Combining solar and district heating in IDA ICE

BuildSim-Nordic 25.9.-26.9.2014 Espoo

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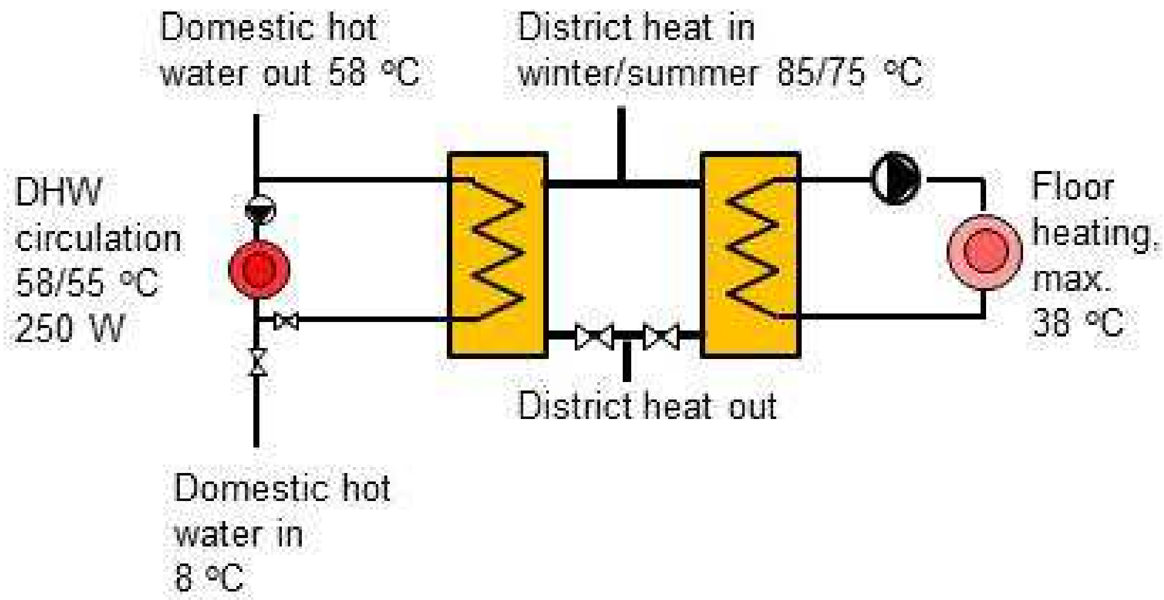
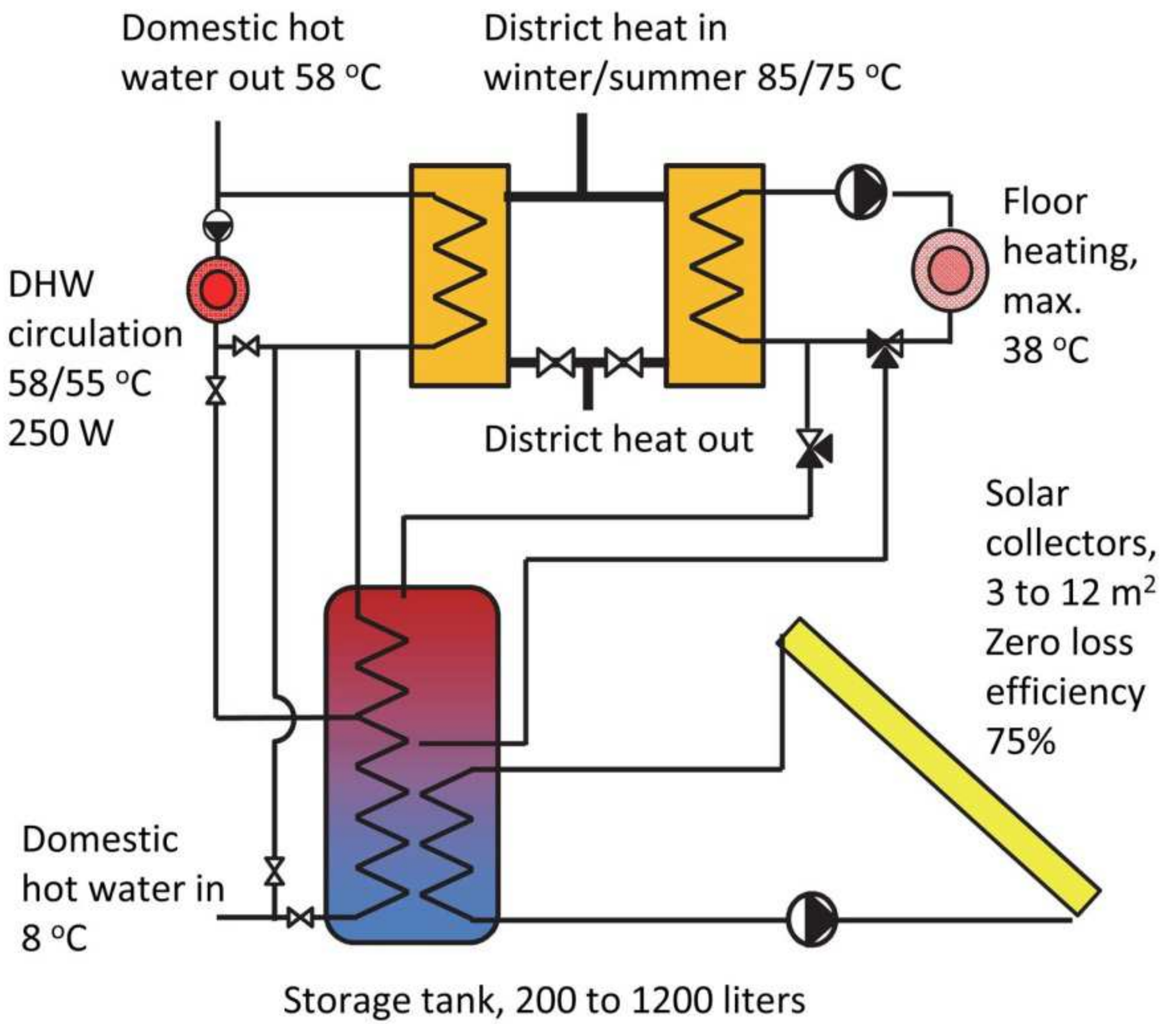
Introduction

- The project aims to find future district heating solutions for residential districts
- How much solar energy can be utilized in connection with district heating in a small house?
- District heating substation model, including solar heating, was implemented into building energy simulation (IDA-ICE)

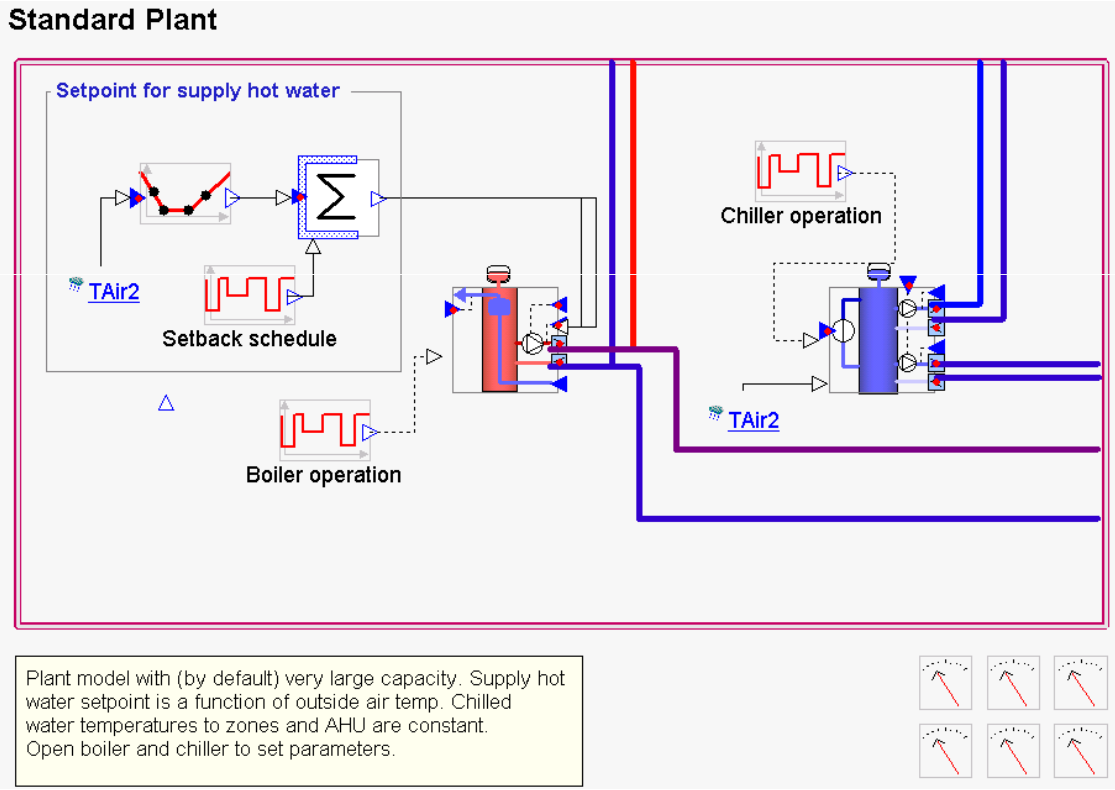
District heating substation



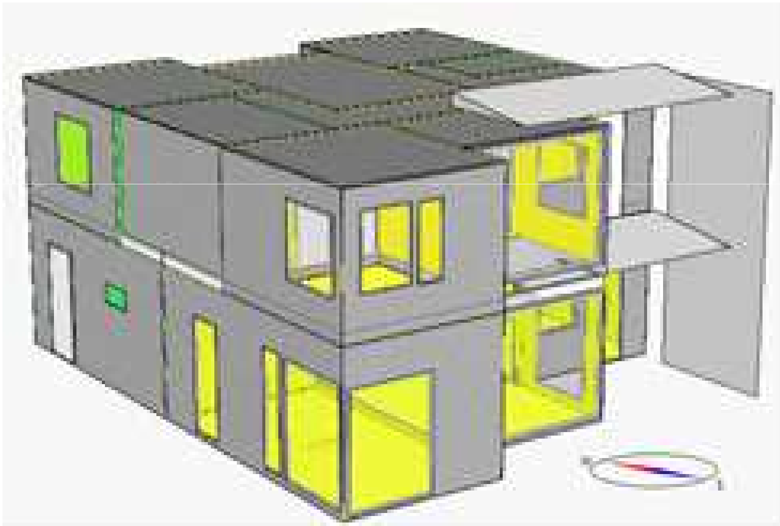
District heating substation, with solar collectors



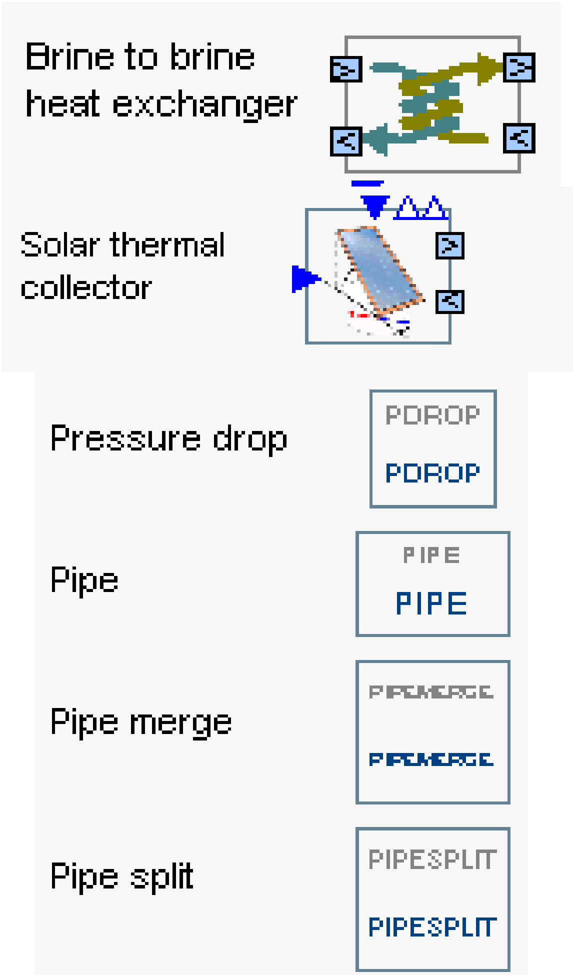
Standard heating plant (boiler) in IDA ICE

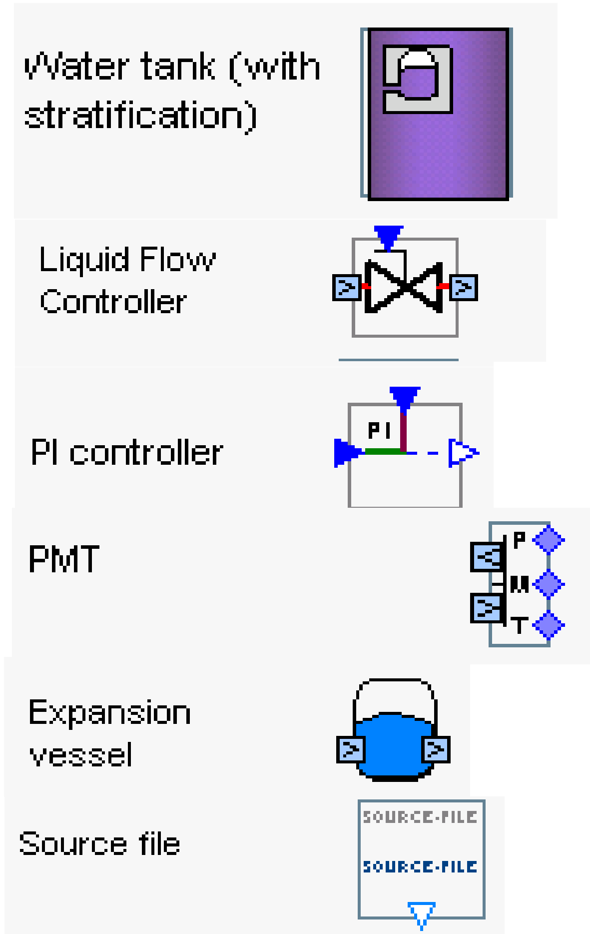


Building



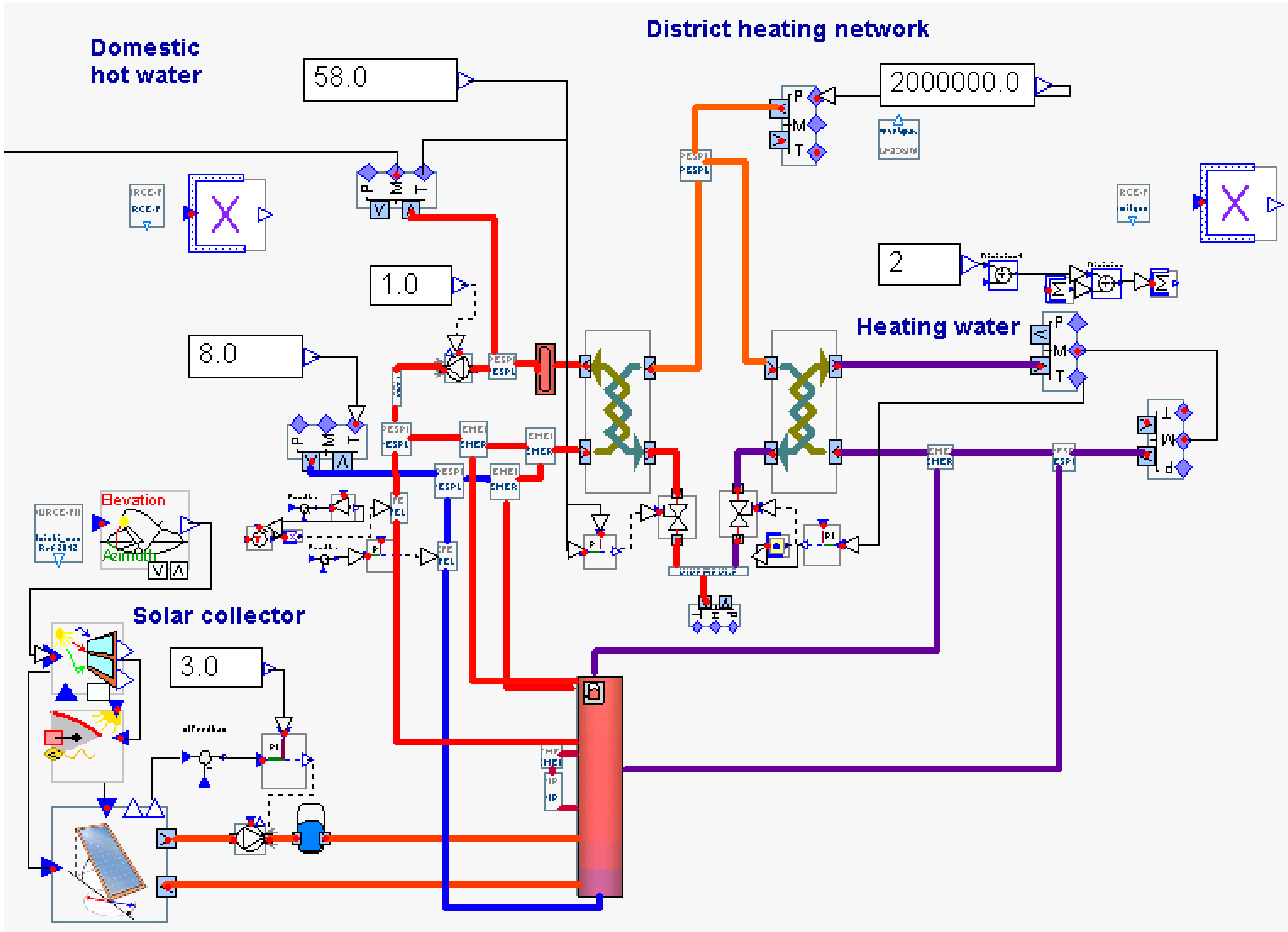
Some useful system components in IDA ICE





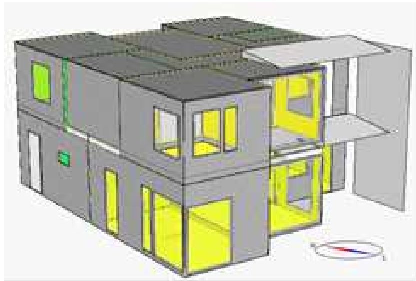
New district/solar heating substation model

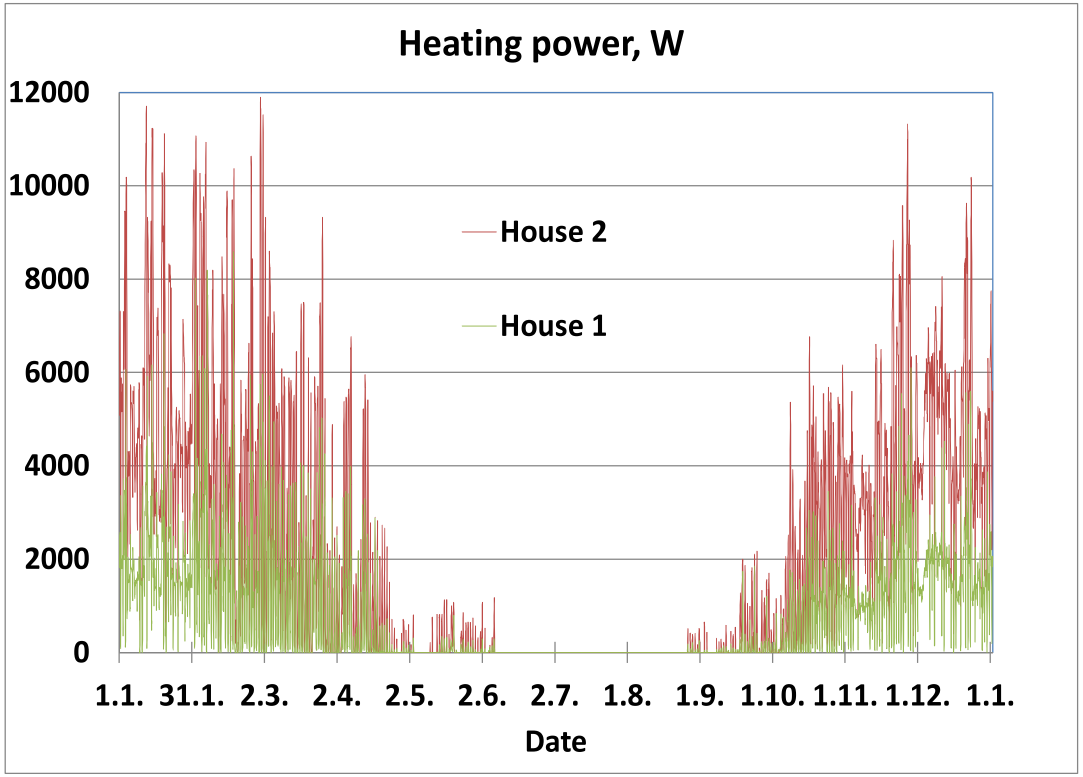
Sunny day 23.6 at 10:00



Building heating power

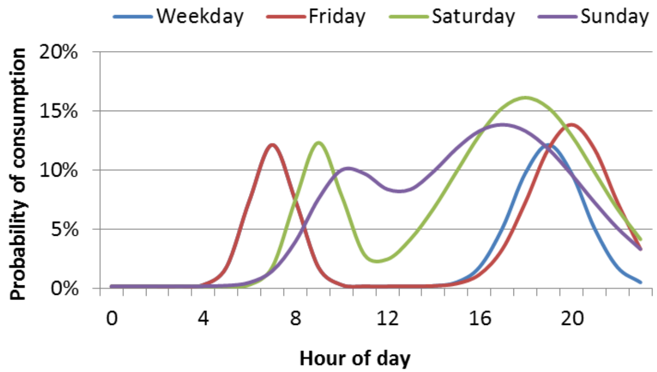
Located in Helsinki, Finland



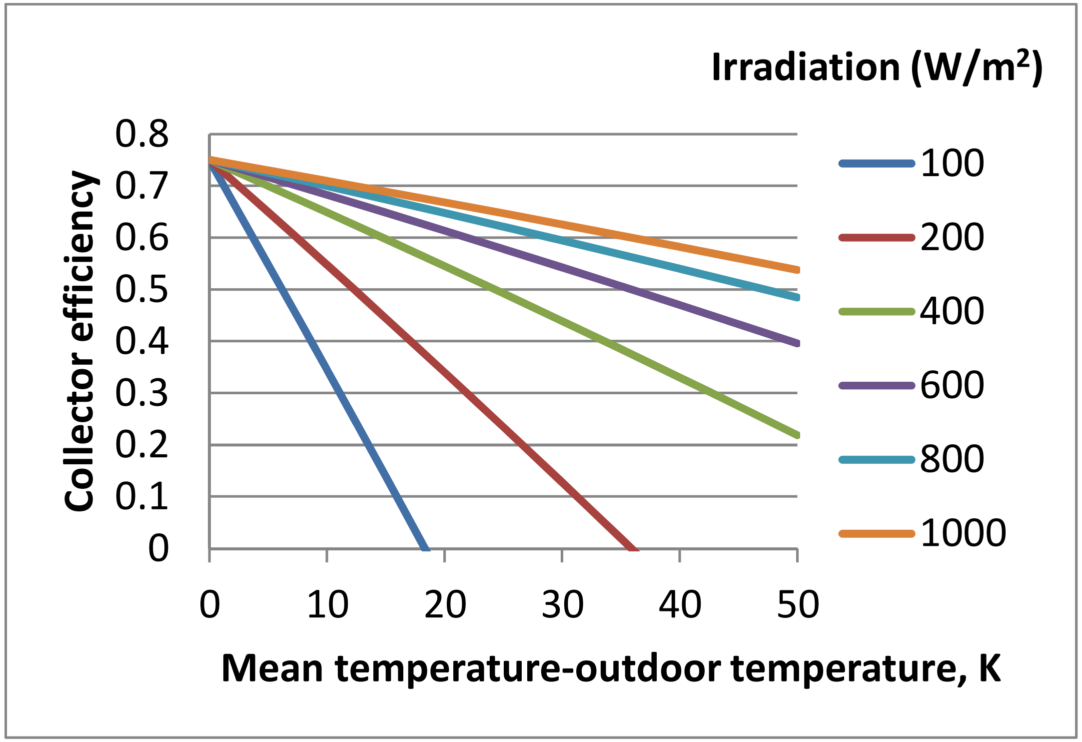


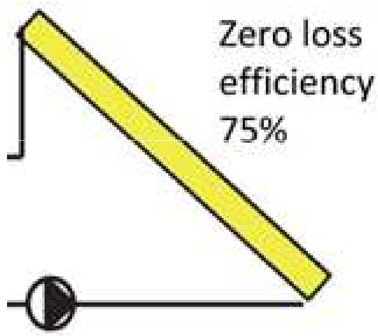
	House 1	House 2
Space heating, kWh	6 401	17 982
DHW use, litres per day	133	220
DHW heating, kWh	2 820	4 675
DHW circulation, kWh	2 190	2 190
Total heating, kWh	11 410	24 845

Hot water use profile



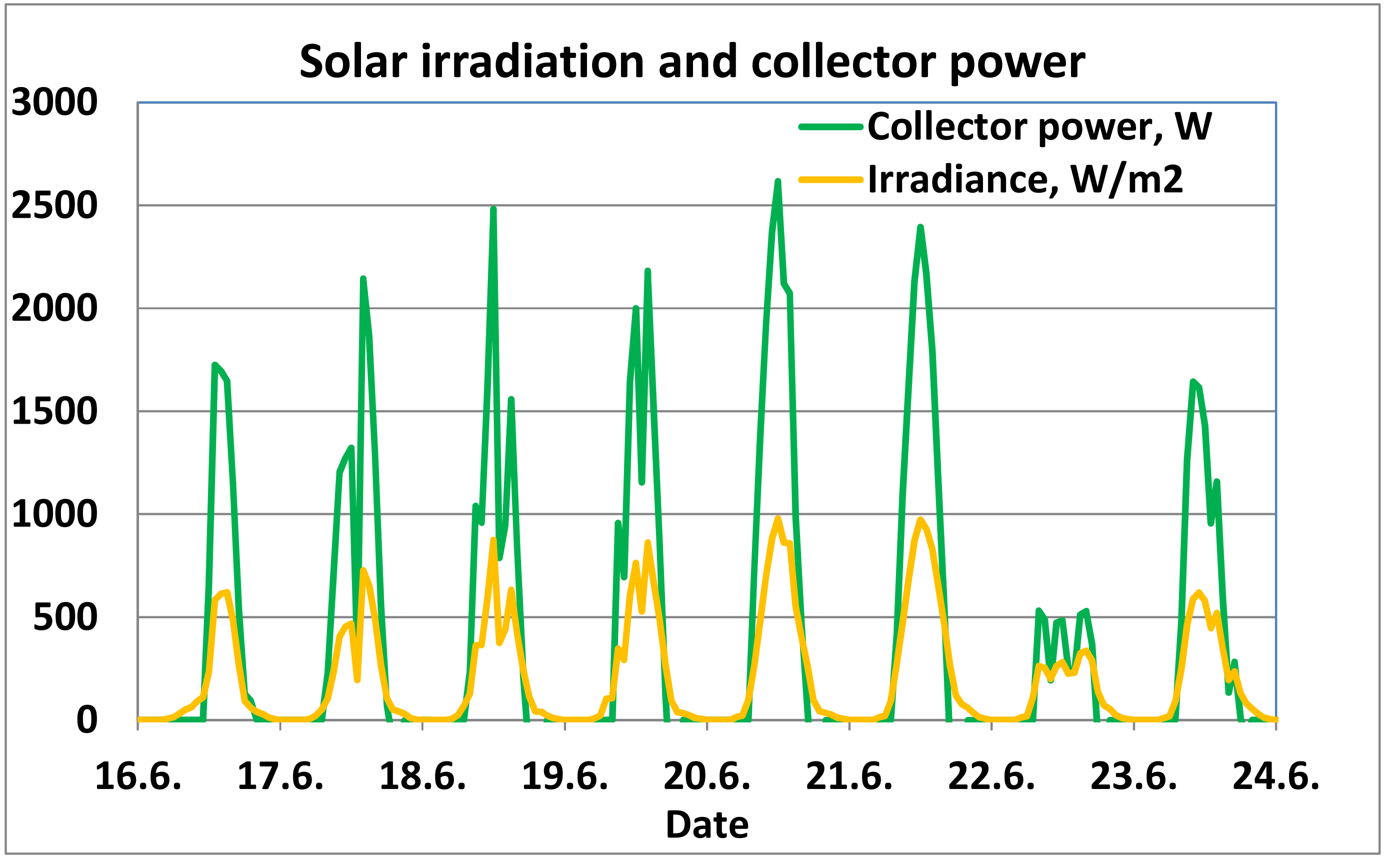
Solar collector efficiency

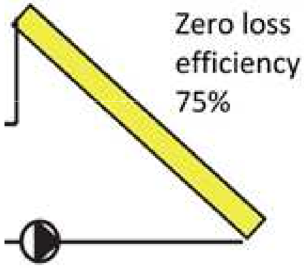




Example of solar collector heating power (W)

House 2, collector area 6 m2 , tank volume 400 l

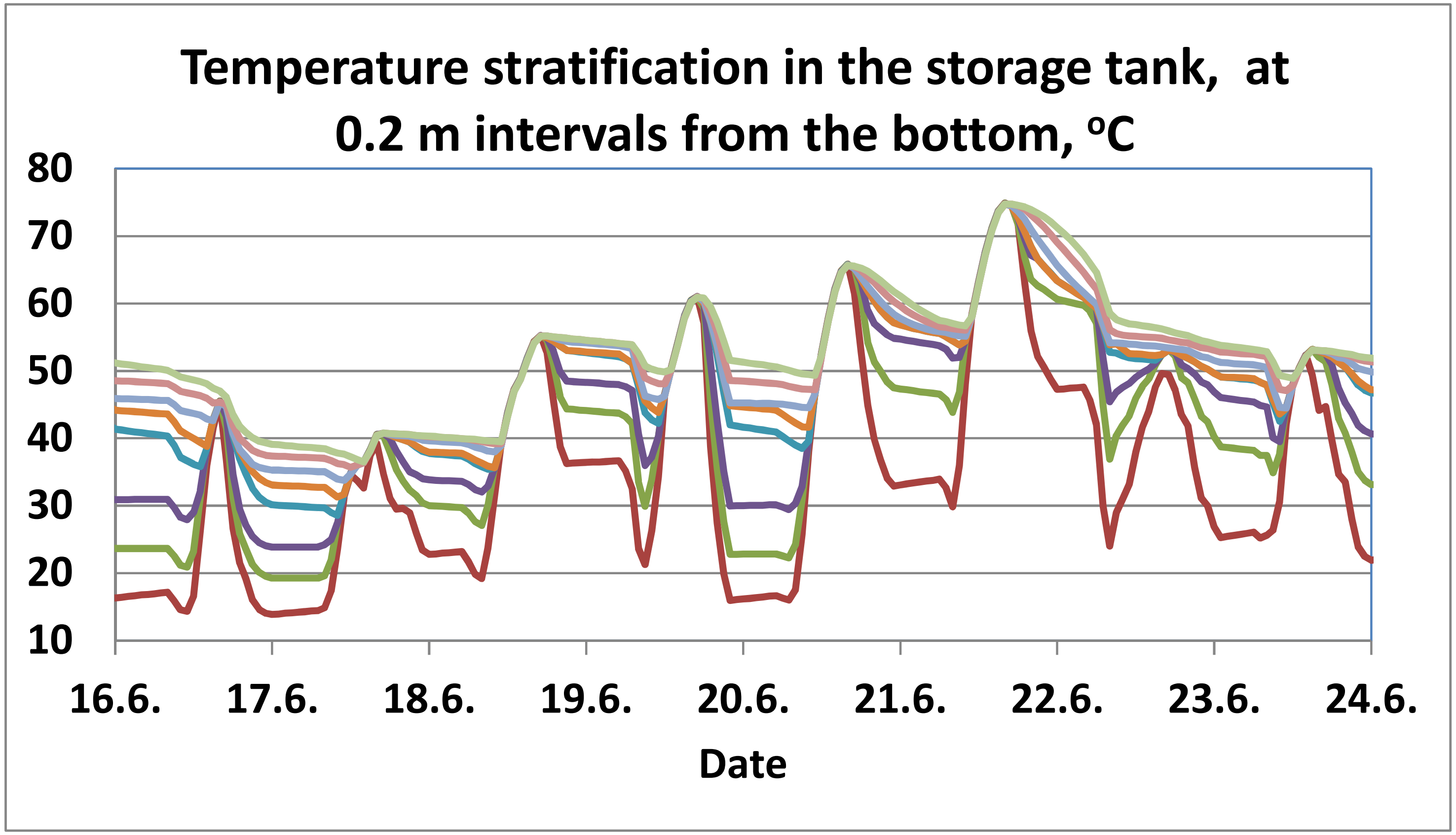


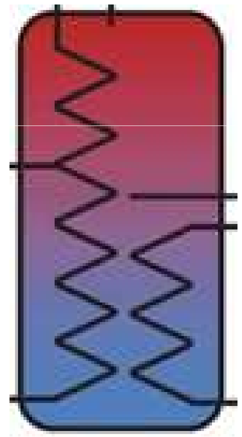


- Less solar heat at the end of the week

Example of tank temperatures

House 2, collector area 6 m2 , tank volume 400 l

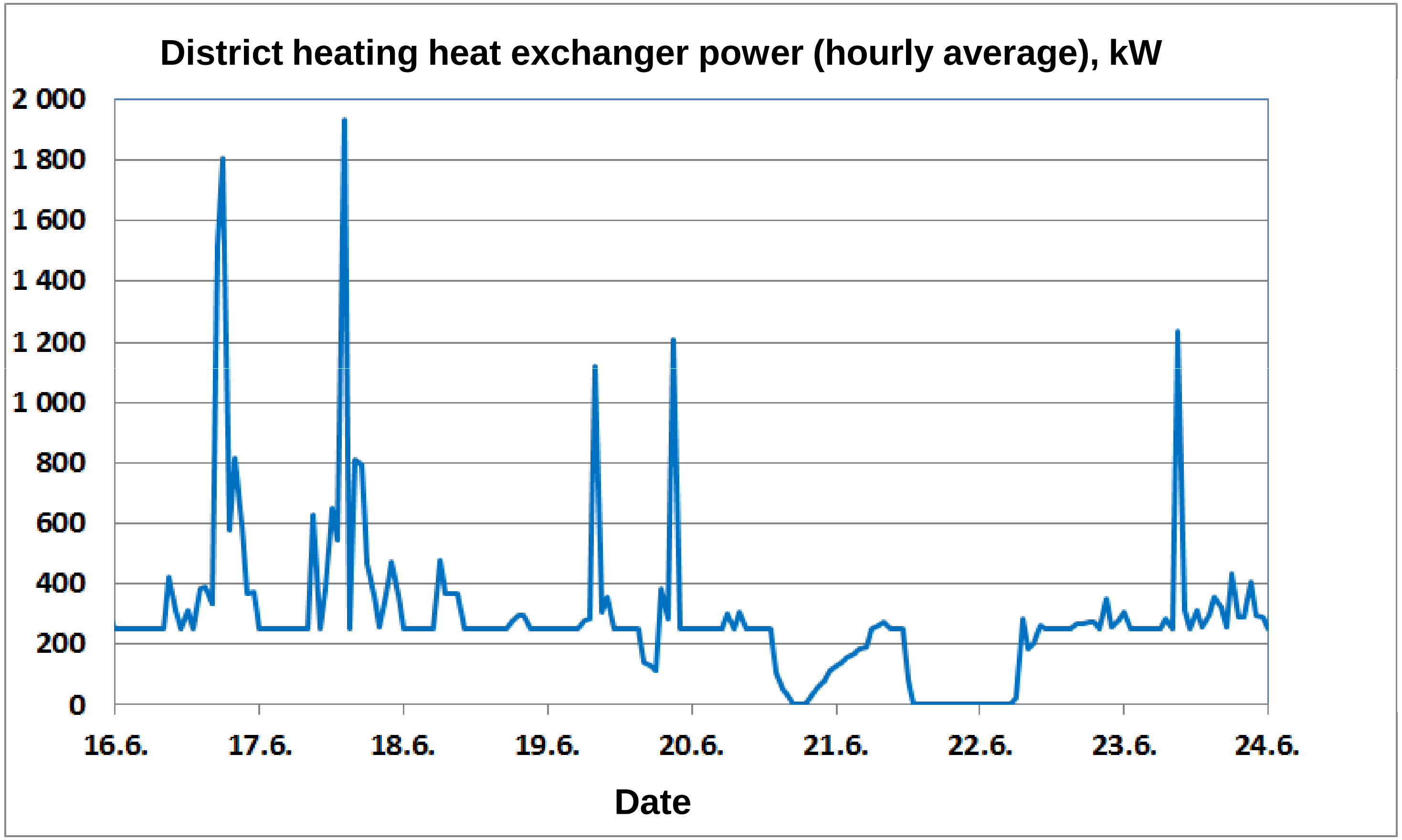


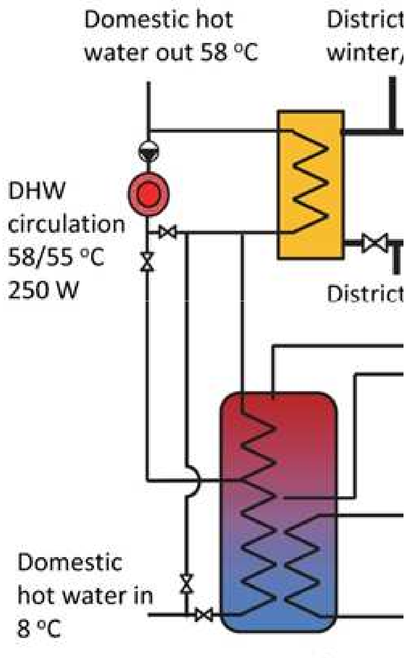


- The tank is cooling down towards the end of the week

Example of DHW heat exchanger operation

House 2, collector area 6 m2 , tank volume 400 l

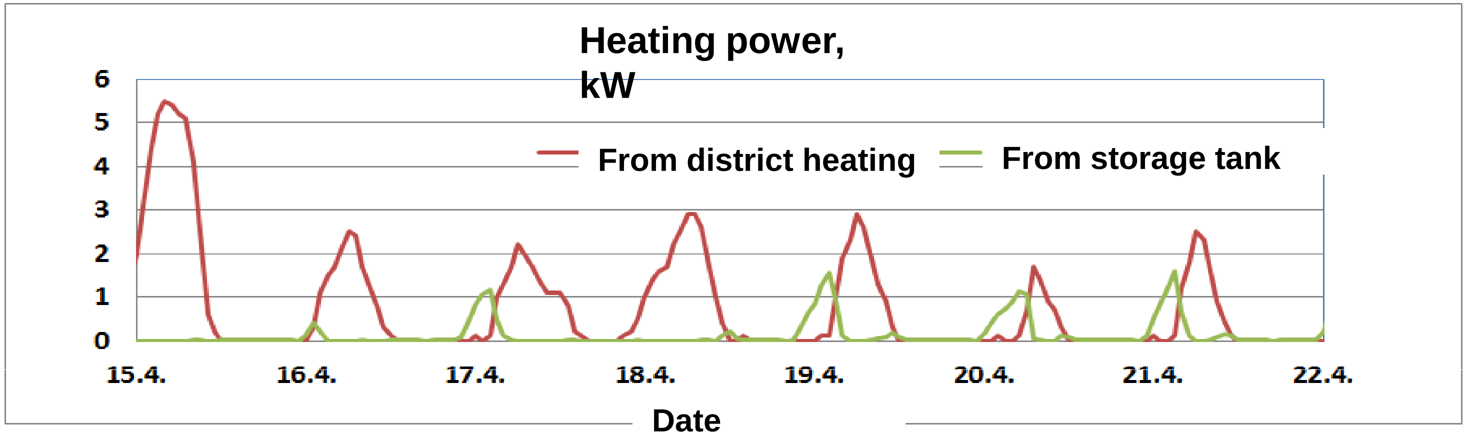


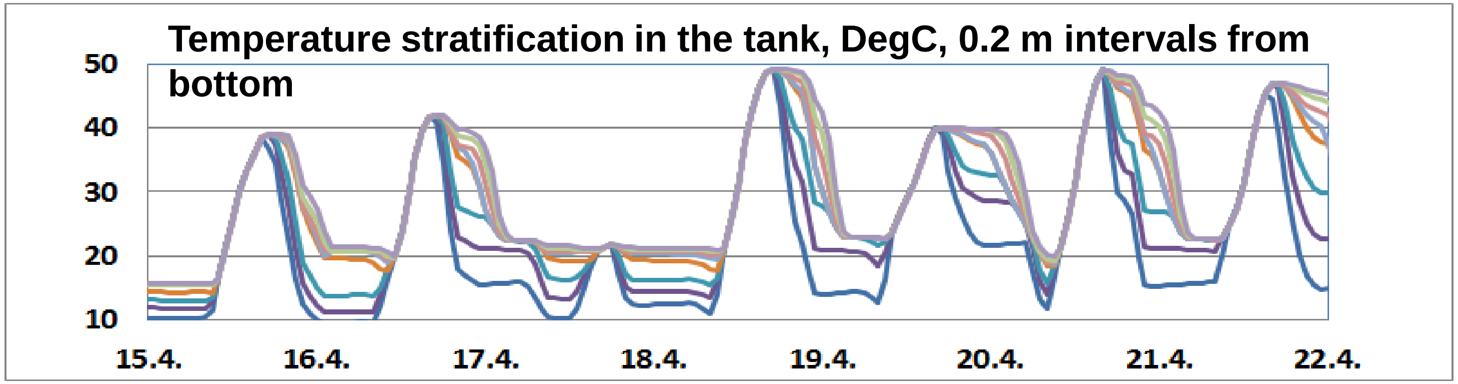


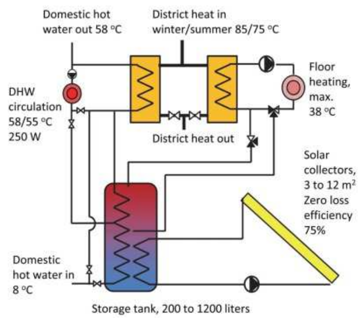
- The storage tank can sometimes cover also DHW circulation need (250 W)

Example of heating heat exchanger operation

House 2, collector area 6 m2 , tank volume 400 l



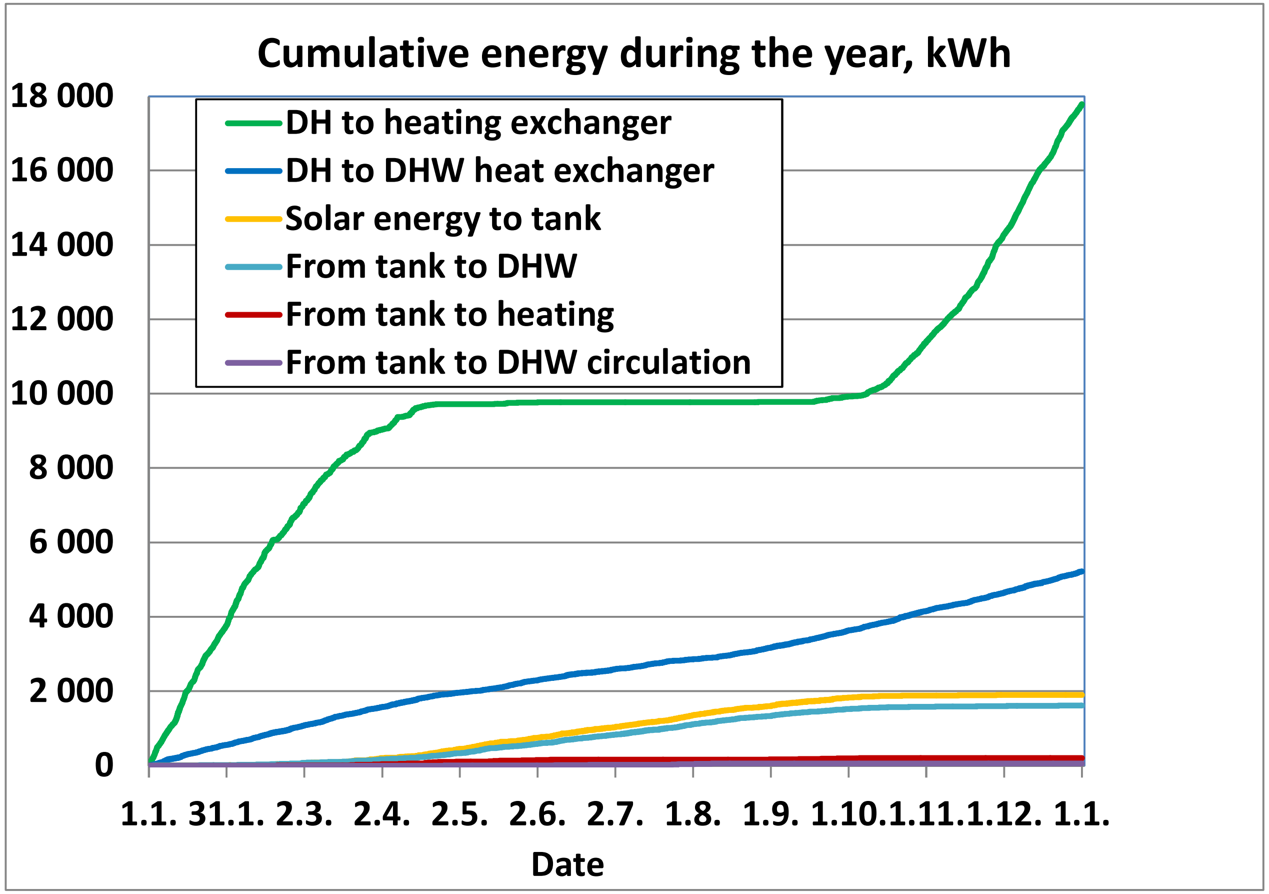


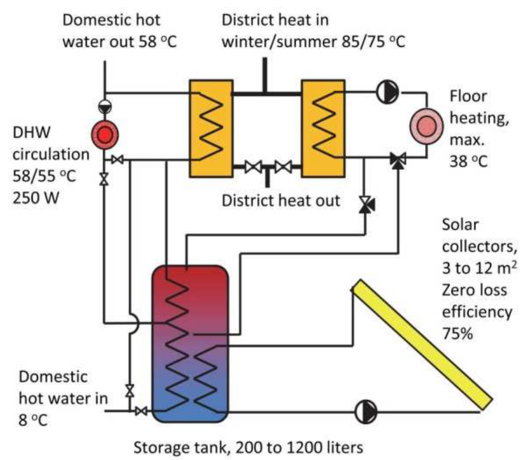


- The storage tank can cover heating need few hours in the evening

Energy cumulation during the year

House 2, collector area 6 m2 , tank volume 400 l





- Solar energy from March to September
- Used mainly for domestic hot water

Savings in district heating energy due to solar heat

House 2

Solar collector area	Storage tank volume	From tank to heating	From tank to DHW	From tank to DHW circulation	District heat to DHW heat exchanger	District heat to heating exchanger	District heat saving	Saving per collector area
m^2	litres	kWh	kWh	kWh	kWh	kWh	kWh	kWh/m^2
3	200	68	1166	18	5681	17914	1259	420
6	400	193	1616	58	5220	17790	1843	307
6	800	241	1610	19	5267	17741	1845	307
12	800	389	2010	149	4764	17593	2496	208
12	1200	425	2027	109	4791	17558	2504	209
0	0	-	-	-	6871	17982	-	-

- Energy saving max. 54% of DHW heating need (4675 kWh, 220 l/day)
- Savings per collector area decrease with increasing collector area
- Storage tank volume has only a small influence
- Solar energy to DHW circulation small

Savings in district heating energy due to solar heat

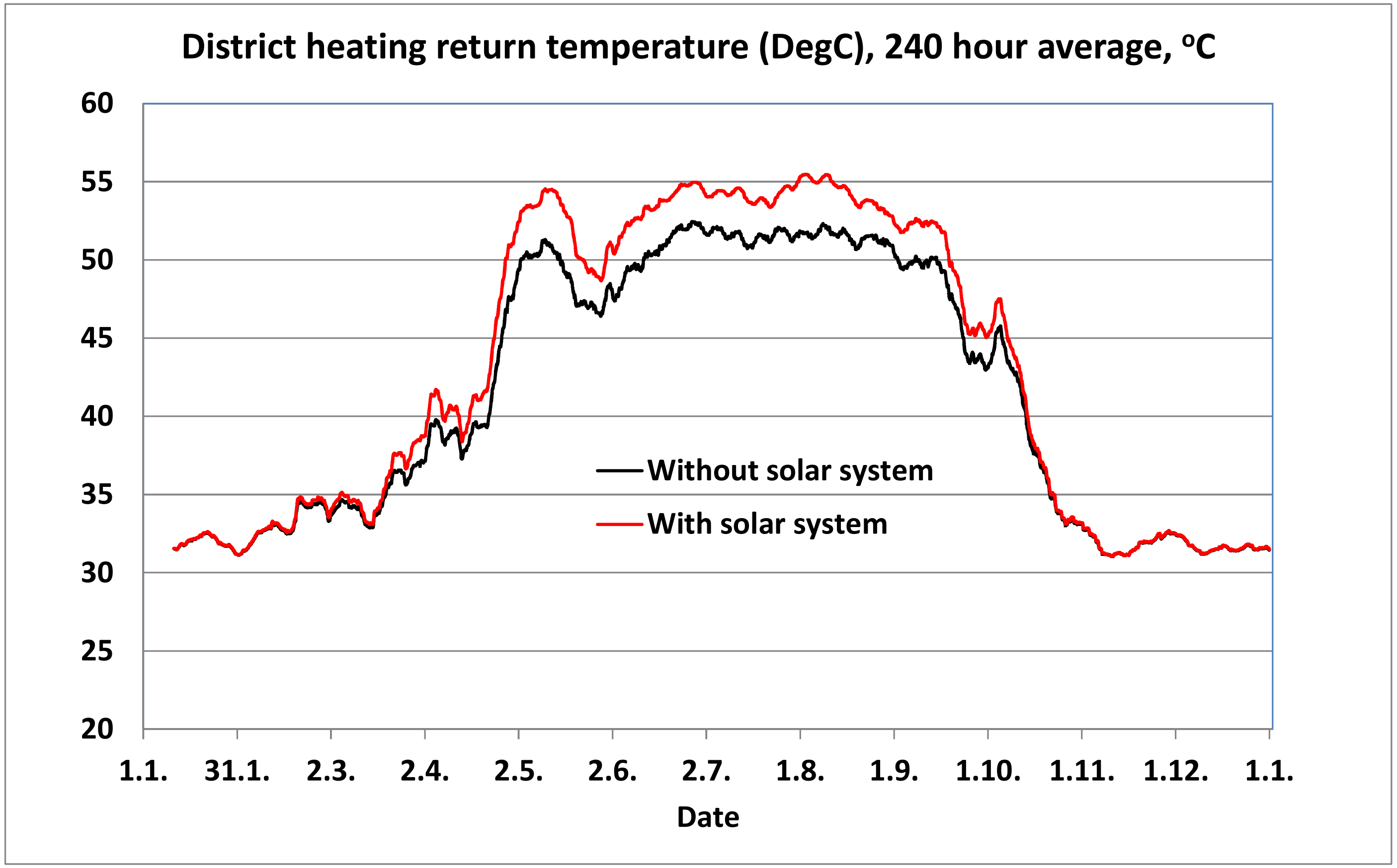
House 1

Solar collector area	Storage tank volume	From tank to heating	From tank to DHW	From tank to DHW circulation	District heat to DHW heat exchanger	District heat to heating exchanger	District heat saving	Saving per collector area
m^2	litres	kWh	kWh	kWh	kWh	kWh	kWh	kWh/m^2
3	200	42	999	67	3988	6335	1090	363
4	300	64	1143	108	3838	6294	1281	320
6	400	138	1319	161	3608	6241	1564	261
6	800	80	1326	188	3662	6213	1537	256
12	800	304	1550	280	3240	6121	2051	171
-	-				5011	6401		

- Energy saving max. 73% of DHW heating need (2820kWh, 133 l/day)

Effect on district heating return temperature

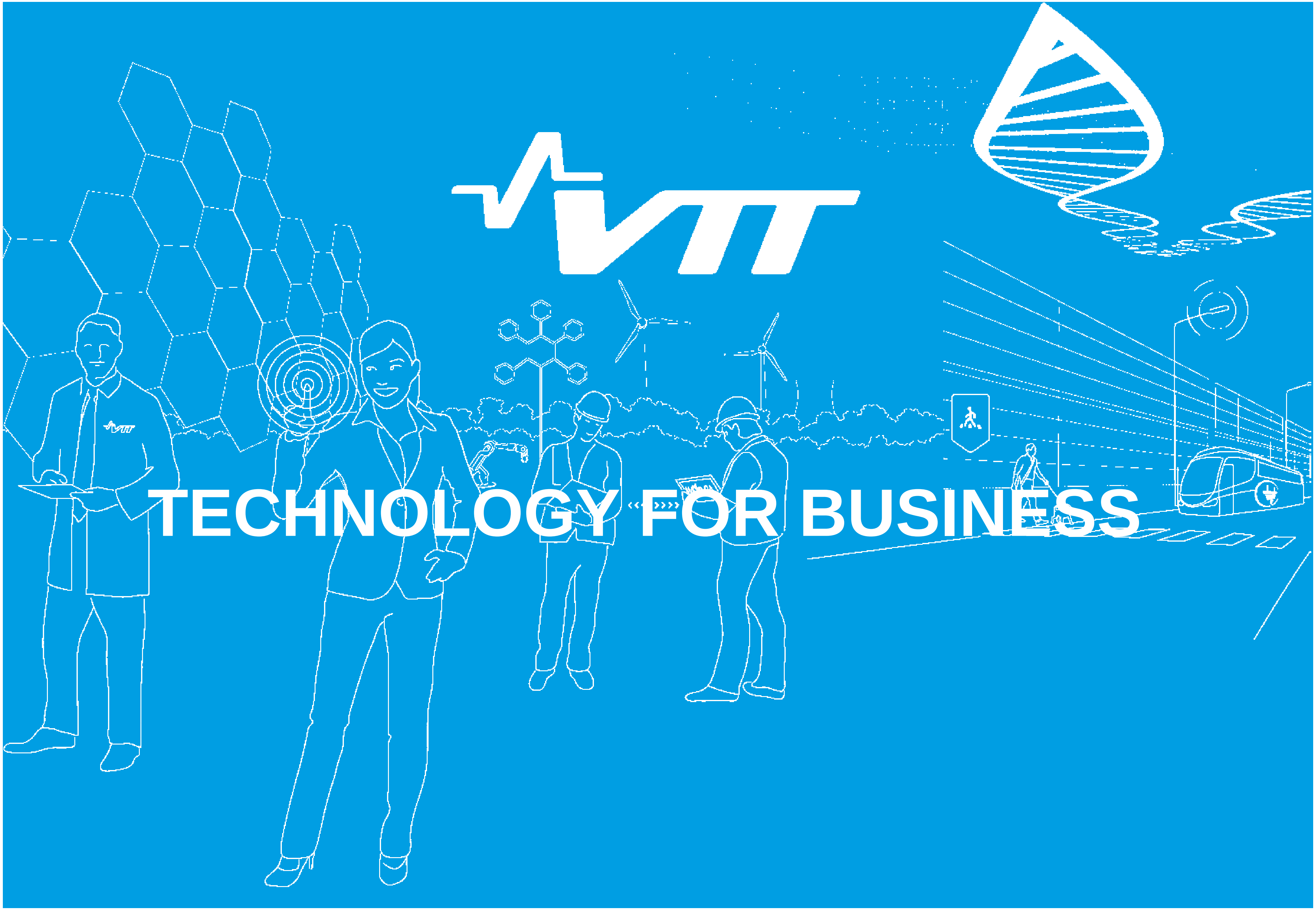
House 2, collector area 6 m2 , tank volume 400 l



- About 3 degrees higher with solar energy
- Decreases CHP (Combined Heat and Power) power production

Conclusions

- Complicated heat production systems can be built into IDA ICE
- Simulation less robust than using the standard heating plant
- Sollar collectors save max 50% - 70 % of domestic hot water heating need
- Relative savings 200 - 400 kWh/m^2 per collector area, decreasing with area
- Tank size does not have a big influence
- It is challenging to combine economically solar heating with district heating
- Better susbtation concepts needed
- Energy for hot water circulation from the tank is small in the present arrangement
- One possibility is to heat the bathroom with the heating system water, instead of domestic hot water circulation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