

Energy Supply System Optimization Baden Nord

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Background

Motivation:

- JASM
- 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.

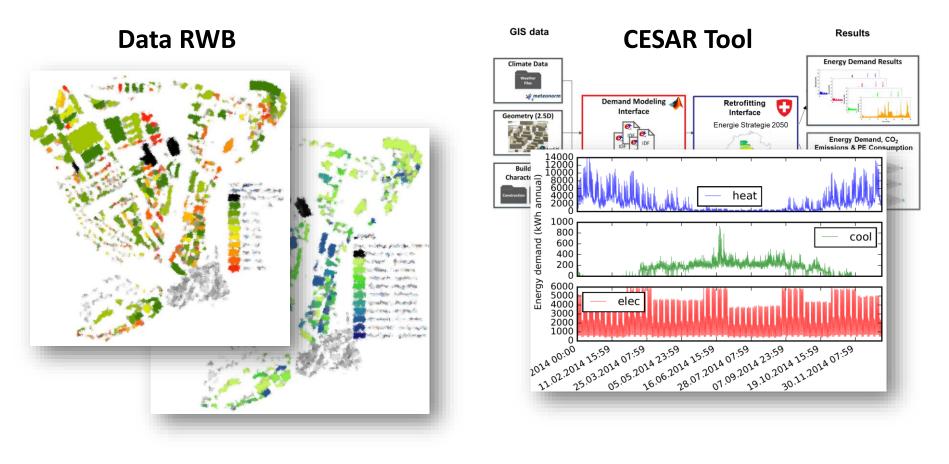
Partners: Regionalwerke Baden (RWB)



Approach



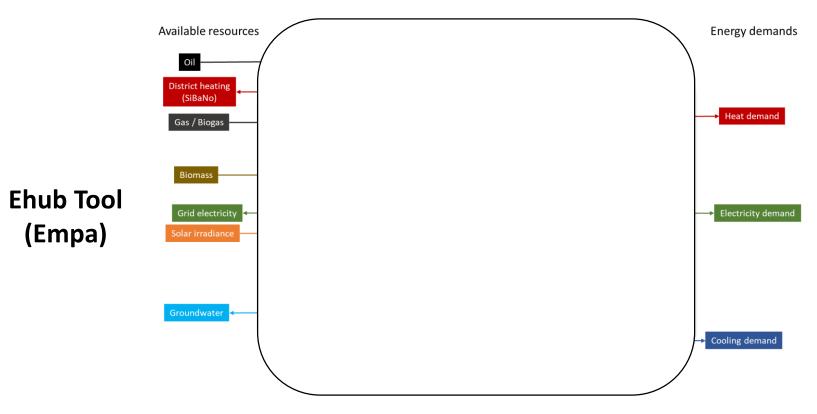
Step 1: Energy demand modelling to estimate the future multi-vector energy demand patterns for the site







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



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			CO2 minimizing solution
	Solution 1	Solution 2	Solution 3	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

CO2-emissions (Tonnes CO2-eq, annualized)

Optimal technology configurations

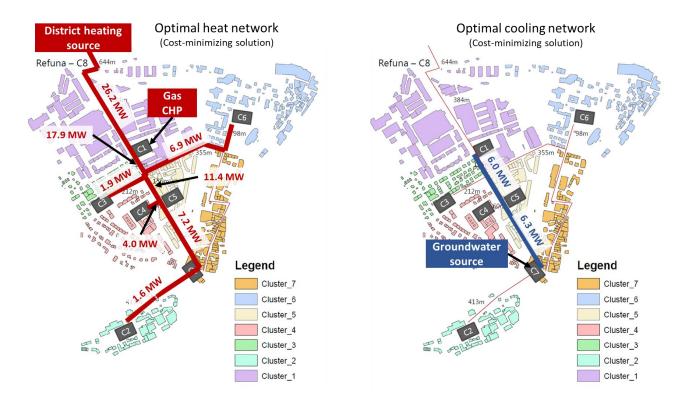
Technology	Cost m	inimizing solution				c	02 minimizing sol	ution
		Solution 1	Solution 2		Solution 3		Solution 4	
Biomass boiler ORC		0		0		22768		1596
Gas CHP		2188		0		0		(
Heat pump / chiller (air-source)		2717		4161		5517		819
Heat pump / chiller (groundwate	er)	0		0		0		415
District heating (SiBaNo)		32463		34649		0		6
Technology	Cost m	inimizing solution				c	O2 minimizing sol	ution
Technology	Cost m	inimizing solution				-	02 minimizing col	ution
		Solution 1	Solution 2		Solution 3		Solution 4	
Heat pump / chiller (air-source)		2717		4161		5517		819
Heat pump / chiller (groundwat	er)	0		0		0		261
Freecooling (groundwater)		2500		2500		2500		250
Electricity production (kW)								
Technology	Cost minim	izing solution)2 minimizing solu	ution
, connorogy		tion 1	Solution 2		Solution 3		Solution 4	
Biomass boiler ORC		0		0		4208		295
Gas CHP		2069		0		0		
Solar PV (kWp)		13128		16071	1	3517		1620



Iteration 2 – Disaggregated optimization

JASM

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

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

Scenarios evaluated

Solution 1 Scenario 0 Solution 2 Scenario 1 ---- Scenario 1 - Scenario 2 Cost-minimizing solution Scenario 2 Scenario 3 Scenario 3 Scenario Scenario 4 Scenario 5 Scenario 5 Scenario Scenario 6 Scenario 7 Scenario 7 Scenario 8 Scenario 8 (¥≷ Scenario 9 Scenario 9 Scenario 10 Scenario 10 Scenario 11 Scenario 11 Capacity Scenario 12 Scenario 12 Scenario 13 Scenario 13 Scenario 14 Scenario 14 Biomass Chiller AS Heat pump AS Heat pump Gas CHP Oil boiler Solar PV Boiler ORC Biomass Gas CHP Oil boiler Chiller AS Heat pump AS Solar PV anergy 3oiler ORC Scenario (----- Scenario 0 Solution 3 Solution 4 - Scenario 1 - Scenario 1 Scenario 2 Scenario 2 CO2 minimizing solution - Scenario 3 - Scenario 3 Scenario 4 - Scenario 4 Scenario 5 Scenario 5 Scenario 6 Scenario (Scenario 7 Scenario 7 Scenario 8 Scenario B ity (kW) - Scenario 9 Scenario (Scenario 10 Scenario 1 Scenario 11 Scenario 11 Scenario 12 Scenario 12 Scenario 1 Scenario 13 Scenario 14 Scenario 14 Heat pump AS Solar PV Biomass Biomass Oil boiler Chiller AS Heat pump Heat pump Chiller AS Heat pump AS Solar PV Boiler ORC anergy Boiler ORC Production technology Production technology

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



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