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INFLUENCE OF CENTRALIZED AND DISTRIBUTED THERMAL ENERGY STORAGE ON DISTRICT HEATING NETWORK DESIGN

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OVERVIEW – STORAGE CONFIGURATIONS

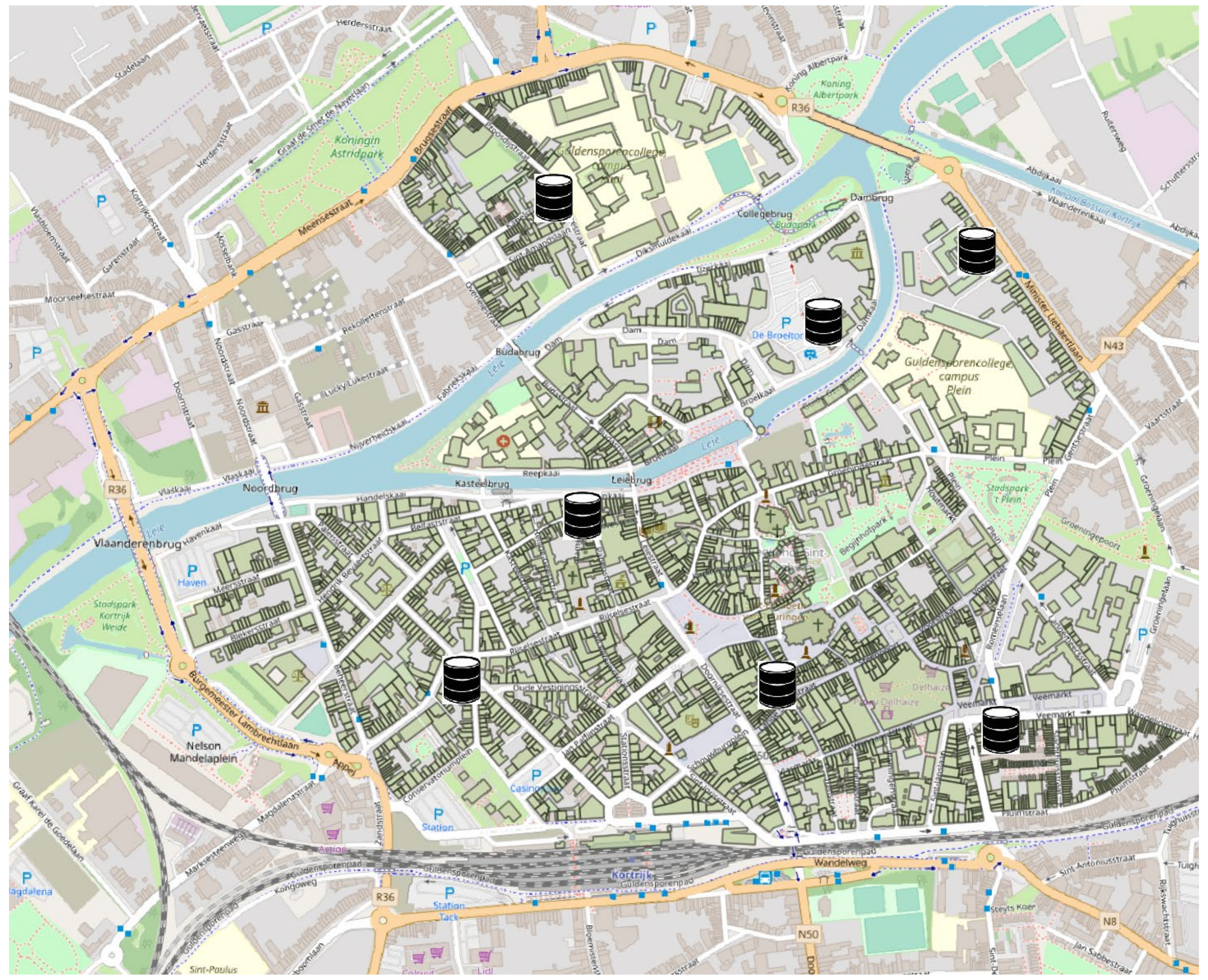
Centralized vs Distributed thermal energy storage

- Centralized storage
- Substation level storage
- Building level storage

- What is the impact on total network cost, consisting of:
  - Heat source cost
  - Storage cost
  - Network pipe systems cost

Can we find an optimum storage size?

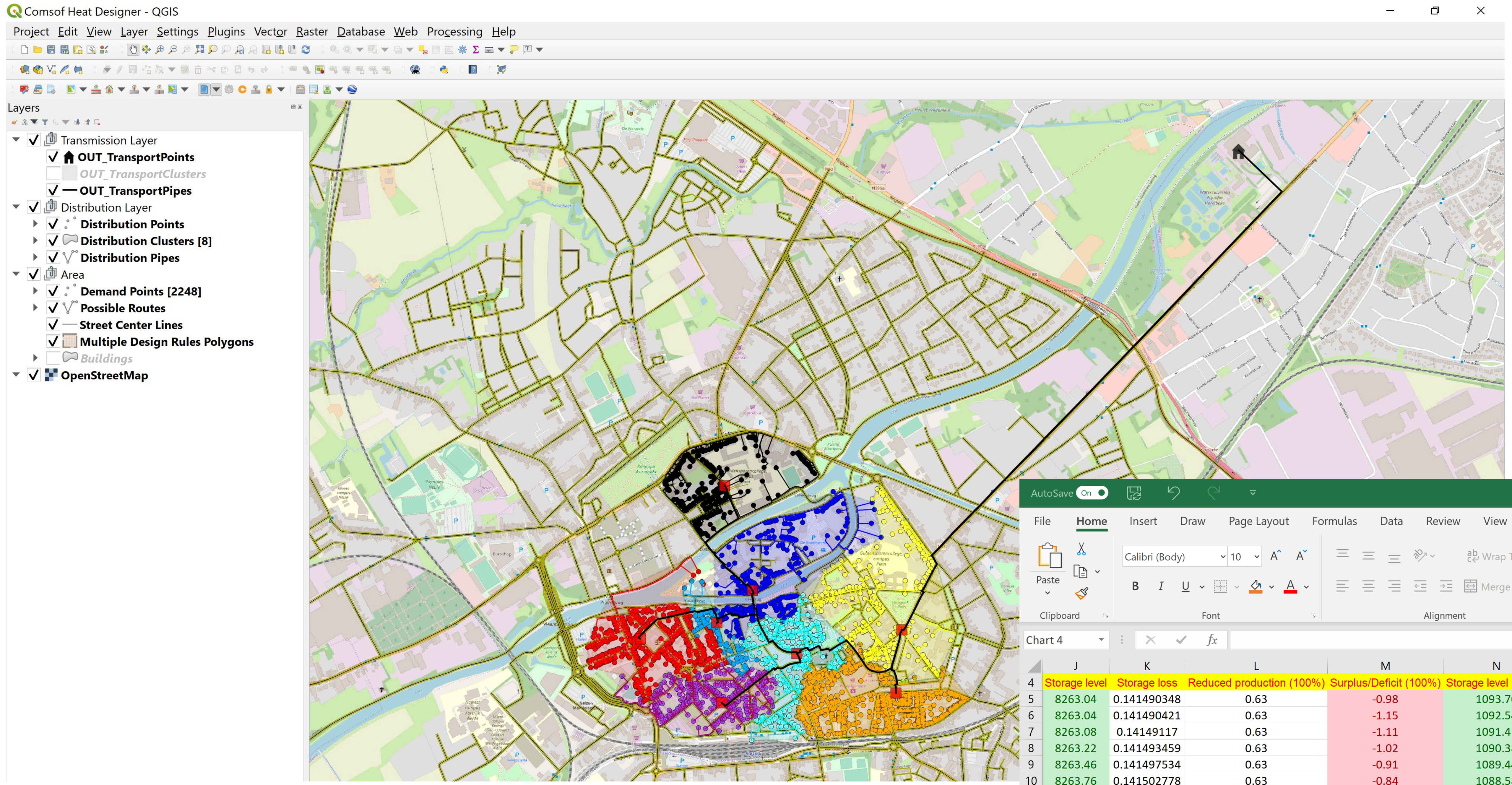
Centralized storage



Distributed storage

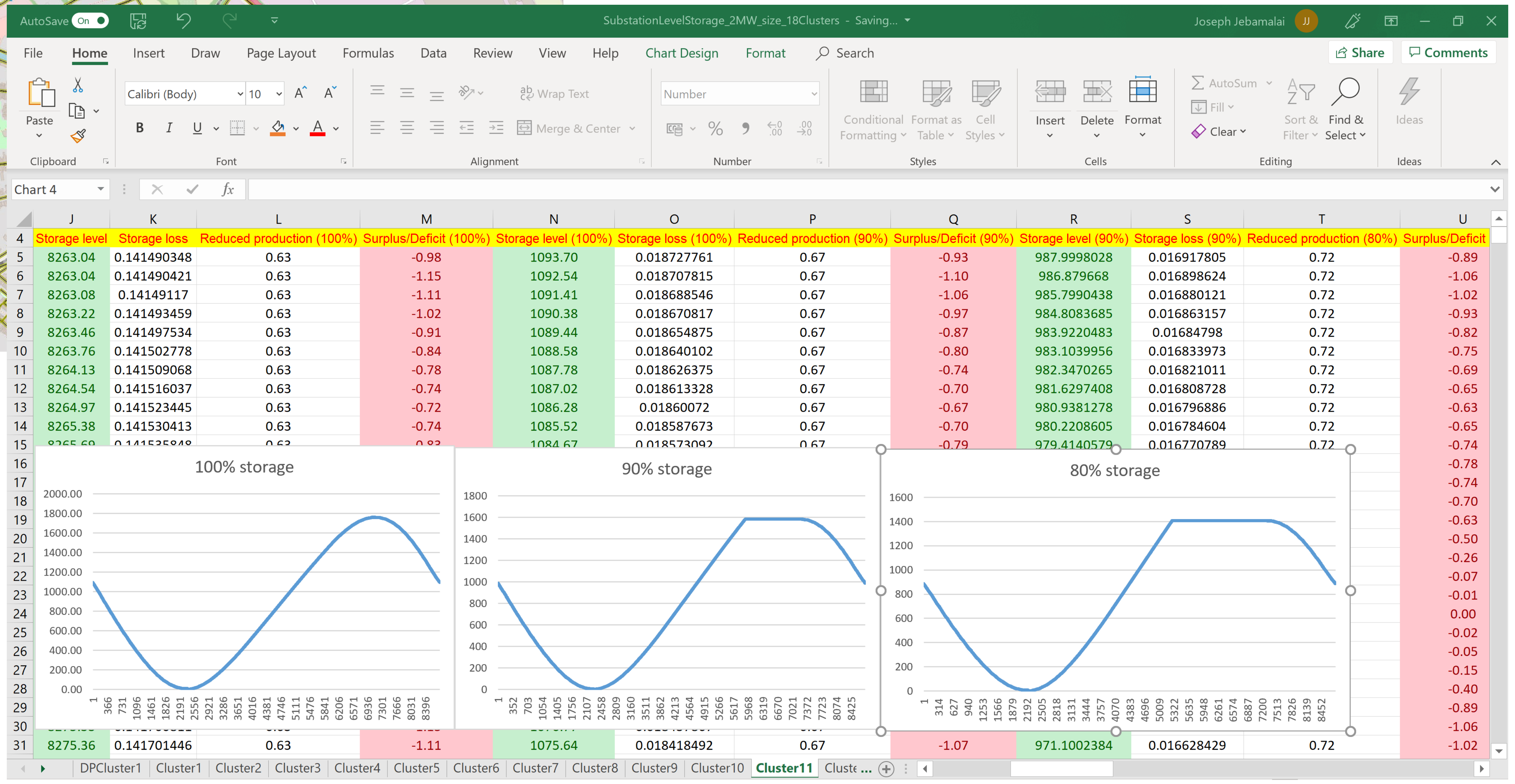
CASE STUDY – METHOD

Comsof heat and excel based storage calculations



Use of Comsof Heat for

- Automated network routing
- Pipe size dimensioning
- Deployment cost calculation (excl. storage costs)



- Use of Excel for
  - Storage tank dimensioning
  - Calculation of storage costs

CASE STUDY - INPUTS

Selected 2328 buildings and heat source – Kortrijk, Belgium

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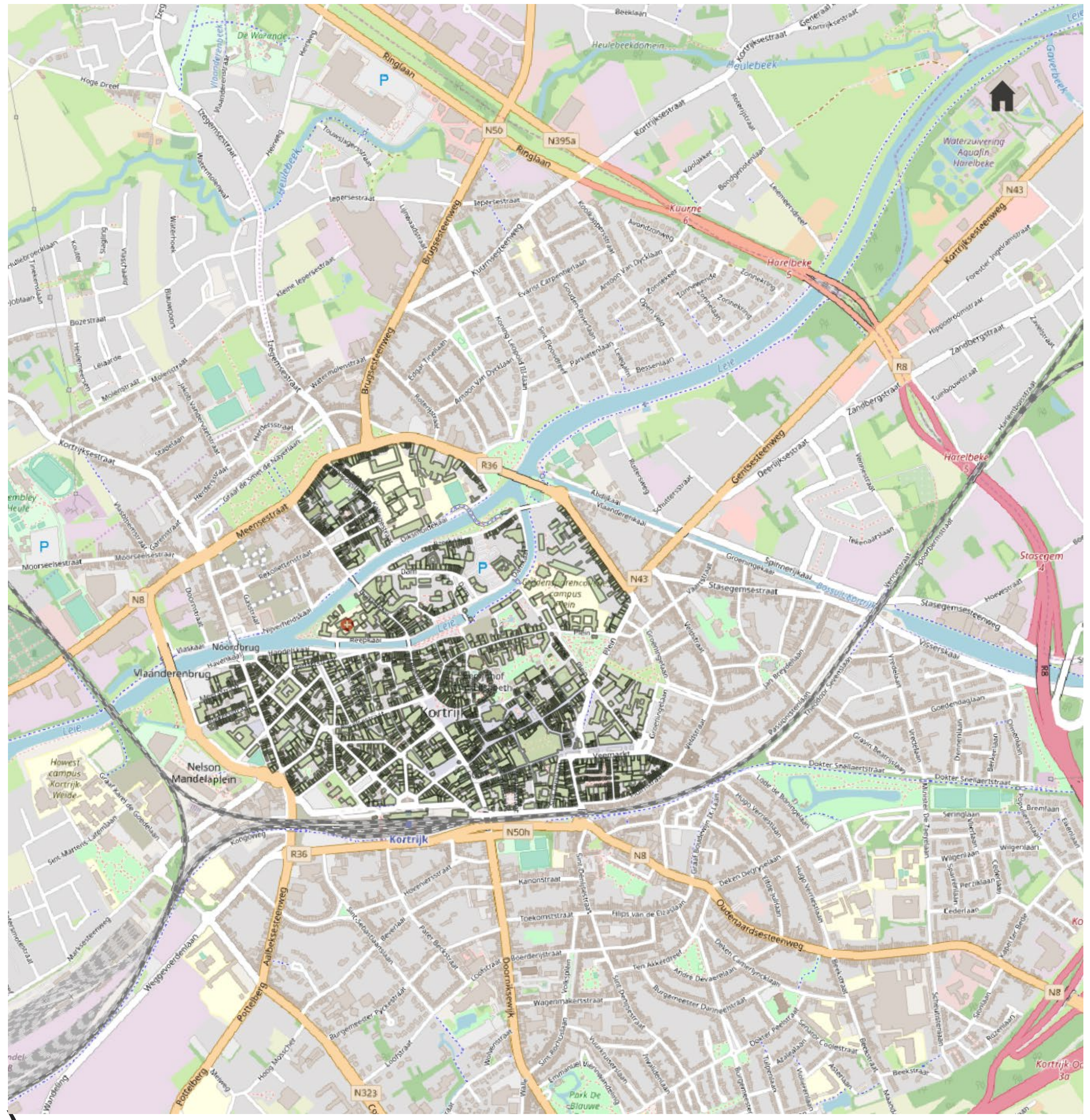
BUILDING:

- Street level gas consumption data
- Building types are categorized as:
  - Residential
  - Commercial
  - Industrial
- Synthetic load profiles

HEAT SOURCE:

- Heat source: IMOG, waste incineration plant
  - 2 km from the network
  - Available heat → 130 GWh / year
  - Source peak capacity → 15 MW (Continuous operation)



Case study area

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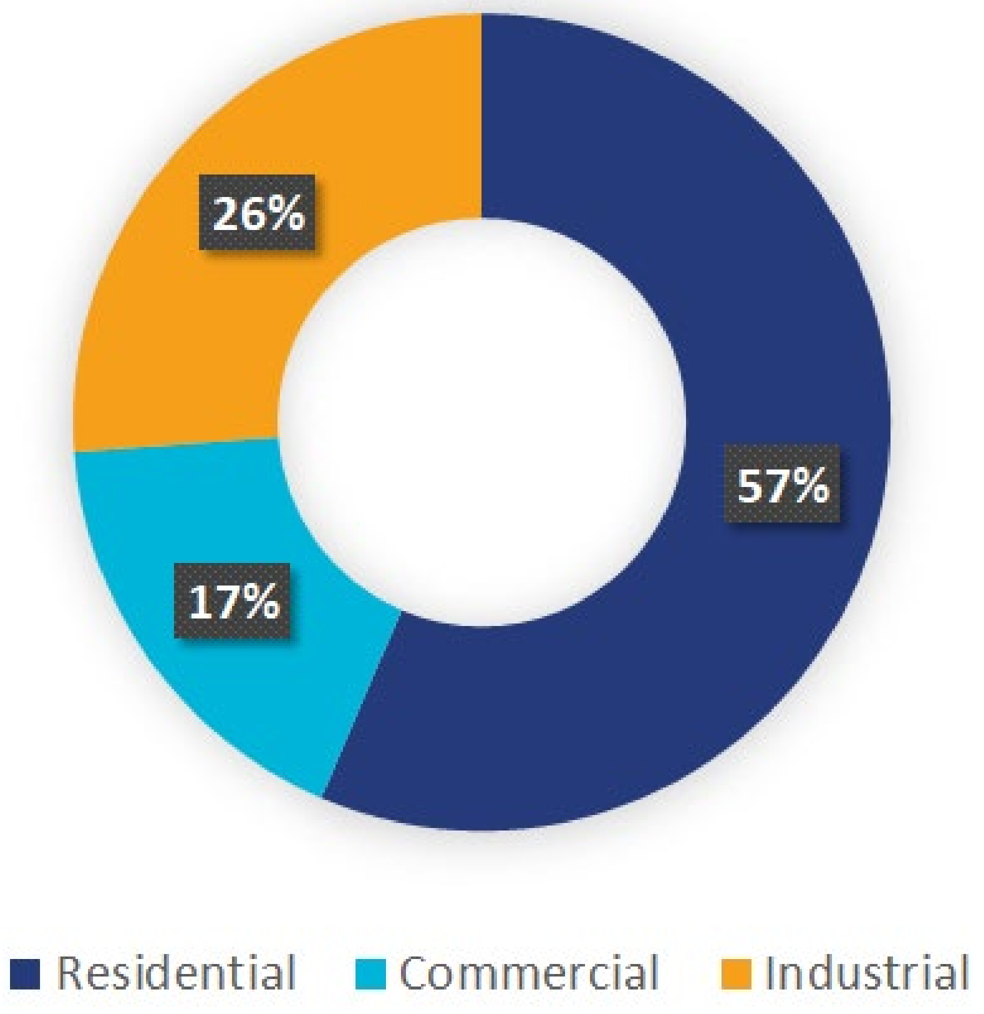
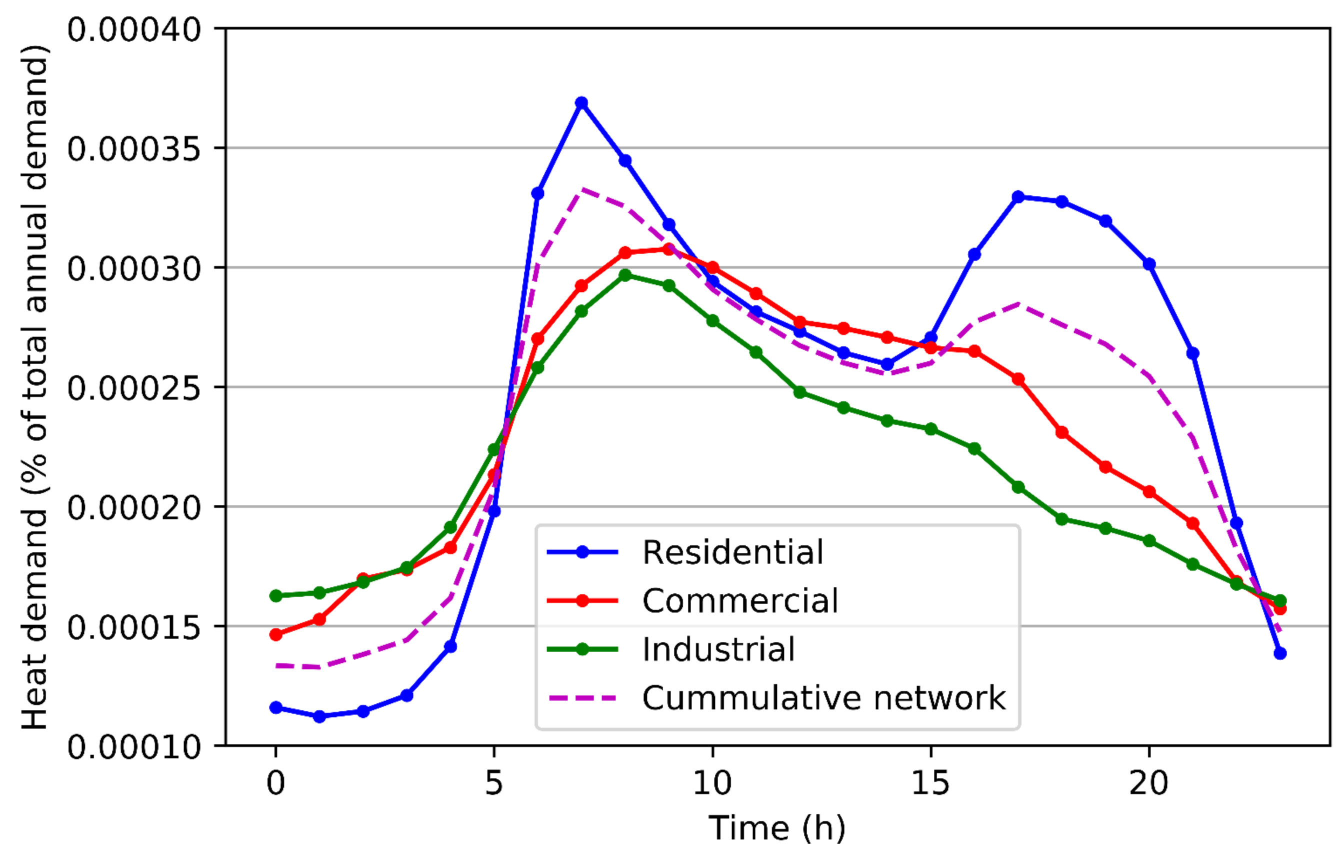
CASE STUDY - NETWORK

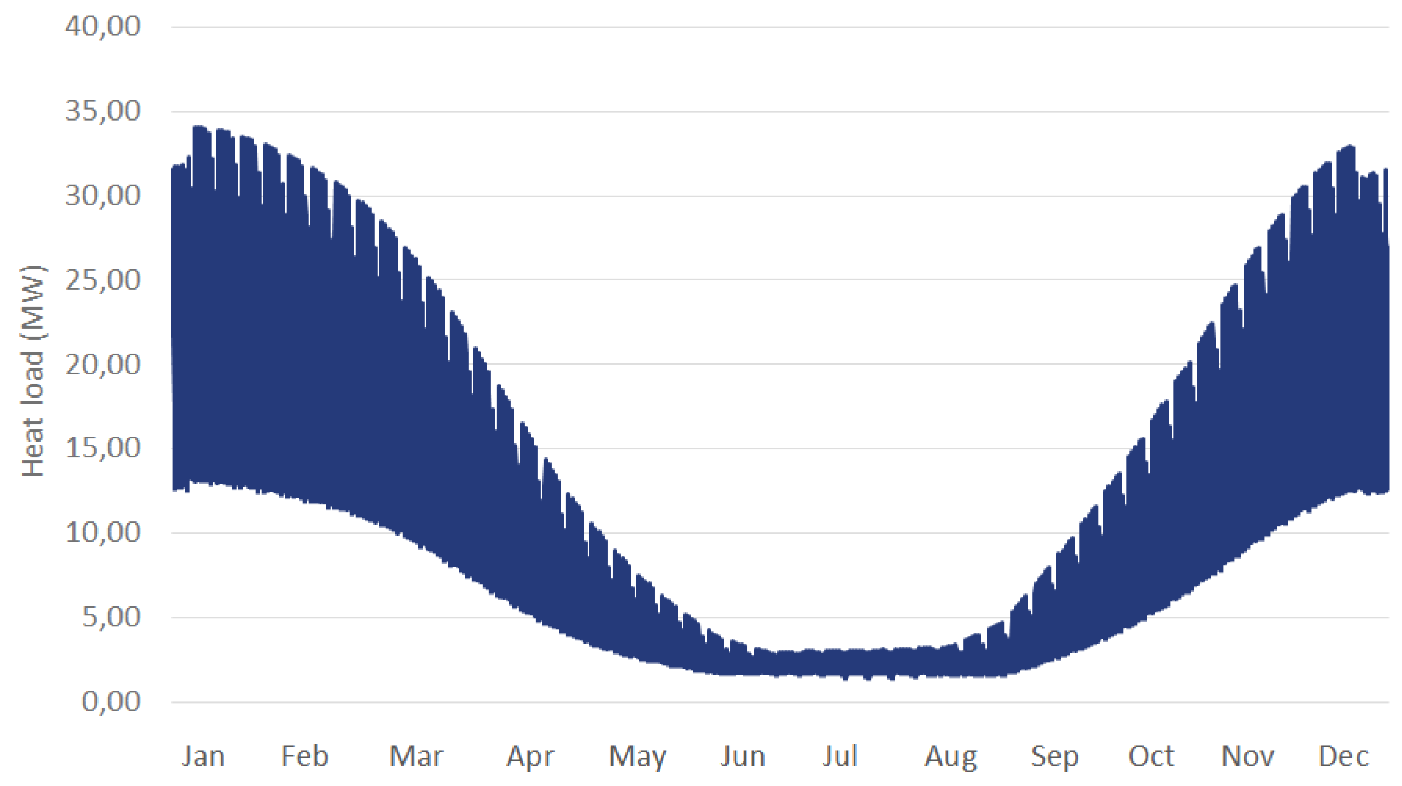
Network demand and peak load

- Building demand → Load profiles, annual gas consumption data
- Network demand → Aggregation of building heat demand
- Network annual heat demand – 95 GWh/year
- Network p [illegible] storage)





Daily profile of different building types



Hourly network heat demand

CASE STUDY – STORAGE

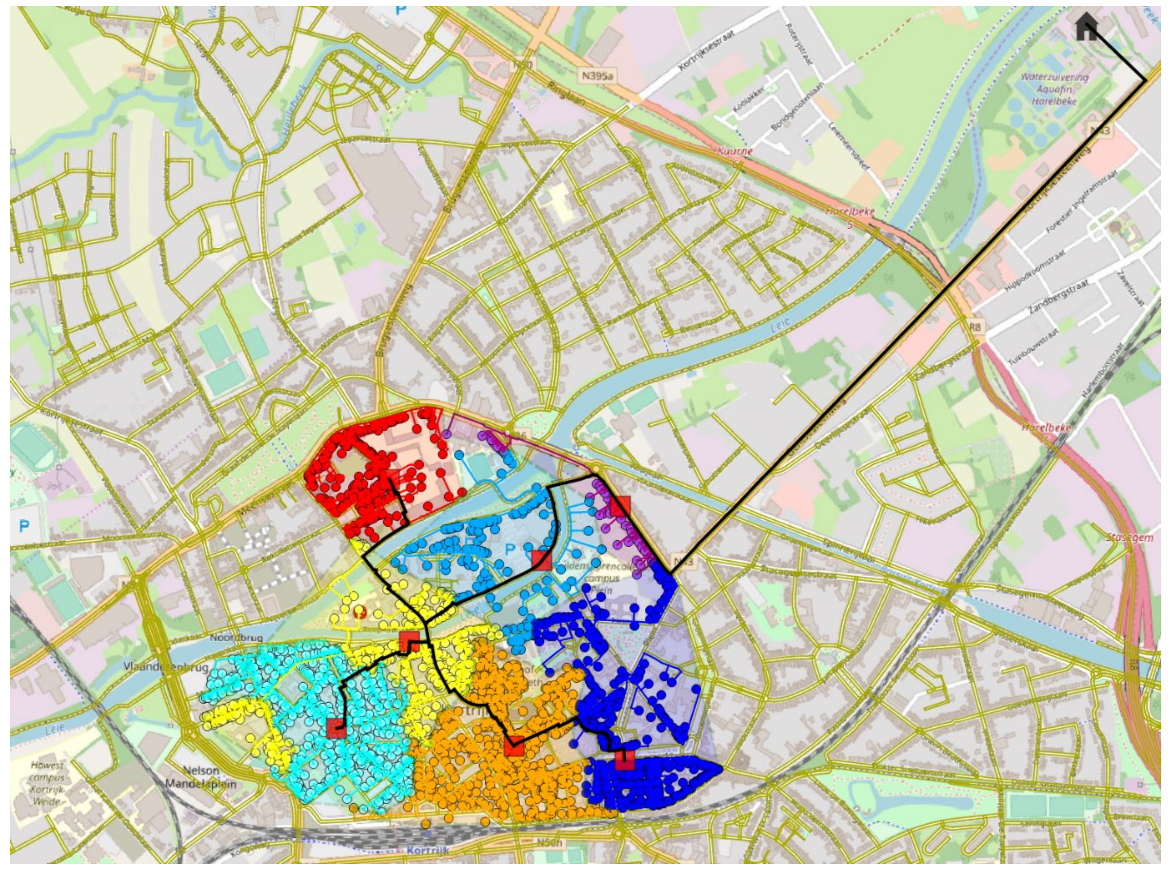
2 - layer network and storage design

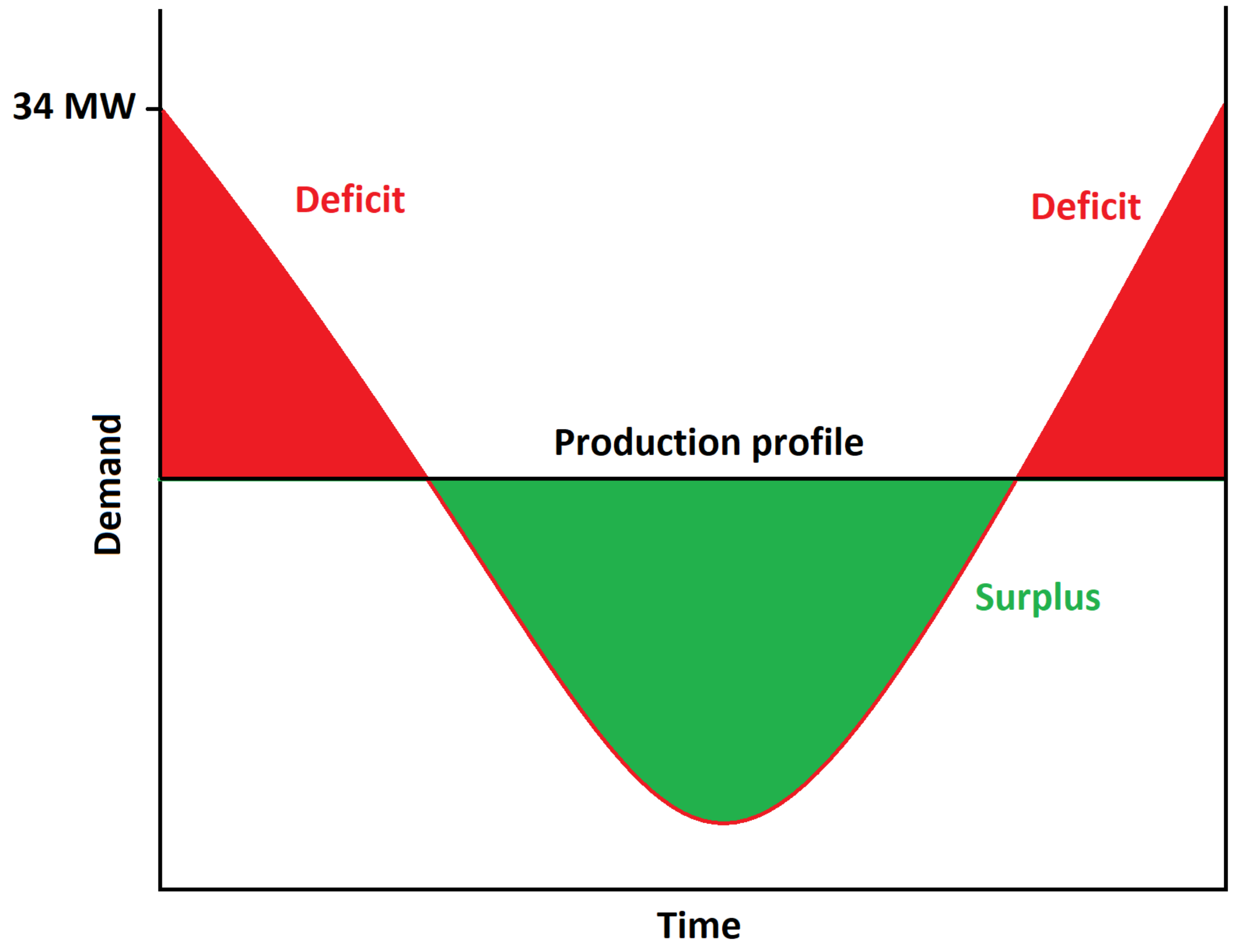
2 – LAYER NETWORK:

- Transport and distribution network

STORAGE DESIGN:

- Production profile → Constant throughout the year
- Consumption profile → Winter peak
- Surplus / Deficit over certain time
  - Charge storage when there is surplus
  - Discharge storage when there is deficit
- Maximum storage size → Energy produced ~= Energy consumed





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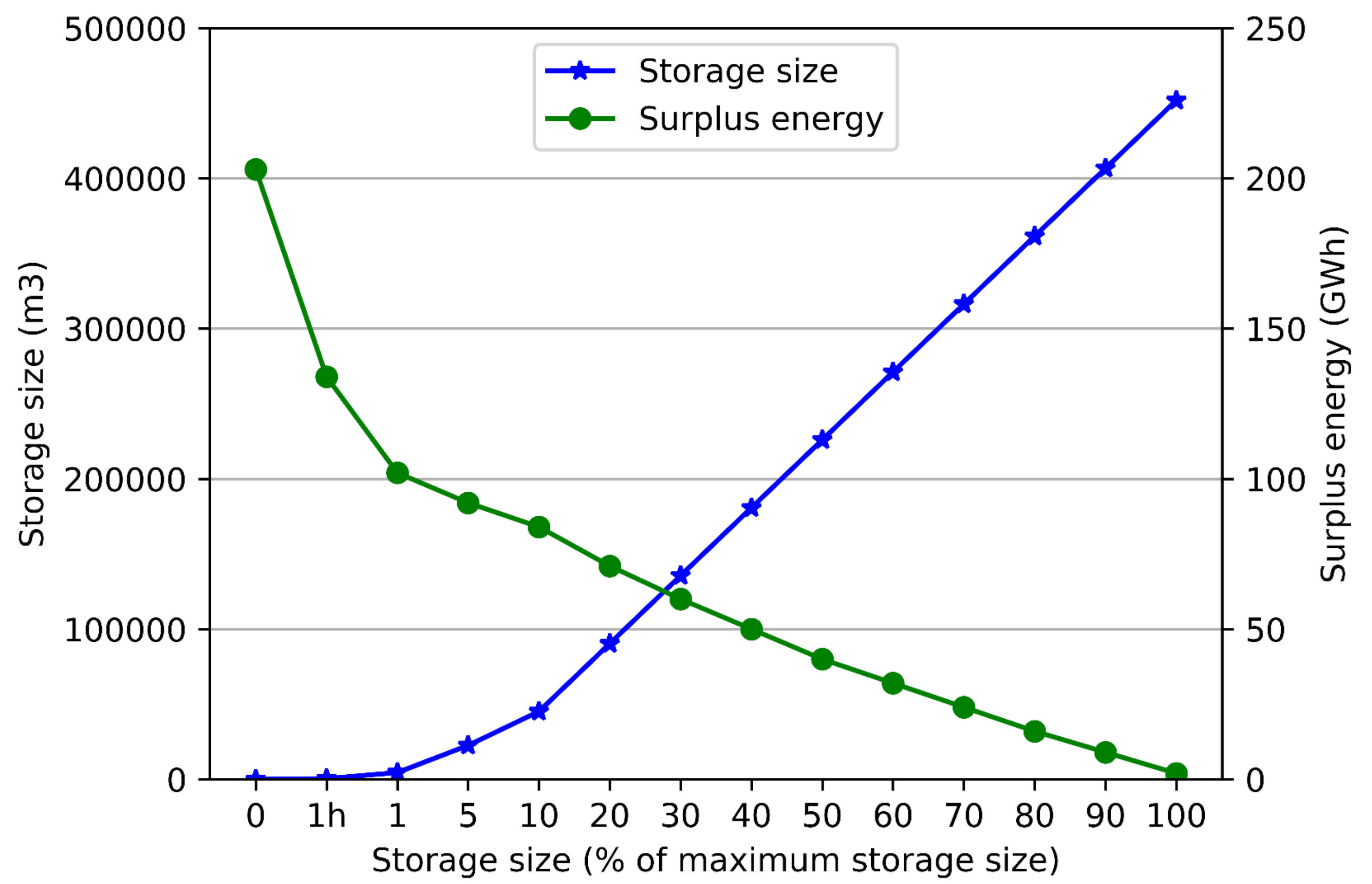
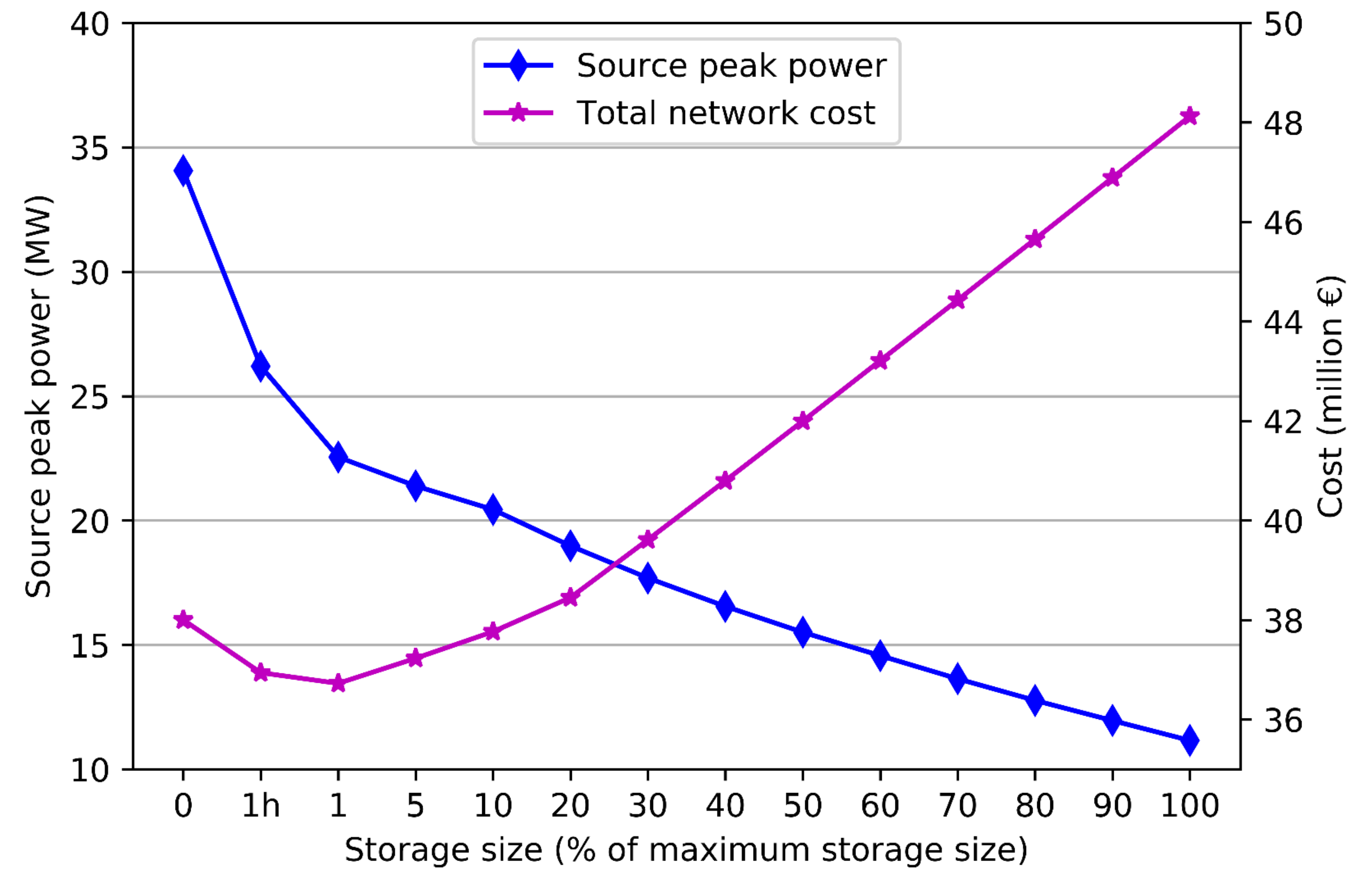
CASE STUDY – CENTRALIZED STORAGE

Source peak power vs Storage size – Seasonal storage

- Source power reduction
- No change in pipe sizes
- Maximum storage size – 450,000 m^3
- Source power can be reduced up to 11 MW
- Minimum total network cost occurs at 1% storage
  - Source peak power around 22 MW
  - Storage size around **4500 m^3**
  - **3.5% cost reduction**

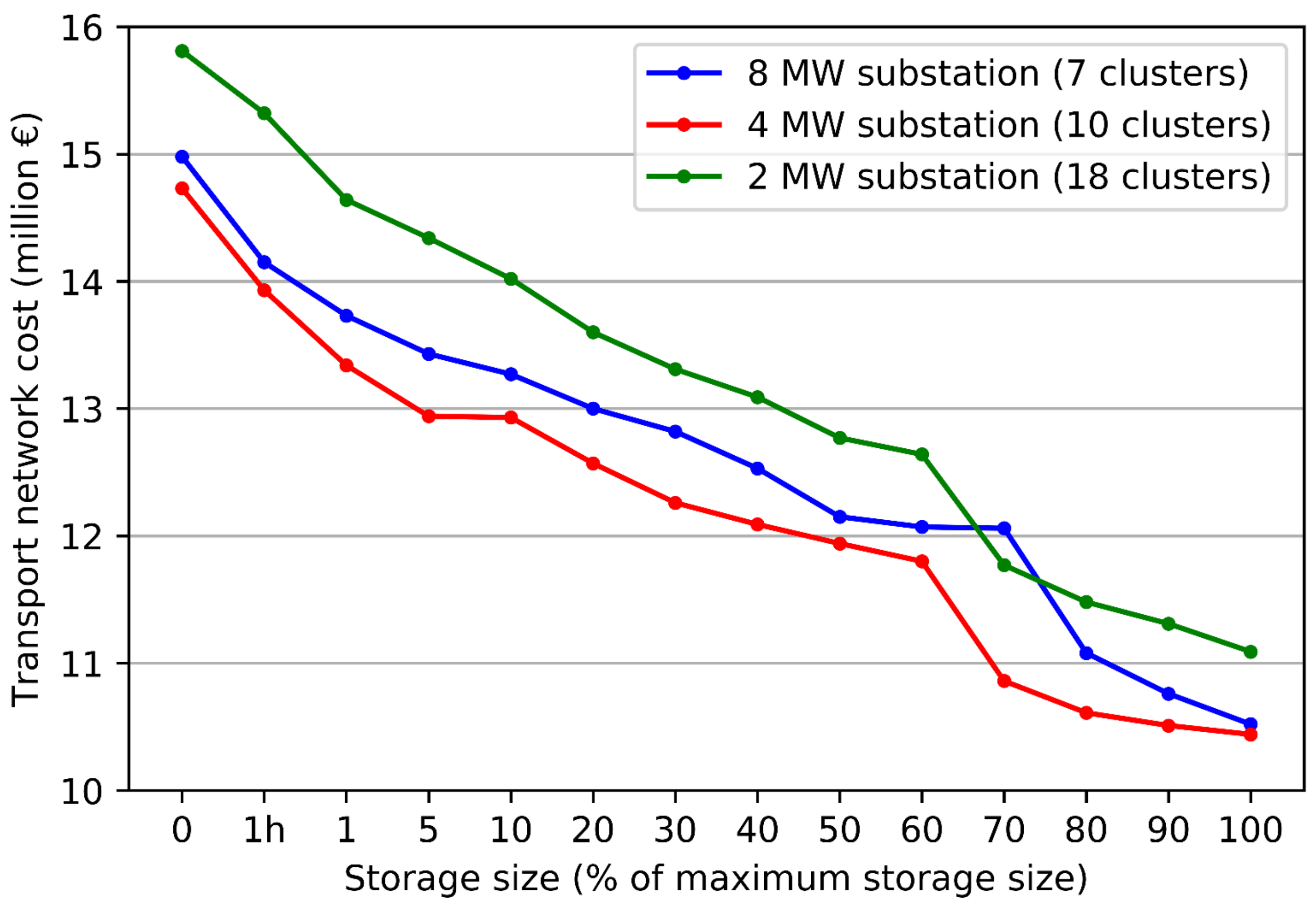


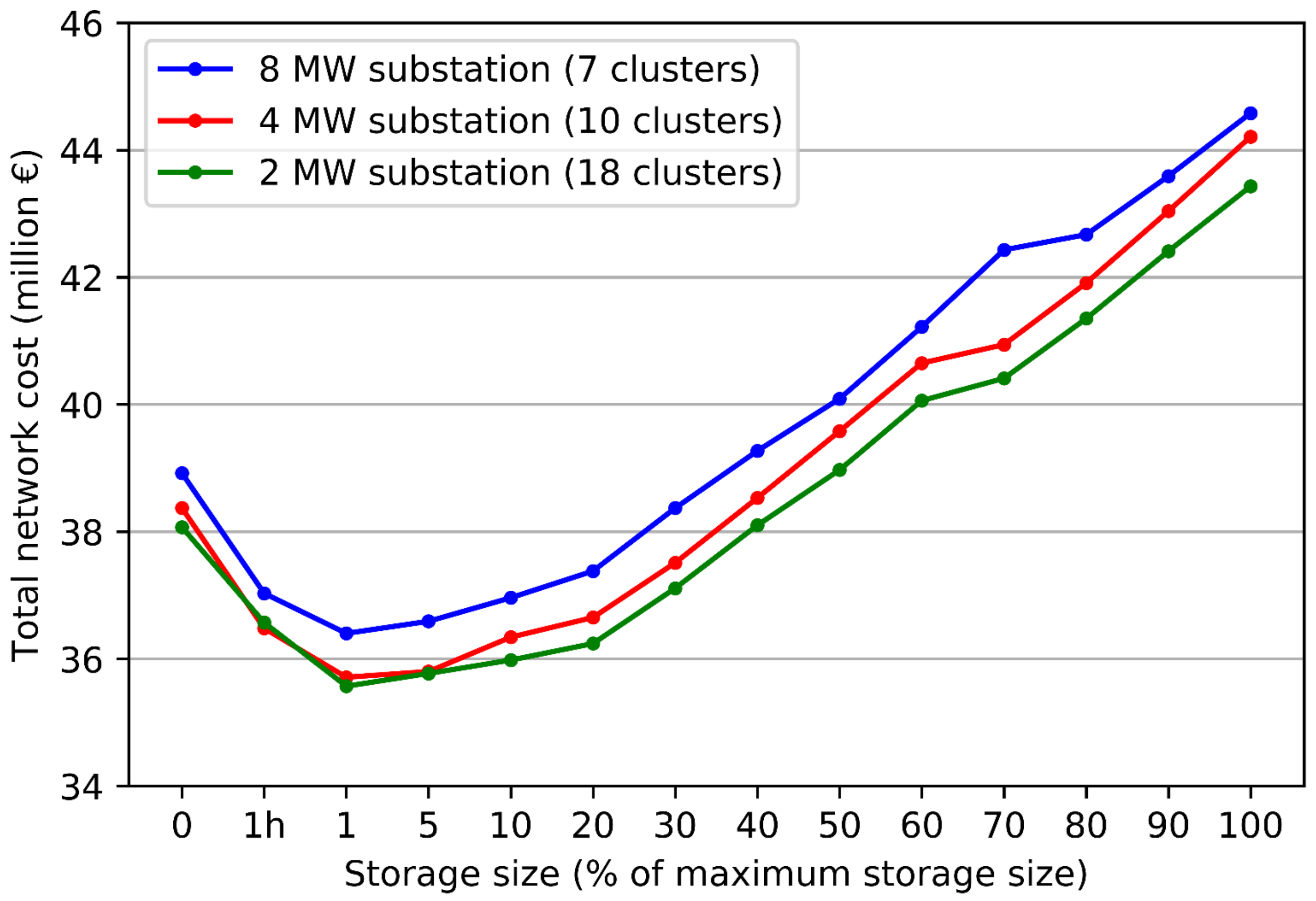


CASE STUDY – SUBSTATION LEVEL STORAGE

Transport and total network cost – Seasonal storage

- Source power reduction
- Reduction in transport network pipe sizes
- Constant distribution network cost
- Increasing storage size (for every substation size)
  - Reduction in transport network cost
  - Minimum total network cost at 1% storage (4500 m^3)
- Total minimum network cost
  - 2 MW substation and 1% storage (4500 m^3)
  - **7% cost reduction**

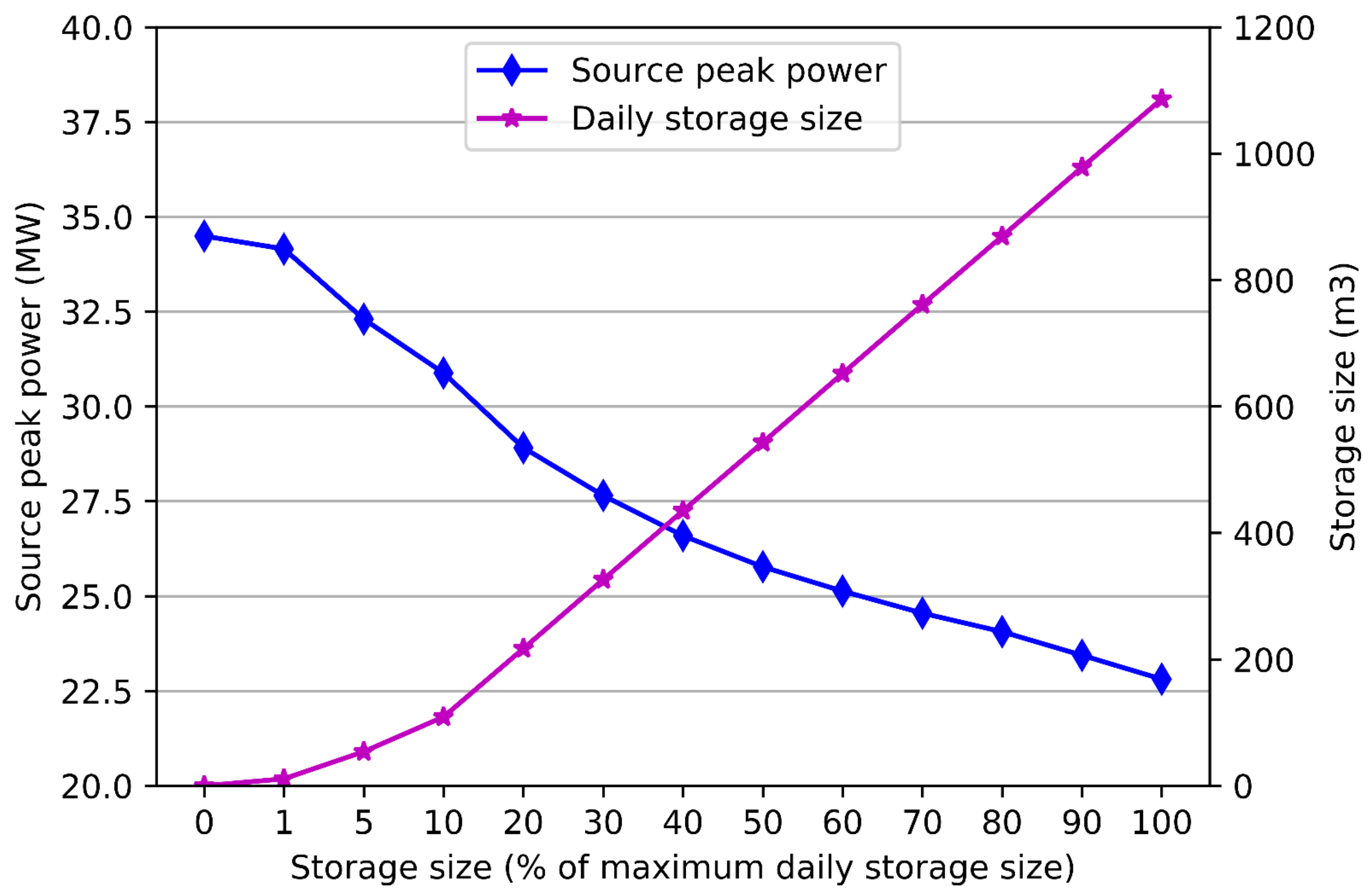


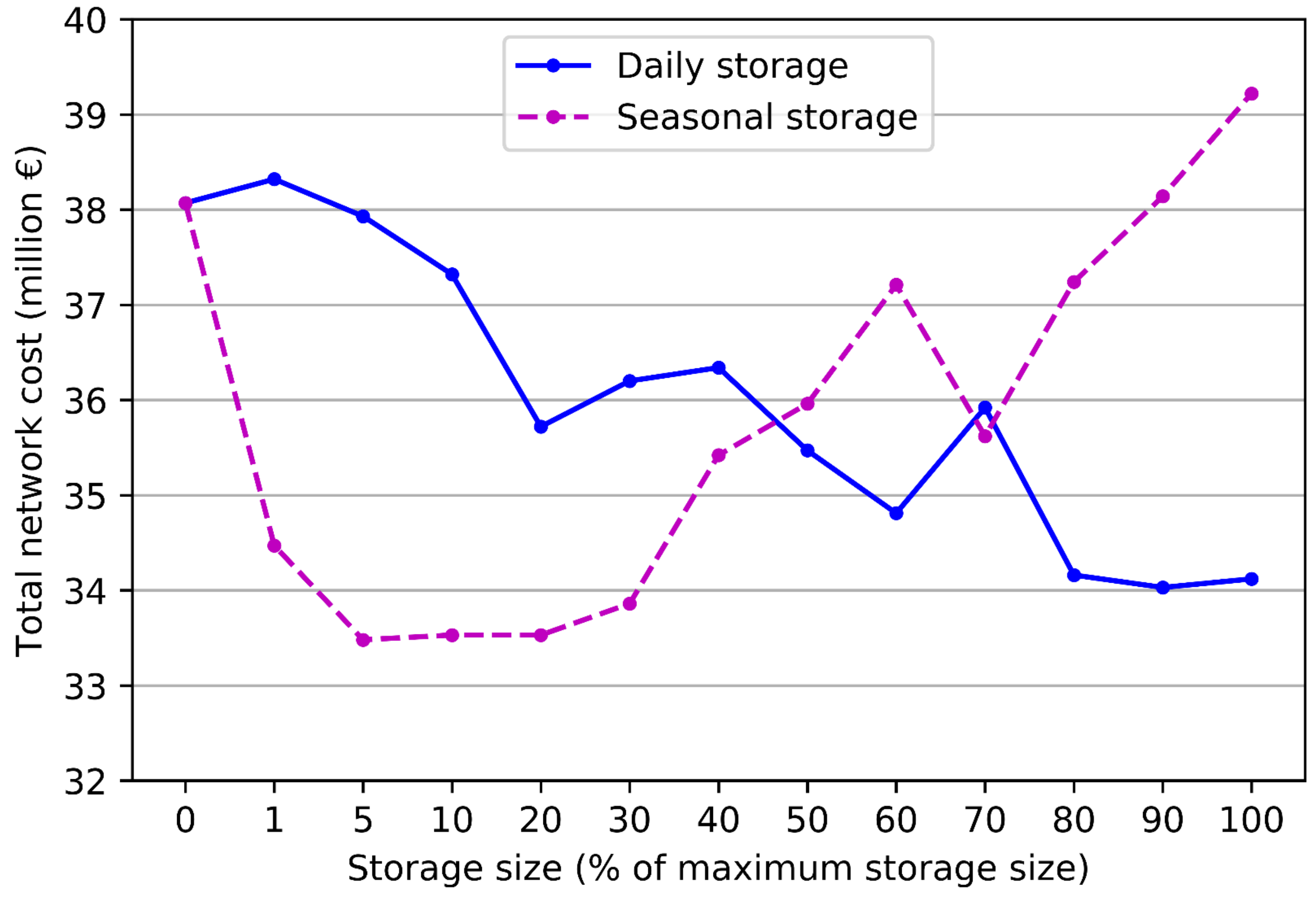


CASE STUDY – BUILDING LEVEL STORAGE

Source power and total network cost – Daily and seasonal storage

- Source power reduction
- Reduction in transport network pipe sizes
- Reduction in distribution network pipe sizes
- Maximum daily storage size - 1086 m^3
  - Source power can be reduced up to 22.5 MW
  - Total network cost - **10% cost reduction!**
- Seasonal storage
  - Minimum total network cost at 22600 m^3
    - **12% cost reduction!**



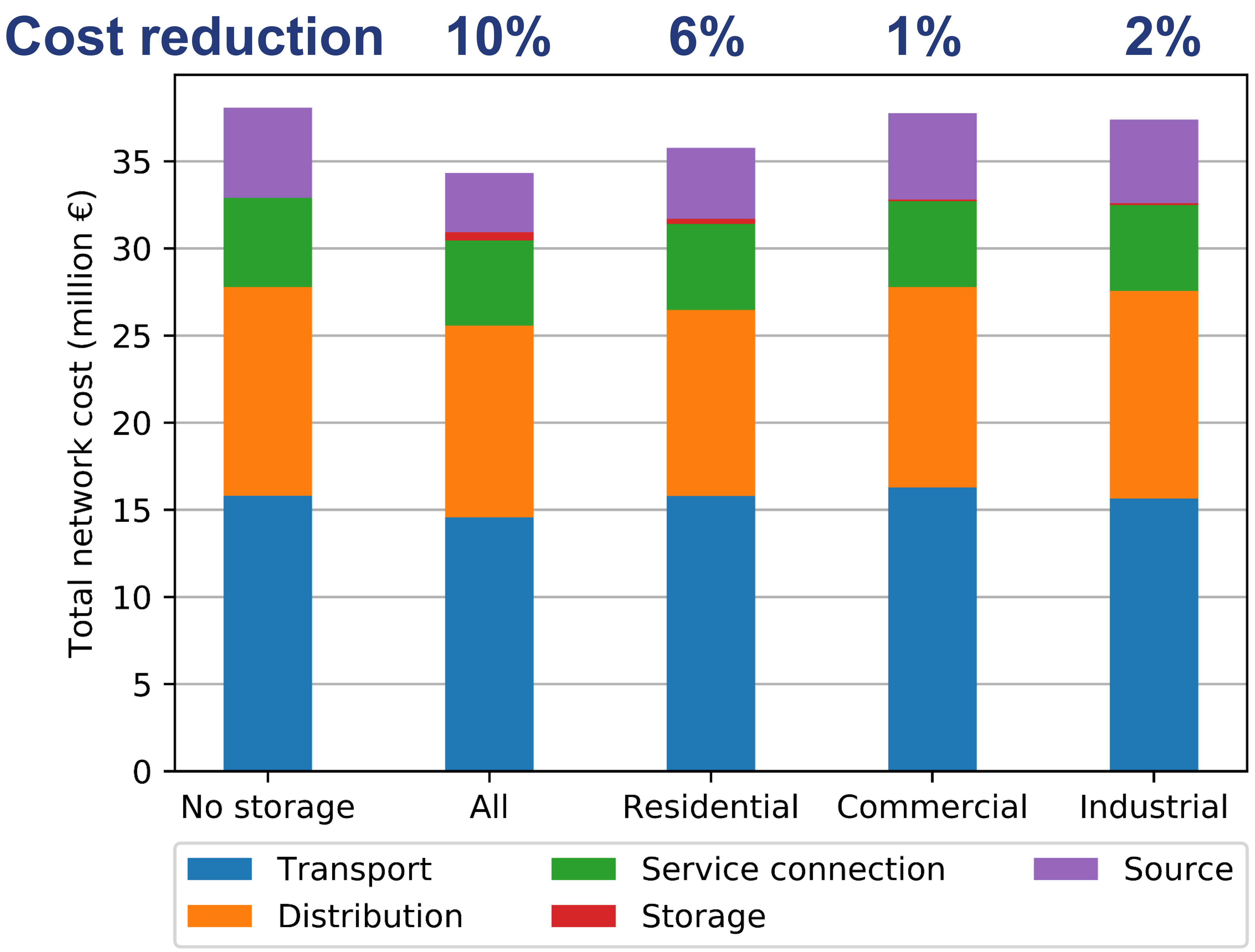


CASE STUDY – BUILDING LEVEL STORAGE

Network cost - Daily storage at different building types

- Average storage tank size per building:

Type	Average storage size (Liters)	Total storage size (m^3)
All buildings	461	1086
Residential	400	700
Commercial	286	156
Industrial	3992	232



Building level storage (Daily storage)

CONCLUSION

Overview and future work

- Successful use of software package Comsof Heat in combination with manual excel based storage calculations

- The more distributed storage, the lower the network cost (due to pipe size reductions):

Storage location	Storage type	Storage size (m^3)	No. of storage tanks	Cost reduction (%)
Centralized	Seasonal	4500	1	3.5
Substation level	Seasonal	4500	18	7
Building level	Daily	1086	2328	10
Building level	Seasonal	22600	2328	12

FUTURE WORK:

- Investigate the effect of different profile types

- Integration of the concepts in Comsof Heat

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