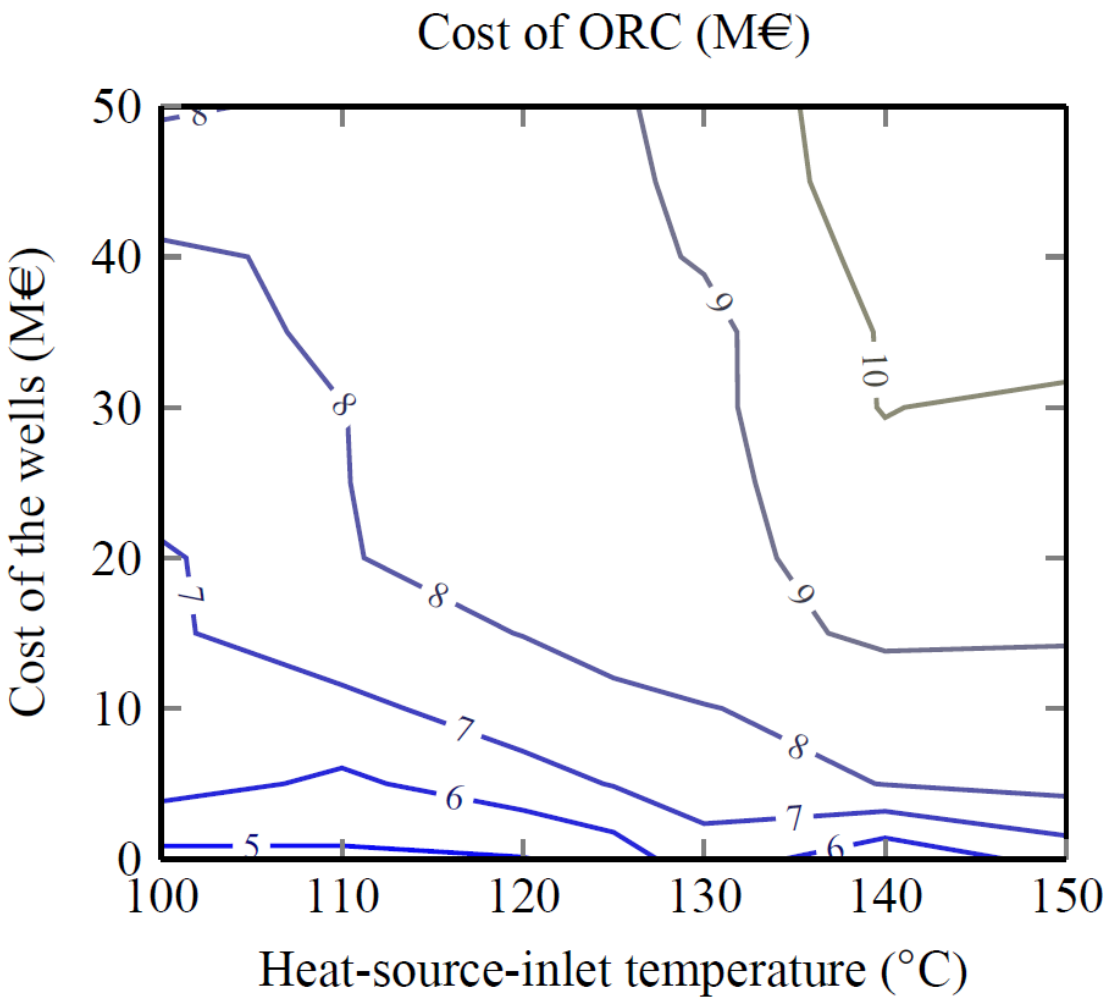
Data of optimal configuration

Well cost (M€)	0	10	30	50
Energetic cycle efficiency (%)	7.3	8.4	9.4	9.6
Pinch-point-temperature-difference in evaporator (°)	7.6	4.7	3.8	3.7
Condenser temperature (°)	41.7	34.4	28.7	27.7
Net electric power output (MW_e)	3.1	4.6	5.7	5.9
Brine-outlet temperature (°C)	73.3	57.3	49.8	48.9
Exergetic plant efficiency (%)	20.6	31.1	38.4	39.5
Cost ORC (M€)	10.2	17.0	26.0	28.2
Specific cost ORC (€/kW_e)	3326	3668	4539	4773
Total project cost (M€)	10.2	27.0	66.0	78.2
Specific cost total project (€/kW_e)	3326	5820	11 521	13 243
Cost ORC/total project cost (%)	100.0	63.0	39.4	36.0
LCOE (€/MWh_e)	32.2	56.4	94.4	128.3

Cost of ORC: air cooled



Cost of ORC: water cooled



Conclusions

- Economic system optimization
- LCOE as a function of heat-source temperature and well costs
- LCOE ORC_{WCT} < LCOE ORC_{ACC}
- Net power ORC_{WCT} > Net power ORC_{ACC}
- Cost ORC_{WCT} < Cost ORC_{ACC}
- Well cost influence the design of the optimal ORC!

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