



INCREASE CHP FLEXIBILITY TO IMPROVE ENERGY SYSTEM EFFICIENCY

MSc Kertu Lepiksaar, Dr.Sc.Ing. Anna Volkova
Faculty of Engineering / Department of Energy Technology
Tallinn University of Technology



25.09.2020



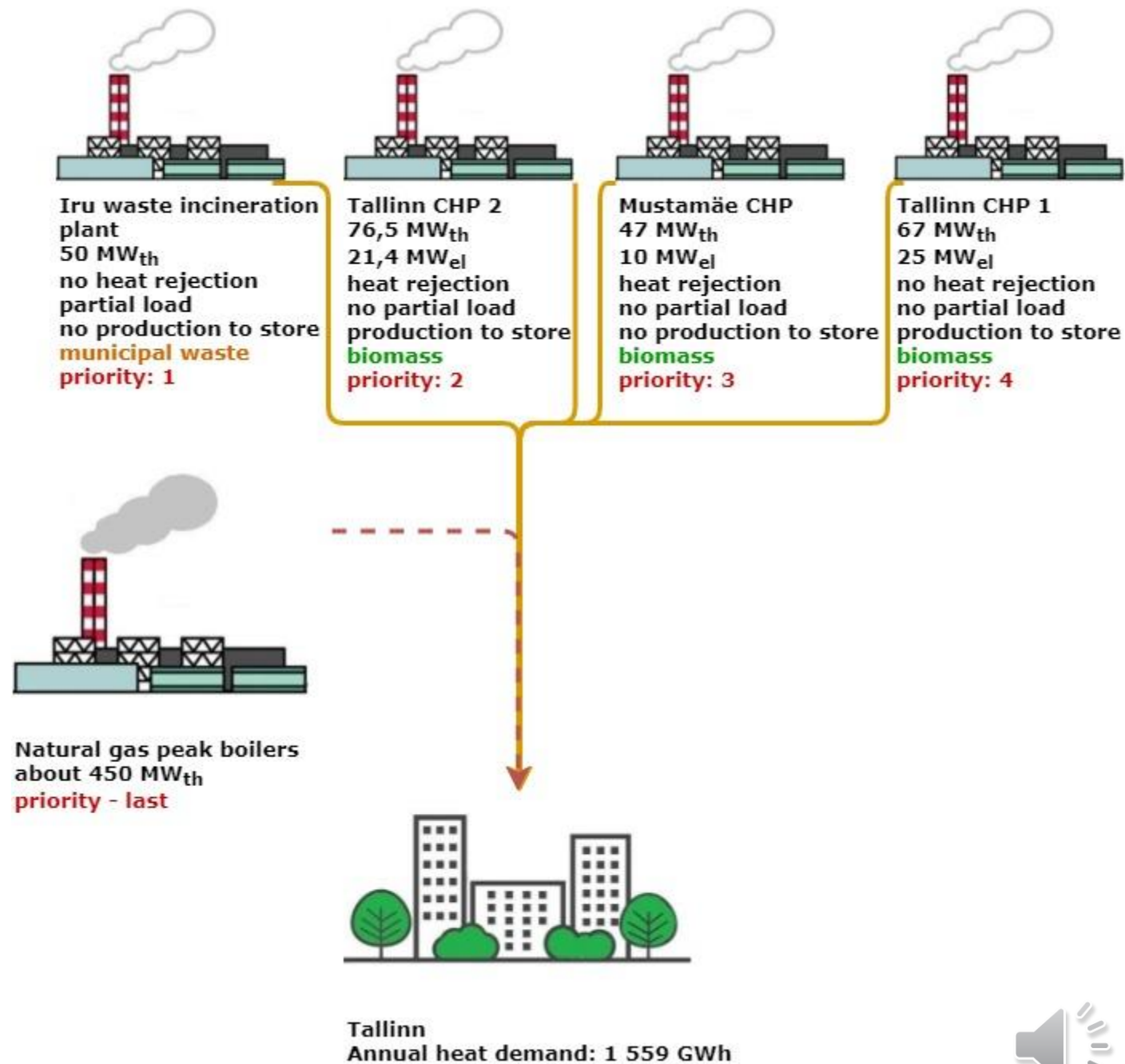
INCREASING CHP FLEXIBILITY

- Different technologies are used to increase CHP flexibility
 - Heat rejection
 - Coupling with district cooling
 - Power to heat solutions
 - Thermal energy storage
- In this study **power to heat** solutions combined with **thermal energy storage** are examined
- Comparison of different solutions is based on:
 - Natural gas consumption
 - Used power to heat potential
 - Stored heat usage
- This study is based on **Tallinn DH** system.



EXAMINED SYSTEM - TALLINN

- 3 biomass CHP
- 1 waste incineration plant
- Natural gas peak boilers
- Can natural gas usage be reduced by power to heat and TES?
- What are the influences?
- Normally (reference) about 215 GWh of heat is produced from natural gas every year.



Priority 5



Natural gas peak boilers
about 450 MW_{th}
priority - last

Priority 4



Tallinn CHP 1
67 MW_{th}
25 MW_{el}
no heat rejection
no partial load
production to store
biomass
priority: 4

Priority 3



Mustamäe CHP
47 MW_{th}
10 MW_{el}
heat rejection
no partial load
no production to store
biomass
priority: 3

Priority 2



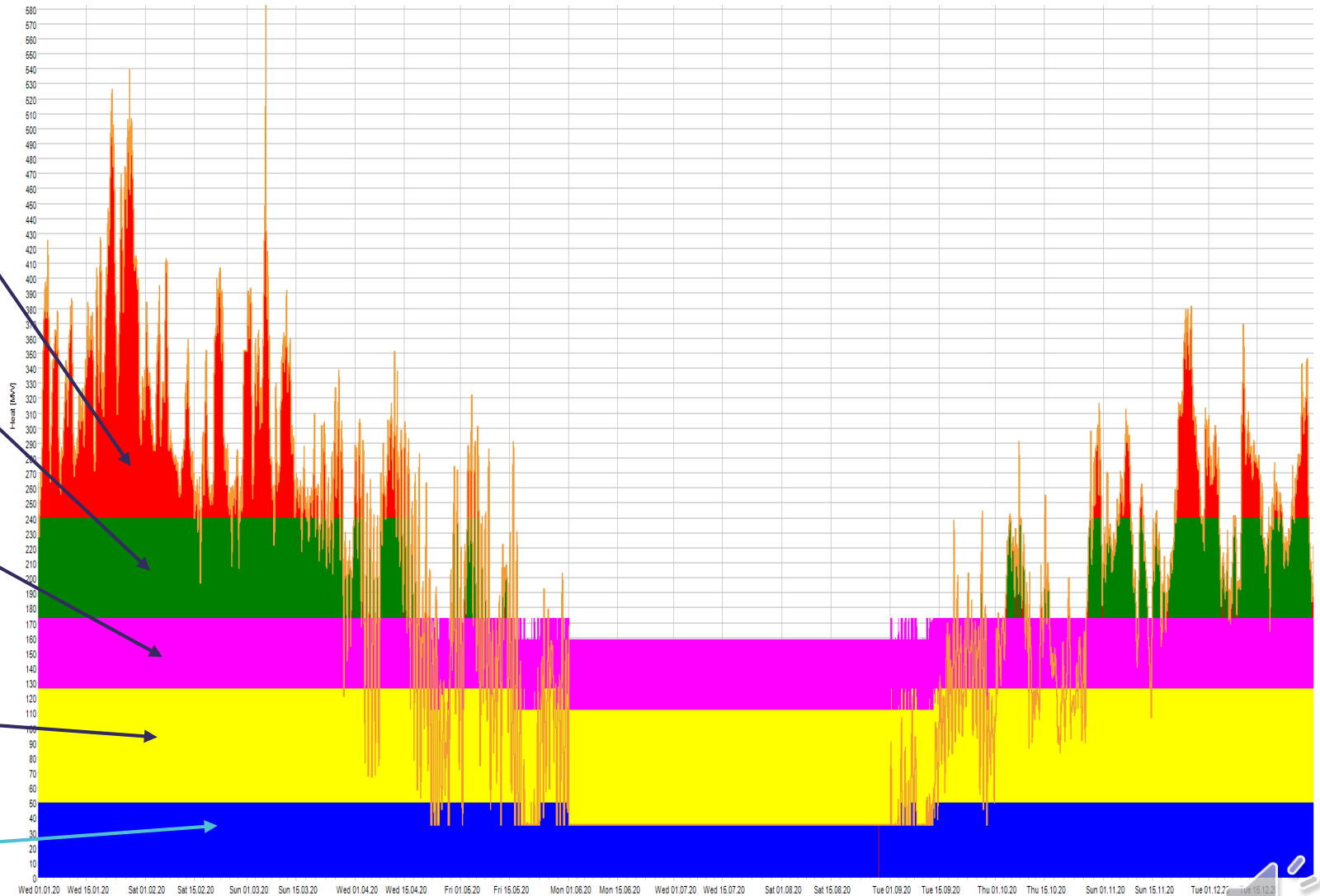
Tallinn CHP 2
76,5 MW_{th}
21,4 MW_{el}
heat rejection
no partial load
production to store
biomass
priority: 2

Priority 1



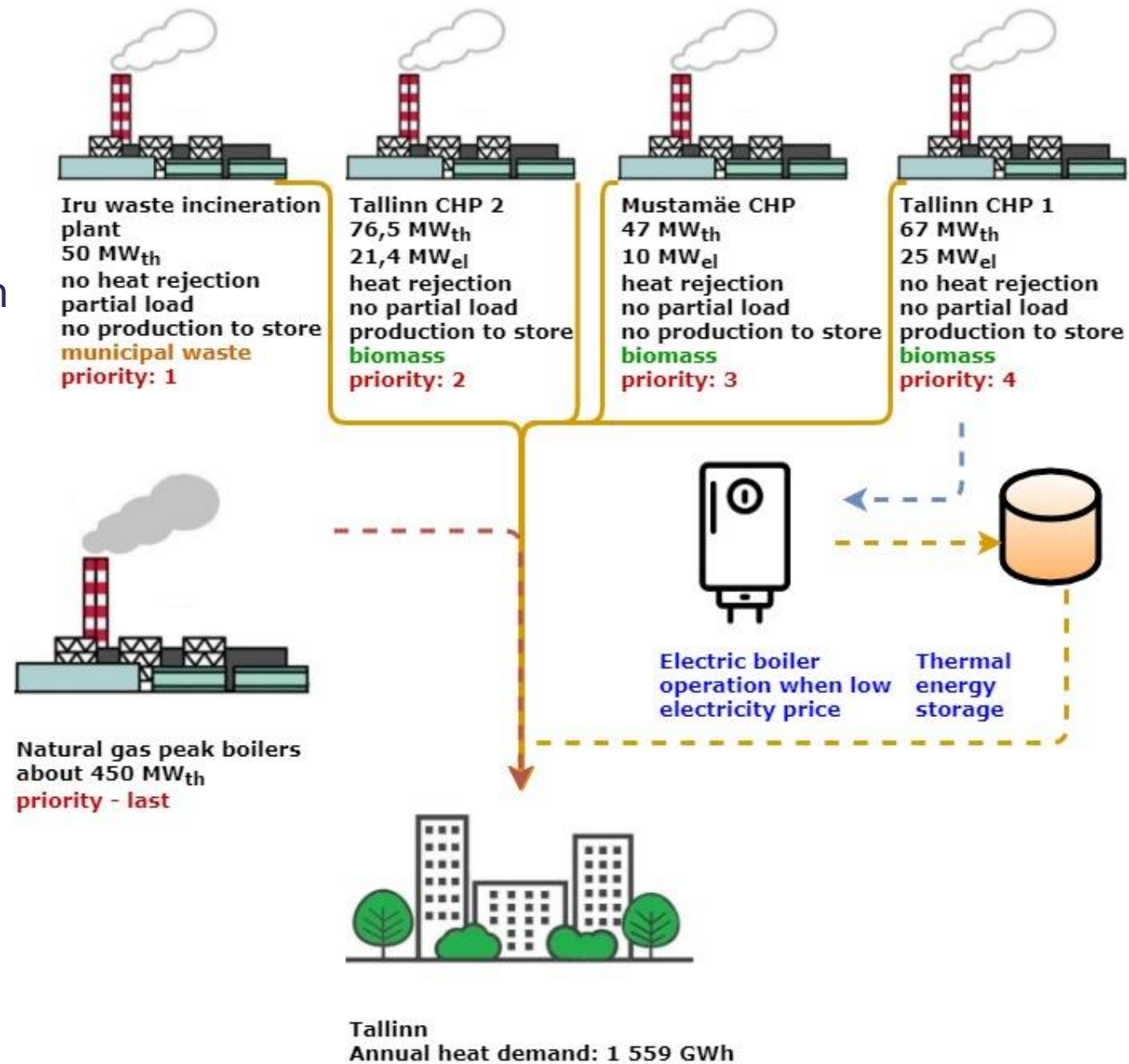
Iru waste incineration plant
50 MW_{th}
no heat rejection
partial load
no production to store
municipal waste
priority: 1

Tallinn heat demand

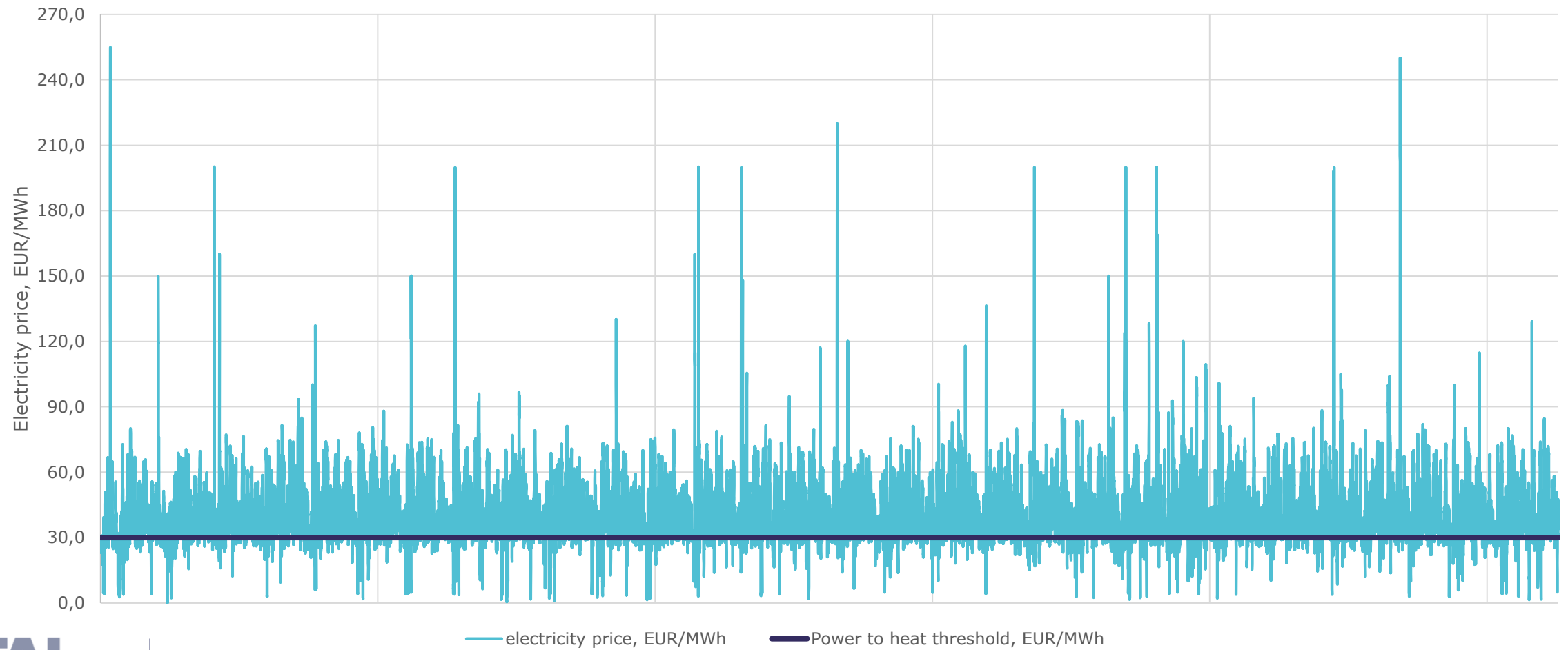


TALLINN IMPROVED SYSTEM

- Electric boiler as power to heat solution
 - Threshold electricity price 30 EUR/MWh
 - The priority of electric boiler is before natural gas boilers
- Thermal energy storage
- Can integration of TES with power to heat (electric boiler) improve the system and how?



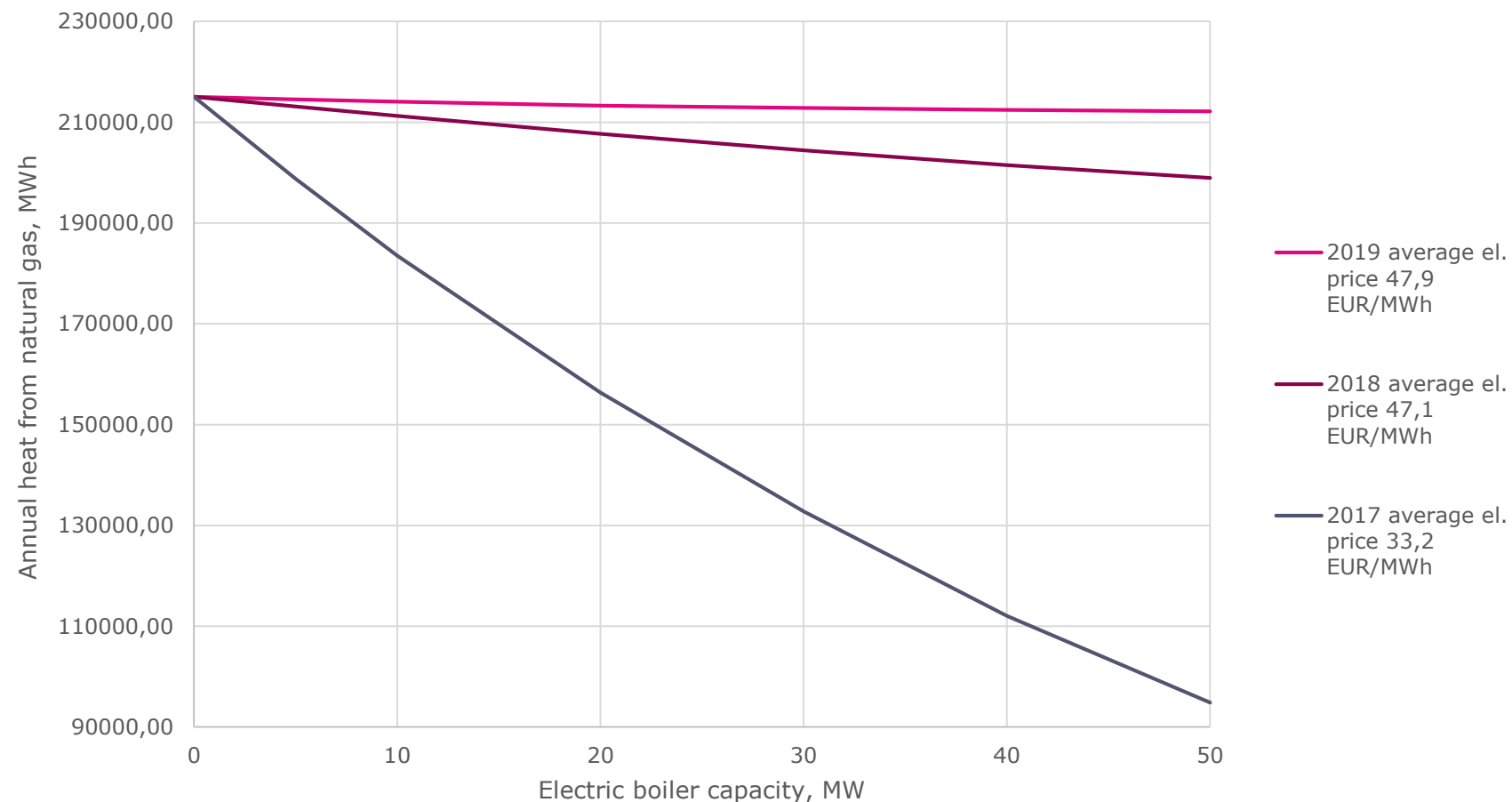
ELECTRICITY PRICE 2017 - 2019



NATURAL GAS CONSUMPTION – ONLY POWER TO HEAT

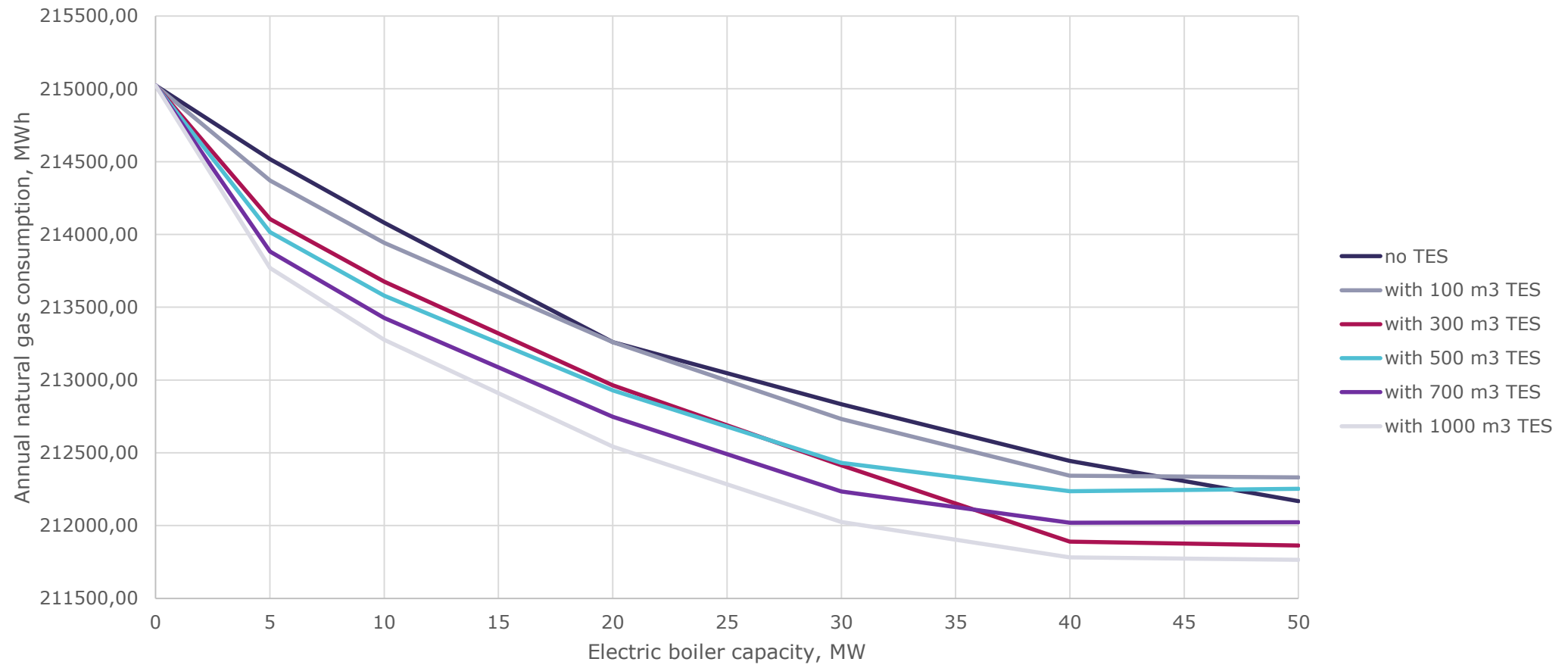
Influencing factors:

- Electricity price and heat demand
- Power to heat start threshold
- Power to heat capacity



NATURAL GAS CONSUMPTION – 2019 EXAMPLE

Power to heat combined with different size TES



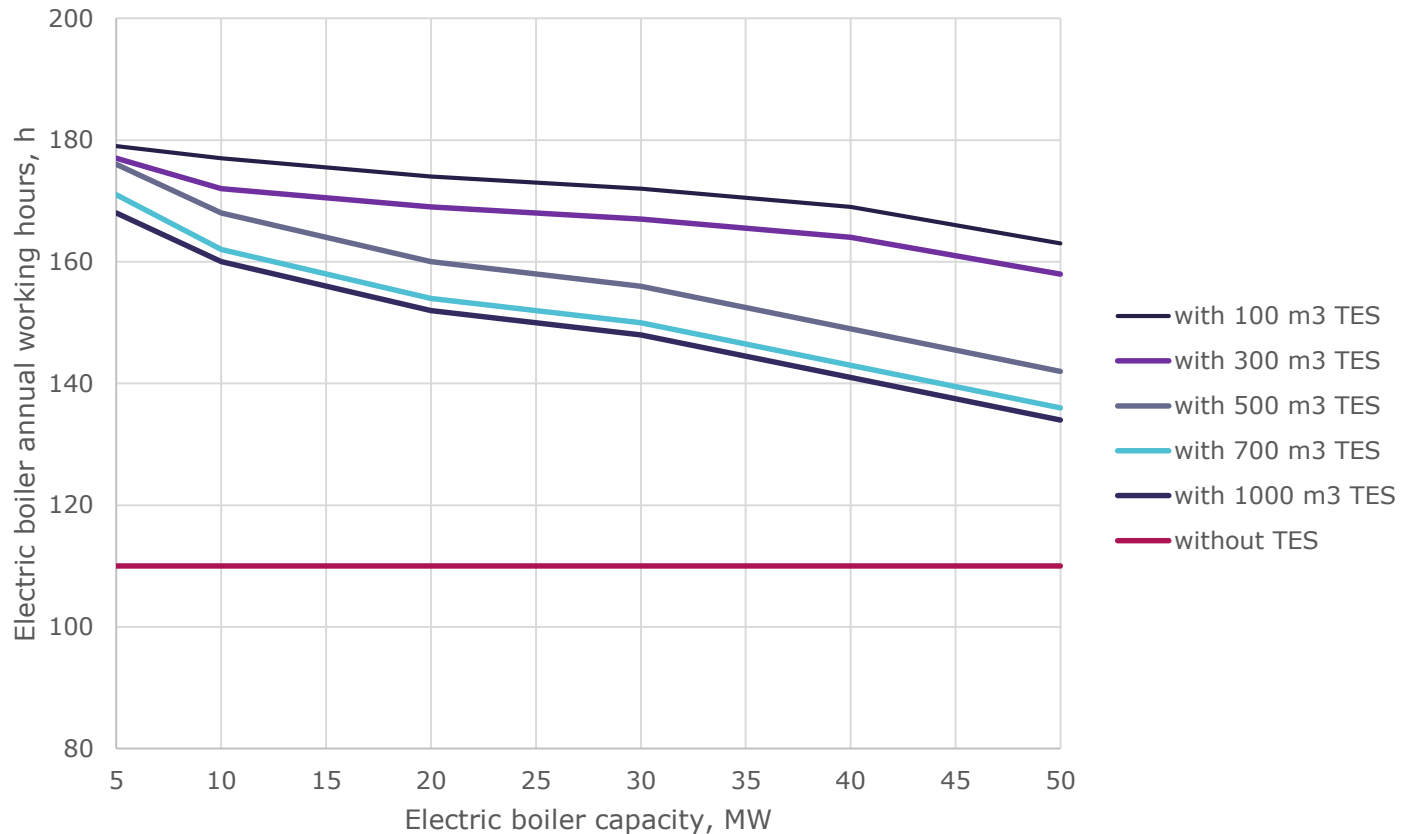
COMBINING TES WITH POWER TO HEAT

- Bigger potential for reducing natural gas consumption
- Power to heat capacity limiting factor – heat demand
 - In case of Tallinn feasible power to heat solution capacity would be 40 MW.
- Finding optimum TES is not so straight forward, because larger TES capacity results always large natural gas savings.



ELECTRIC BOILER WORKING TIME

- Using TES combined with power to heat can significantly improve power to heat usage potential
- **Less dependent on heat load**
- The effect is bigger with smaller TES
 - With 100 m³ TES increase of working hours can be up to 63%



INFLUENCES

- No influence on base load (in Tallinn case biomass) CHP working time.
- Number of TES usage hours increases as TES size increases.
- Number of TES usage hours increases as power to heat capacity increases.
- When threshold price is lower, then natural gas consumption reduction is smaller because of number of power to heat usage hours is smaller (less hours when electricity price is below threshold price).

CONCLUSIONS

- Combining power to heat solutions with TES can improve the systems flexibility and reduce natural gas consumption.
- Using power to heat together with TES is more flexible solution than using these technologies separately.
- Using power to heat solutions combined with TES is efficient technology combination for peak shaving, both electricity and heat.
- The social-economic influences can be further studied.



TALLINN UNIVERSITY OF TECHNOLOGY

Kertu Lepiksaar

kertu.lepiksaar@taltech.ee

taltech.ee

