

CENTRALISED POWER-TO-HEAT UNITS AS FLEXIBLE CONSUMERS IN THE POWER GRID

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ELECTRIFICATION OF DISTRICT HEATING NETWORKS



- Electrifictaion of DH networks is one way to introduce renewable energy to heating sector
 - Electricity from RES
 - Low-temperature heat sources
 - Heat pumps
- This is one way to couple power and thermal grids



FLEXIBILITY FROM THERMAL INERTIA





- Electrical heat sources heat pumps are
 - Consumers for power grid
 - Producers for thermal grid
- In power grid **demand side response** can be beneficial
 - When renewable energy is not available
 - Consumption in the power grid is very high
- Electrical producers in thermal grid can offer flexible consumption to power grid as demand side response by utilising DH networks thermal inertia
- How flexible can electrical heat sources can be due to thermal inertia?
 - Capacity MW
 - Time h
 - Energy MWh

THERMAL INERTIA OF DISTRICT HEATING NETWORK



- As district heating system has considerable thermal capacitance, then lowering the heat production for small amount of time will not be noticeable for DH consumers
 - Mainly from buildings thermal capacity
- Assumptions
 - Indoor temperature is 22°C
 - Heat production capacity (W) can be lowered to indoor temperature 21°C
 - Time of lowered heat production is equal to time that the building can maintain indoor temperature 22°C by its thermal inertia
 - DH consumers will not notice the difference



LOWERED HEAT PRODUCTION

- Different buildings with different energy efficiency classes were examined
- Amount of lowered capacity depends on the buildings thermal heat transfer coefficient





- Lower energy efficiency class buildings have higher possible lowered heat production because they simply need more energy to raise temperature by 1 K
- Therefore more energy can be saved when tempeature is lowered by 1 K



BUILDINGS THERMAL INERTIA

- Buildings thermal inertia influences the time that heat production can be lowered
- Different buildings with different energy efficiency classes were examined and compared by thermal capacitance of the buildings 1 m² of usable surface



- Lower energy efficiency class buildings have slightly higher thermal capacitance
- This is because of construction materials with higher thermal capacitance are used
- Energy efficiency class does not have significant impact to thermal capacitance as the materials thermal capacitance is quite same



LOWERED HEAT PRODUCTION TIME

Lowered heat production time depends on both – heat production capacity and the buildings thermal capacitance



Lowered heat production time – outdoor temperature 0°C

Buildings with higher energy efficiency class can store heat for longer time



EXAMINED DH NETWORKS

- The results were examined using data about Estonian DH networks and ambient temperatures
- 135 small DH networks and Tallinn DH network were examined
 - Small DH networks were divided into 7 groups and average values were used
 - In case of Tallinn, results from other studies were used
- Data about consumers usable surface and energy efficiency class was considered
- With these networks around 85% of district heating systems are covered.

DHN group	Average annual heat consumption, MWh	Number of DHN in group				
1	681	23				
2	1 914	58				
3	3 956	24				
4	6 235	8				
5	7 812	8				
6	10 393	9				
7	14192	5				
Tallinn	325 000	1				
Only heat that can be given by heat pumps						

DEMAND SIDE RESPONSE TO POWER GRID – FLEXIBLE CAPACITY

Total flexible electric capacity

Small DHNs TALLINN





DEMAND SIDE RESPONSE TO POWER GRID – FLEXIBLE CAPACITY

DHN group	Average flexible capacity per DHN, kW	Average flexible capacity for whole group, kW	Maximum flexible capacity, kW	Maximum flexible capacity for whole group, kW
1	0,9	19,7	2,0	45,7
2	3,1	181,6	7,3	421,9
3	6,2	149,0	14,4	346,2
4	9,8	78,1	22,7	181,3
5	13,7	109,4	31,8	254,2
6	19,1	171,6	44,3	398,6
7	26,2	130,8	60,8	303,8
Tallinn	580,8	580,8	1349,1	1349,1
Total	659,6	1420,9	1532,3	3300,9



CONCLUSIONS

- Buildings thermal inertia can be used as effective demand side response only when there are very many DH networks with electrified heat production
- Part of Tallinn DHN alone can provide significant amount flexible power consumption, compared to small DHNs
- Buildings with higher energy efficiency class can provide flexible power consumption for longer time
- Amount of lowered heat capacity depends on the buildings heat transfer coefficient and is bigger for lower energy energy efficiency class buildings





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