


HpCosy - Heat Pump Comfort System

Swarm-Controlled B/W Heat Pump System for Multi Family Houses

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Swiss Federal Office of Energy SFOE

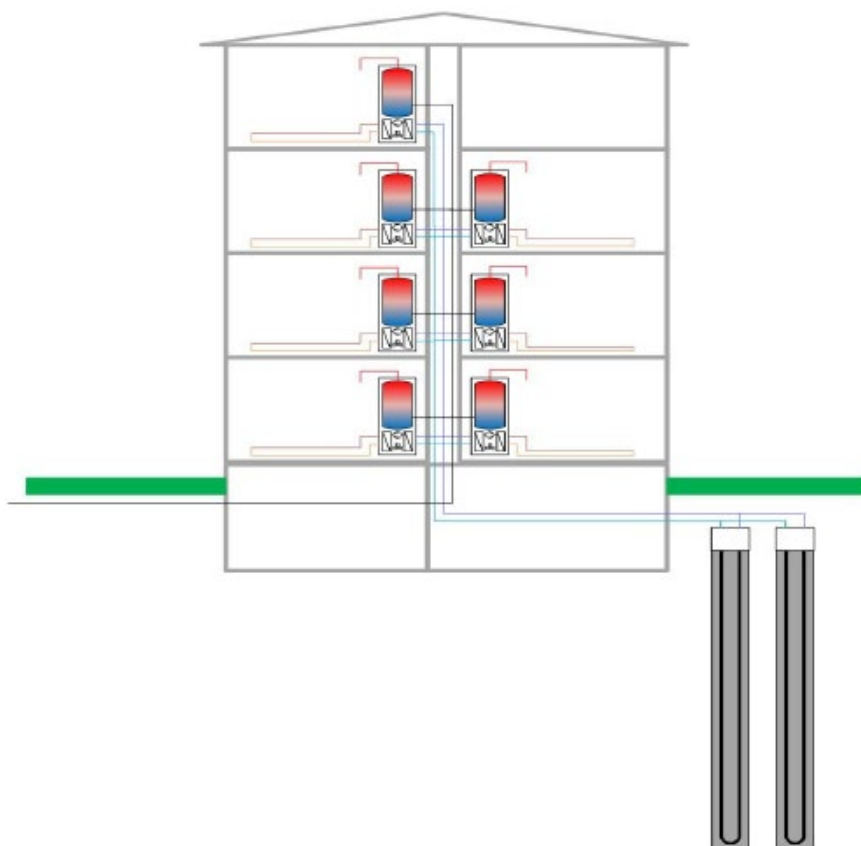
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- In the HpCosy project, the basic principles for a decentralized brine-water heat pump system for apartments in multi-family houses (MFH) were developed and investigated for:

Heating, cooling and DHW preparation.

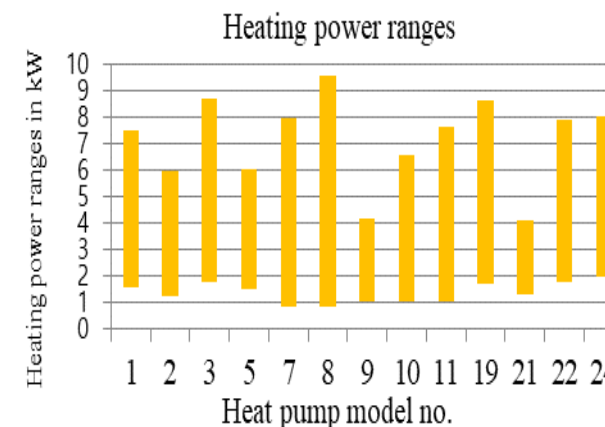
- The regulation/control system shall allow the consideration of the own photovoltaic power availability for the single system in a swarm network with the other heat pumps of the building.



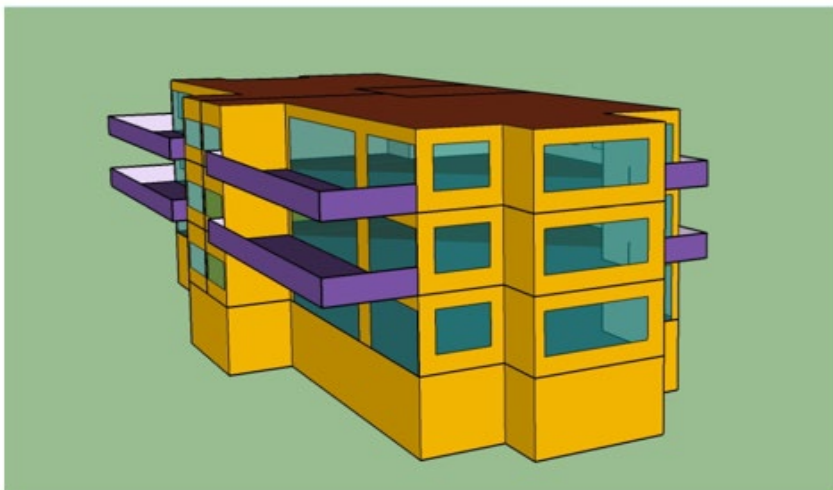
HpCosy – Market Potential



- According to the Swiss Federal Statistical Office (SFSO) Switzerland had in 2019:
 - 1.76 Mio buildings with residential use, of which
 - 0.48 Mio were MFH, whereby
 - 0.25 Mio of the MFH with 3 - 9 apartments
 - 0.06 Mio residential buildings with secondary use and 3 - 9 apartments
 - 0.31 Mio total buildings with 6 apartments on average
 - 1.86 Mio decentr. HPs with HpCosy system potential
- Suitable heat pumps/storage systems are available with:
 - necessary power setting range
 - low noise operation
 - compact design
- Modifications for refurbishment of existing buildings are known

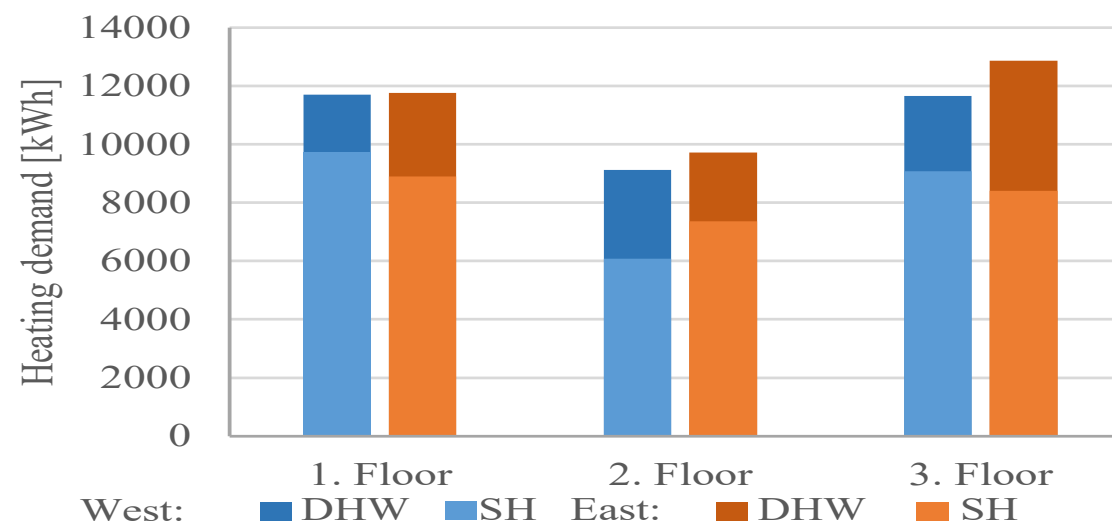


Heat demand of the simulated MFH

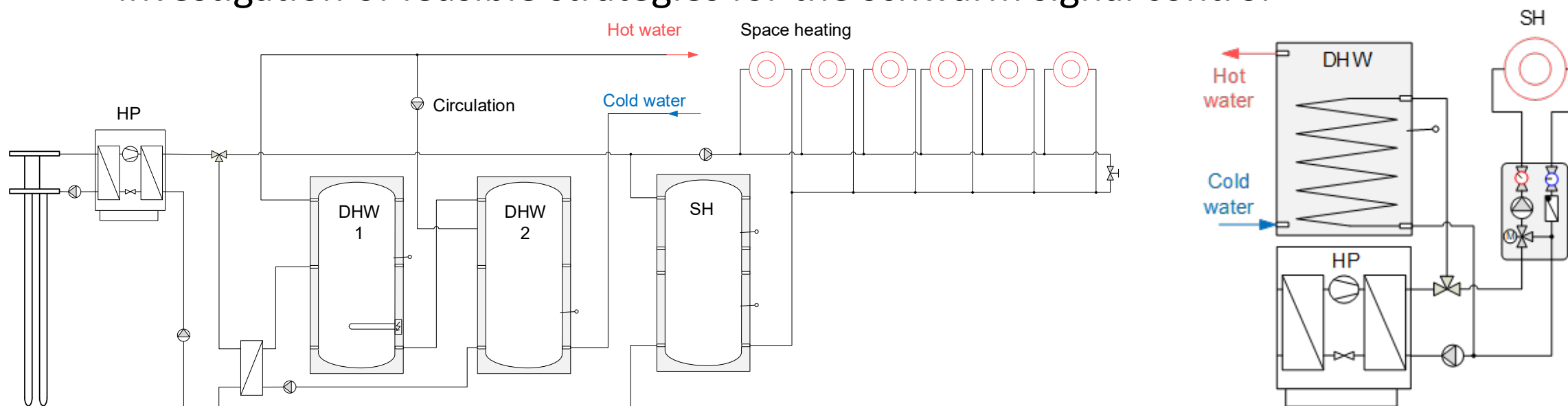


	West	East
3. Floor	2 Pers.	EU tapping cycle "L"
2. Floor	4 Pers.	2 Pers.
1. Floor	2 Pers.	4 Pers.

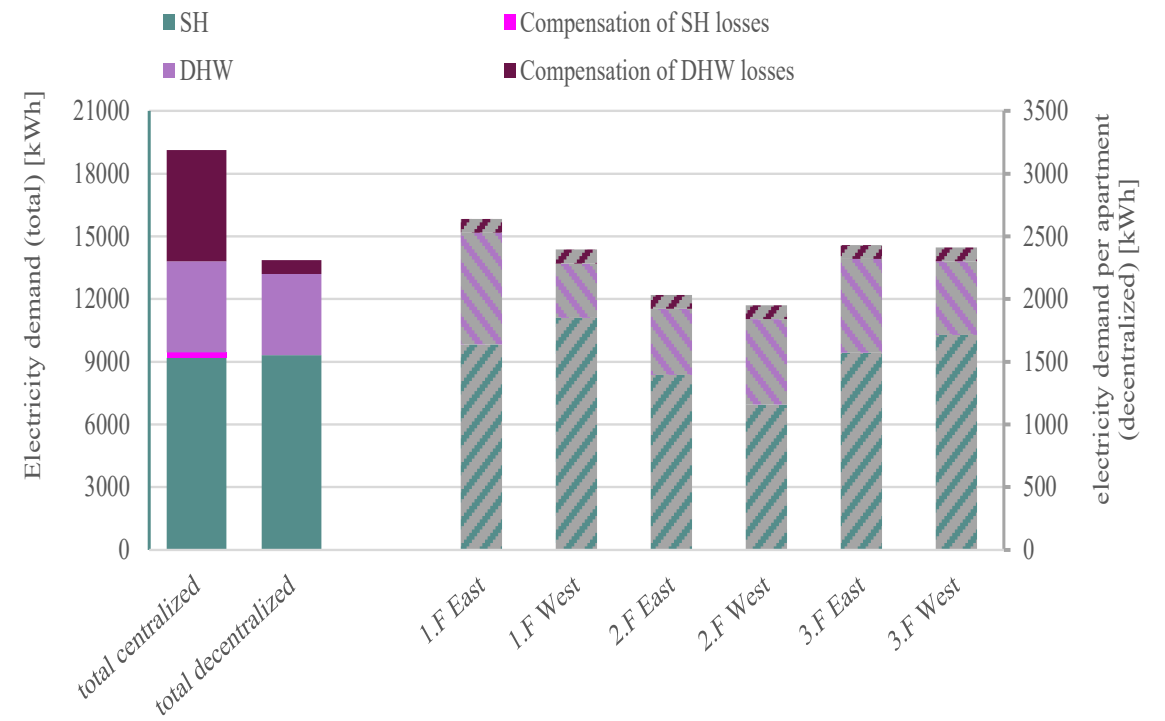
Energy reference area (ERA)	1'302 m ²
Net floor area	1'103 m ²
Specific heat demand	45 kWh/(m ² .a)
Ratio envelope surface to ERA	1.3



- Simulations with TRNSYS / spreadsheet calculations
- Comparison centralized vs. decentralized HP systems (renovated MFH)
- Comparison of losses for the DHW preparation /distribution/circulation
- Investigation of feasible strategies for the schwarm signal control



Heat and electricity demand for centralized vs. decentralized system

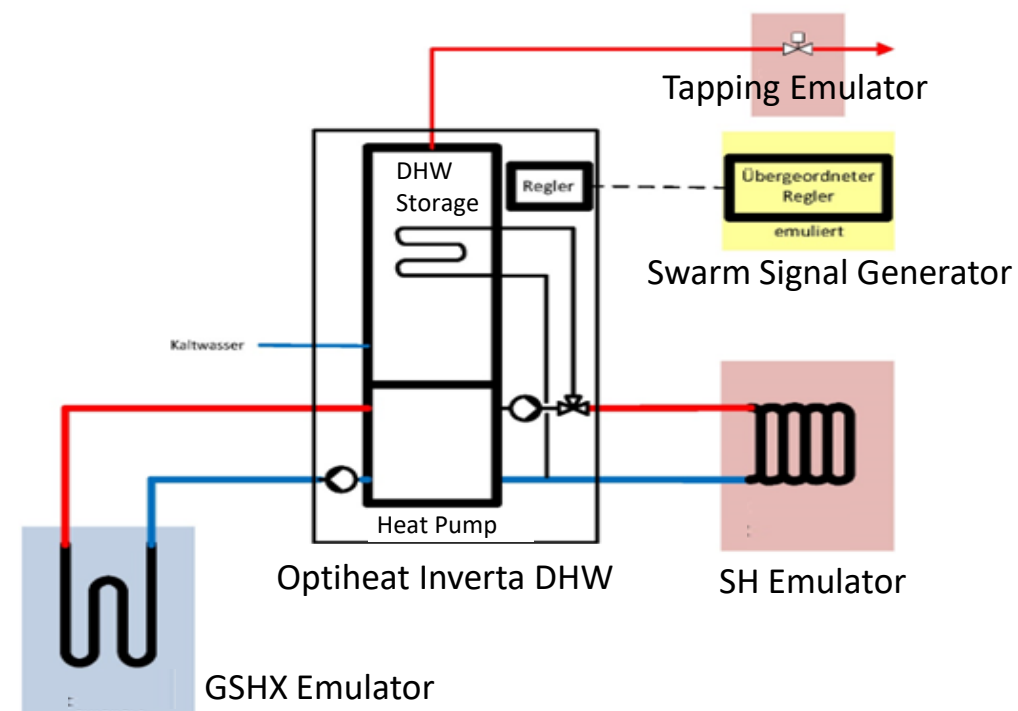


Optiheat Inverta DHW (CTA AG)



- Testing the functionality and controllability
- Adaption of HP controller for Swarm-signal control
- Measuring the efficiency (system and DHW storage stratification)

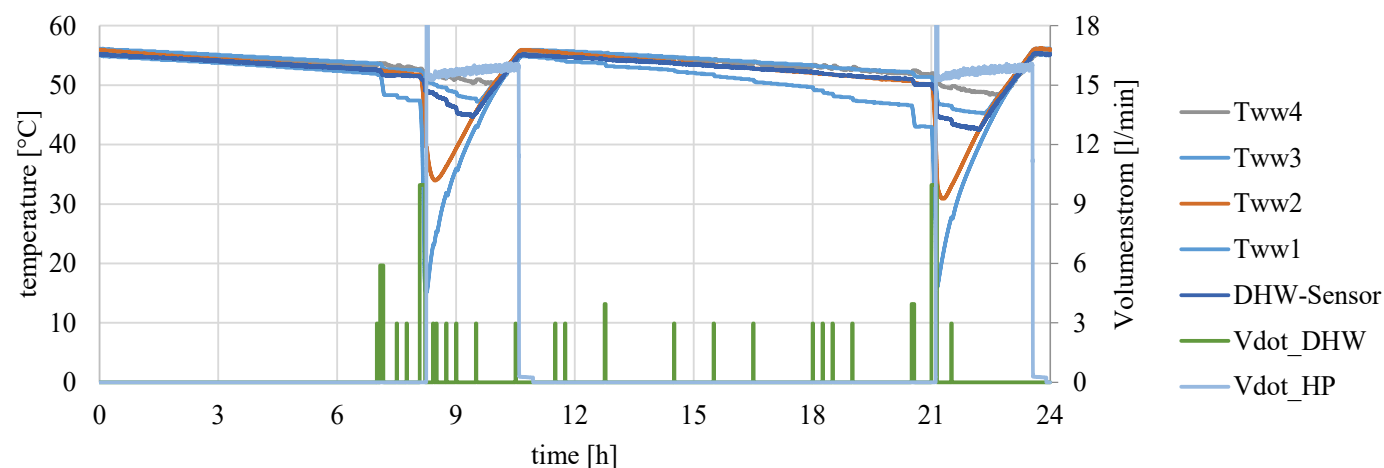
Schematic of the HIL testing setup



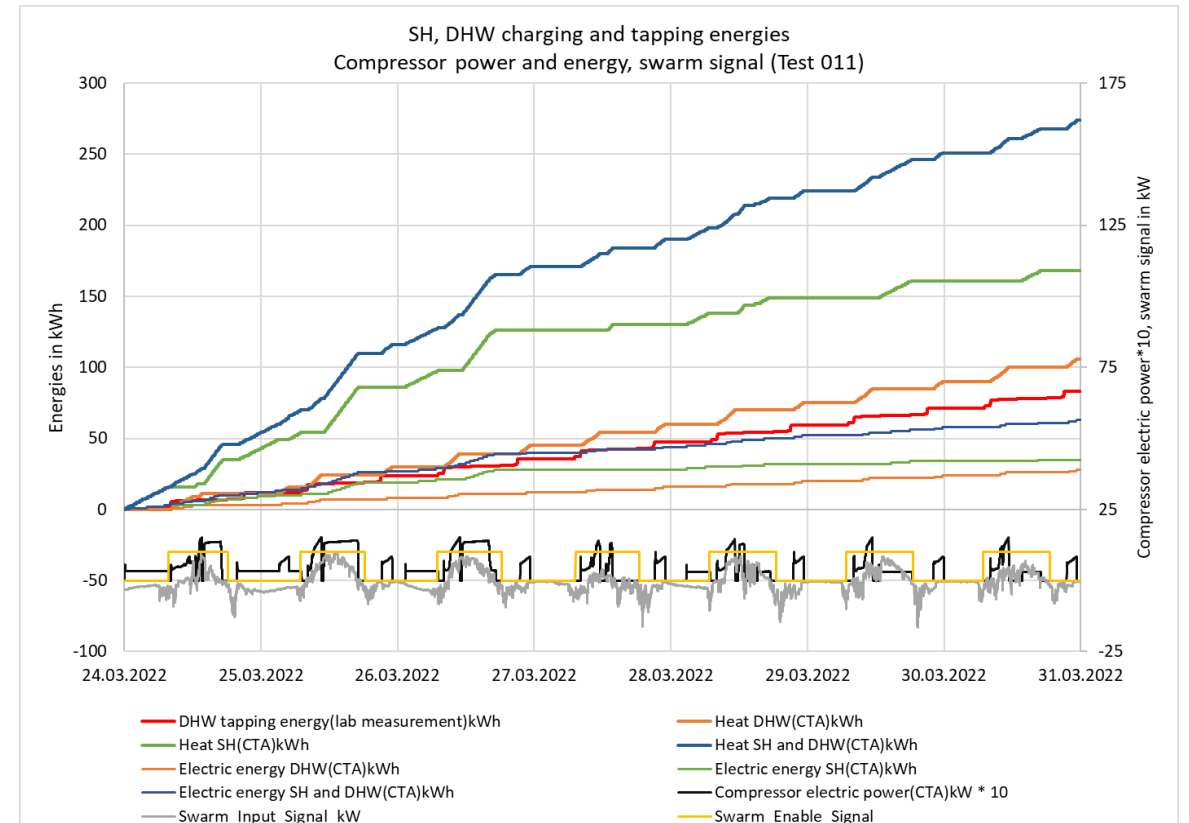
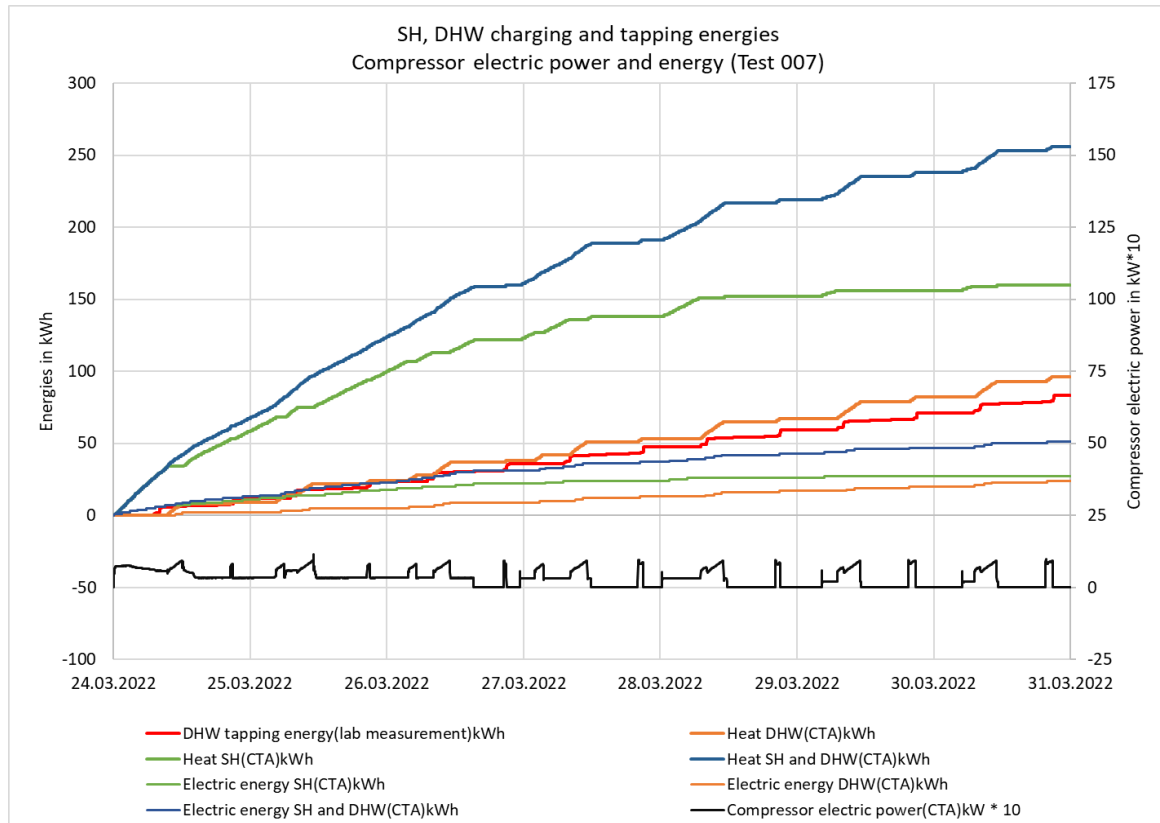
DHW Storage tank measurements



- Functional control of the emulators for source and tappings
- Measurement of temperature stratification (inserted lance with 4 PT100 at different heights)
- EN 16147:2017 tappings / profile L 4 days / standby 3 days



Energies and compressor powers of Test 007 (demand) and 011 (swarm)





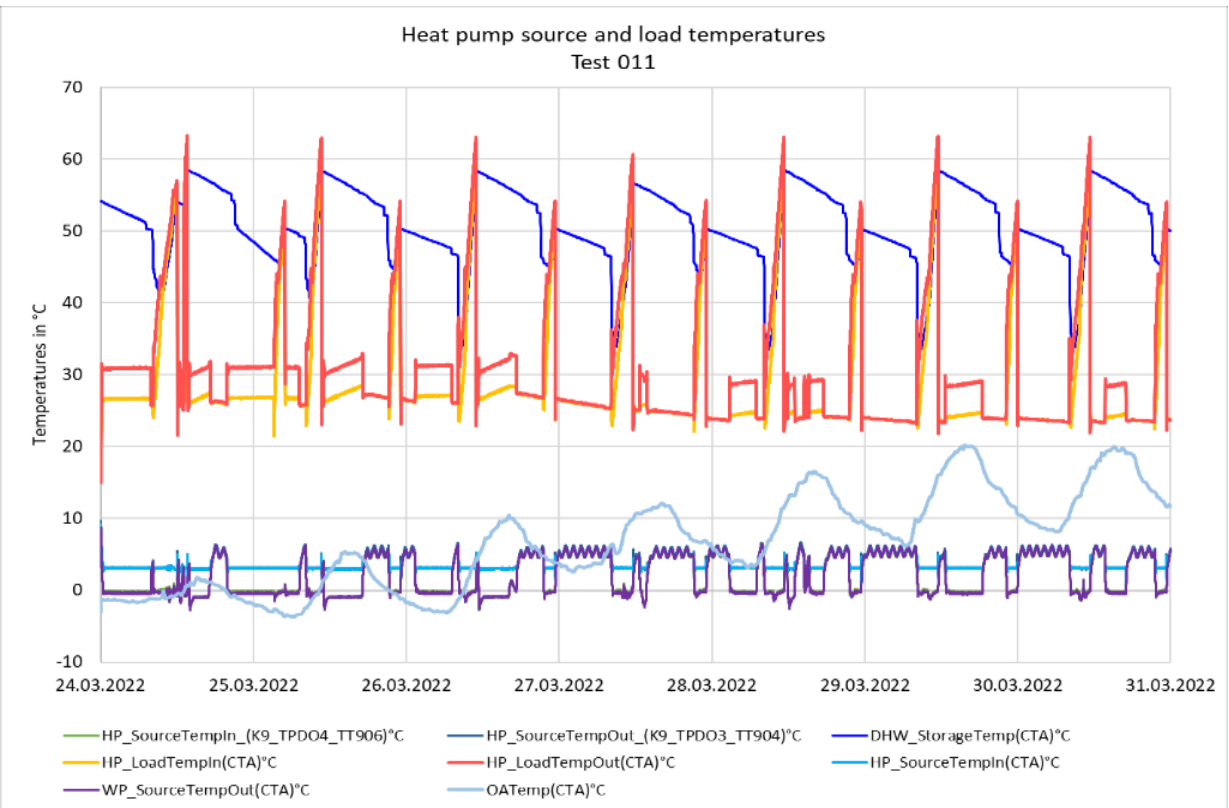
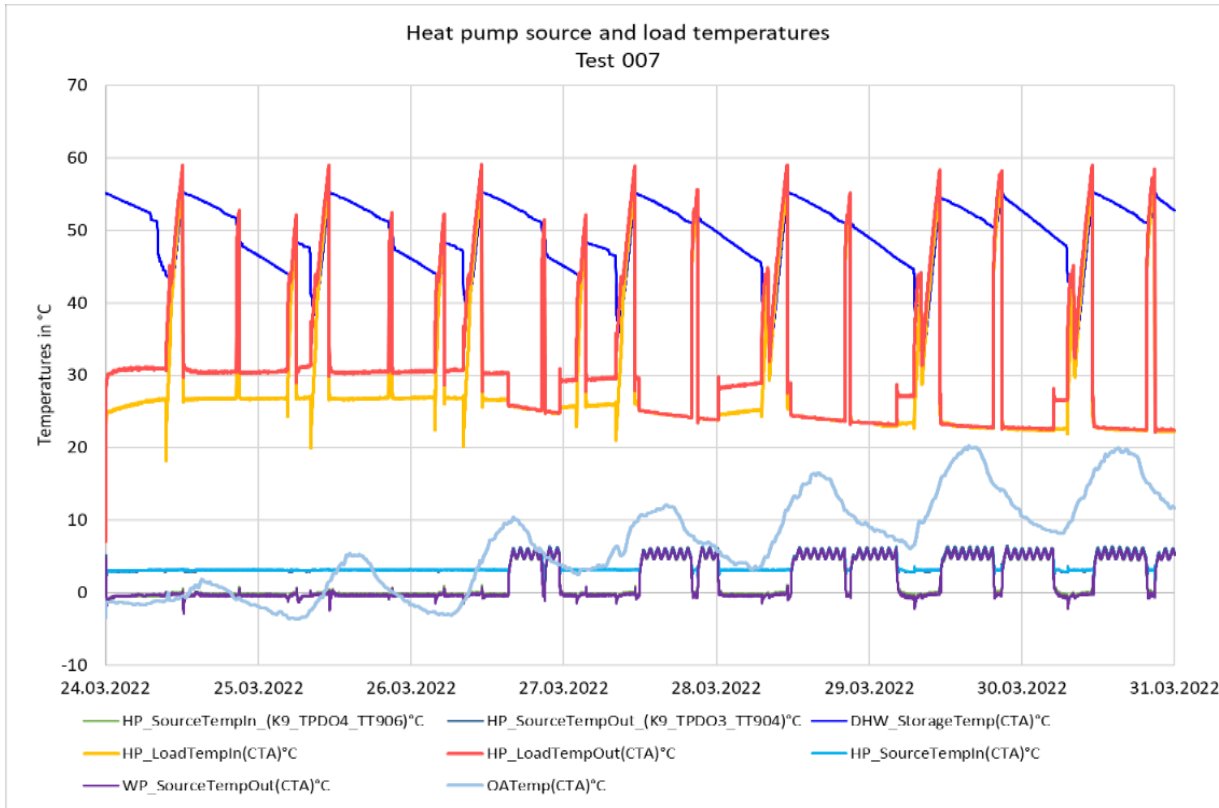
HpCosy – Performed Lab Tests



Energies and COP's of Test 007 (demand) and 011 (swarm control)

Value	Unit	Test 007 Demand Total	Grid electricity	Self-consumed PV electricity	Test 011 Swarm Total	Grid electricity	Self-consumed PV electricity	Change Total	Change Grid / PV electricity
Heat for SH	kWh	160			168			+5%	
Heat for DHW	kWh	96			106			+10%	
Heat for SH+DHW	kWh	256			274			+7%	
Electric Energy SH	kWh	27	22	5	35	18	17	+30%	-18% / +240%
Electric Energy DHW	kWh	24	14	10	27	13	14	+17%	-7% / +40%
Electric Energy SH+DHW	kWh	51	36	15	62	31	31	+24%	-14% / +107%
COP avg SH	-	5.93			4.80			-19%	
COP avg DHW	-	4.00			3.79			-5%	
COP avg SH+DHW	-	5.02			4.35			-13%	

HP source and load temperatures of Test 007 (demand) and 011 (swarm)



Mode: Swarm control

Energy flows

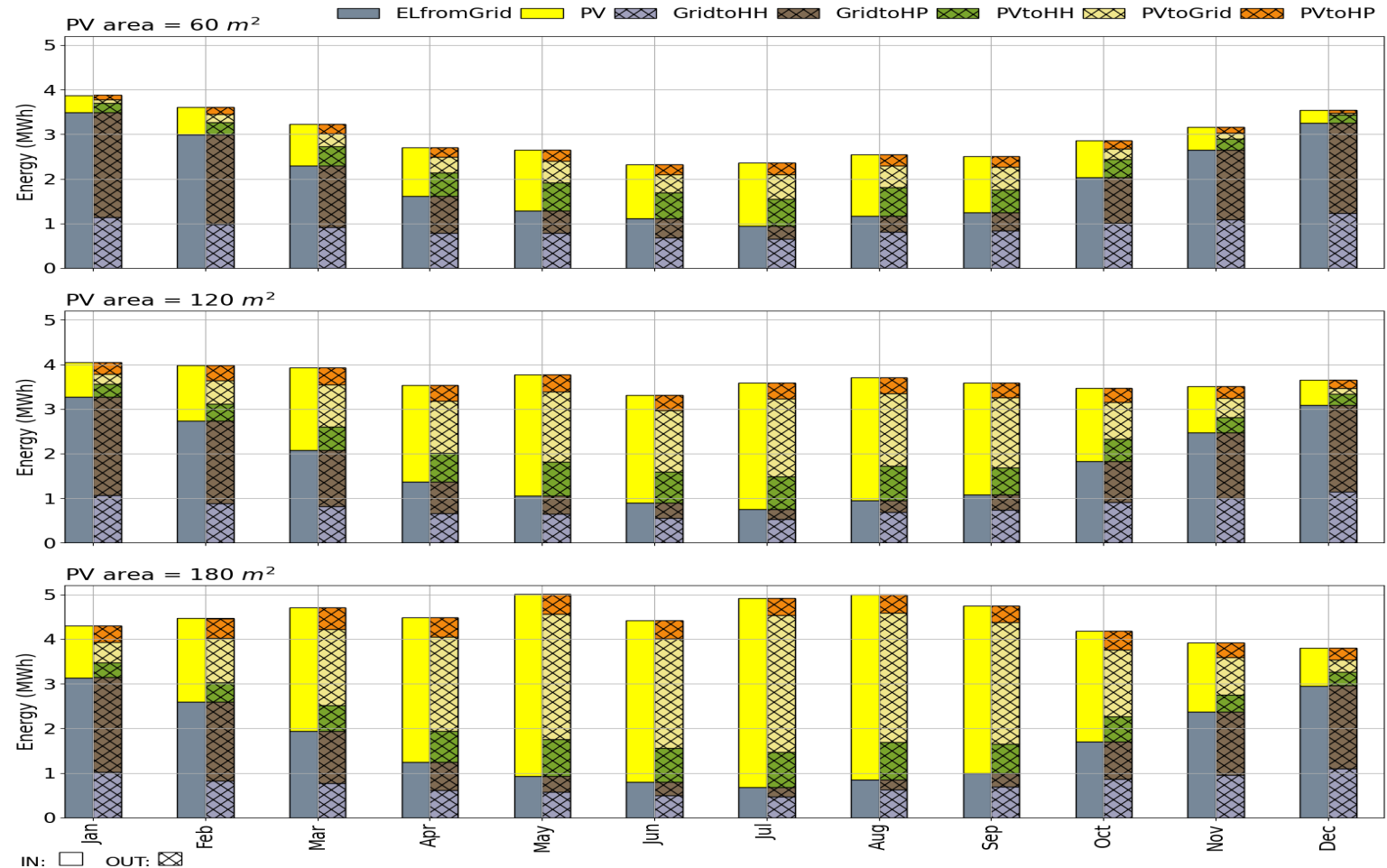
In:

from grid/PV

Out:

to HP, HH, grid

HH = household energy





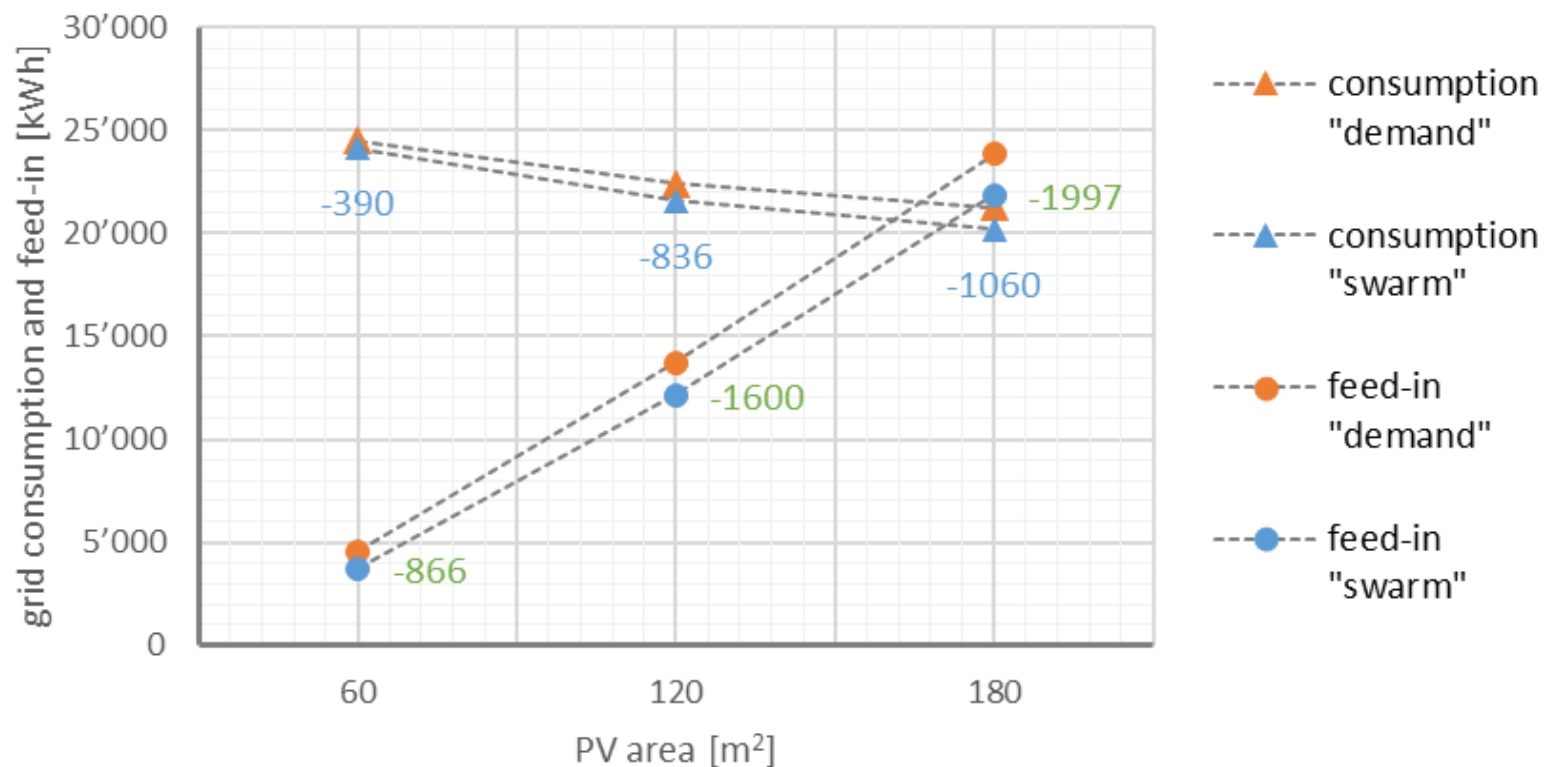
HpCosy – Annual Simulations



Influence of the PV area/size on the results

PV total area	[m2]	60		120		180	
		No	Yes	No	Yes	No	Yes
Swarm control	[No/Yes]	No	Yes	No	Yes	No	Yes
PV yield	[MWh]	11.3		22.5		33.8	
Total energy consumption	[MWh]	31.2	31.7	31.2	31.9	31.2	32.1
Total consumption heating systems	[MWh]	15.0	15.5	15.0	15.8	15.0	16.0
PV coverage heating systems	[MWh]	1.4	2.3	2.3	3.9	2.8	4.8
Grid power consumption	[MWh]	24.5	24.1	22.4	21.6	21.3	20.2
Grid power feed-in	[MWh]	4.6	3.7	13.7	12.1	23.8	21.8
Self-consumption quotient	[%]	59	67	39	46	29	35
Autarky	[%]	21	24	28	32	32	37
PV yield ratio	[%]	0.36	0.36	0.72	0.70	1.08	1.05

Influence of the PV area on grid consumption and feed-in





HpCosy – Summary and Conclusions



- Decentralized system showed better efficiency with electricity savings up to 31% (no DHW circulation/reduced distribution losses)
- Swarm signal control enables influence on operation and power level
- Grid consumption can be reduced up to 5%
- PV power self-consumption can be increased by 11 to 17 %
- Swarm signal can be generated locally or remotely by the energy supplier
- Products are available
- HpCosy system can use the sources GSHX, LT-Networks, Ground water, ..

Outlook and further fields of interest:

Pilot project, smart swarm signals, state of charge considerations, implementation of weather forecasts



HpCosy – Summary and Conclusions



Acknowledgements

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