International Conference on Smart Energy Systems

Special session on Energy transition and decarbonisation in the district heating sector

SET HEAT

Copenhagen

16-17.09.2025

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Programme for the Environment and Climate Action

LIFE Clean Energy Transition sub-programme

What can we do in Bucharest? The issues of decarbonising large district heating systems

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(Silesian University of Technology)

Project number
101119793

Project acronym:
LIFE22-CET-SET_HEAT

Call:
LIFE-2022-CET

Topic:
LIFE-2022-CET-DH

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Agenda

- Bucharest district heating system
- The energy transition and decarbonisation challenge
- Identified local energy resources
- Critical hurdles identified.
- How others do this.
- System energy modelling.
- Potential investment projects
- Transition programme economic performance
- Key conclusions

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Bucharest DH system

- Population of around **1,700,000** inhabitants,
- Number of DH consumers is around **504,730**
- DH network has a total length is around **3847 km**.
- Annual heat input to the network is around **4500 GWh/year**.
- DH system is administratively divided into **6 zones** (sectors).
- Around **92%** of heat purchased from external suppliers.
- ***100%**. of heat is from combustion of natural gas.*
- Around **74%** of heat is produced in co-generation (old-fasioned steam cycle)
- Network operating forward temperature ranging from **80℃℃ to 110℃**.
- System availability ranges from **75 to 85%** due to numerous failures.
- Annual heat losses from the network amount to **30 – 40%.**

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Residential heat density

(https://www.hotmaps.eu/map)

5

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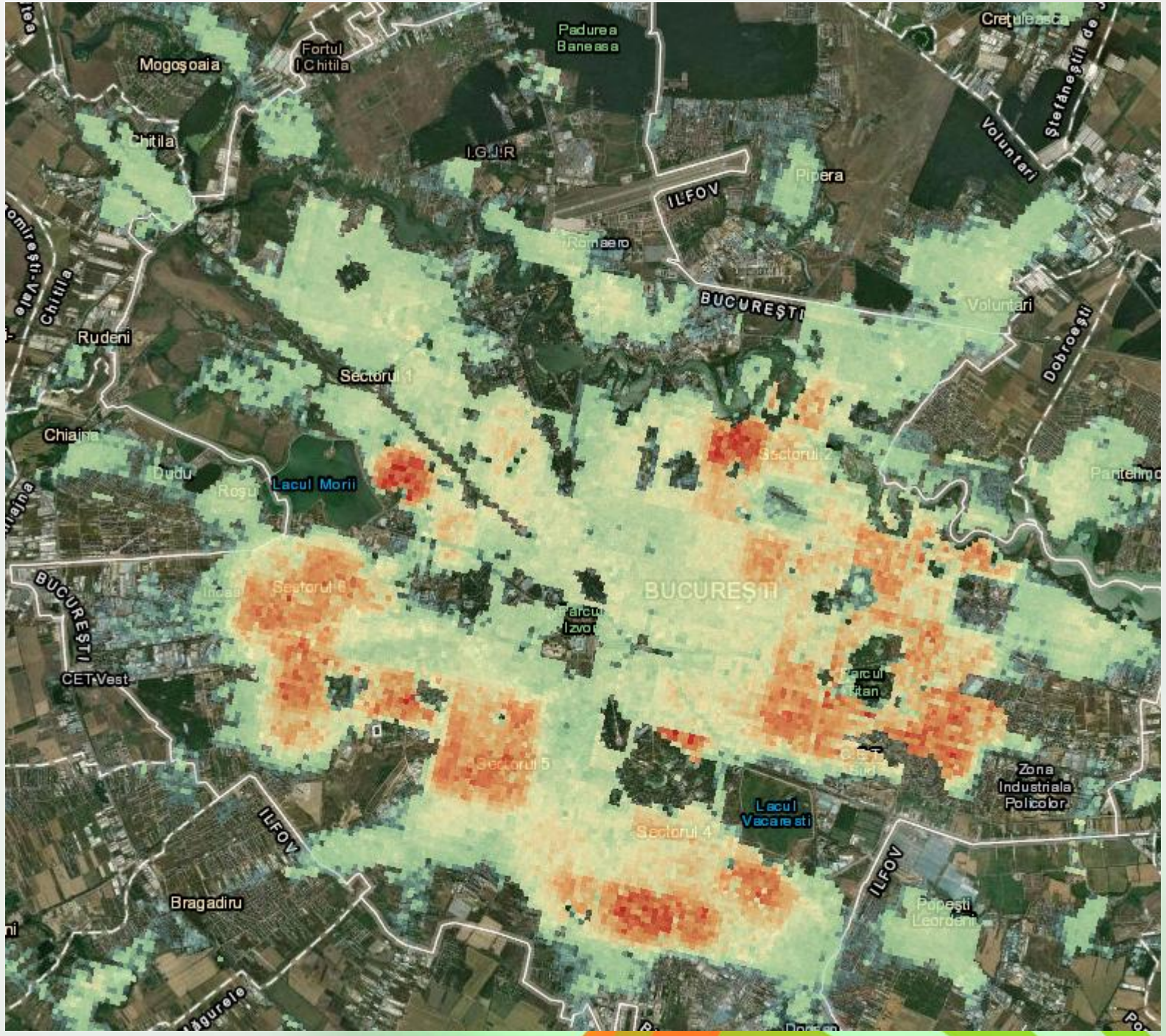
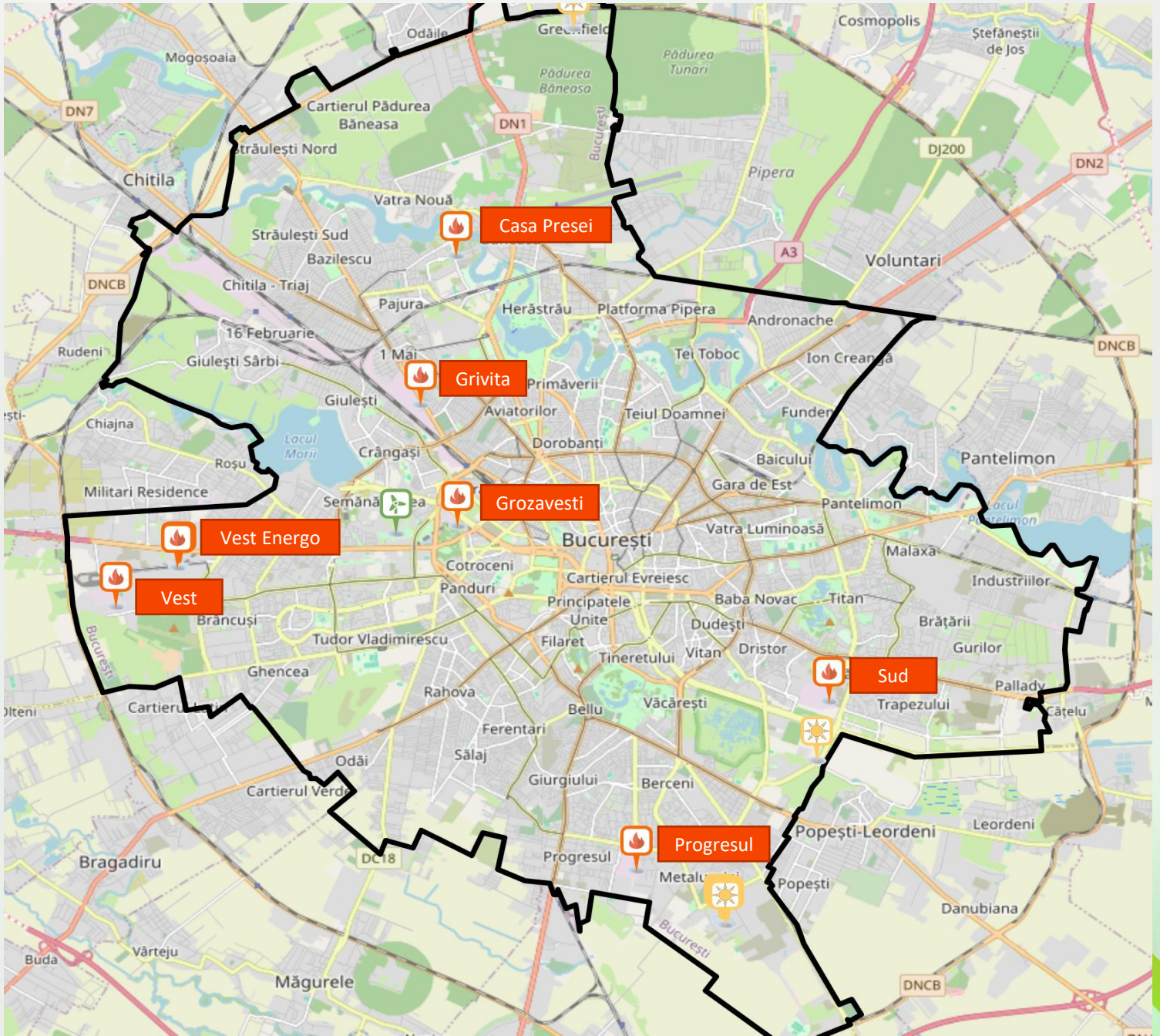
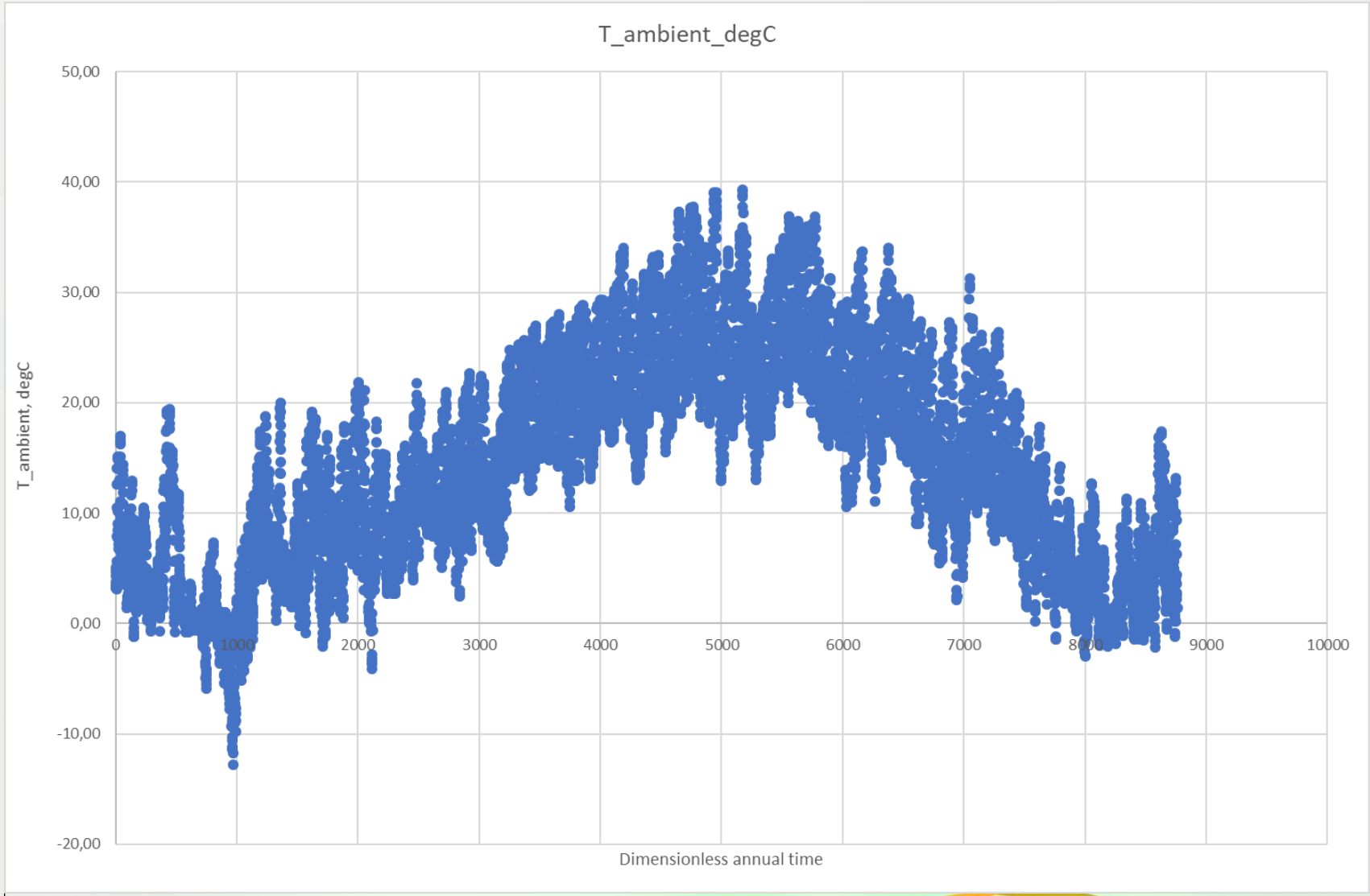


Bucharest DH system



Ambient temperature (2023)

7



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Estimated hourly heat input to the DH network

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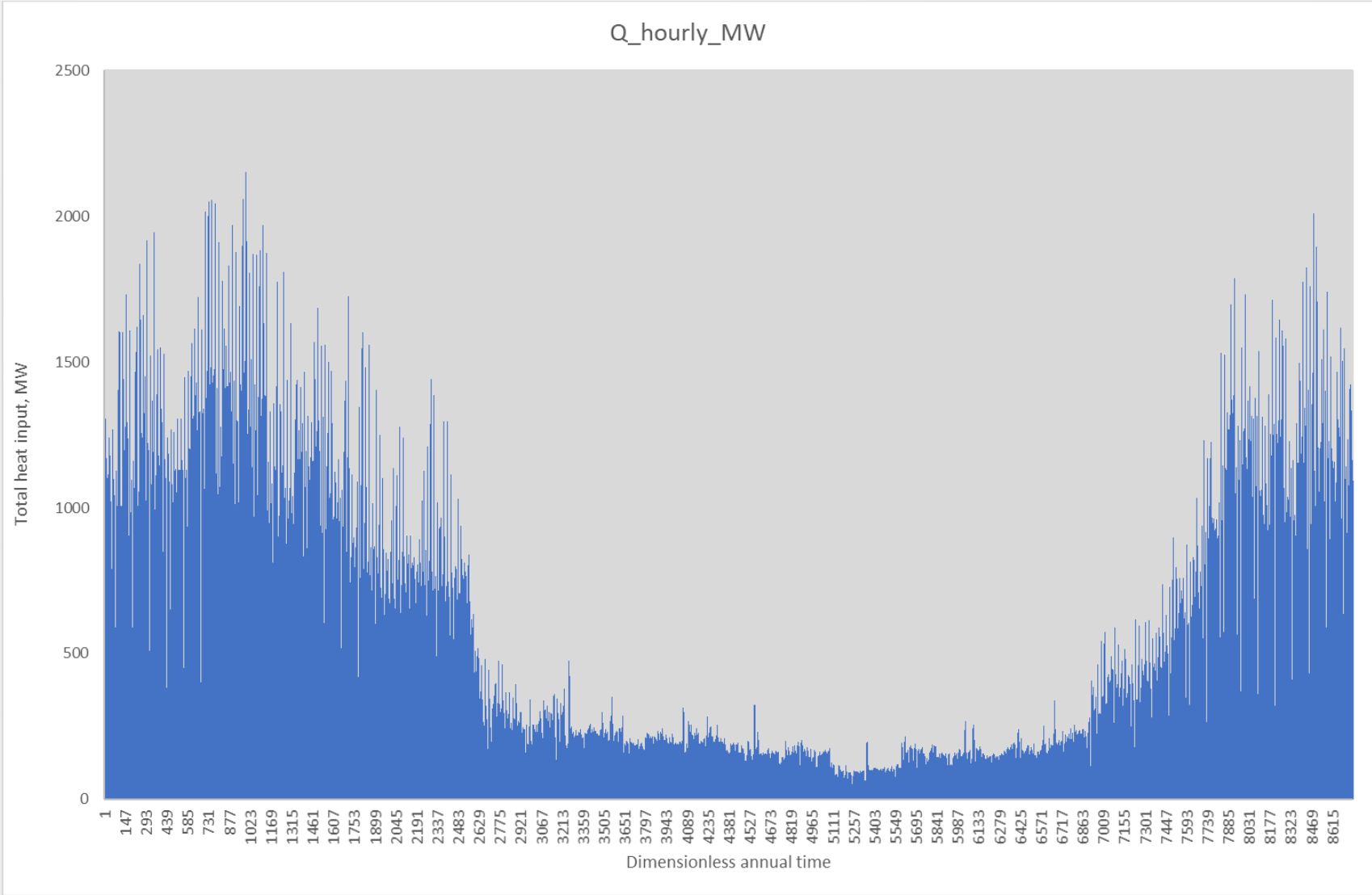

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The energy transition and decarbonisation challenge

Heat source:	RES	Wate heat	Highly efficient CHP	CHP	Coal boilers	Gas boilers
until 31st DEC 2027						
Option 1	50%			50%		
Option 2		50%		50%		
Option 3	any		75%		<25%	
from 1st JAN 2028 until 31st DEC 2034						
Option 1	50%			50%		
Option 2		50%		50%		
Option 3	50%			50%		
Option 4			80%	20%		
Option 5	5%	45%		50%		
from 1st JAN 2035 until 31st DEC 2039						
Option 1	50%			50%		
Option 2		50%		50%		
Option 3	50%			50%		
Option 4	35%	45%		20%		
Option 5	35%		45%	20%		
from 1st JAN 2040 until 31st DEC 2044						
Option 1	75%			25%		
Option 2		75%		25%		
Option 3	75%			25%		
Option 4	35%	55%		5%		
from 1st JAN 2045 until 31st DEC 2049						
Option 1	75%			25%		
Option 2		75%		25%		
Option 3	75%			25%		
from 1st JAN 2050						
Option 1	100%			0%		
Option 2		100%		0%		
Option 3	100%			0%		

Stage 1

Stage 2

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The task

- Share of heat from RES and waste heat must meet the EED requirements

$$u_{RES} = \frac{\sum_t \sum_i Q_{i(\mathrm{RES}),t}}{\sum_t \sum_i Q_{i,t}} = 0.05\ (0.35)$$

This is the highest share of RES explicitly defined

$$u_{RES+waste} = \frac{\sum_t \sum_i Q_{i(\mathrm{RES,waste}),t}}{\sum_t \sum_i Q_{i,t}} = 0.50$$

Or other option depending on the share of cogeneration

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The task

- Costs of heat supply to the end users must be at the minimum

$$C_q = \sum_i C_{q\,i,fixed} +$$

$$\sum_t \sum_i \left(C_{q,i,purchase} + C_{f,i} + C_{el,i} + C_{om,i} + C_{env,i} + C_{ETS,i} + C_{\text{pumping},i} - S_{el,chp,i} \right)_t$$

t – time step
i – system component (heating device, pump, storage, etc.)

- Production and purchase must meet demand and losses

$$\sum_i \dot{Q}_{i,t} = \dot{Q}_{d,t} \pm \dot{Q}_{storage,t} + \dot{Q}_{loss,t}$$

- Each unit is run within its allowable load range

$$\dot{Q}_{i,min} \leq \dot{Q}_{i,t} \leq \dot{Q}_{i,max}$$

- Share of heat from RES and waste heat must meet the EED requirements

$$\sum_i \dot{Q}_{i,t} = \dot{Q}_{d,t} \pm \dot{Q}_{storage,t} + \dot{Q}_{loss,t}$$

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Identified local energy resources

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Total estimated potenetial for new installed capacity: 274 MW

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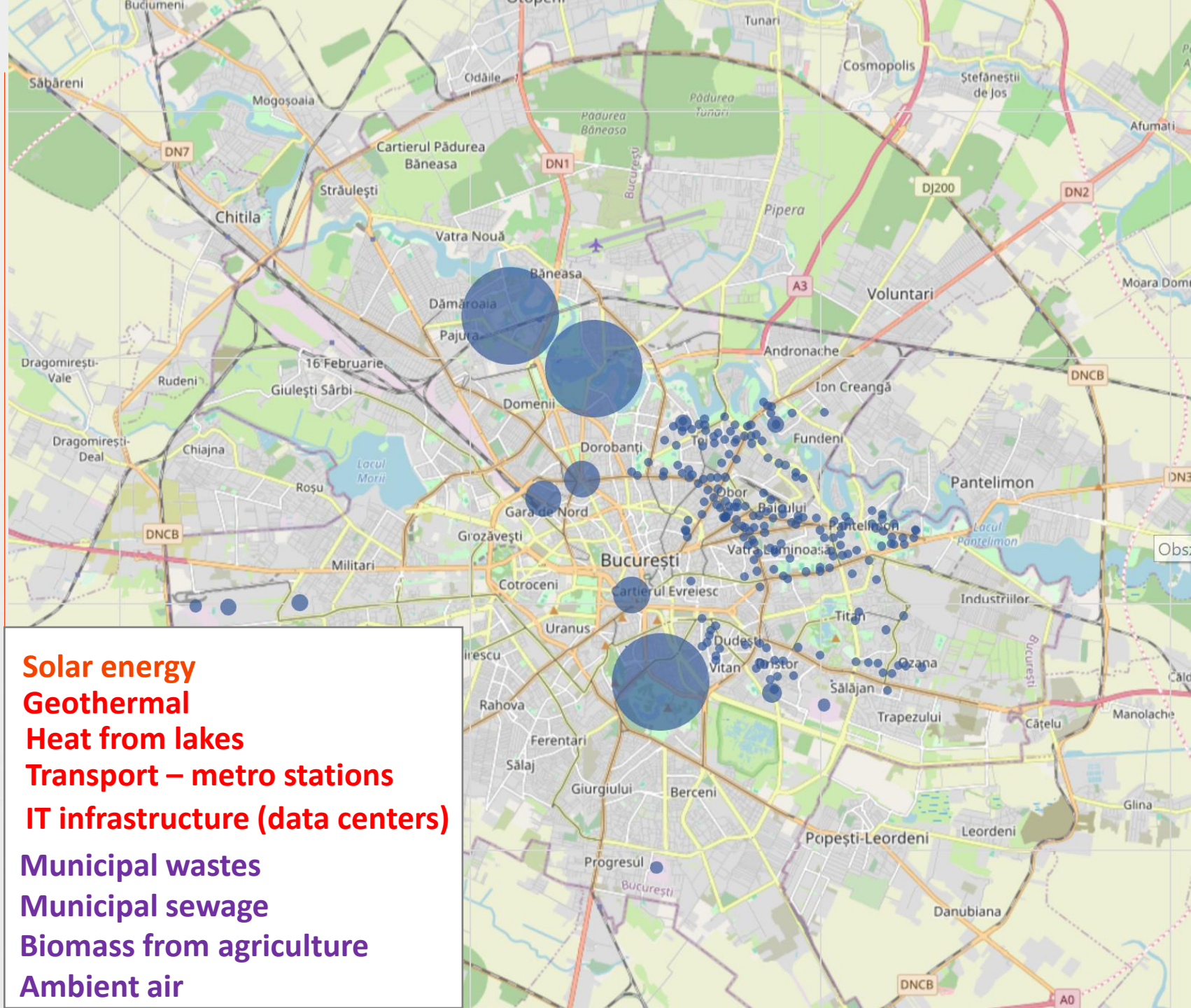

Critical hurdles identified

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— Enormous scale of the required change.

— Relatively short timeline.

— Unfavourable state of play, including technological and infrastructural constraints.

— Required urgent revitalisation of worn out production and network assets.

— Dense urban environment, earthquake risk.

— Limited alternative heat sources.

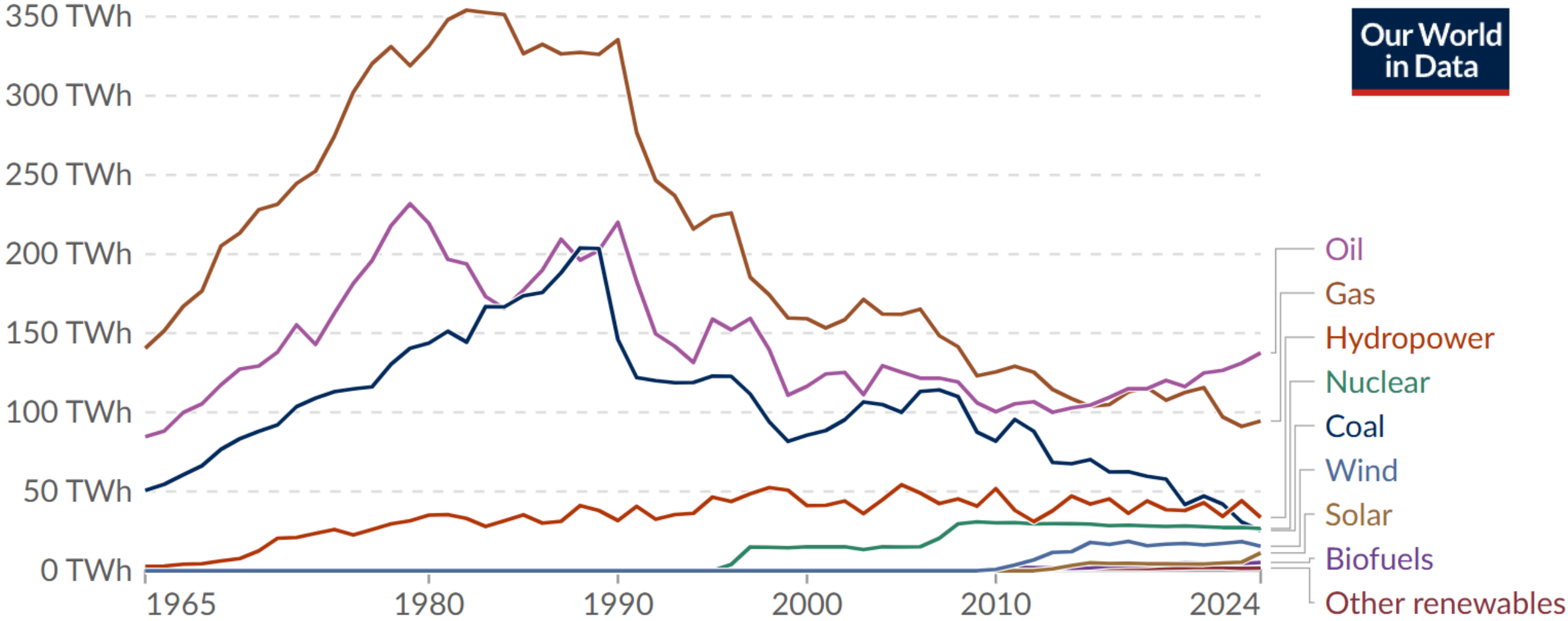
— Retrofit priorities: 1) reliability and security of heat supply, 2) heat affordability, 3) heat greening.

— Socio-cultural factors, subsidised heat for residential consumers.

— Limited capital resources.

— Early stage of overall energy transition in Romania.

Romania Energy Transition Trends



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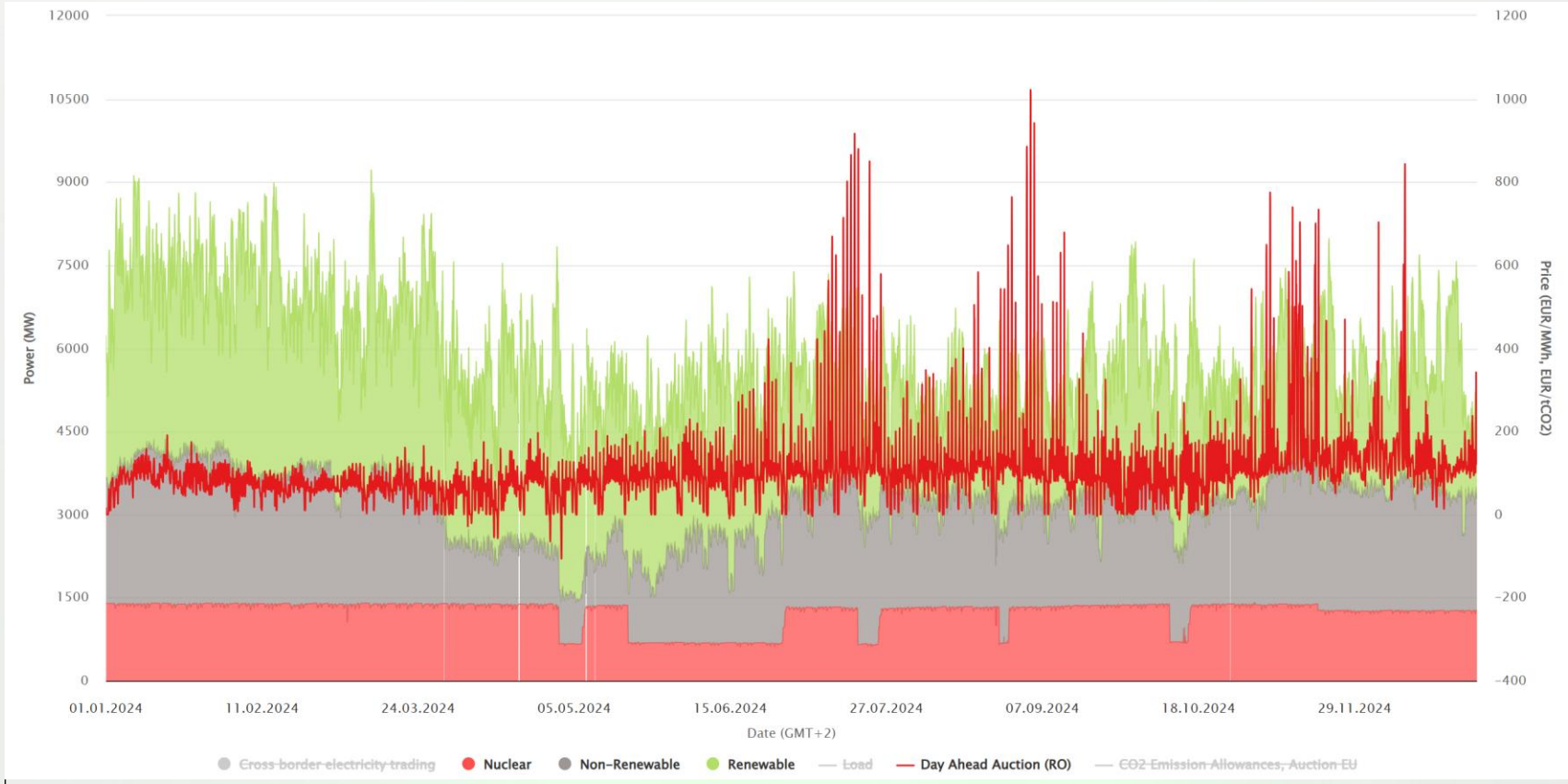
Source: https://ourworldindata.org

Electricity prices 2024

15



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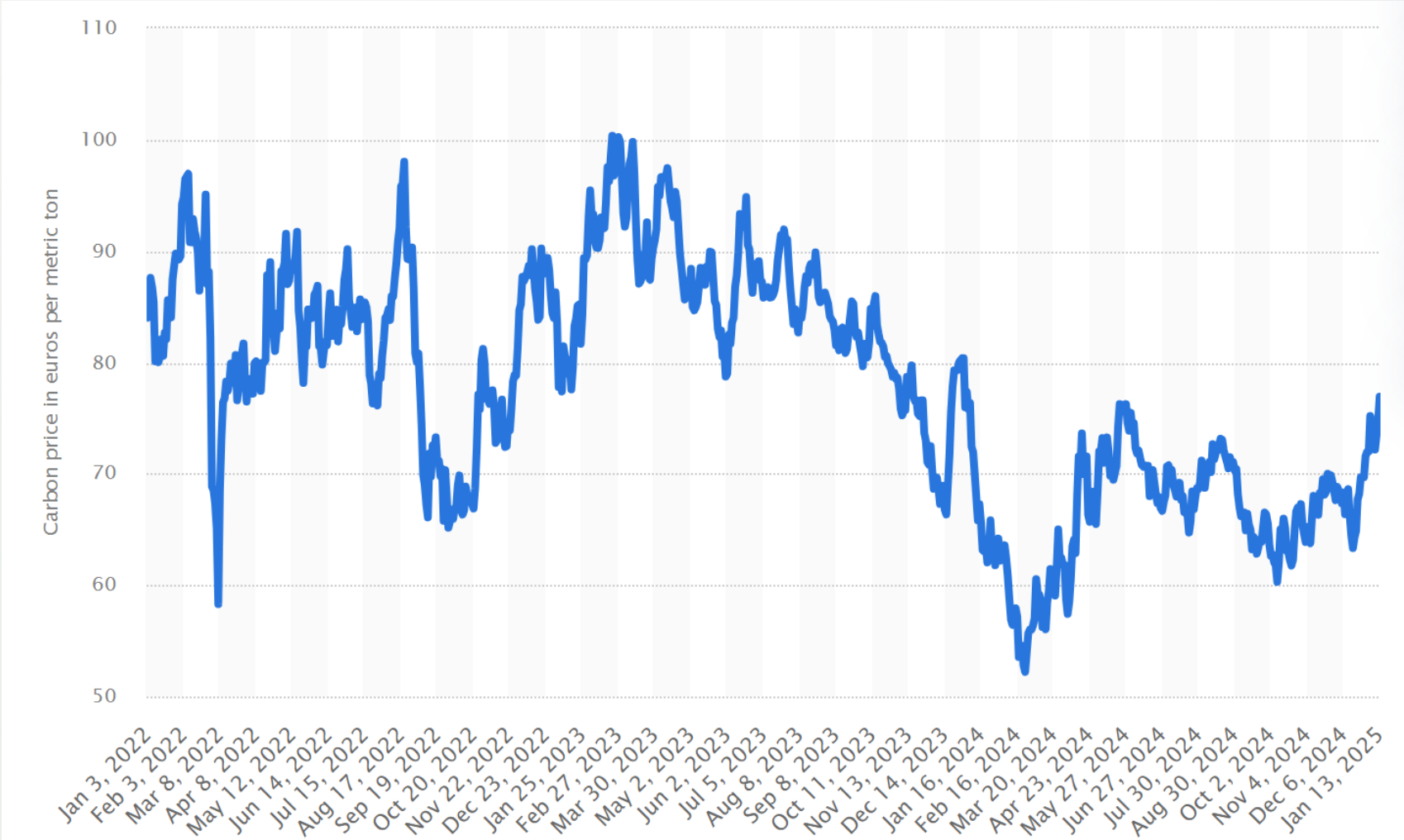
EUA prices 2022-2025



Dependence on the overall performance of the EU economy is noticeable

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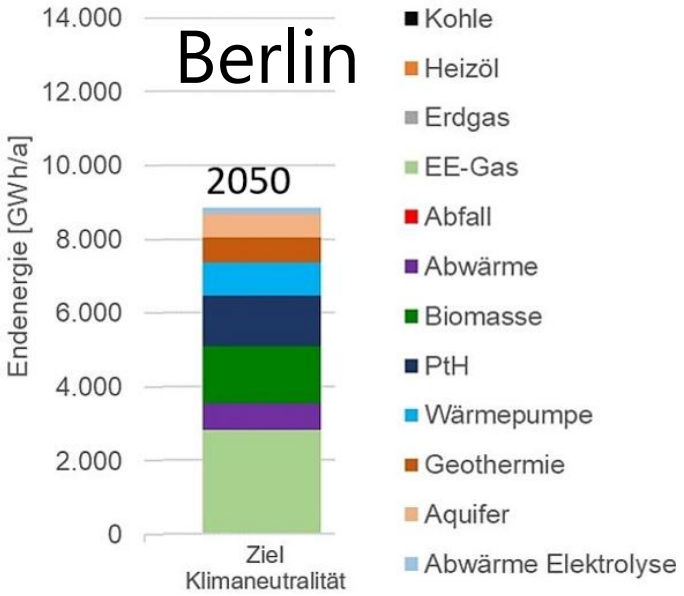
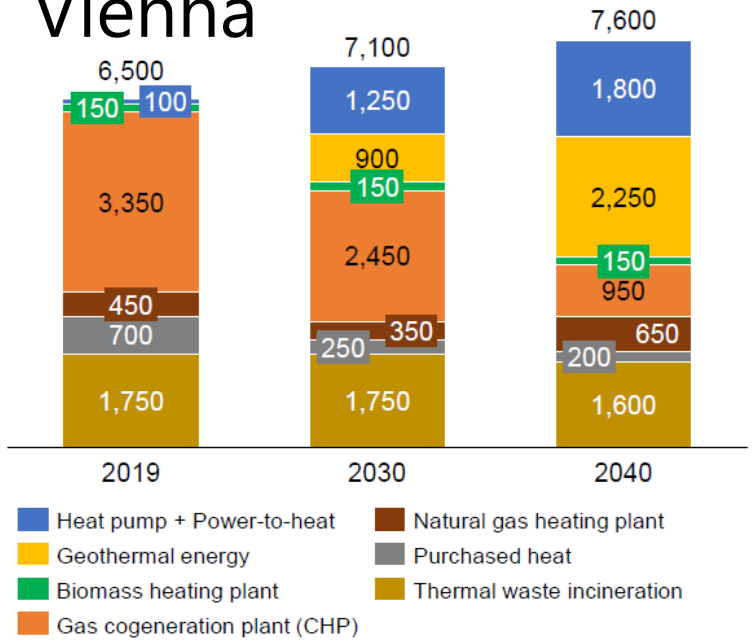
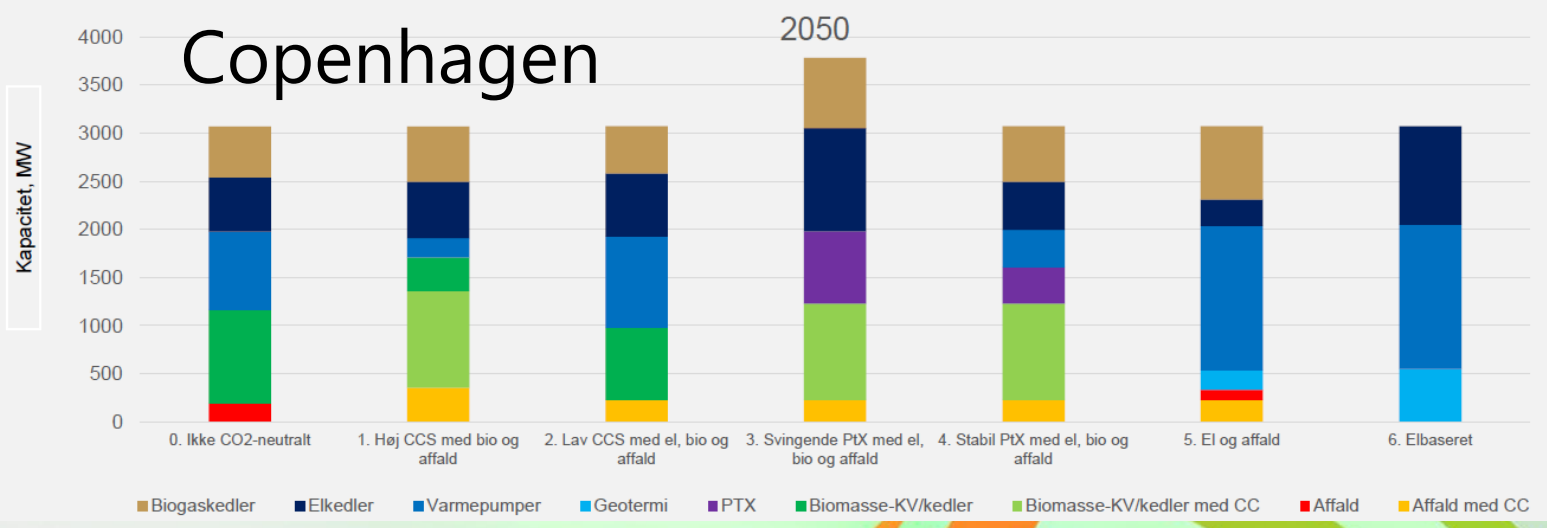
How others do this







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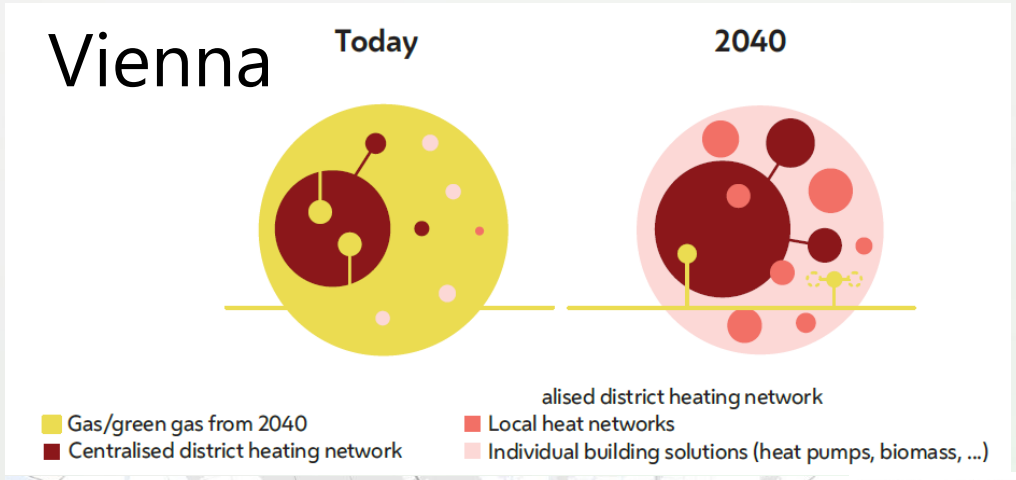
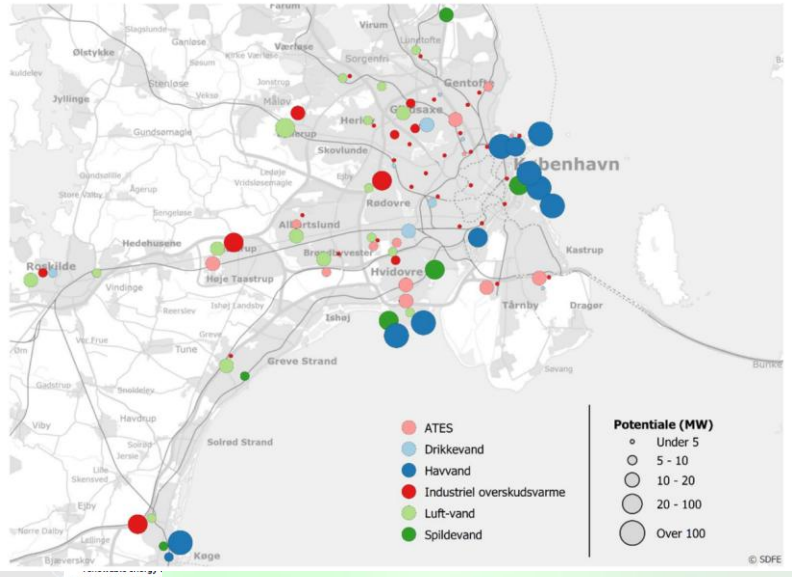
How others do this

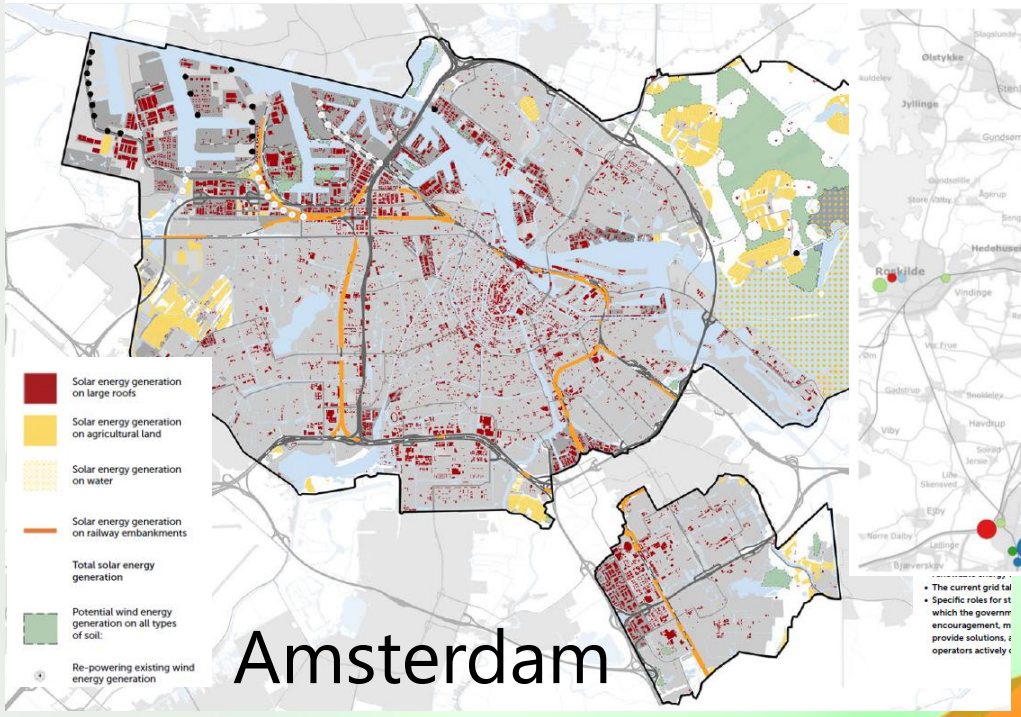
Vienna



Copenhagen



Amsterdam



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How others do this

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- Decomposition
- Reconfiguration
- Distributed heat sources
- Zero-emission sources
- Multiple sources
- Intermittent sources
- Heat storage
- Adjustment of heat sinks
- Territorial expansion
- Digitisation
- Low forward temperature (<90ºC)
- Sector integration
- Decarbonised fuels
- Improved energy efficiency in sinks
- Active consumers
- Electrification
- Large-scale investments in municipal infrastructure
- Optimisation
- Multidimensionality
- New and integrated businesses – value stacking

System energy modelling

Scenario 1

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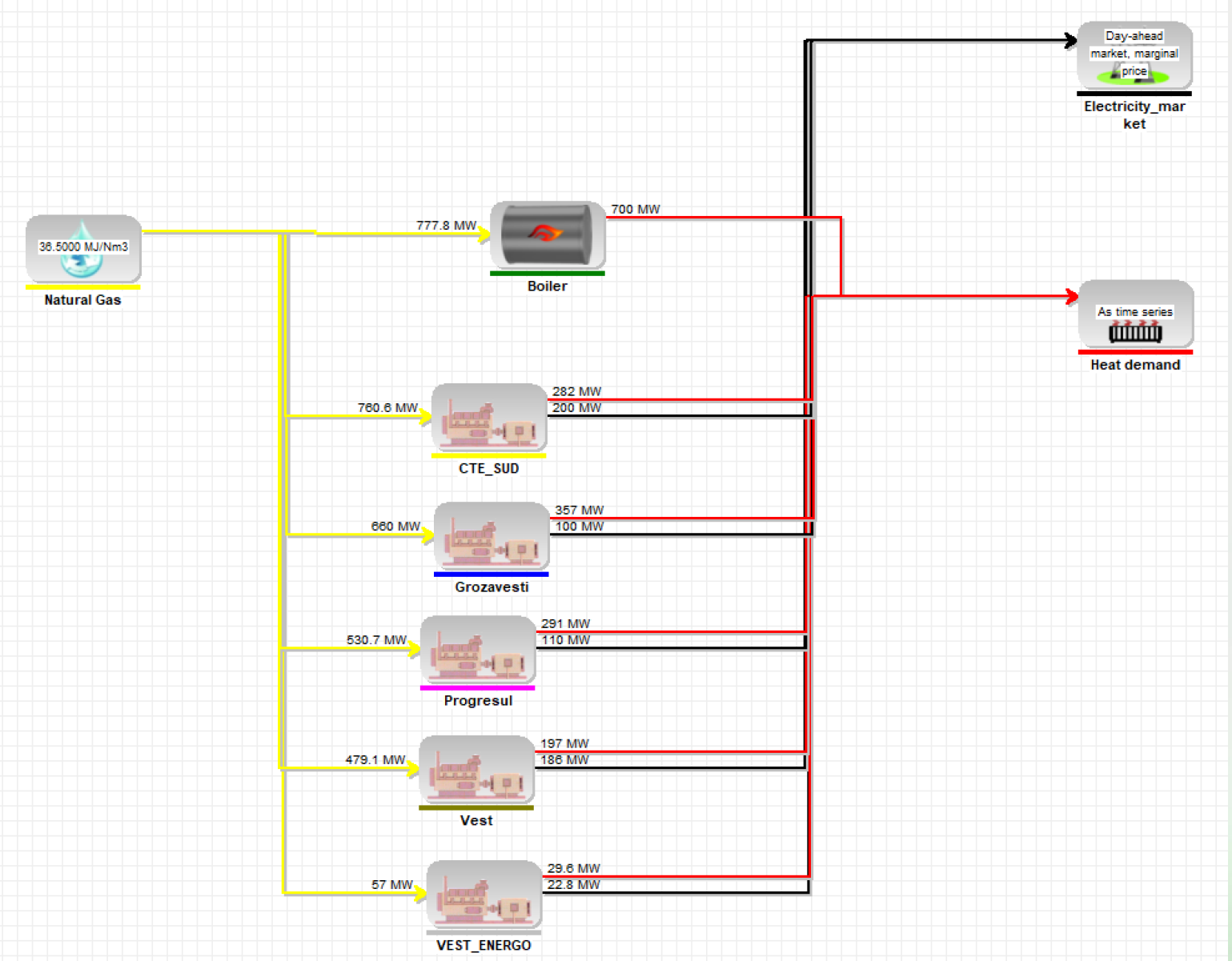
Phase 1: To meet 5% RES share in 2028

- Renovation of networks
- Thermorenovation of building stock
- Renovation of CHP plants (3 new CCGT blocks)
- Waste incineration plant (~135 MW energy input)
- Distributed solar plants (rooftops, free parcels; ~13,2 MW)

Phase 2: To meet 35% RES share in 2035

- Lake heat pump (30 MW)
- Geothermal plants (2 MW)
- Air Source Heat Pumps (10 MW)
- Biogas CHP (10 MW heating)
- Additional solar plants (33 MW)
- PTES (~1,000,000.0 m3)

Reference state



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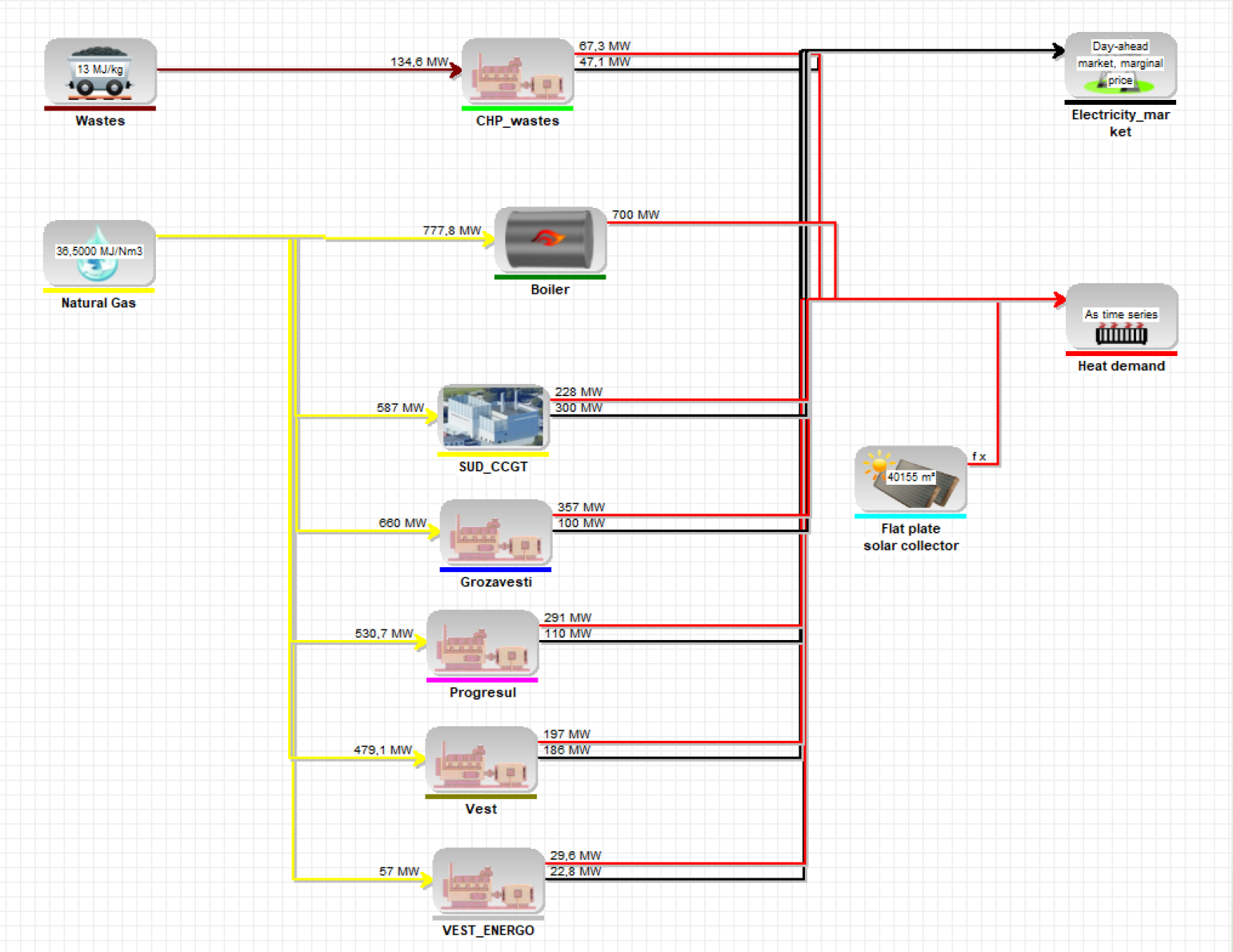
2028



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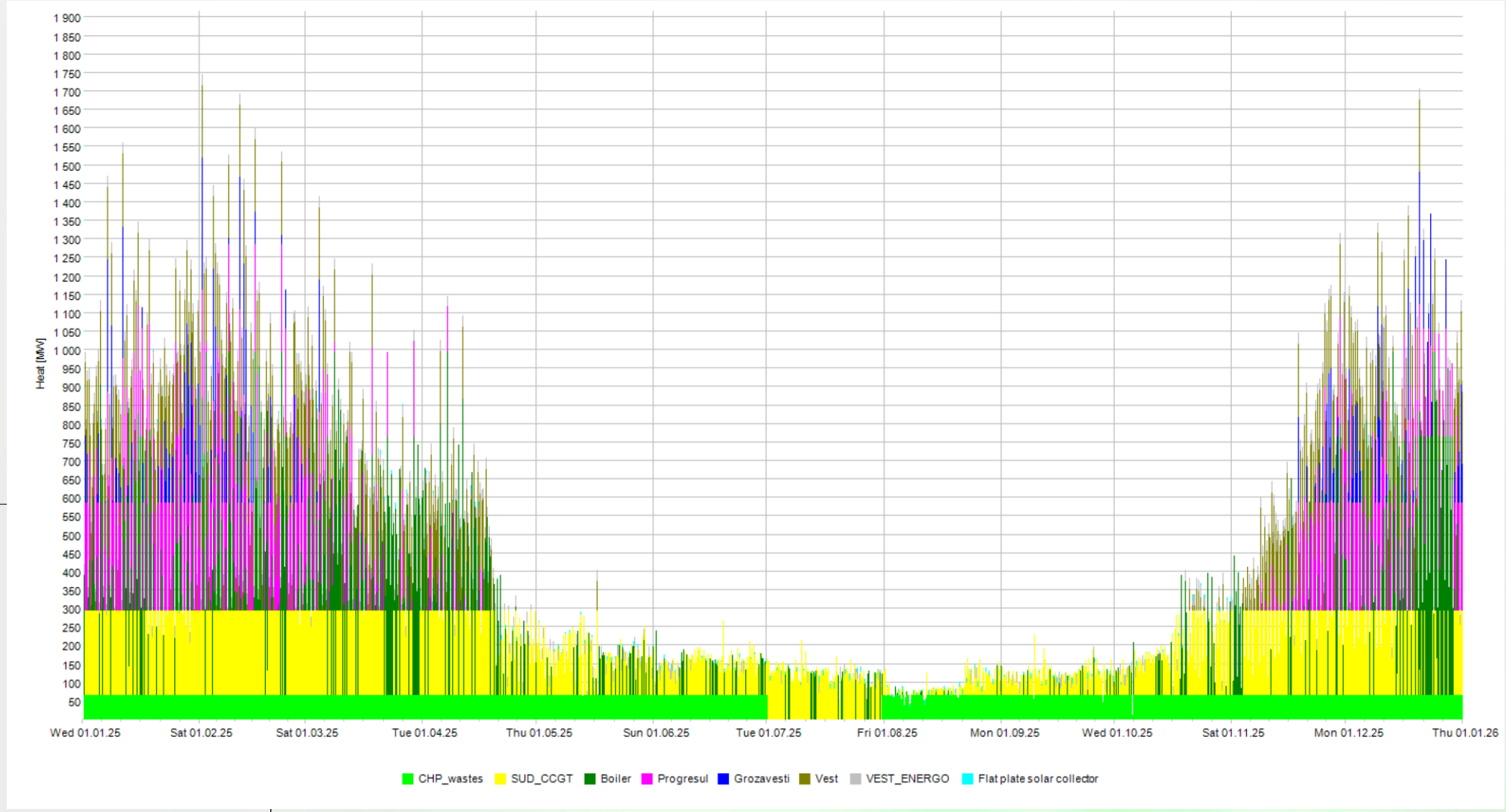
2028



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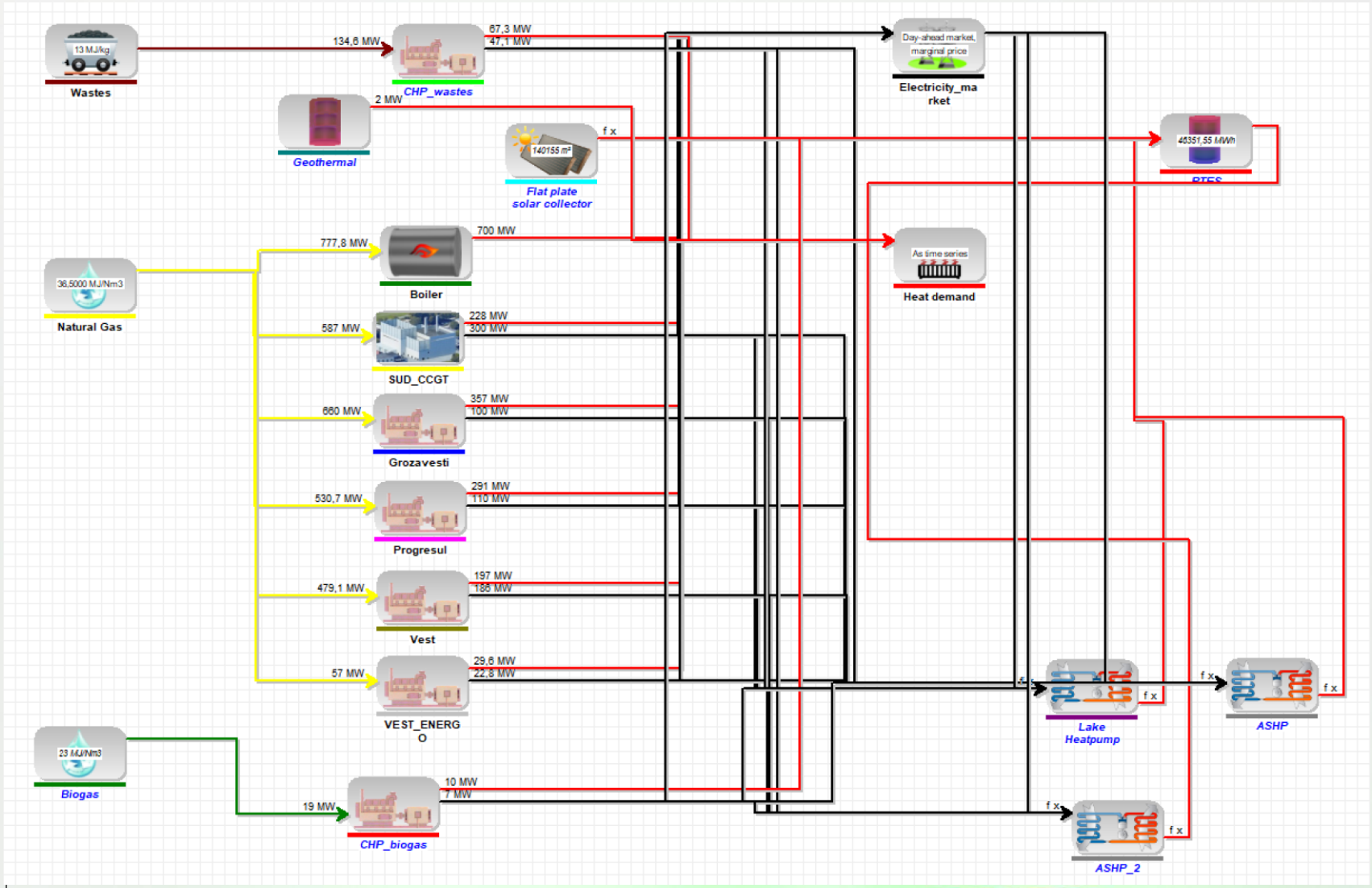
2035



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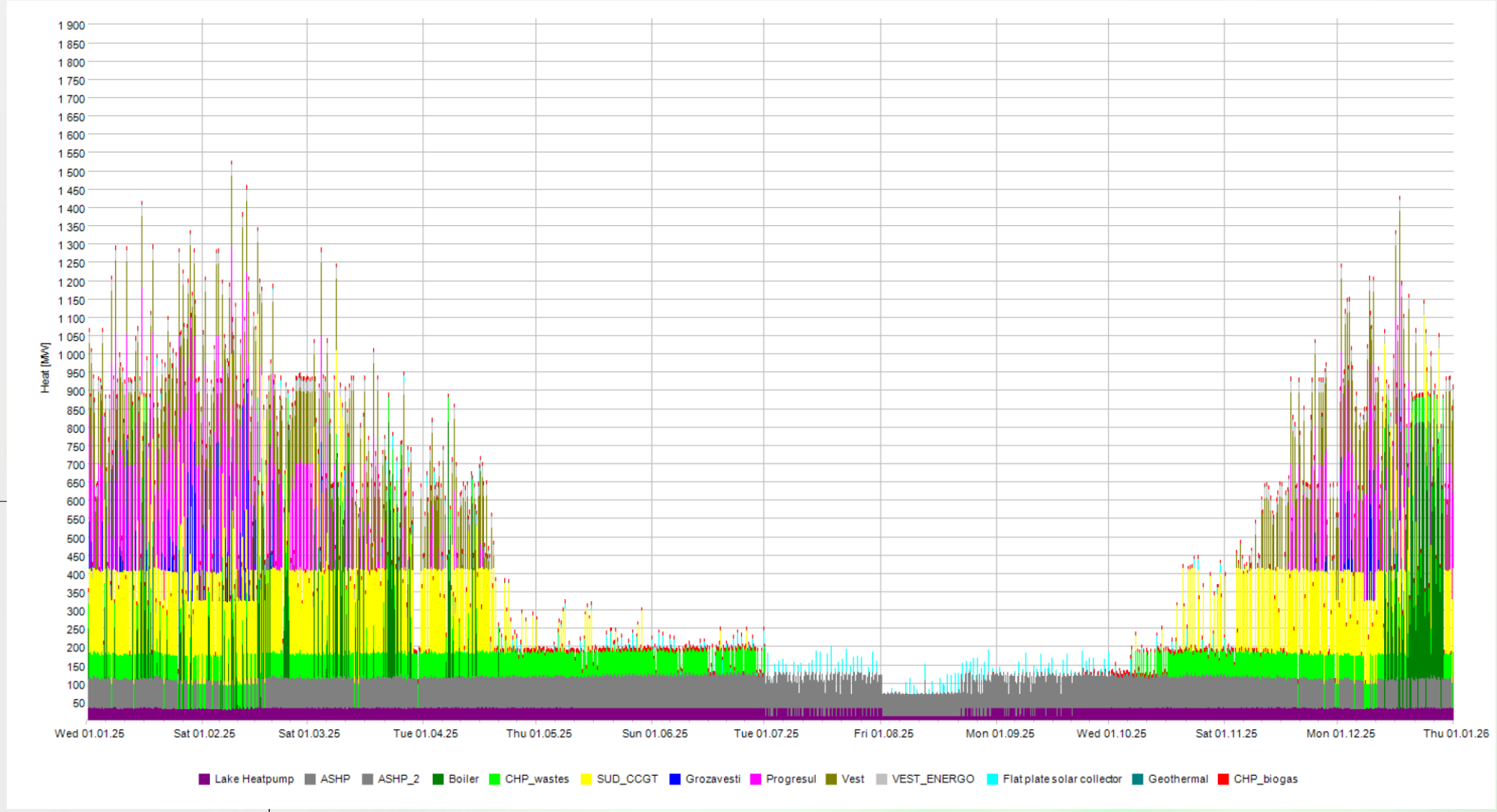
2035



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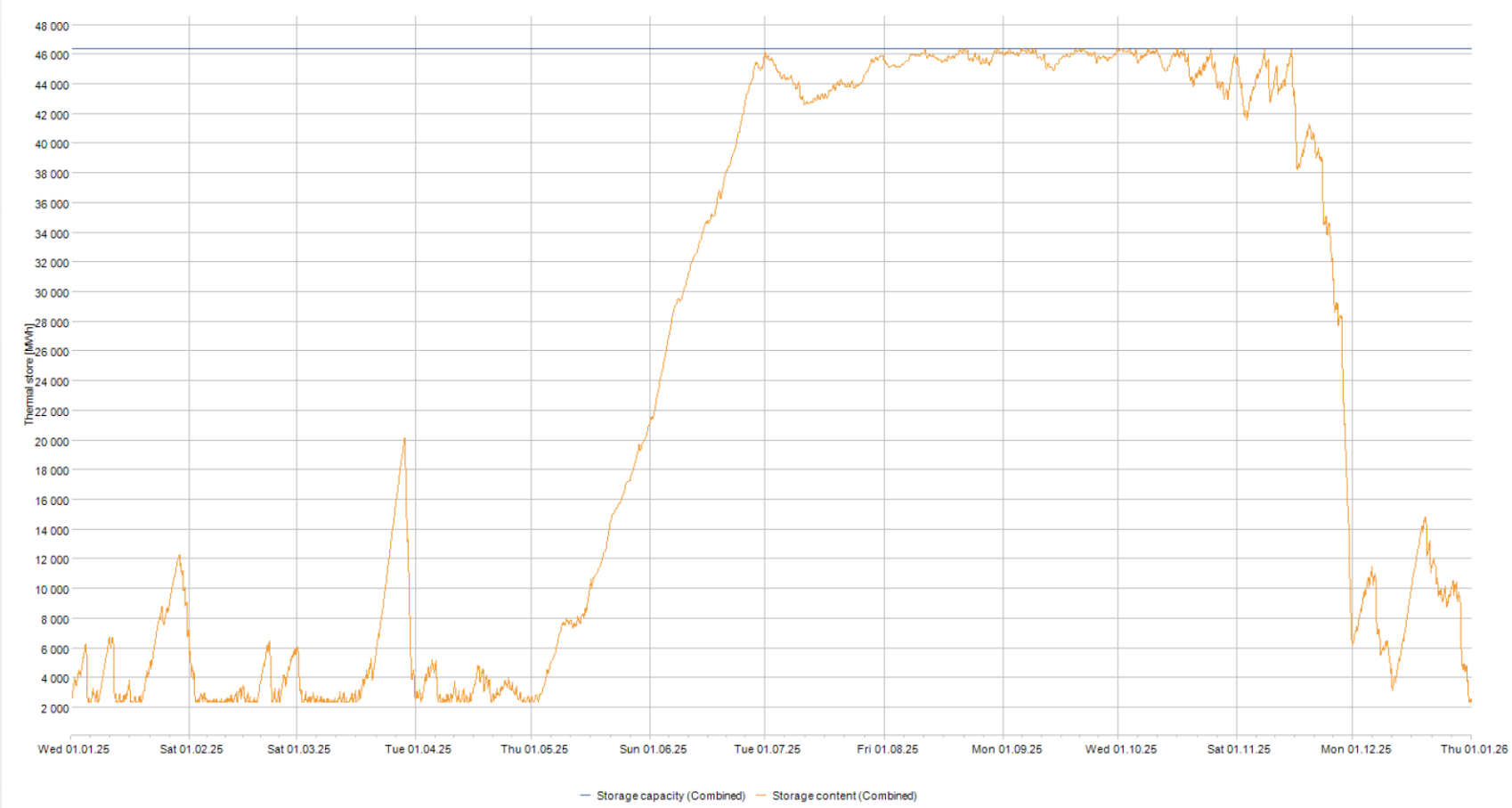
2035 Demand for sesonal storage

26



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Scenario 1 Variable heat costs change

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2028

—EUR -35 176 781.77

2035

—EUR -37 496 452.04

Scenario 1 CAPEX estimates, phase 1

2028 (unrealistic timing)

- Renovation of networks – first phase (500 km) : EUR 1,000 million
- 3 CCGT blocks: EUR 450 – 600 million
- Waste-to-Energy plant (~135 MW energy input): EUR 300 – 400 million
- Distributed solar plants (~13,2 MW): EUR 10 million

Total phase 1: EUR 1,760 to 2,010 million

+ thermoinsulation of buildings

Equipment only phase 1: EUR 760 to 1,010 million

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Scenario 1 CAPEX estimates, phase 2

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2035

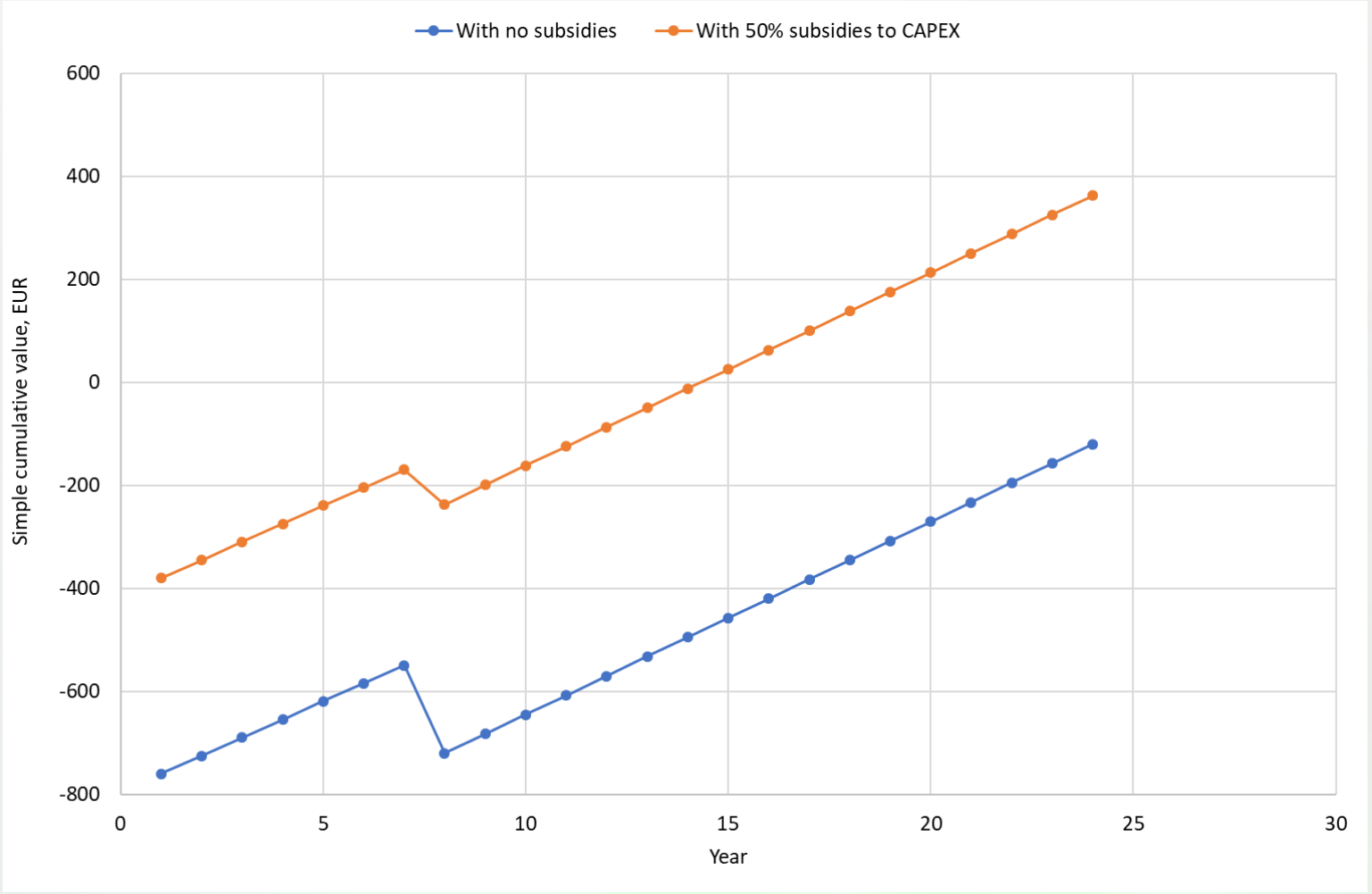
- Renovation of networks – second phase (1500 km) : EUR 3,000 million
- Lake heat pump (30 MW) – EUR 30 million
- Geothermal plants (2 MW) – EUR 25 million
- Air Source Heat Pumps (10 MW) – EUR 11 million
- Biogas CHP (10 MW heating) – EUR 40 million
- Additional solar plants (33 MW) – EUR 30 million
- PTES (~1,000,000.0 m3) – EUR 70 million

Total phase 2: EUR 3,206 million

+ thermoinsulation of buildings

Equipment only phase 1: EUR 206 million

Transition programme economic performance



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Scenario 2 (visionary)

- RES as in scenario 1 up to 35%
- Remaining 65% - waste heat (existing + new industry)

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New energy and chemical infrastructure (hubs)

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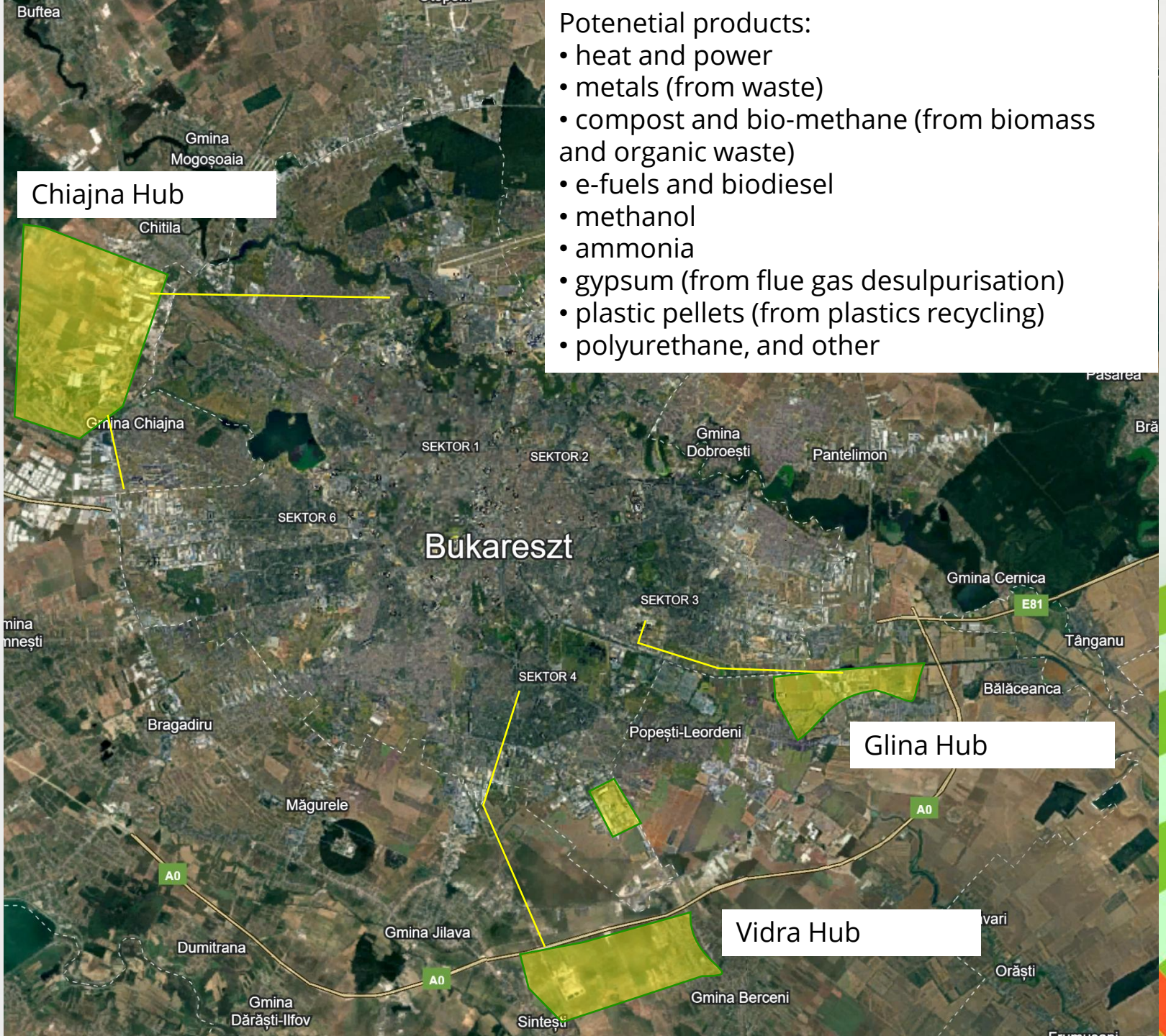
Potenetial products:
- heat and power
- metals (from waste)
- compost and bio-methane (from biomass and organic waste)
- e-fuels and biodiesel
- methanol
- ammonia
- gypsum (from flue gas desulpurisation)
- plastic pellets (from plastics recycling)
- polyurethane, and other



New energy and chemical infrastructure (hubs)

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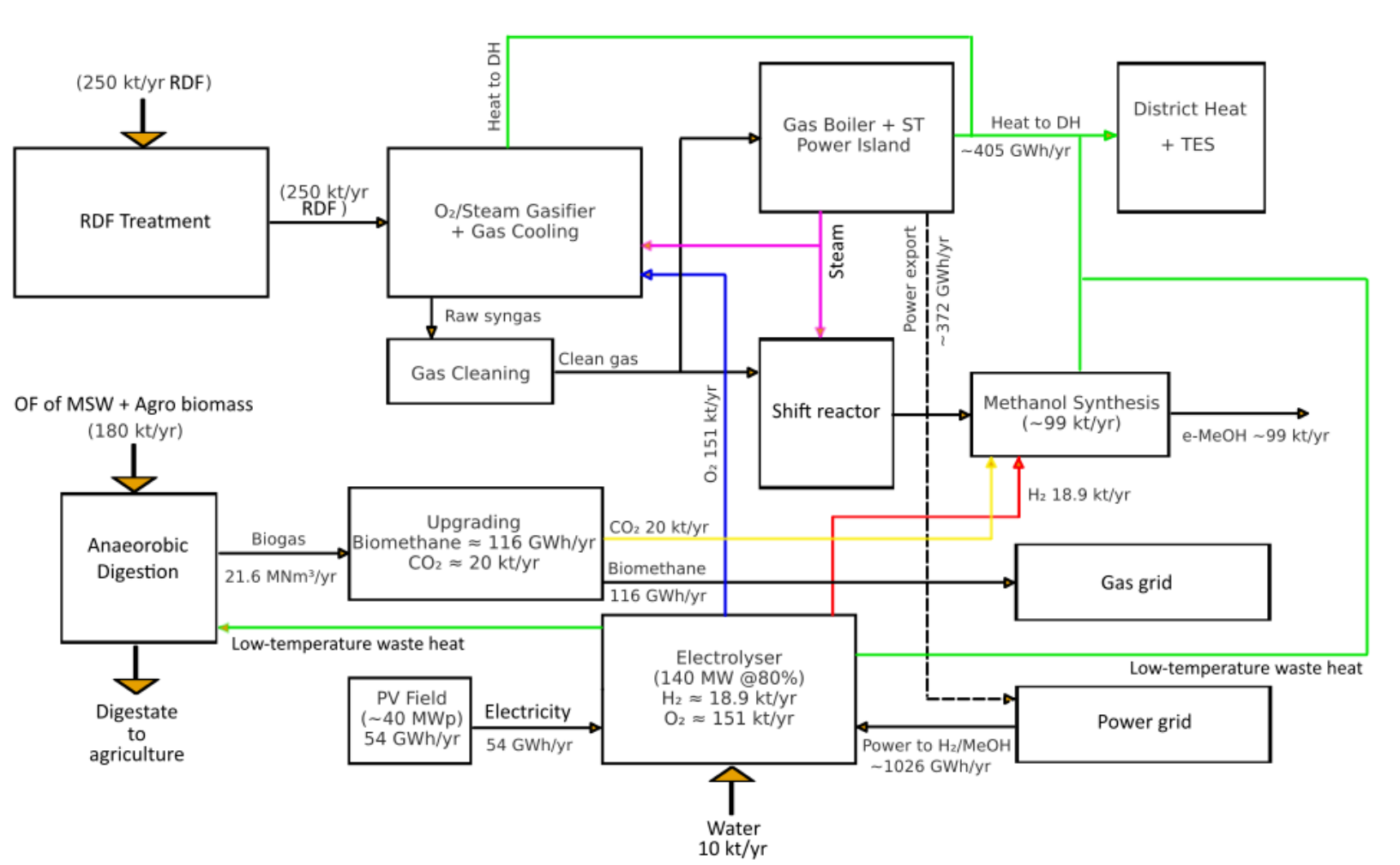
Glina Hub – indicative proces diagram



Indicative CAPEX: EUR 861–1,406 million

Conclusions

- The EED poses a serious challenge to large DH systems in terms of decarbonisation.
- Renewable and waste energy potential is limited considering spatial and infrastructural constraints.
- It is relatively easy to meet EED requirements in 2035 but further transition is very challenging.
- New energy ifrastructure must be established and signifficant investments must be brought to cities.
- Multidimensional, holistic strategic planning is a must.
- Energy harvesting is a common feature of transition plans.

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Conclusions

- Collaboration between DH system operator and external stakeholders must be significantly intensified and coordinated.



All hands on deck !

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Contact information

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