



AKADEMIA GÓRNICZO-HUTNICZA
IM. STANISŁAWA STASZICA W KRAKOWIE

AGH UNIVERSITY OF SCIENCE
AND TECHNOLOGY

Modelling district heating systems transition towards climate neutrality, case study of Poland

Maciej Raczyński
Artur Wyrwa

05.05.2023 Dresden



Agenda

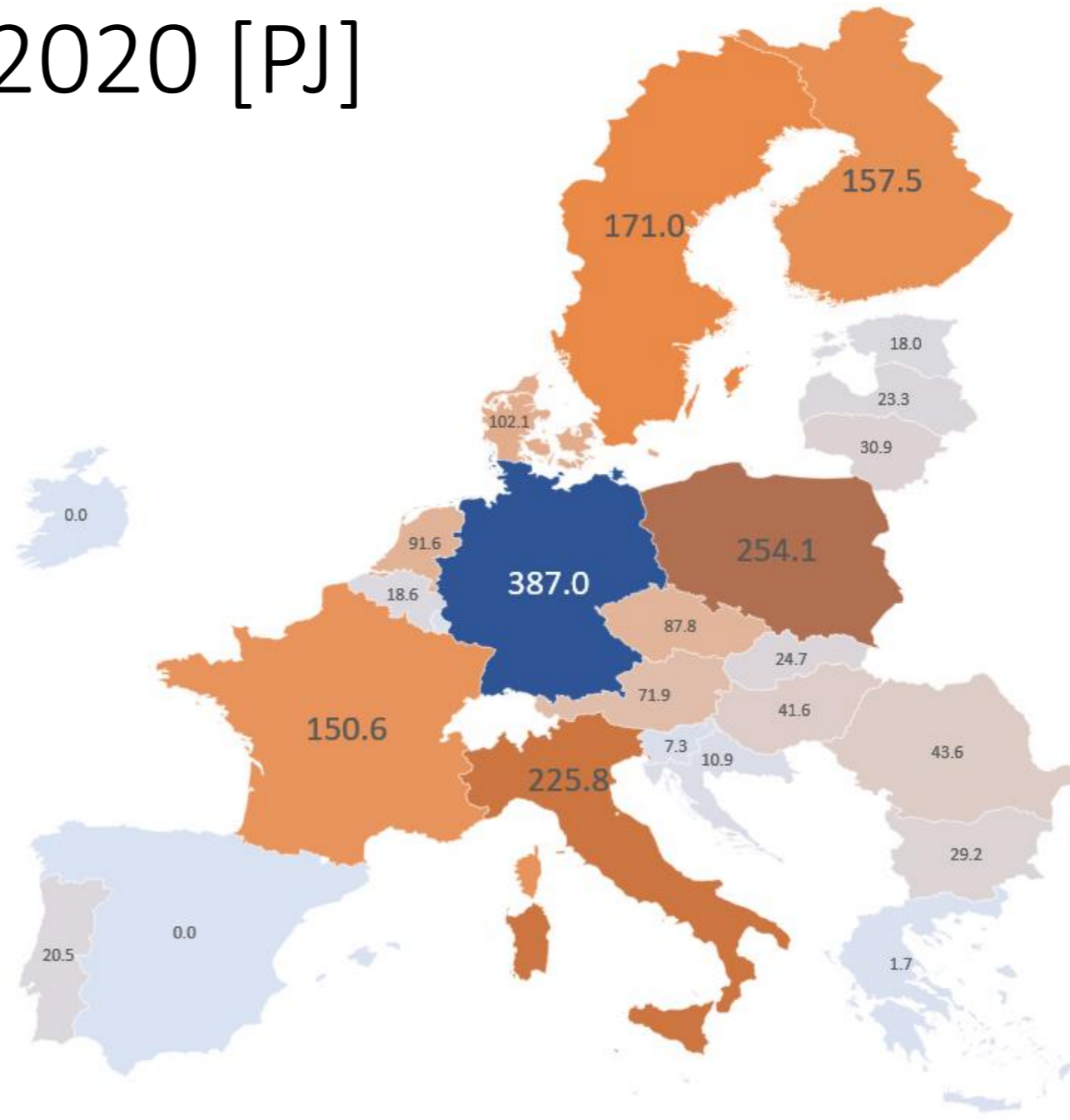


- District Heating Systems
- TIMES-HEAT-PL Model
- Results
- Conclusions & Summary

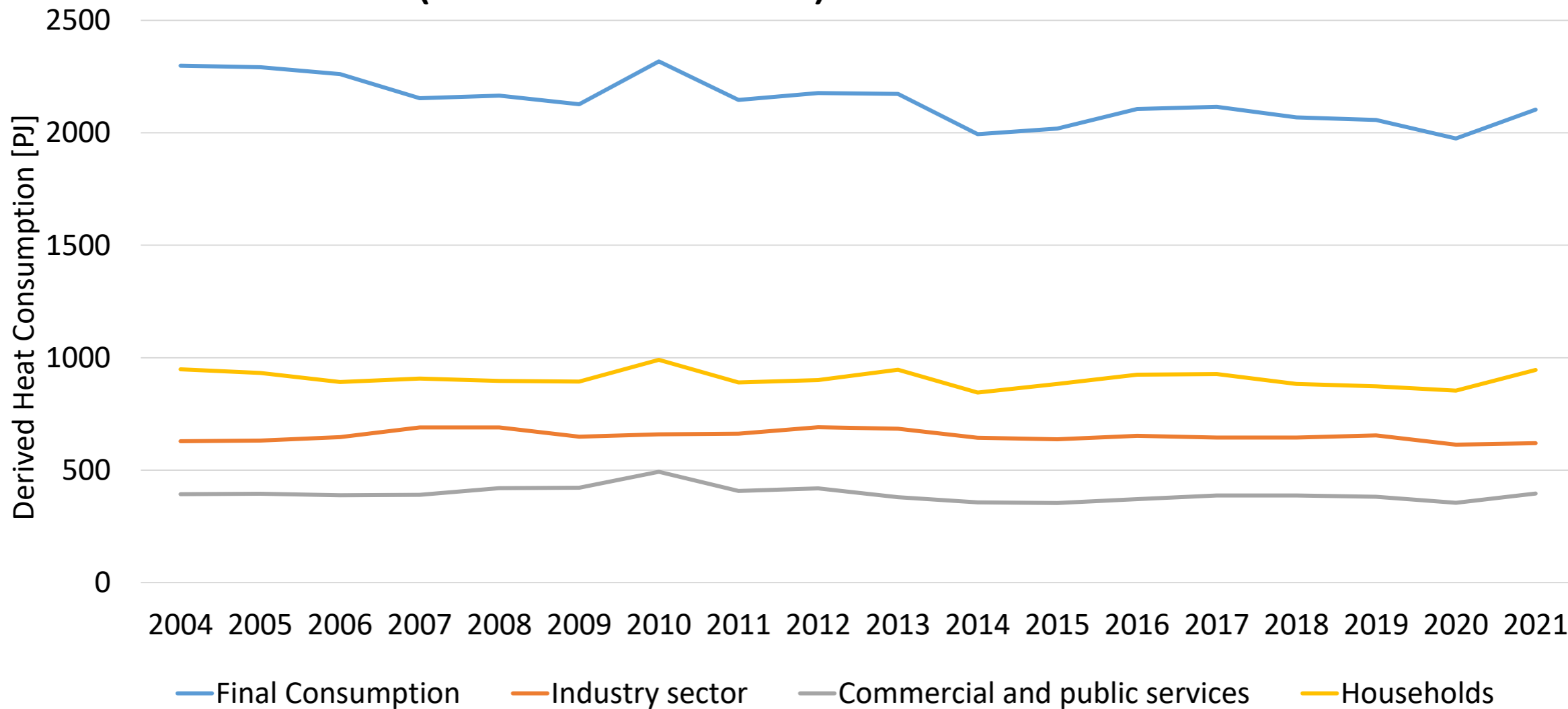
- **District Heating Systems**
- TIMES-HEAT-PL Model
- Results
- Conclusions

Final Consumption of Derived Heat in the EU-27 in 2020 [PJ]

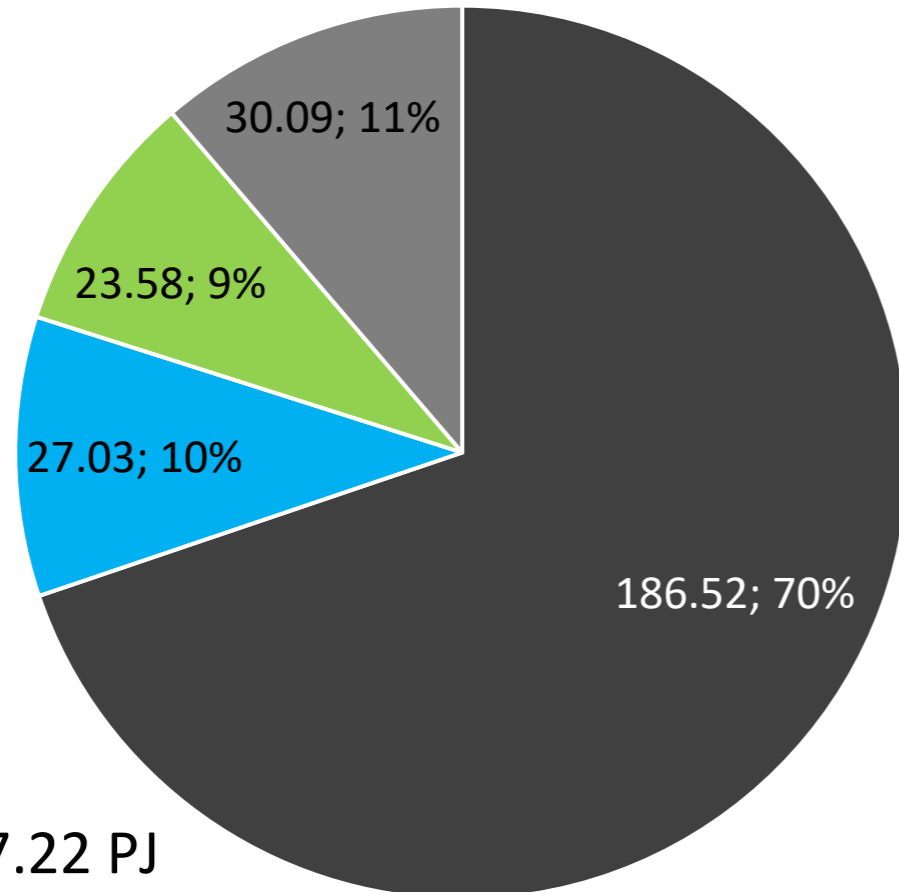
EU27 sectoral breakdown	PJ
Final consumption of derive heat	1974.8
of which	
Industry sector	613.4
Commercial and public services	354.5
Households	854.2



Derived Heat Consumption Trend in EU27 (2004-2021)



District Heat production in Poland in 2020 by fuel [PJ]



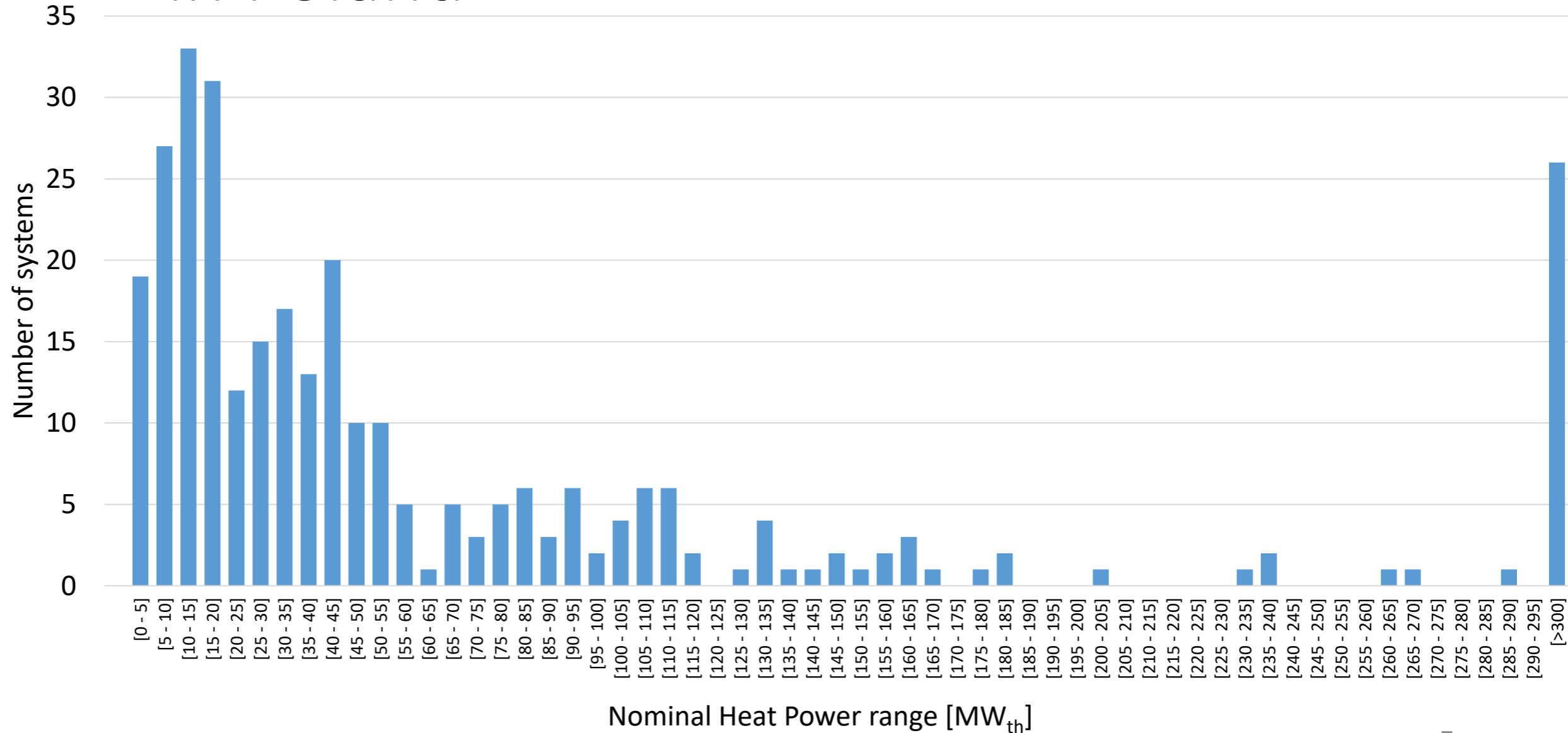
267.22 PJ
in total

■ Hard Coal ■ Natural Gas ■ Biomass ■ Other

Regulations resulting from energy policies:

- Fit for 55:
 - Energy Efficiency Directive
 - Renewable Energy Directive
- will make carbon-based systems inefficient and they will have to undergo a deep transformation

Size of District Heating Systems (DHS) in Poland





Agenda



- District Heating Systems
- **TIMES-HEAT-PL Model**
- Results
- Conclusions & Summary

TIMES model generator

- Developed by IEA-ETSAP
- Linear programming, optimisation model
- Bottom-up, technology rich approach
- Minimizes total discounted system costs
 - Subject to user constraints

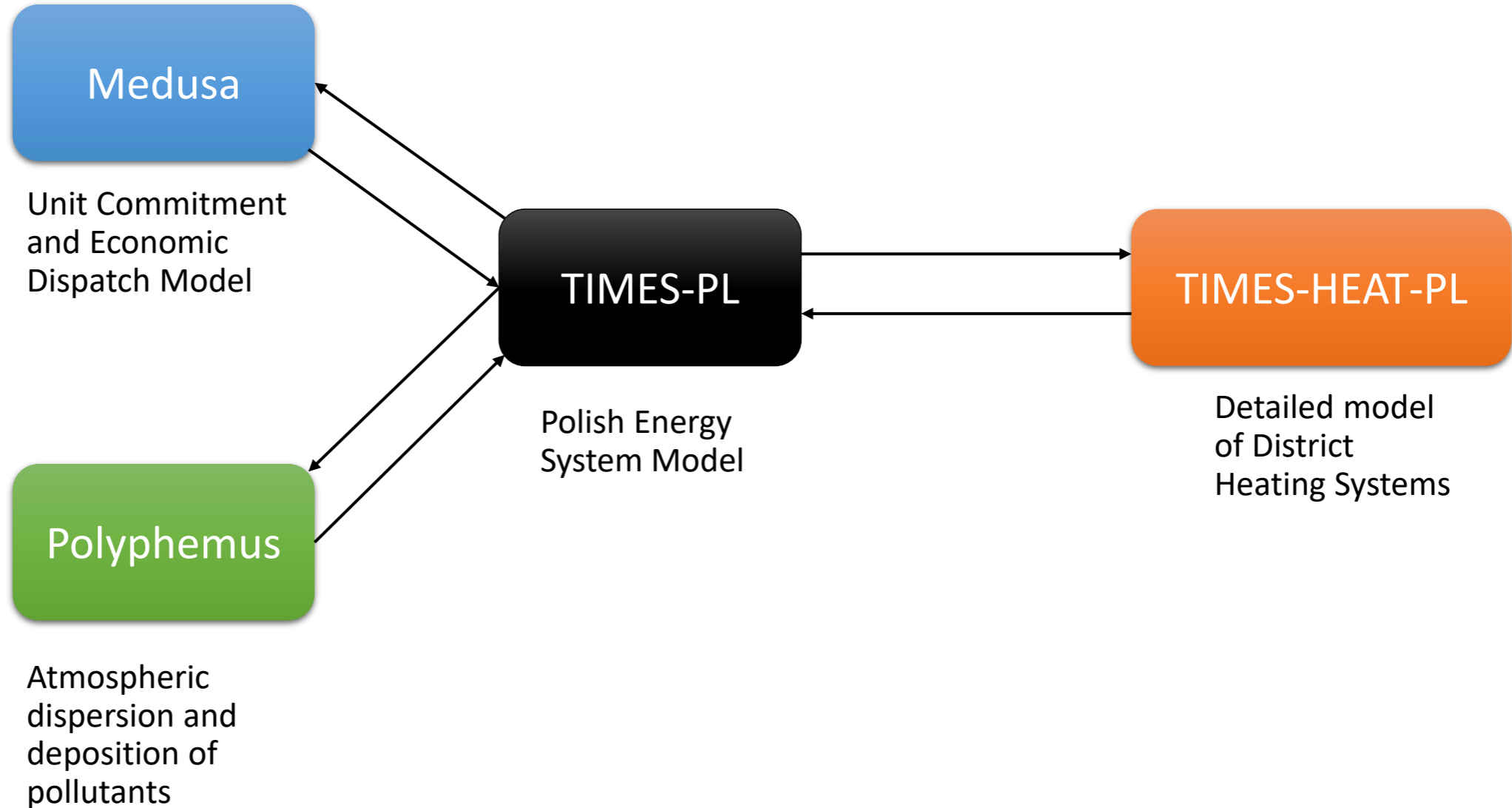
JRC uses its TIMES-PAN-EU to evaluate European energy policies

TIMES-HEAT-PL – general concept

- Multi-regional model – each DHS is treated as a separate region
- Use of geospatial data (GIS) to better address local conditions and limitations
- Systems divided into 5 size categories (<5, 5-20, 20-50, 50-300, >300 MW)
- Sets of new technologies:
 - Tied to the system size
 - Suited to their operation characteristics o (base, medium, peak load, all year)
 - 50 new technologies in total



TIMES-HEAT-PL – as a part of modelling system



District Heating Systems included in TIMES-HEAT-PL

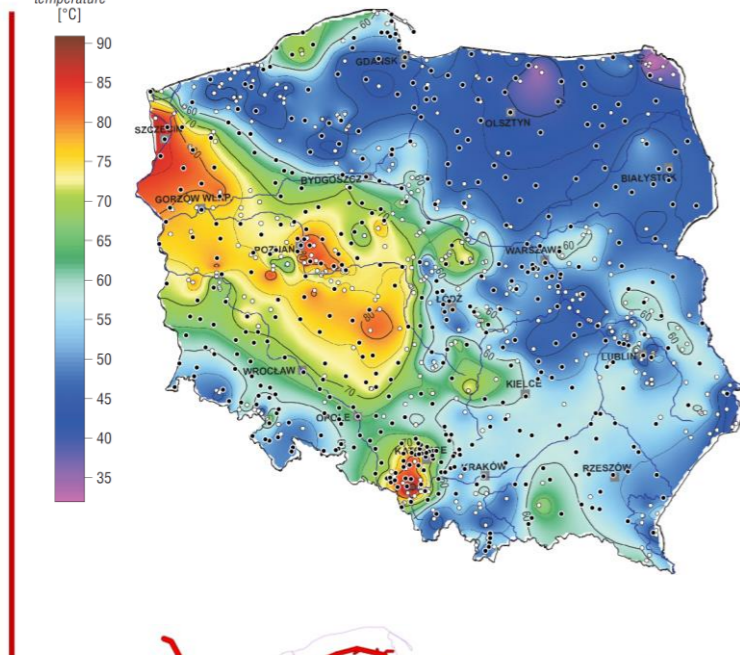


313
individual
district
heating
systems
in total

Source: Own
elaboration based on
data from Główny
Urząd Statystyczny

TIMES-HEAT-PL – examples of geospatial data used

temperatura
temperature
[°C]

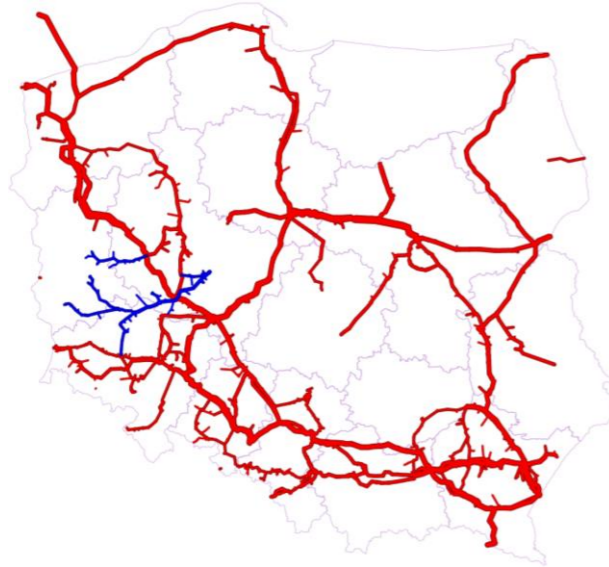


Geothermal potential



Biomass potential

< 4,0
4,0-5,0
5,0-6,0
> 6,0 [PJ]

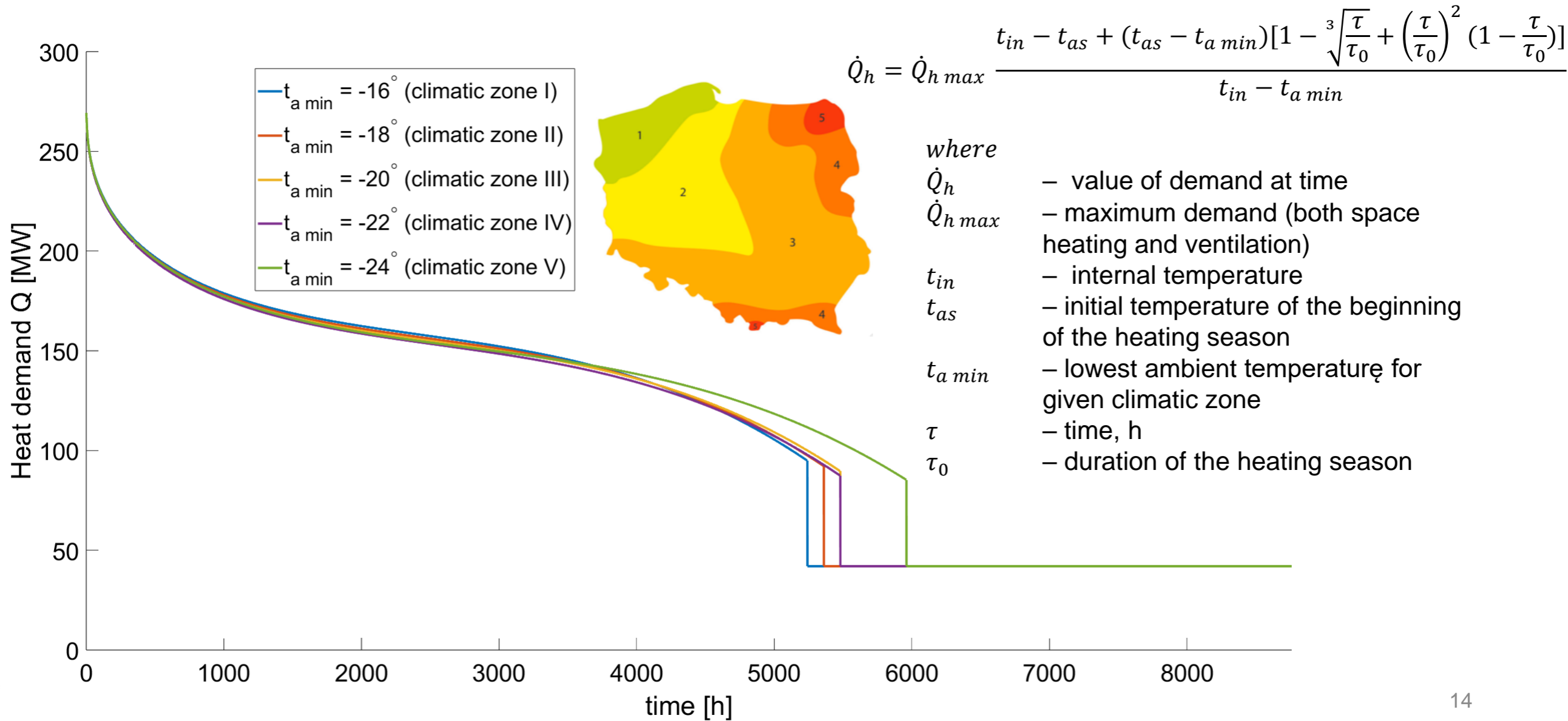


Natural gas availability



Solar irradiation

Heat load duration curve estimated using the Raiss equation:

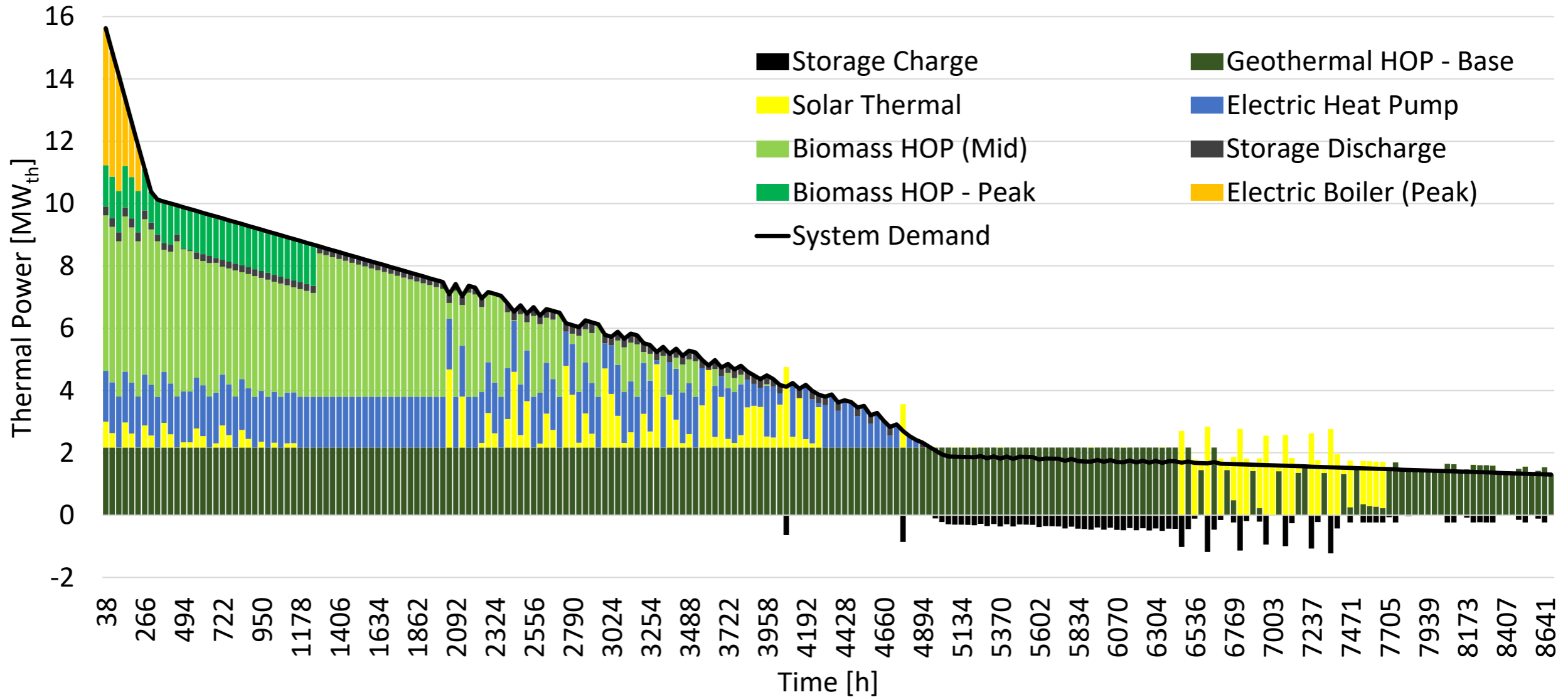


Agenda

- District Heating Systems
- TIMES-HEAT-PL Model
- **Results**
- Conclusions & Summary

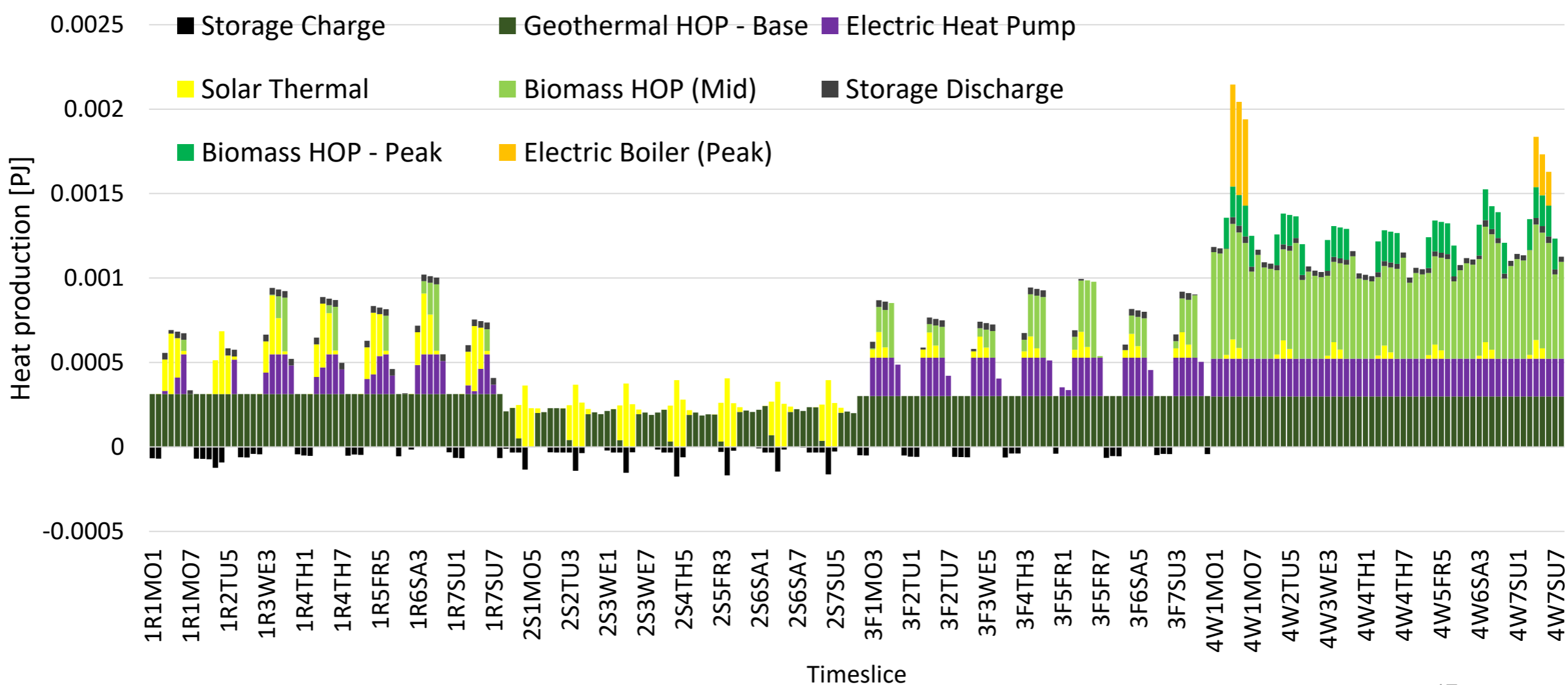
Ordered Heat Load Duration Curve (2050)

Small System $\sim 16 \text{ MW}_{th}$



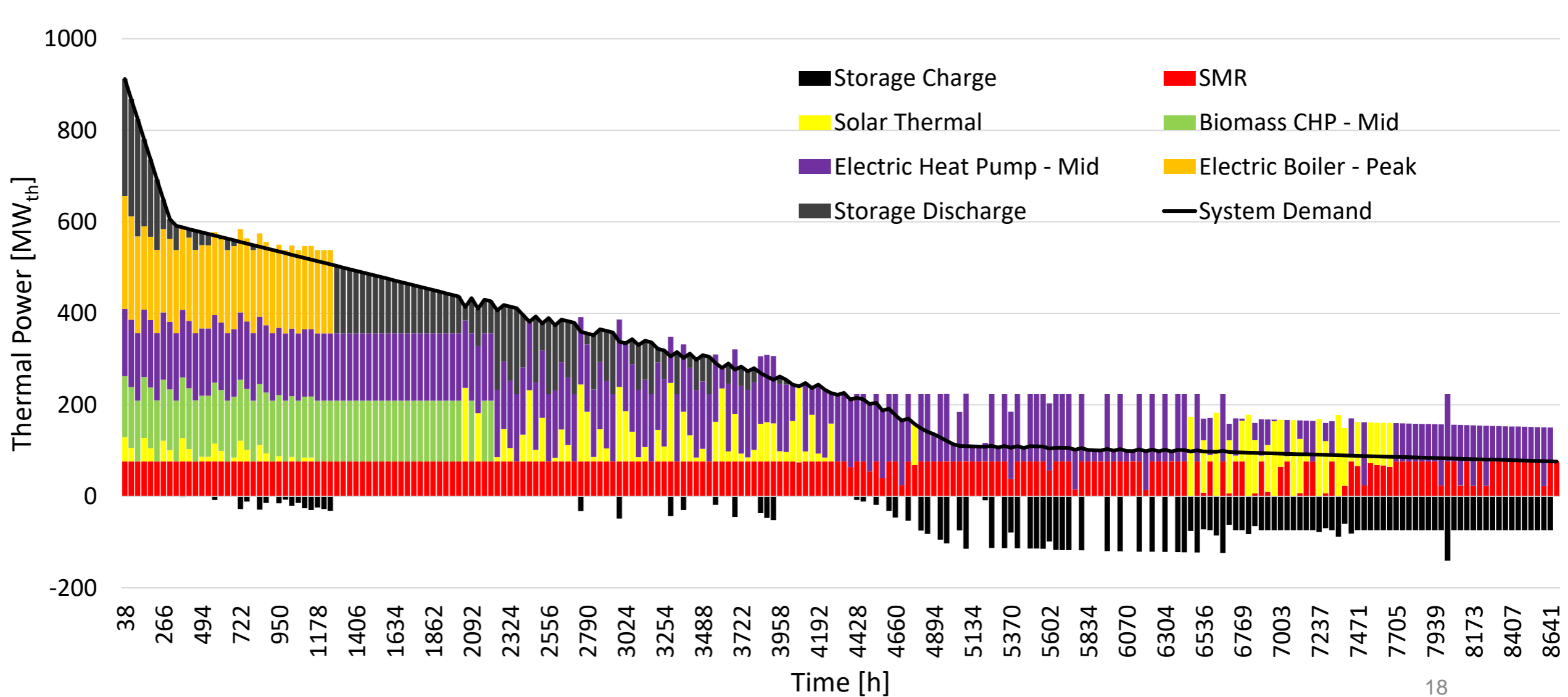
Heat production over a year 2050

Small system ~16 MW_{th}



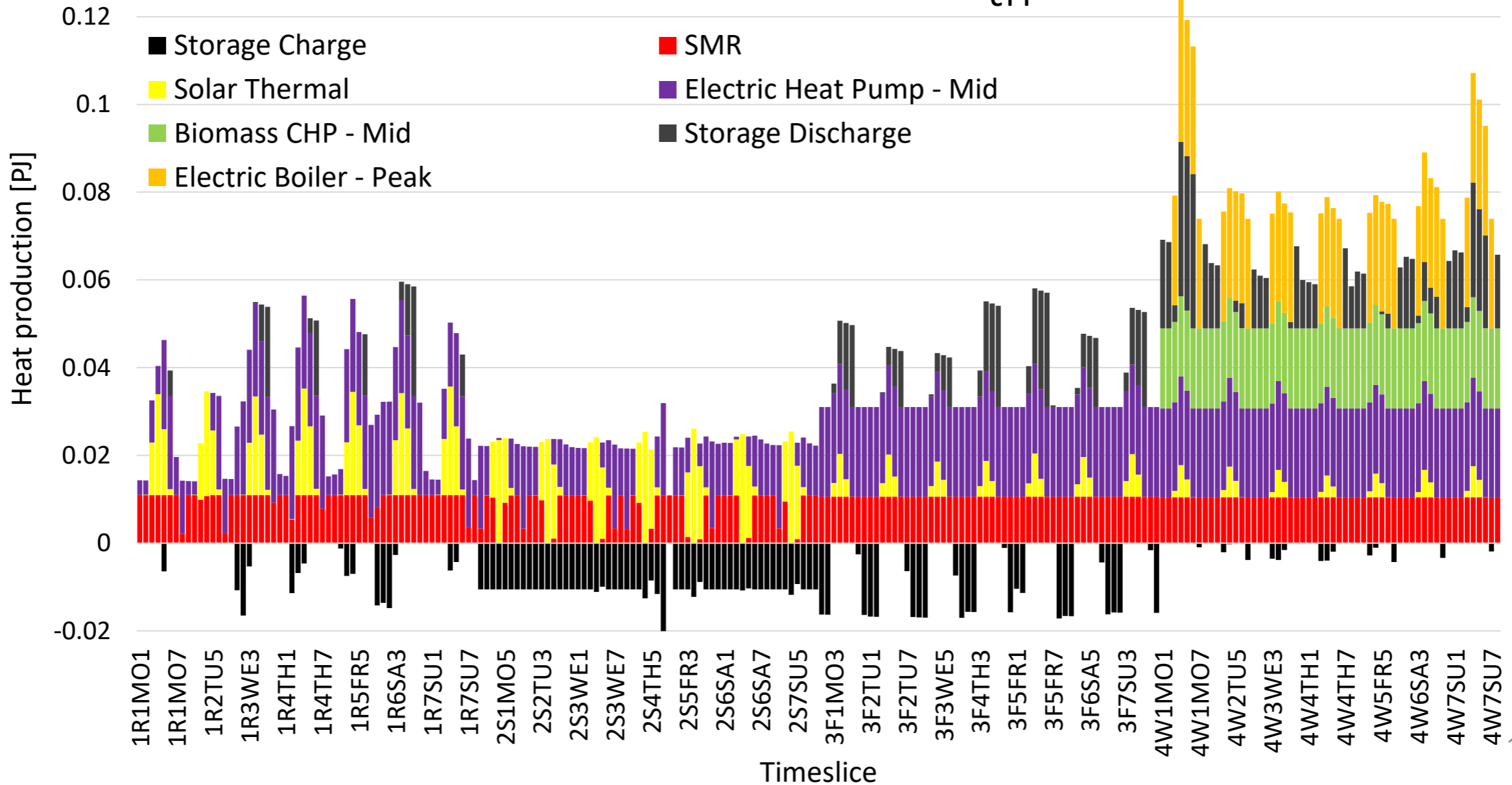
Ordered Heat Load Duration Curve (2050)

Large System $\sim 900 \text{ MW}_{\text{th}}$



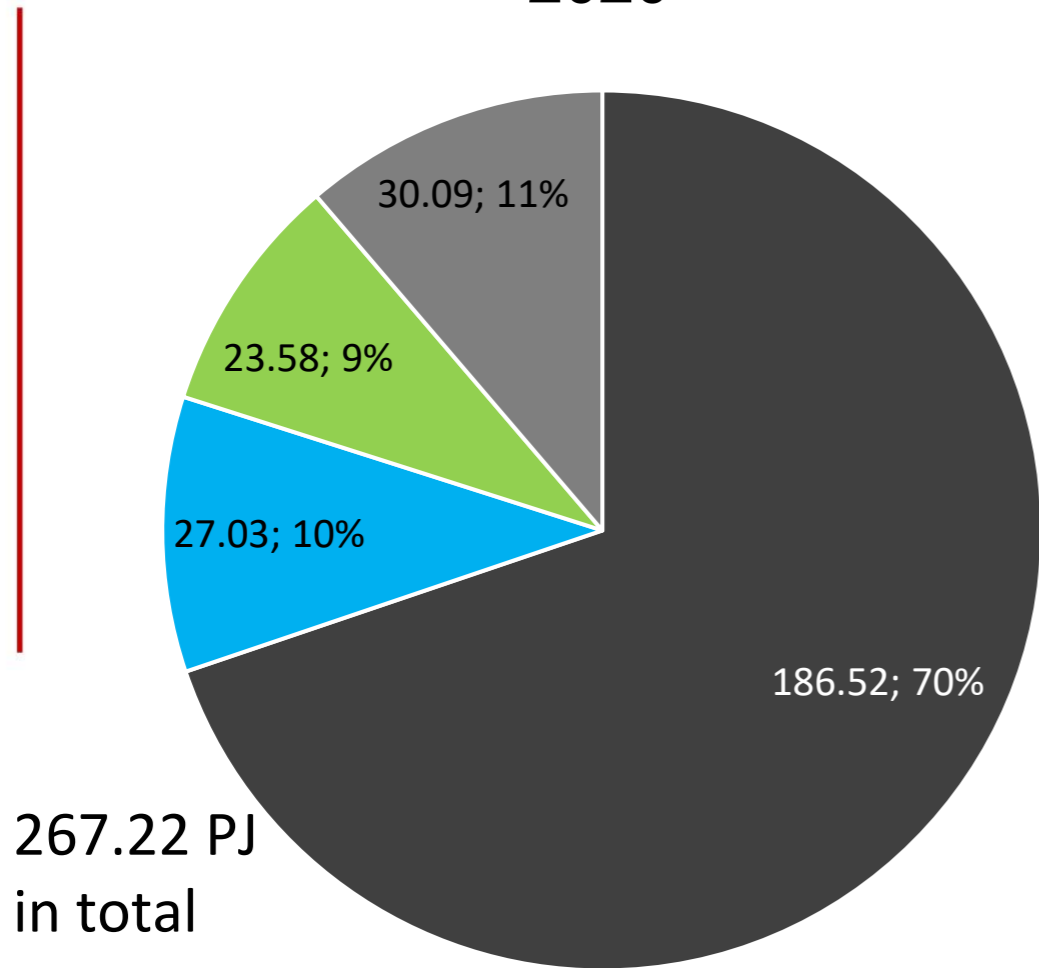
Heat production over a year 2050

Small system ~900 MW_{th}



Heat production by fuel in Poland [PJ]

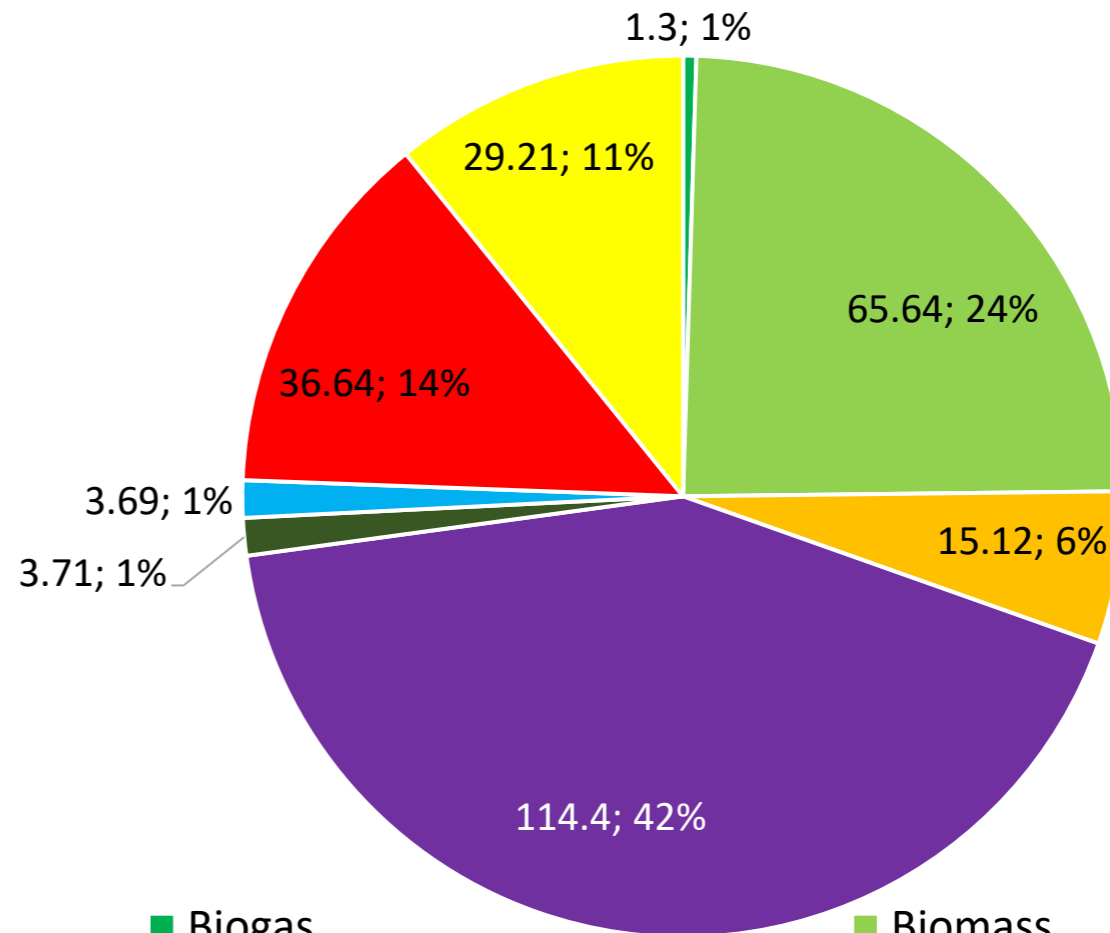
2020



267.22 PJ
in total

- Hard Coal
- Natural Gas
- Biomass
- Other

2050



- Biogas
- Electricity (Boiler)
- Geothermal
- Nuclear
- Biomass
- Electricity (Heat pump)
- Natural Gas
- Solar Thermal

Agenda

- District Heating Systems
- TIMES-HEAT-PL Model
- Results
- **Conclusions & Summary**

Conclusions & Summary

- The model developed chooses technologies appropriate for the area (base, mid, peak) of the ordered heat load duration curve
- Takes into account local (GIS) and national constraints
- As part of a larger modelling system, it allows the integration of district heating into the country's energy system
- The model is intended to evaluate the paths of technological transformation of district heating systems in Poland and to estimate the transformation cost
- It is important to develop a set of heat generation technologies that meet the requirements of energy policies (efficient heating system definition)
- Many issues require further work, e.g. H₂, P2H, SMRs, RES, waste heat, storage; investments on demand side & heat network infrastructure (n_{th} generation), to reflect them in the model as close to reality as possible



Thank You



Contact Details



Maciej Raczyński

maciej.raczynski@agh.edu.pl

Artur Wyrwa

awyrwa@agh.edu.pl

AGH University of Science and Technology, Krakow, Poland

<http://home.agh.edu.pl/esmlab>