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Load Shift Experience with ULTDH Substation for Multifamily Building

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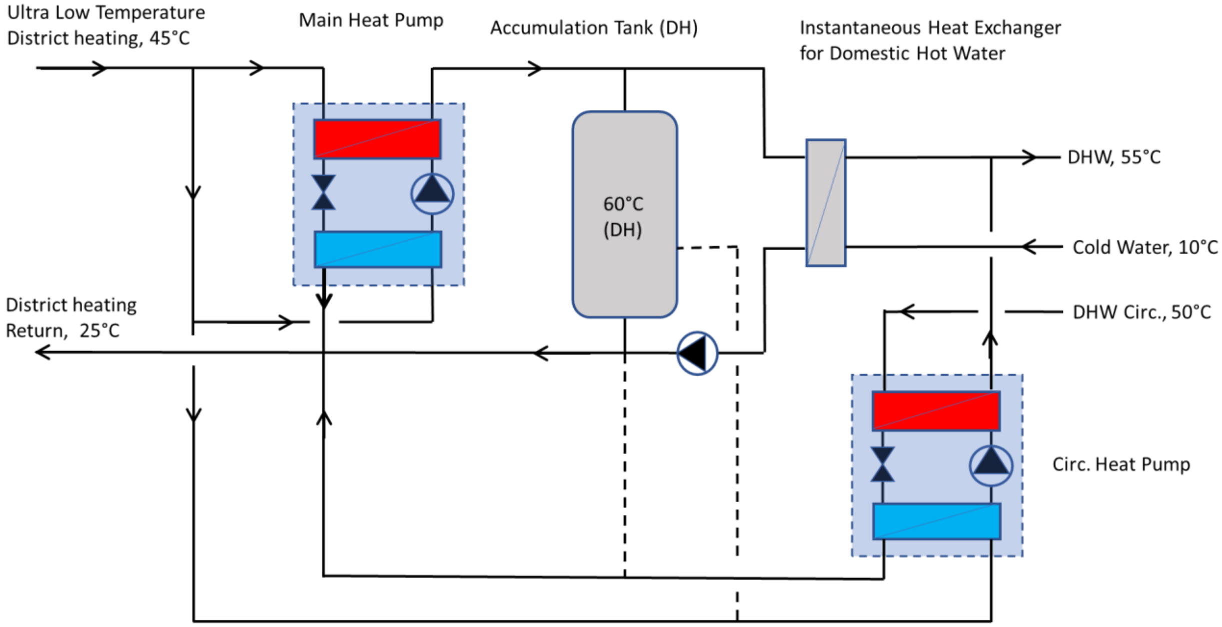
DENMARK

4DH
4th Generation District Heating Technologies and Systems

Danfoss

The ULTDH Booster Substation



Main HP (MHP):
On/Off operation
Variable T evap. Out
IN FOCUS

Small HP (circ. HP):
On !
T evap. out given by
DHW circulation energy
Demand
NOT IN FOCUS

Part of project:
www.energylabnordhavn.dk

ENERGYLAB NORDHAVN

Funded by:

EUDP
Energiteknologisk udvikling og demonstration

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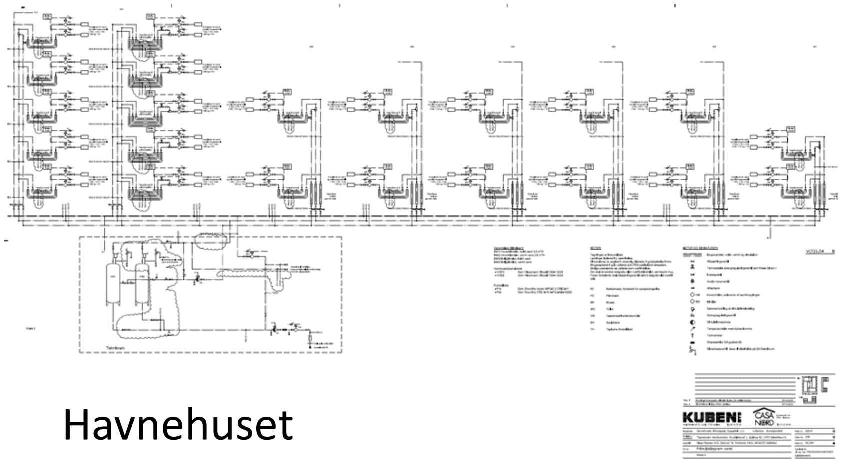
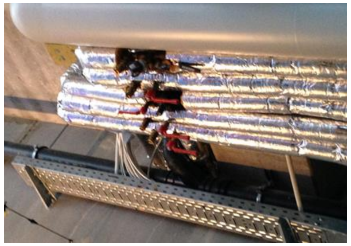
The building site

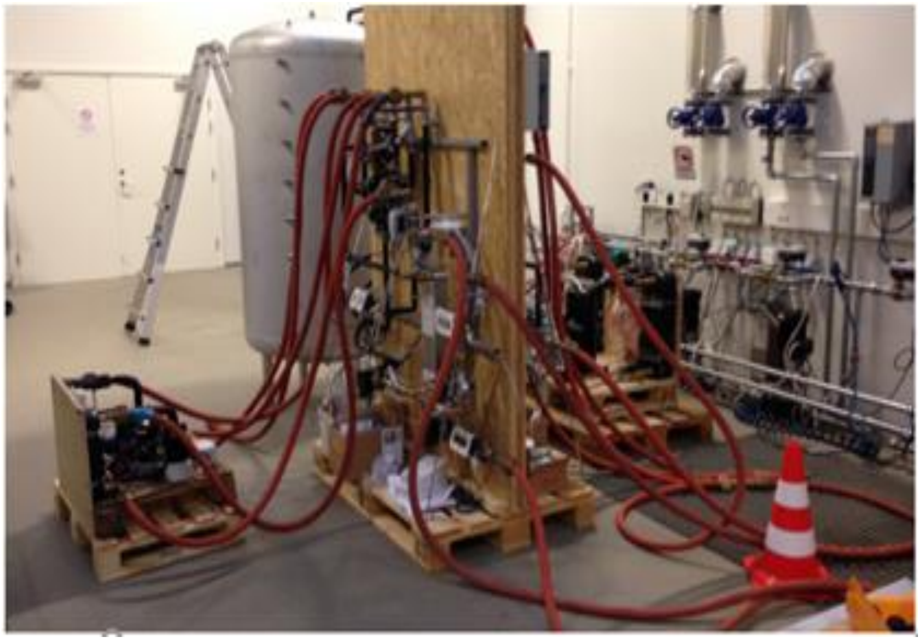


Havnehuset
Aarhusgade

22 Flats
8 Risers
5 floors + 2 floors



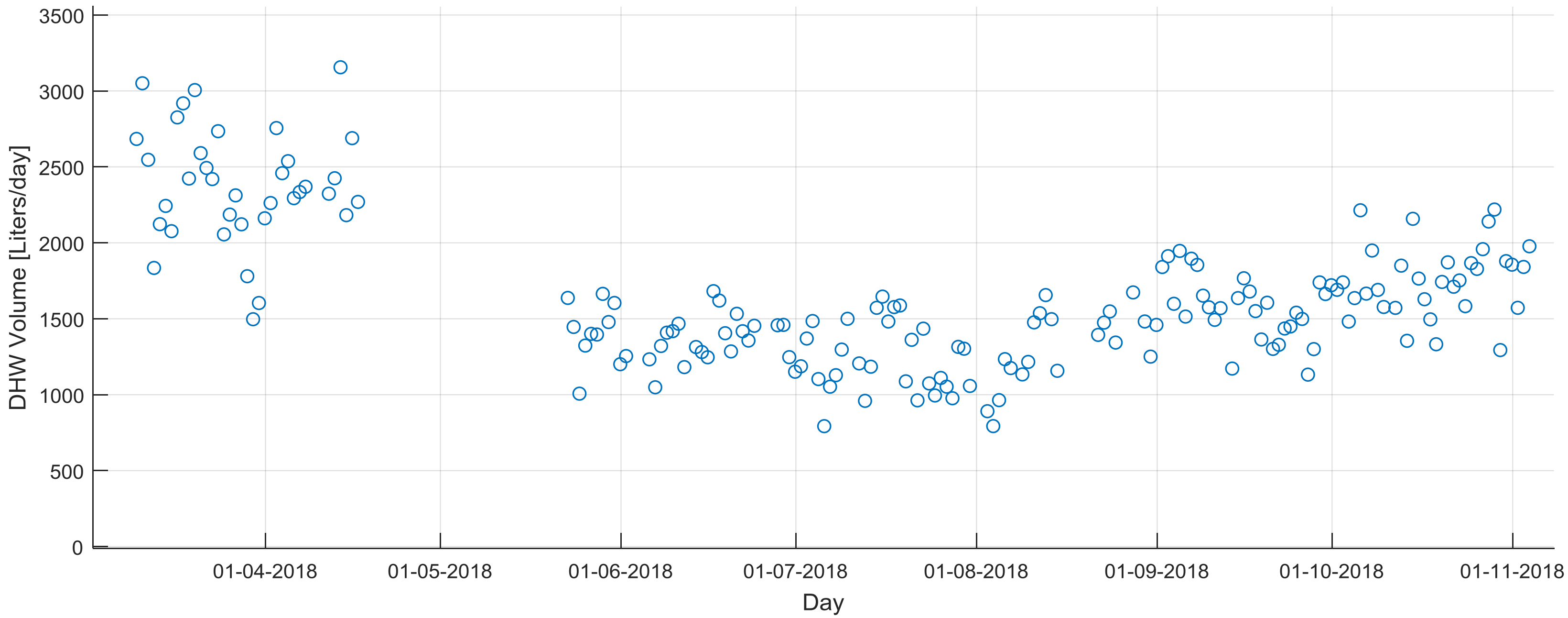
Prototyping and installation in building



Danfoss Lab in Aarhus

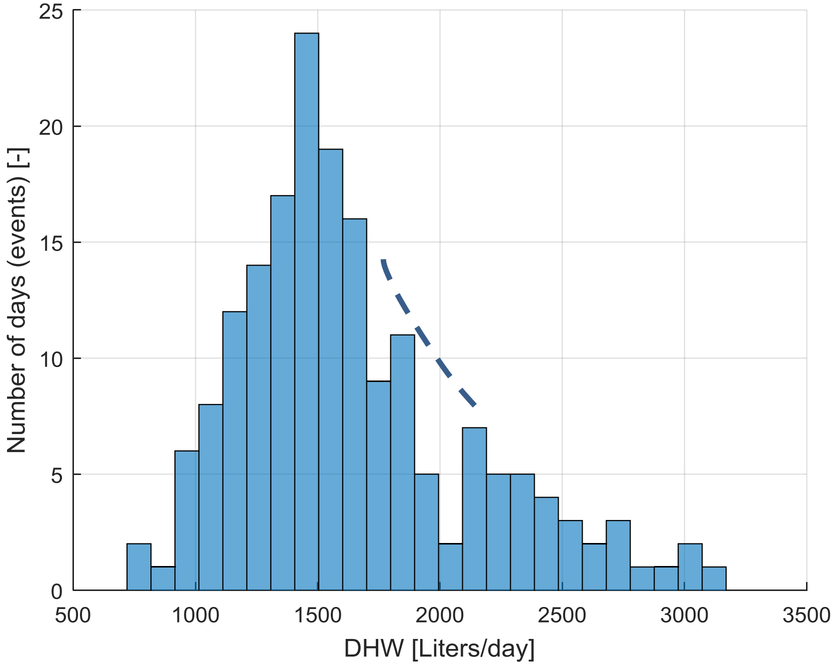
Installed at Nordhavn site

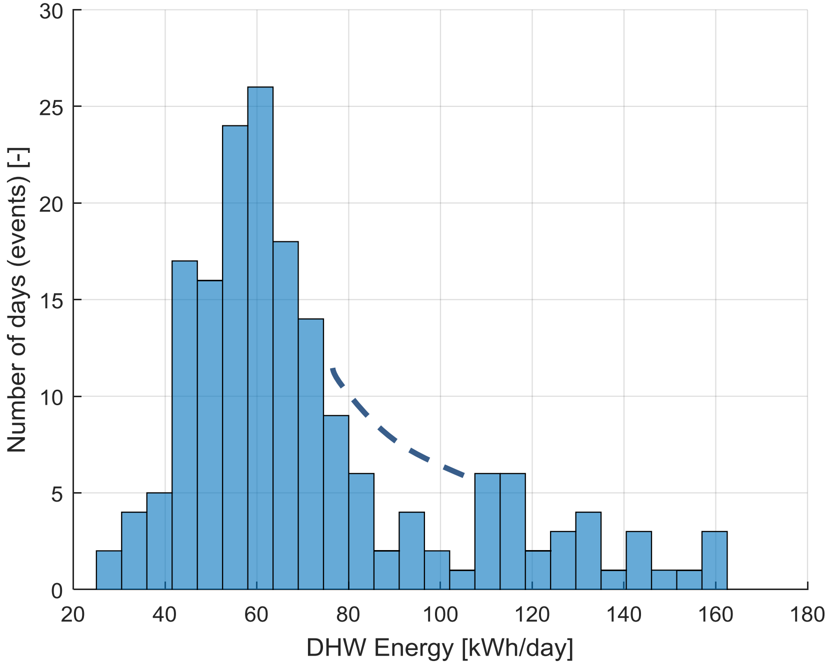
DHW tapping volume pr. Day (55°C from HBS)



Seasonal variation of DHW consumption !
> Ambient temperature !
> Cold water temperature, due to mixing at tap/shower !
> Alternative places to use DHW, e.g. vacation !

DHW volume and energy pr. day

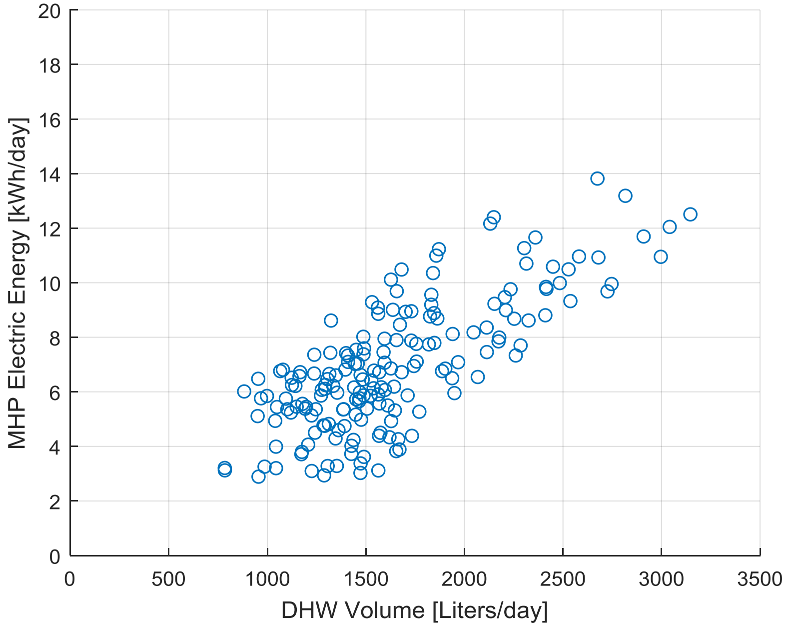


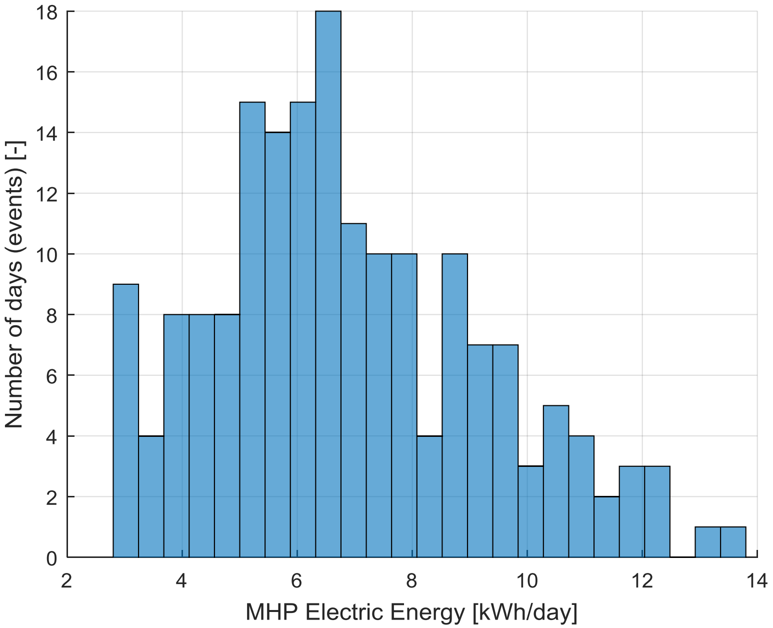


DHW Volume average: 1.650 liters/day

DHW Energy average: 72 kWh/day (DH+Elec. MHP)

Main HP electric energy pr. day





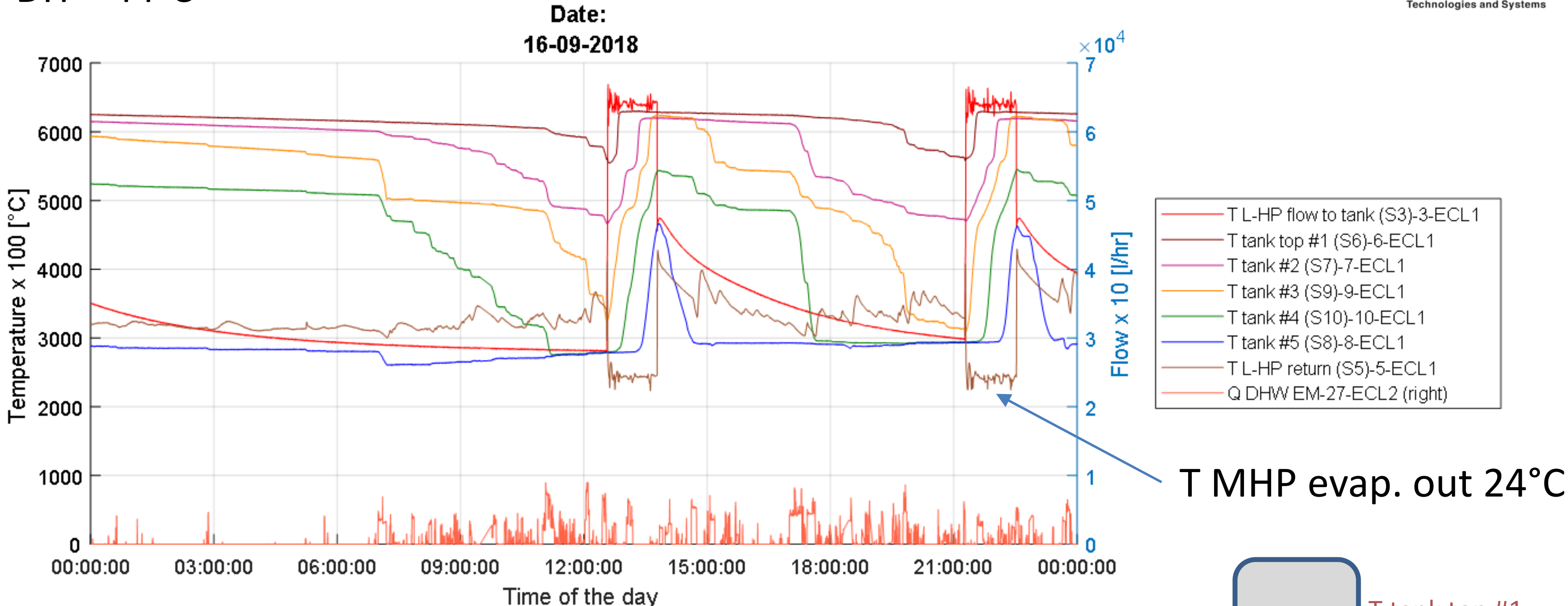
MHP elec. energy average: 6,8 kWh/day

DH energy average: 65.2 kWh/day, thus in total 72 kWh/day

Corresponds to ~2 hrs. 30 min. charging pr. day

Typical Charging profile

T DH = 44°C

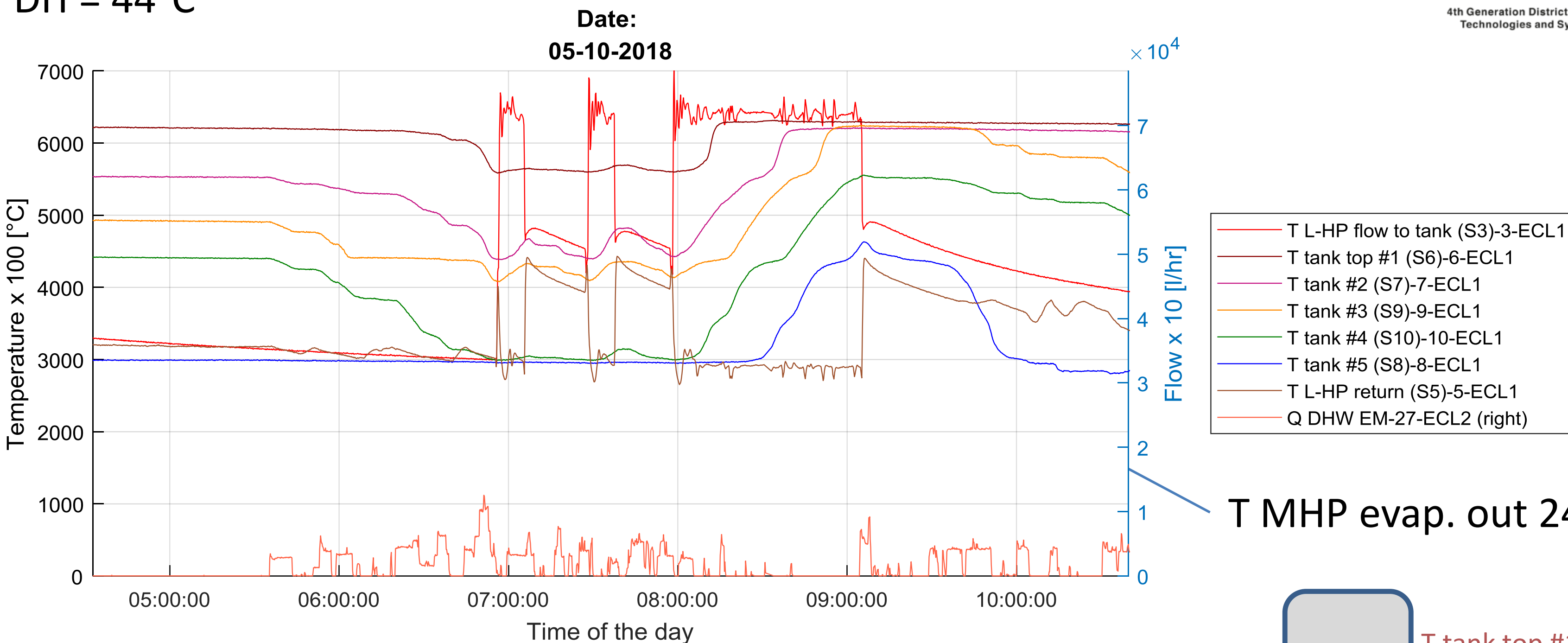


Avoid Charging
05:00-08:00
(DH+ Elec.)

Avoid Charging
16:00-20:00
(DH + Elec.)

Non Typical Charging profile

T DH = 44°C



T MHP evap. out 24°C

Avoid Charging
05:00-08:00
(DH+ Elec.)

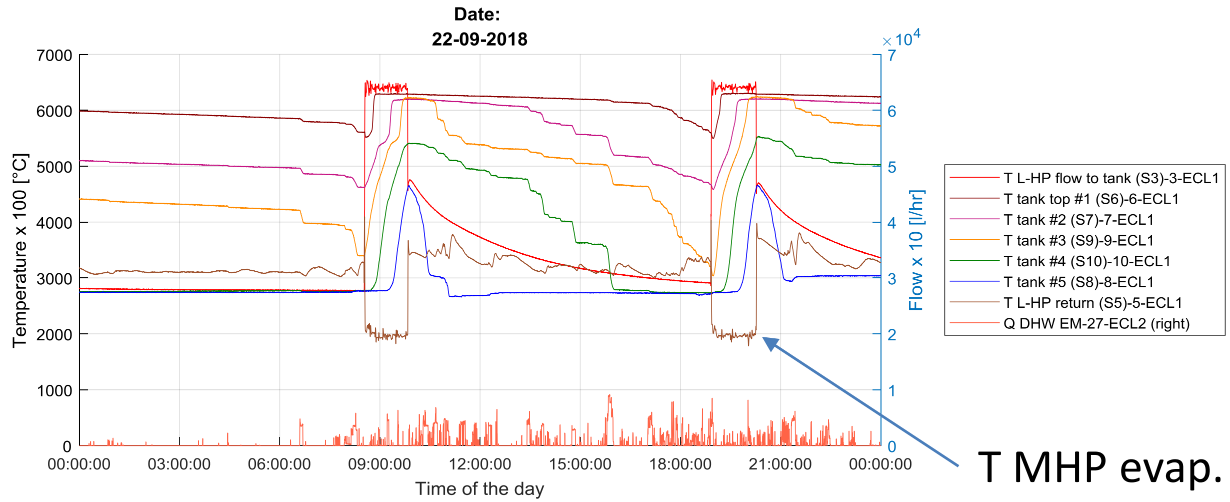
Simple Economy for load shift

DH energy for DHW:	65,2 kWh/day
Elec. energy for DHW:	6,8 kWh/day
Normal DH price is:	0,73 DKK/kWh – end user price incl. VAT
Normal electricity price is:	2,25 DKK/kWh - end user price incl. VAT
Reduction of electricity price at low load period: (reduced electric/transmission fee in spec. hours)	0,89 DKK/kWh
Reduction of DH price at low load period: (Assumed half of normal variable costs in spec. hours)	0,22 DKK/kWh
Daily average saving for prod. DHW with load shift: (End user price, incl. VAT)	20,40 DKK/day *
Normal tariff Daily energy costs for DHW:	~63 DKK/day *

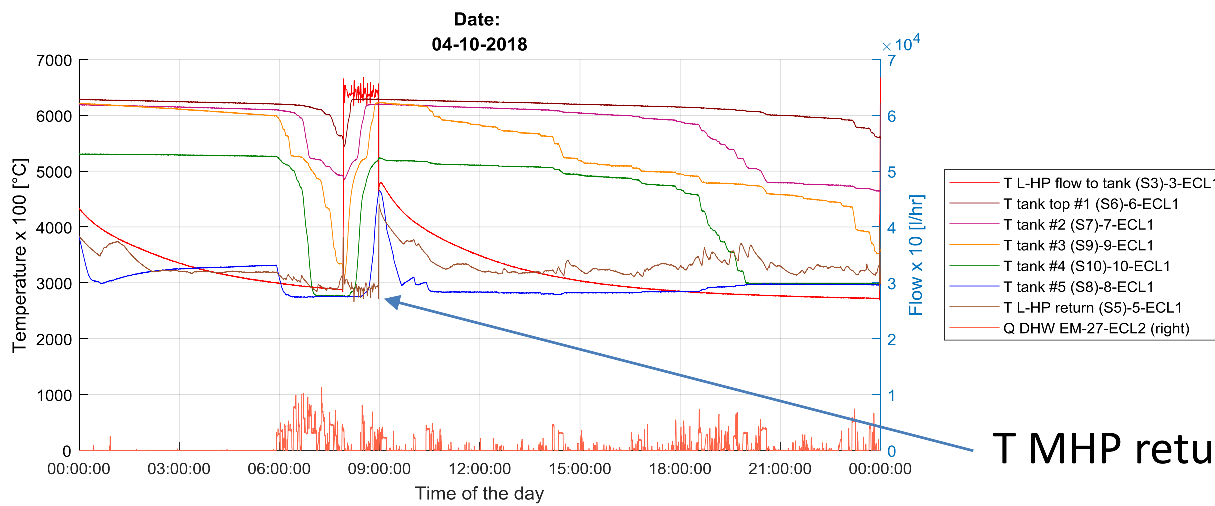
*) Approx. 1/3 is saved with applied price assumptions

Main HP temperature profile impact

T DH = 45°C

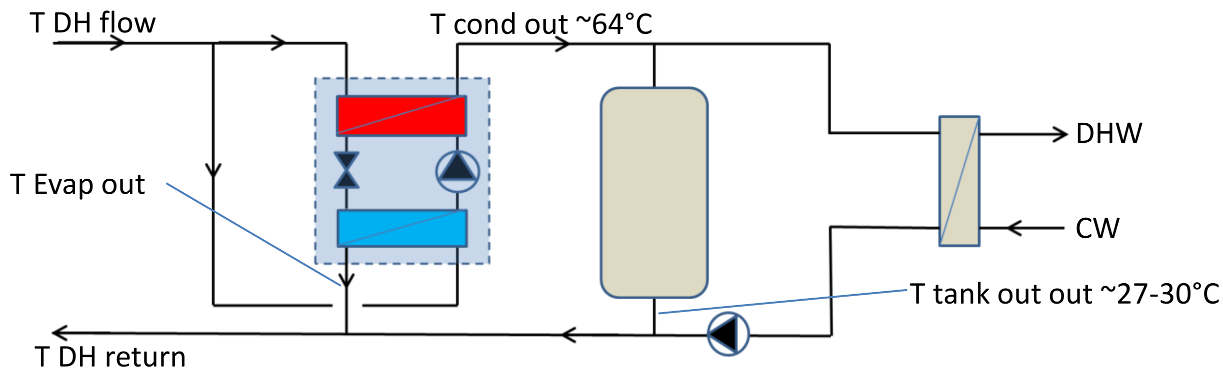


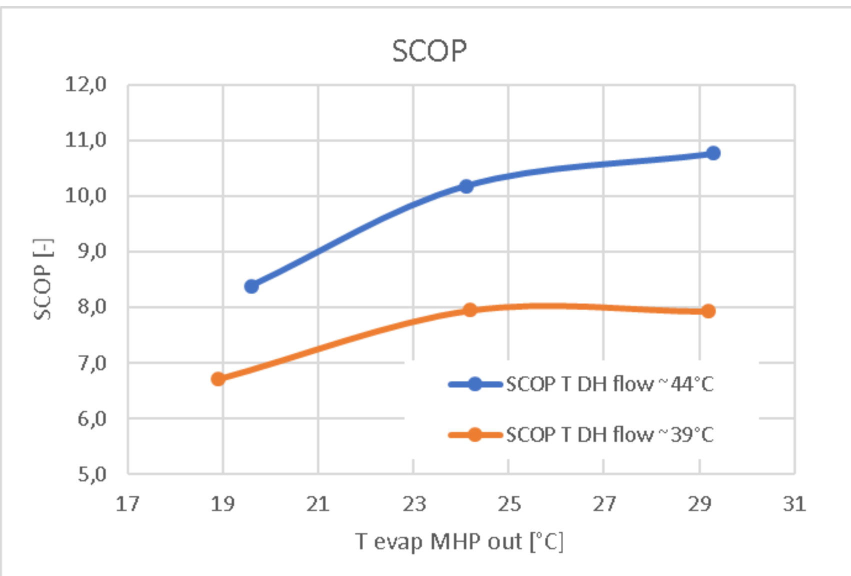
T MHP evap. out ~20°C



T MHP return ~29°C

Main HP temperature profile impact



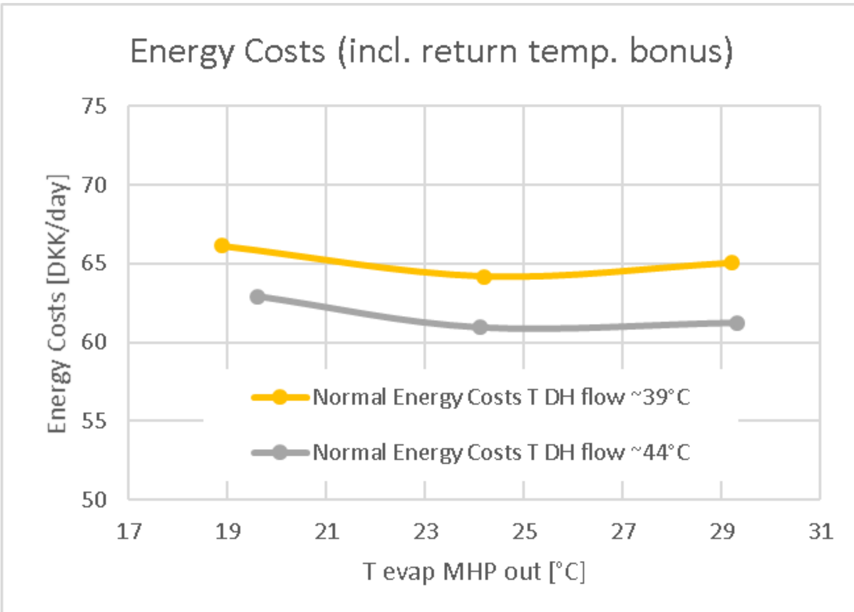


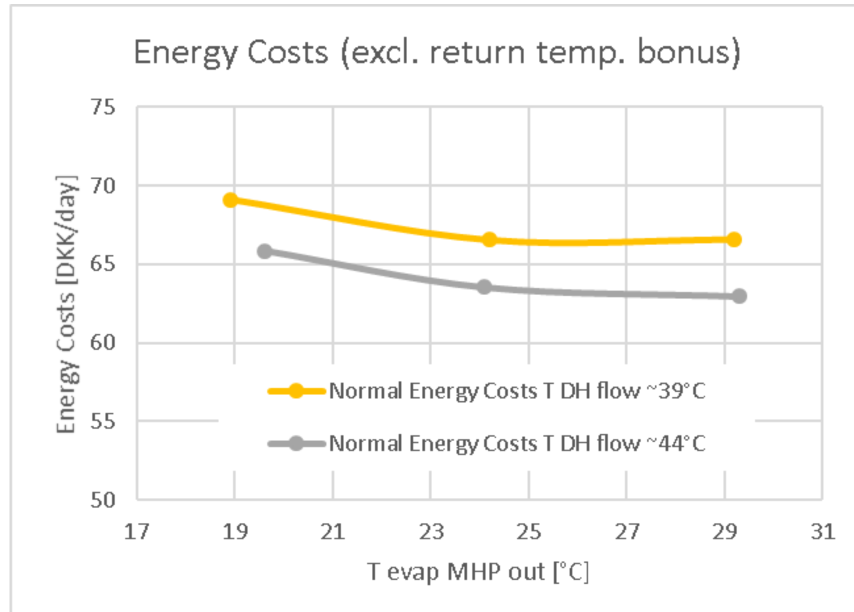
1,9 kWh shifted between Elec. and DH,
at T DH flow = 44°C

1,6 kWh shifted between Elec. and DH,
At T DH flow = 39°C

for a DHW consumption of 72 kWh/day
(DHW circulation is not part of this)

Main HP temperature profile impact





Curves are rather flat, limited impact of Main HP operation profile
DH temperature has an impact
In case of DH return temp. bonus optimal Evap T out is ~24°C
In case no DH return temp. bonus optimizing COP of HP gives lowest energy costs

Conclusions

The daily **average** DHW **load shift** potential is in average 72 kWh/day for a 22 flat building
- Hereof is electricity 6,8 kWh/day and DH 65,2 kWh/day in average.

On a yearly basis its at least on the same level as the load shift potential for the heating system !

We see a yearly variation of a factor 2 for DHW use, with an average “so far” of 1.650 liters/day
- In cold season the DHW use is higher (for central supply)

Fuel shift optimization potential based on temperature profiles for the Main HP is 1,6 to 1,9 kWh/day, depending on DH flow temperature. **This is rather small potential.**
- This corresponds to SCOP changes of 7,7 to 7,9 @ T DH = 39°C; and 8,4 to 10,8 @ T DH = 44°C

With the assumed energy price for electricity and DH, a energy cost saving due to Load shift of **approx. 20 DKK/day** is calculated, this is a reduction of approx. 1/3 compared to normal energy costs. This corresponds to 7.300 DKK/year.

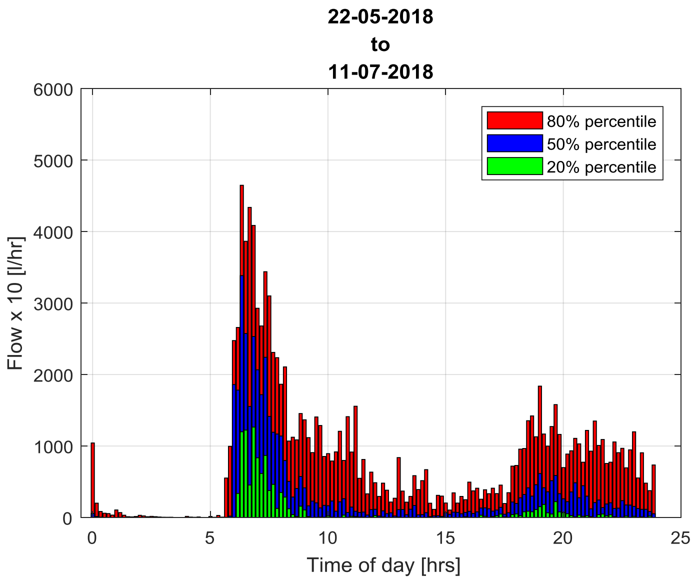
There is no reason not to apply the load shift, the consumers will feel no difference related to DHW comfort !

Future Work

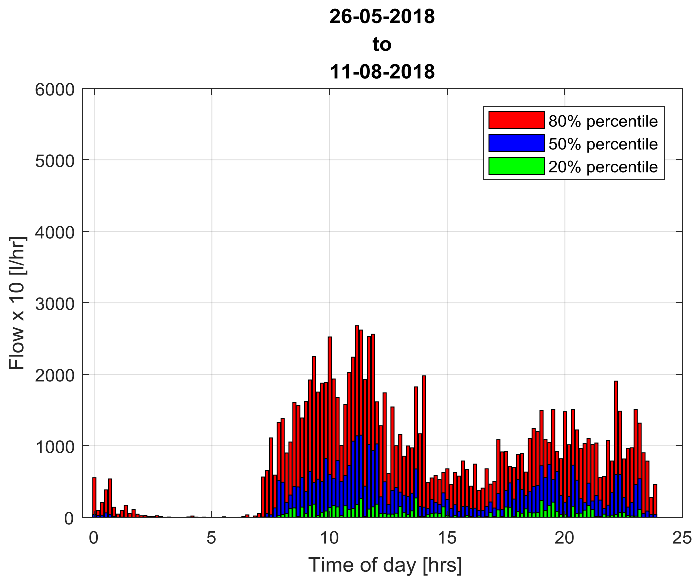
Continue the operation, logging more data, at least a complete year

Cluster DHW patterns for DHW load prediction

Develop and implement advanced method of the charging control (e.g. MPC)



Week-days



Weekend

Thank You for the Attention

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