Energy Supply System Optimization Baden Nord

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Background

Motivation:

- Baden Nord is undergoing a transition from primarily industrial use to more commercial and residential.
- Changes in energy demand patterns and renewable energy requirements.

Objective: to identify optimal energy supply solutions for the energy system of Baden Nord

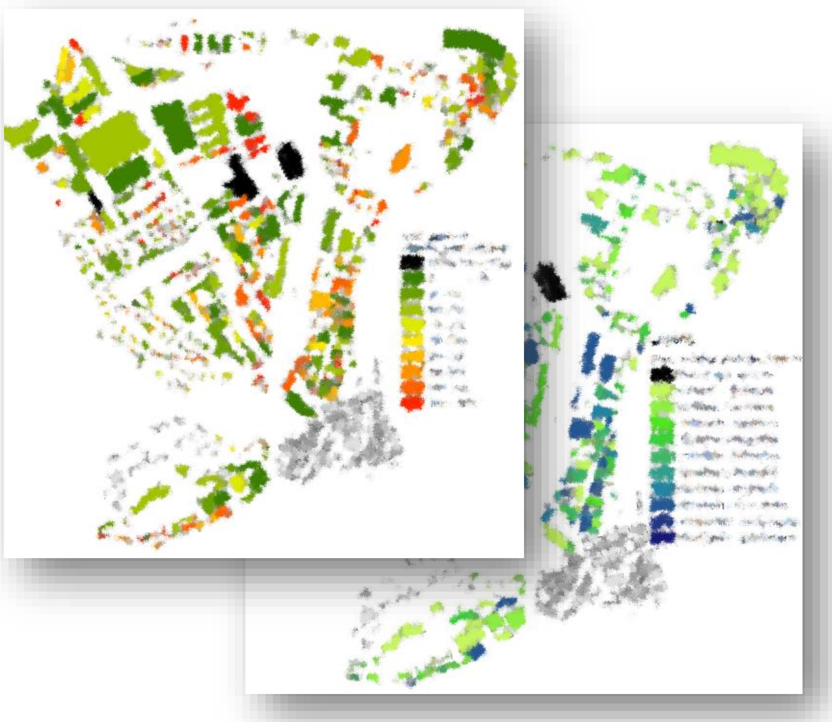
Focus: Technical feasibility and costs of achieving different levels of sustainability performance for the area’s energy supply.

Partners: Regionalwerke Baden (RWB)

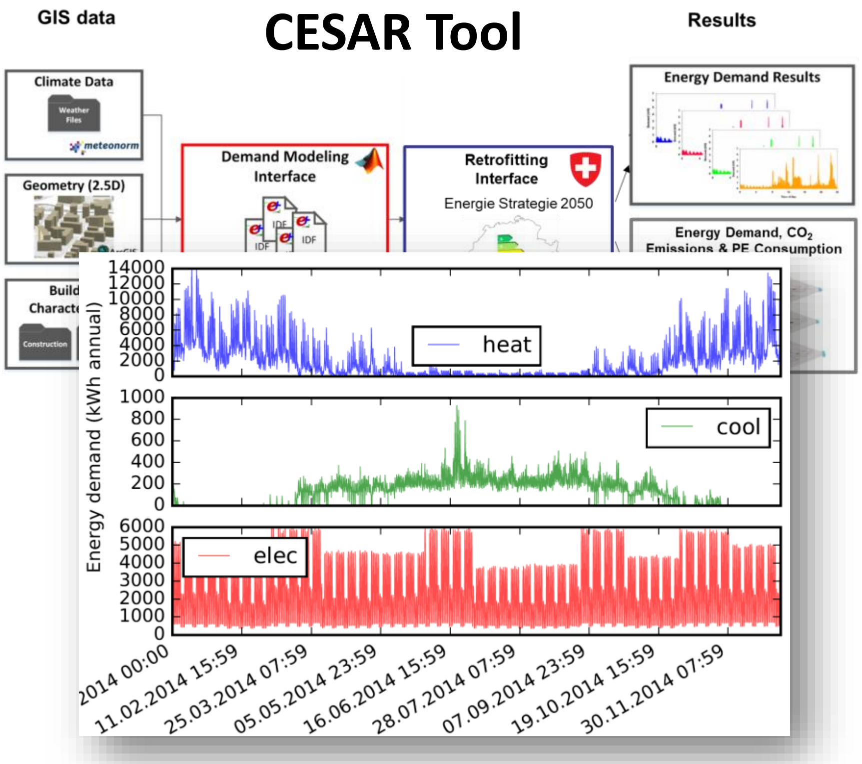
Approach

Step 1: Energy demand modelling to estimate the future multi-vector energy demand patterns for the site

Data RWB



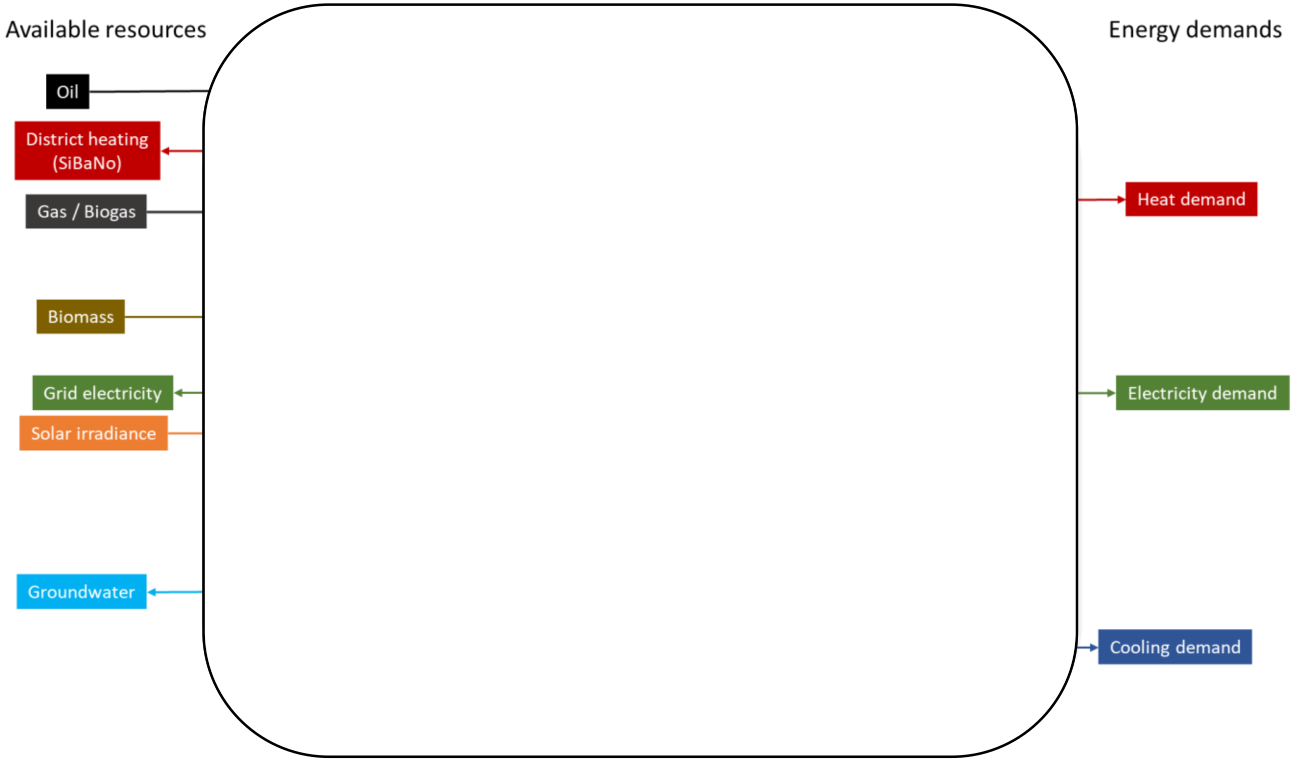
CESAR Tool



Approach

Step 2: Optimization modelling to identify a set of optimal energy supply solutions for the site, representing different levels of sustainability performance.

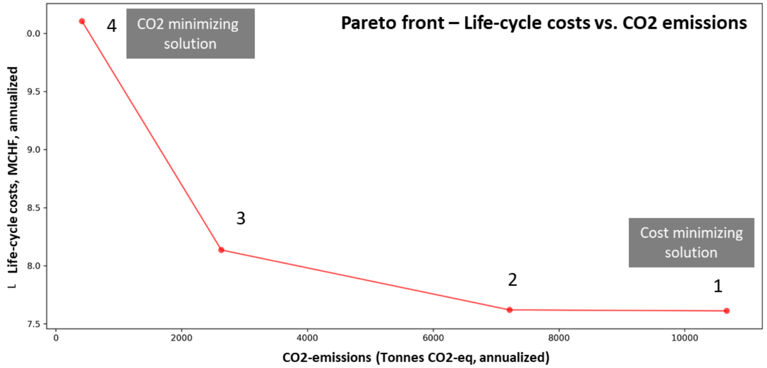
Ehub Tool (Empa)



Iteration 1 – Aggregated optimization

Objective: to determine the optimal energy supply options for the site as a whole, given the range of available supply options

Pareto front of optimal energy supply solutions



Cost category	*Cost minimizing solution* Solution 1	Solution 2	Solution 3	*CO2 minimizing solution* Solution 4
Investment costs	Fr. 3,635,204	Fr. 3,884,161	Fr. 3,629,318	Fr. 4,513,473
Energy costs	Fr. 4,301,271	Fr. 4,287,156	Fr. 4,663,392	Fr. 5,842,397
O&M costs	Fr. 110,259	Fr. 104,408	Fr. 240,095	Fr. 343,402
Income	-Fr. 435,480	-Fr. 656,795	-Fr. 397,924	-Fr. 594,051
Total costs	Fr. 7,611,253	Fr. 7,618,929	Fr. 8,134,880	Fr. 10,105,221

Optimal technology configurations

Heat production (kW)

Technology	*Cost minimizing solution* Solution 1	Solution 2	Solution 3	*CO2 minimizing solution* Solution 4
Biomass boiler ORC	0	0	22768	15961
Gas CHP	2188	0	0	0
Heat pump / chiller (air-source)	2717	4161	5517	8193
Heat pump / chiller (groundwater)	0	0	0	4153
District heating (SiBaNo)	32463	34649	0	0

Cooling production (kW)

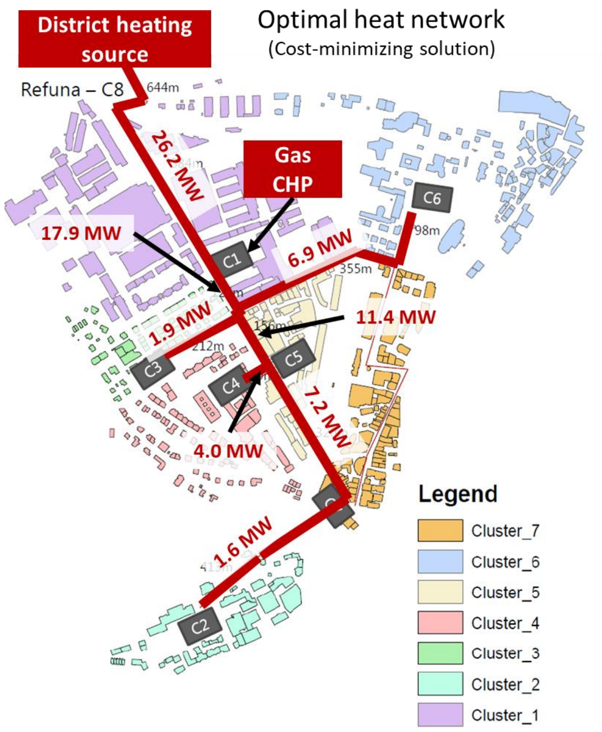
Technology	*Cost minimizing solution* Solution 1	Solution 2	Solution 3	*CO2 minimizing solution* Solution 4
Heat pump / chiller (air-source)	2717	4161	5517	8193
Heat pump / chiller (groundwater)	0	0	0	2617
Freecooling (groundwater)	2500	2500	2500	2500

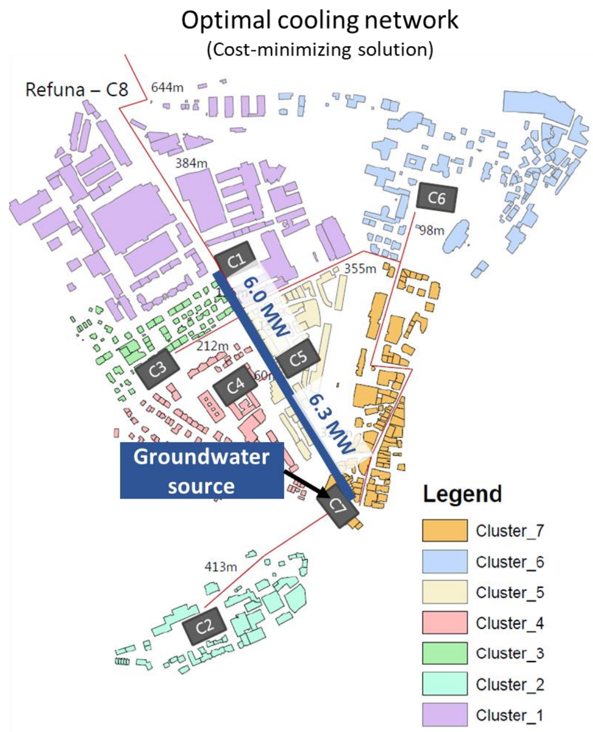
Electricity production (kW)

Technology	*Cost minimizing solution* Solution 1	Solution 2	Solution 3	*CO2 minimizing solution* Solution 4
Biomass boiler ORC	0	0	4208	2950
Gas CHP	2069	0	0	0
Solar PV (kWp)	13128	16071	13517	16201

Iteration 2 – Disaggregated optimization

Objective: to identify the optimal supply technology locations and thermal network structures, assuming a more limited set of available technology options





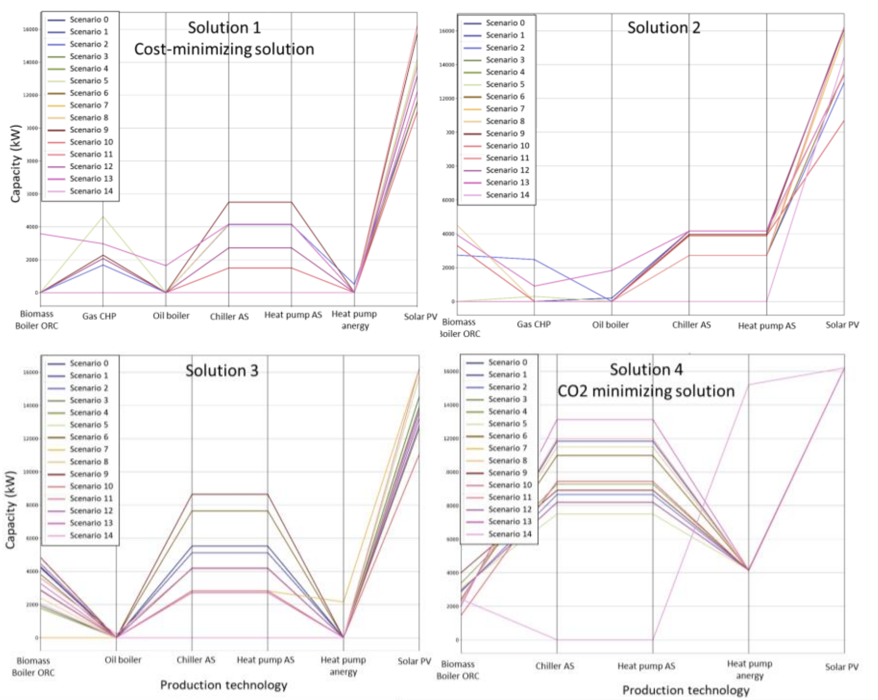
Iteration 3 – Sensitivity analysis

Objective: to determine the influence of different uncertain developments on the future optimal energy supply solution for the site

Scenarios evaluated

Scenario #	Parameter modification	Cost change (%)	CO2 change (%)
0	Base scenario	N/A	N/A
1	Gas price +20%	2	-16
2	Gas price -20%	-1	1
3	Biogas price +20%	0	11
4	Biogas price -20%	1	11
5	Electricity price +20%	6	3
6	Electricity price -20%	-6	-13
7	Biomass price +20%	1	11
8	Biomass price -20%	-1	-24
9	Energy demands +20%	19	23
10	Energy demands -20%	-17	-43
11	PV price -50%	-16	4
12	Battery price -50%	0	0
13	District heating (SiBaNo) excluded	3	-24
14	Unlimited use of groundwater	-3	-14

Optimal technology configurations per scenario



Generalizability of results

- **Results are specific to the site** and cannot easily be transferred to other locations
- **Approach & methodology applicable to other locations** from neighborhood to district scale
- Offers a way to identify **optimal energy transformation pathways at local scale** towards the Energy Strategy 2050

Thank you for your attention!

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