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AN AUTOMATED METHOD TO DESIGN MULTI-SOURCE DISTRICT HEATING NETWORKS WITH THERMAL STORAGE – CASE STUDY

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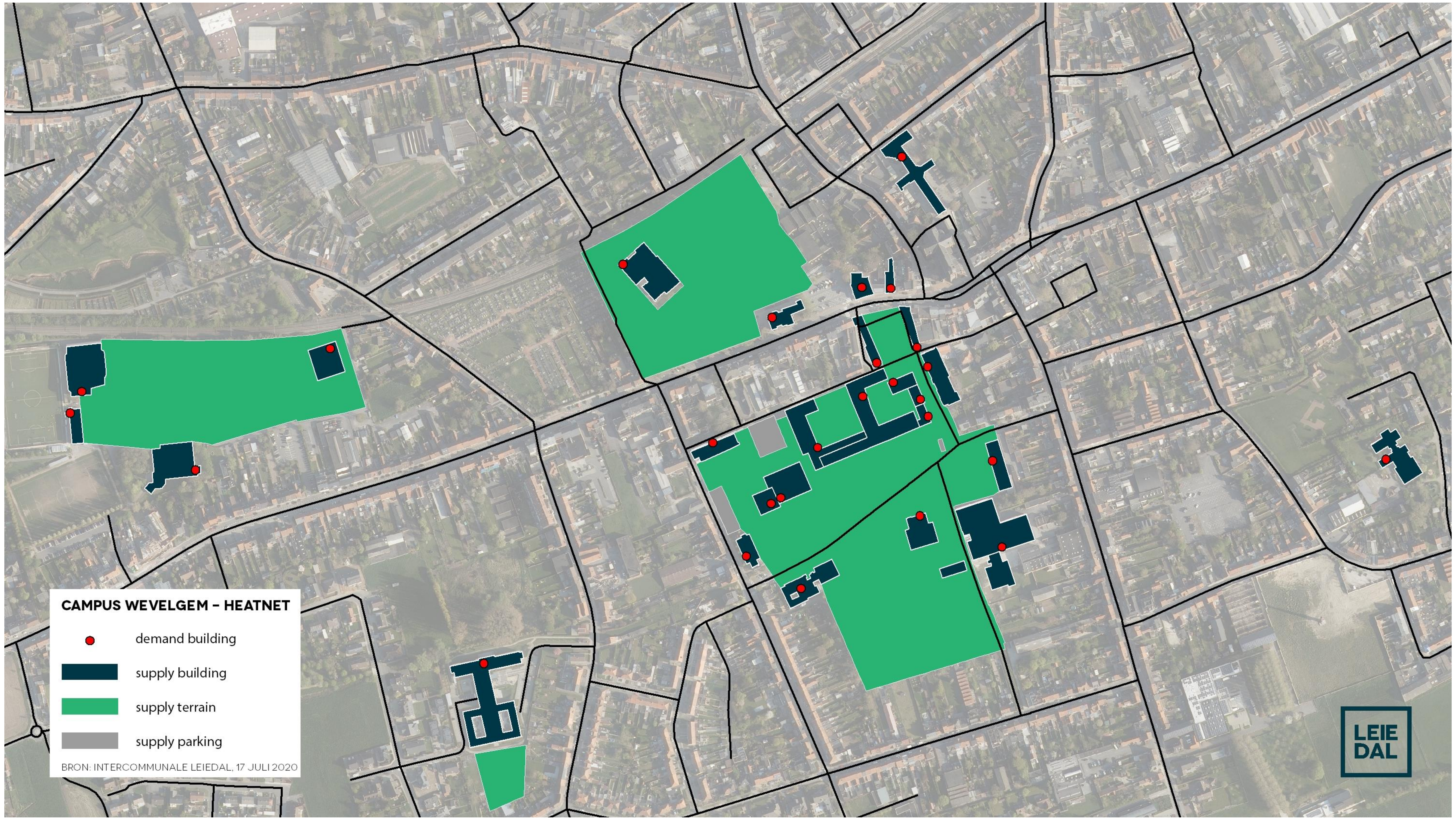
CASE STUDY - AREA DESCRIPTION

Wevelgem, Belgium



CASE STUDY - INPUTS

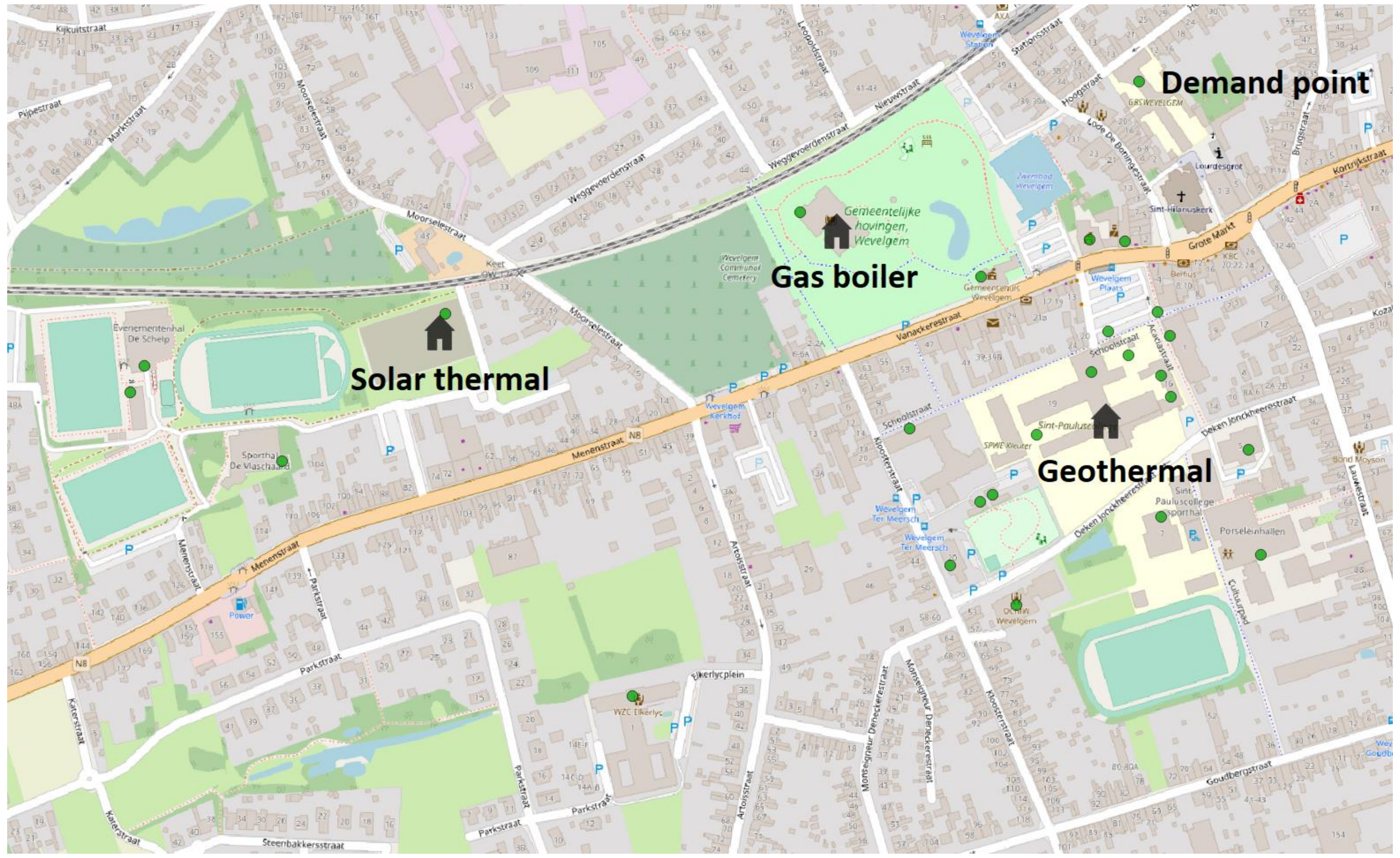
26 buildings and heat source – Wevelgem, Belgium

BUILDING INPUTS:

- Open source street level gas consumption data
  - Mapped street level to building level using building area ratio

HEAT SOURCE:

- Geothermal source
  - Main source
  - Estimated capacity of 4 MW
- Gas boiler
- Solar thermal



Case study area

CASE STUDY - INPUTS

Heat source attributes

Source type	Capacity (MW)	Investment cost (€/MW)	Energy production cost (€/MWh)	CO2 released (t per MWh)
Geothermal	4	2.13 million €	28	0.05
Solar thermal	1	1.2 million €	95	0.02
Gas boiler	1	150,000	42	0.5

CASE STUDY – NETWORK

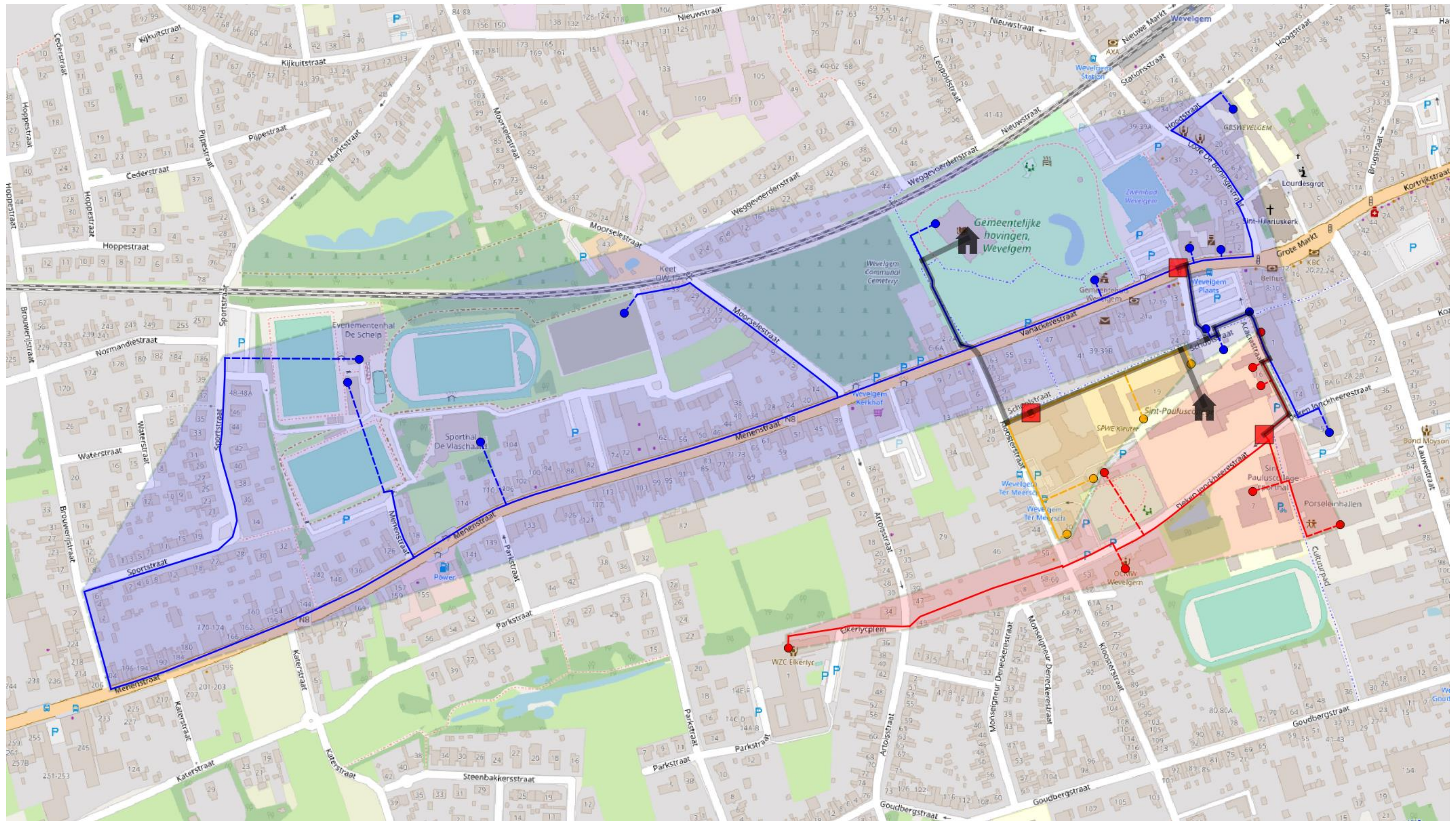
2 - layer network

2 – LAYER NETWORK:

- Transport network → Source to substations
  - Multiple source design method
  - 80/50 temperature level

- Distribution network → Substation to buildings
  - Branched network design method
  - 70/40 temperature level

- Network sizing
- Cost estimation



MULTI SOURCE DESIGN METHOD

Assumptions and method

ASSUMPTIONS:

- All sources are assumed to have only equal supply temperature.
- Simultaneity is set to 1 in transport layer → No simultaneity is applied in transport layer.

METHOD:

- All sources are connected to all substations directly through the best possible routes.
  - Combination of substation connections are not considered

MULTI SOURCE DESIGN METHOD

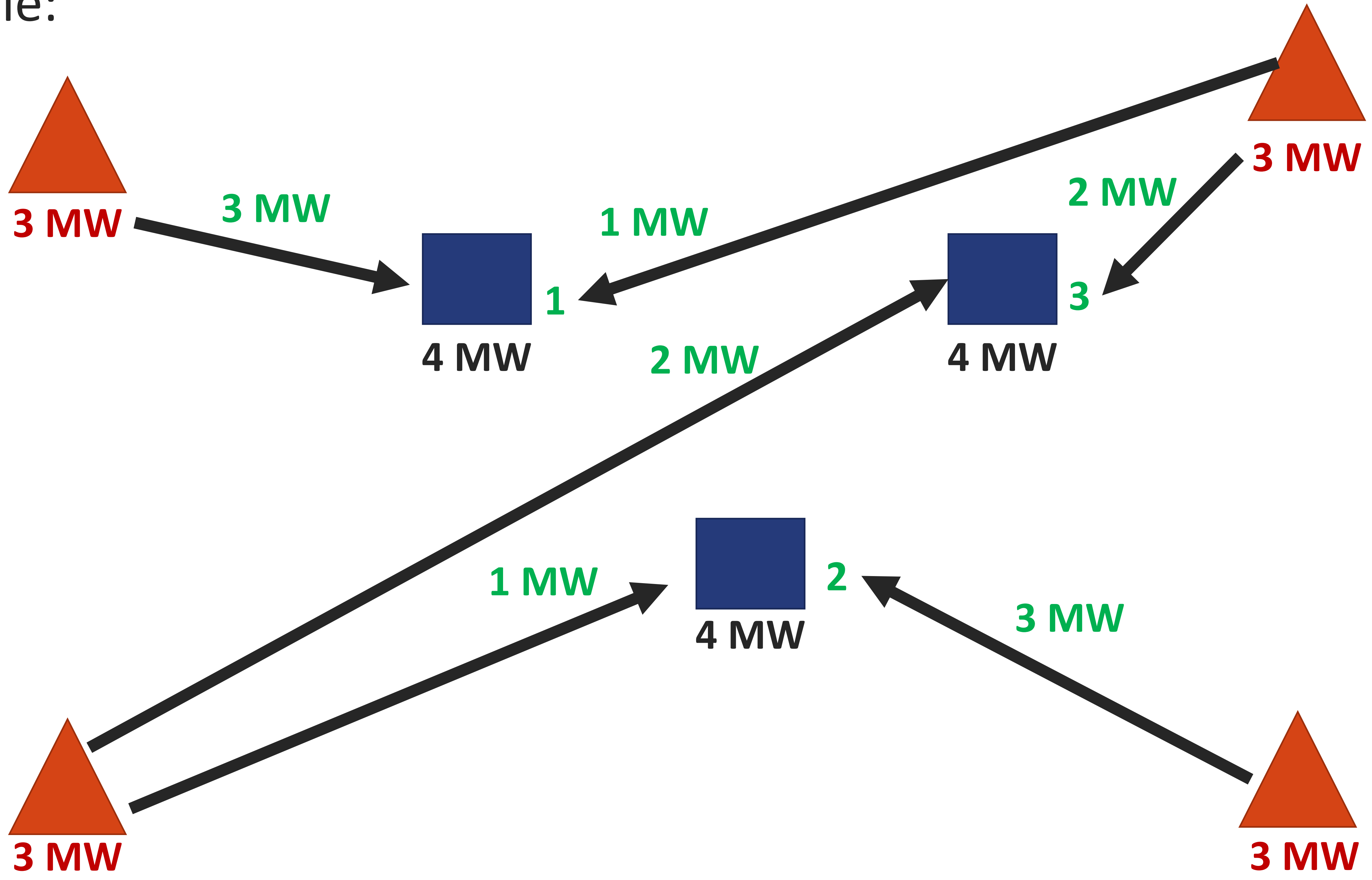
Bottom up approach

- Sort the substation with Linear heat density (Note: can also be done with revenues if available)
- Start from the highest linear heat density substation and filter out the sources by higher cost.
  - Cost includes only routing costs
- Keep the lowest cost source for the selected substation and reduce the assigned source power from the source and substation.
- Move to the next highest linear heat density substation after the first substation power is completely met and filter the sources again using the costs.
- Repeat the same until all the substations are connected or all the source powers are utilized.

MULTI SOURCE DESIGN METHOD - CHALLENGES

Pipe duplication

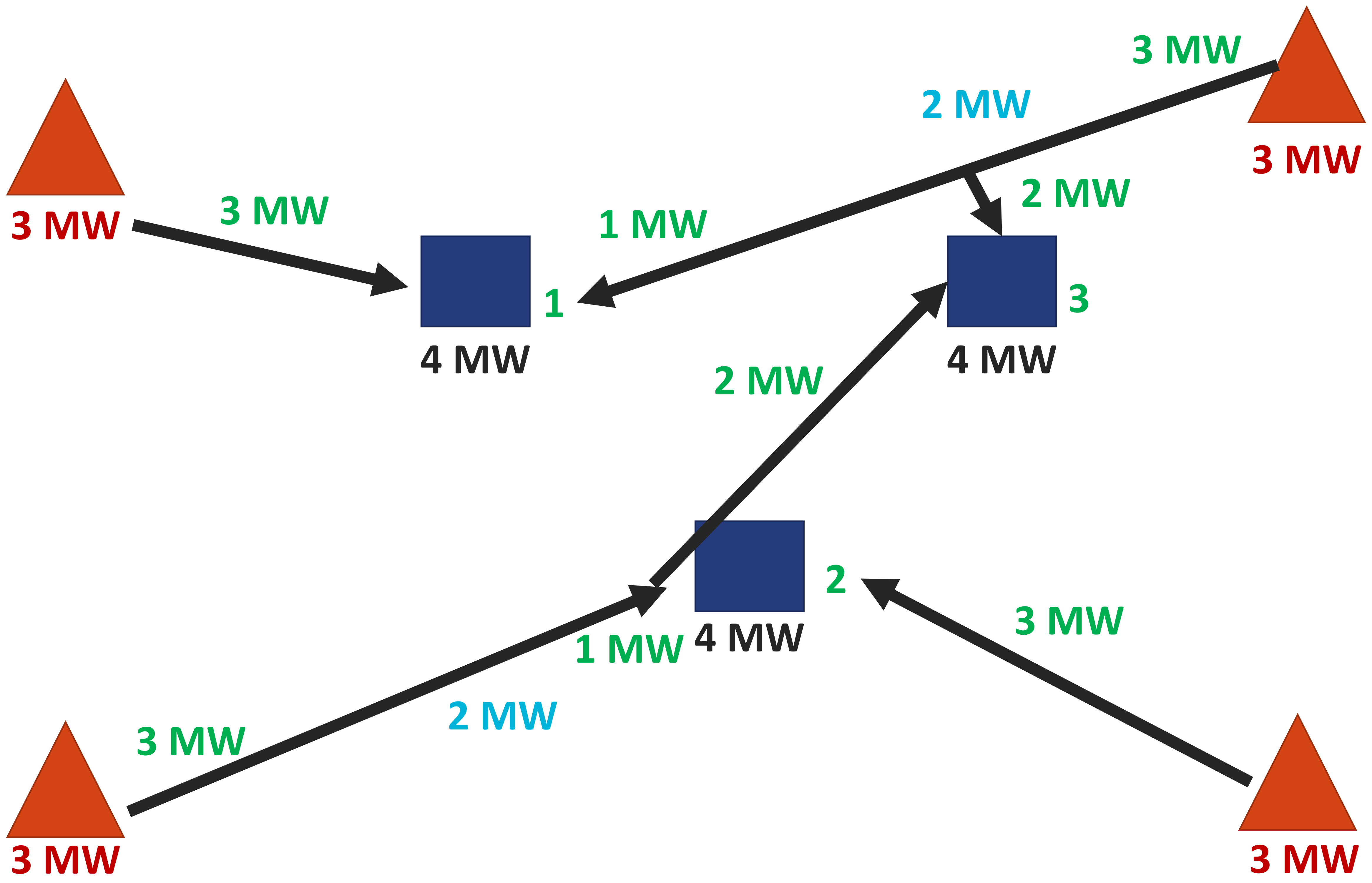
- Duplication of pipes from the source possible → Combination of substations to source is not considered.
  - Can be avoided by providing available power along the pipes
- Example:



MULTI SOURCE DESIGN METHOD - CHALLENGES

Pipe duplication

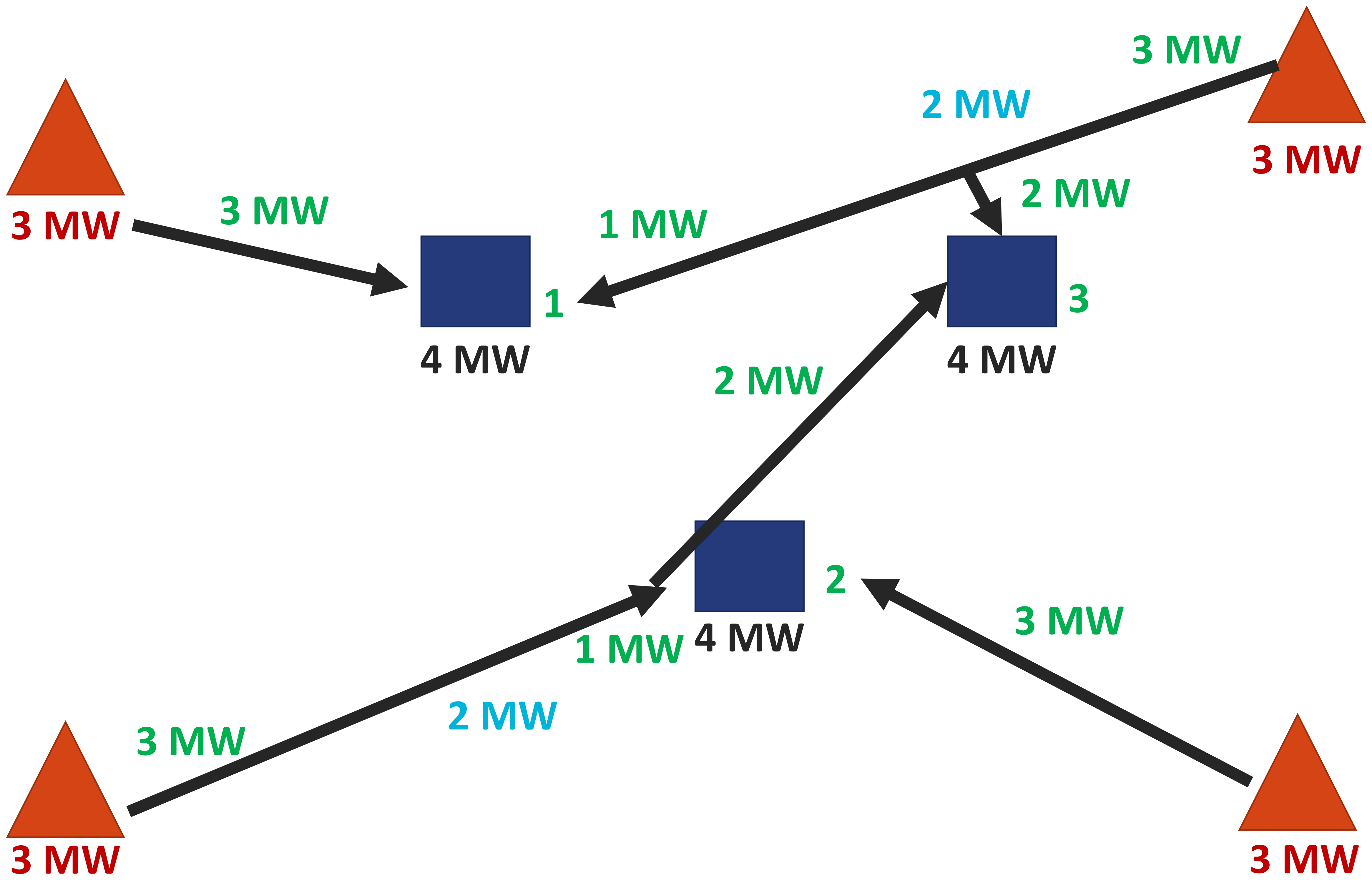
- Providing available power along the line
- Example:



MULTI SOURCE DESIGN METHOD - CHALLENGES

Order of substations

- Order of substation can provide different result → It might not be the optimal result if we take the sorting order with high linear density
- Example: Order 1-3-2



MULTI SOURCE DESIGN METHOD - CHALLENGES

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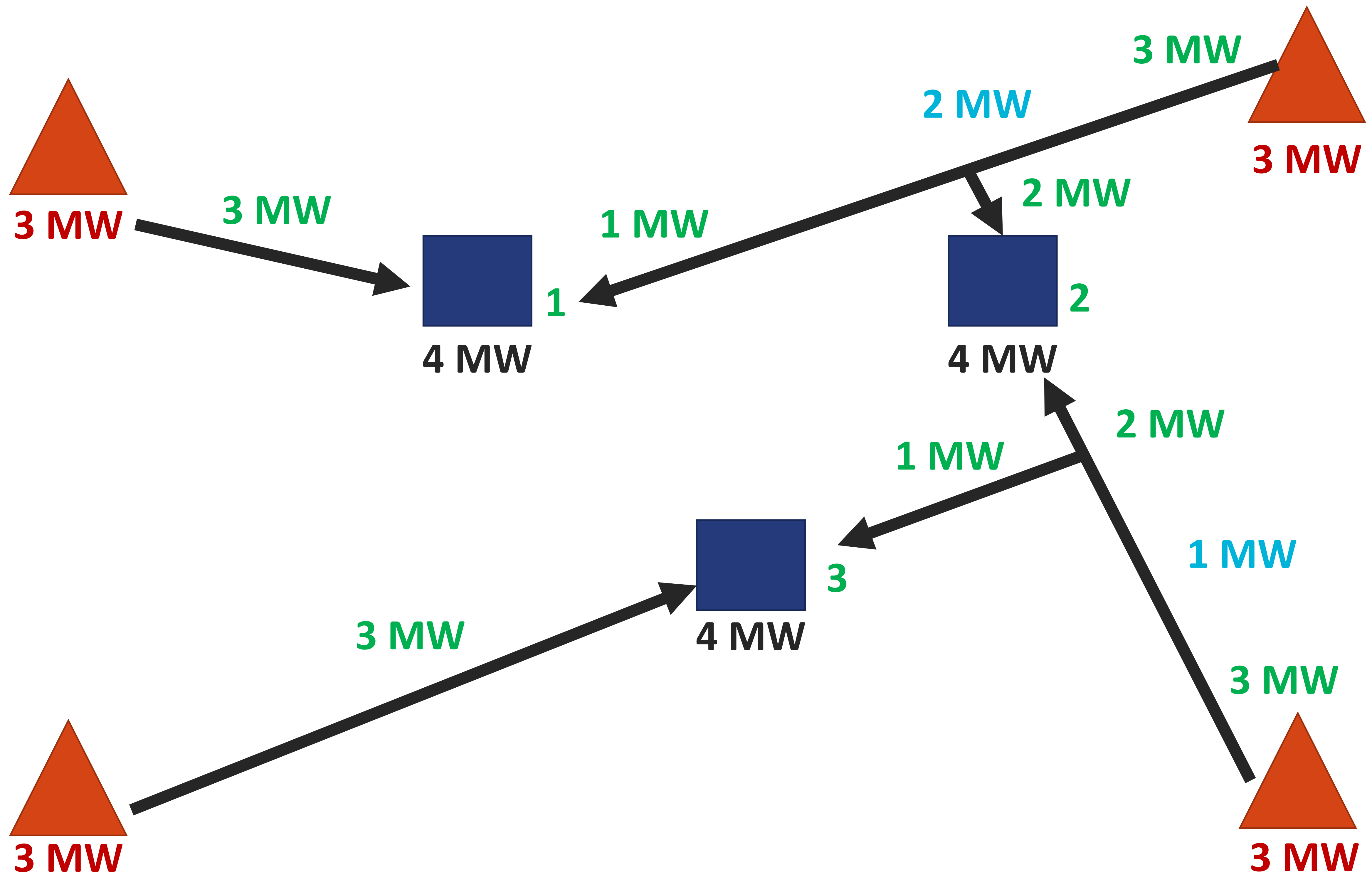
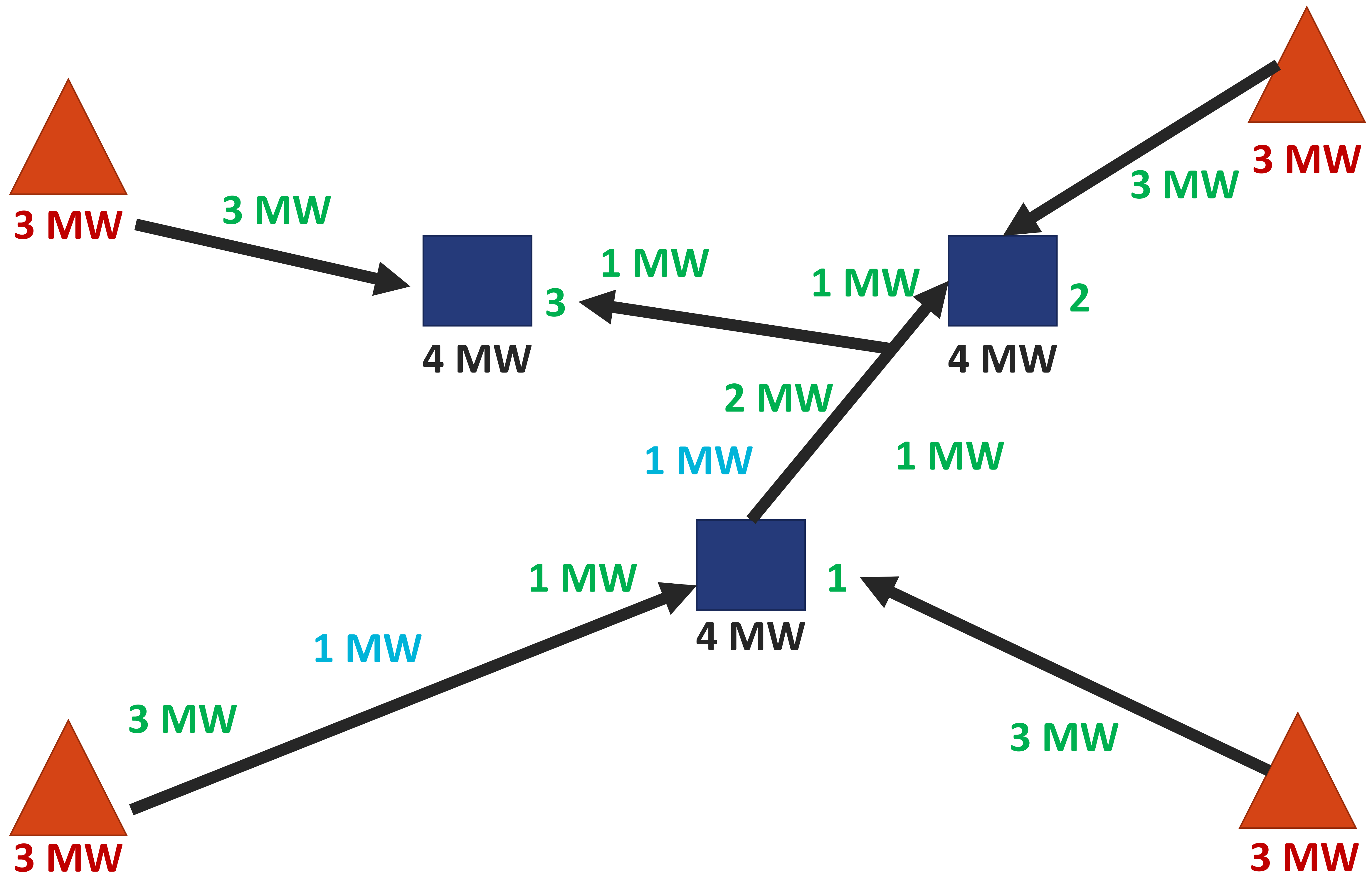
- Example: Order 1-2-3



MULTI SOURCE DESIGN METHOD - CHALLENGES

Order of substations

- Order of substation can provide different result → It might not be the optimal result if we take the sorting order with high linear density
- Example: Order 3-2-1

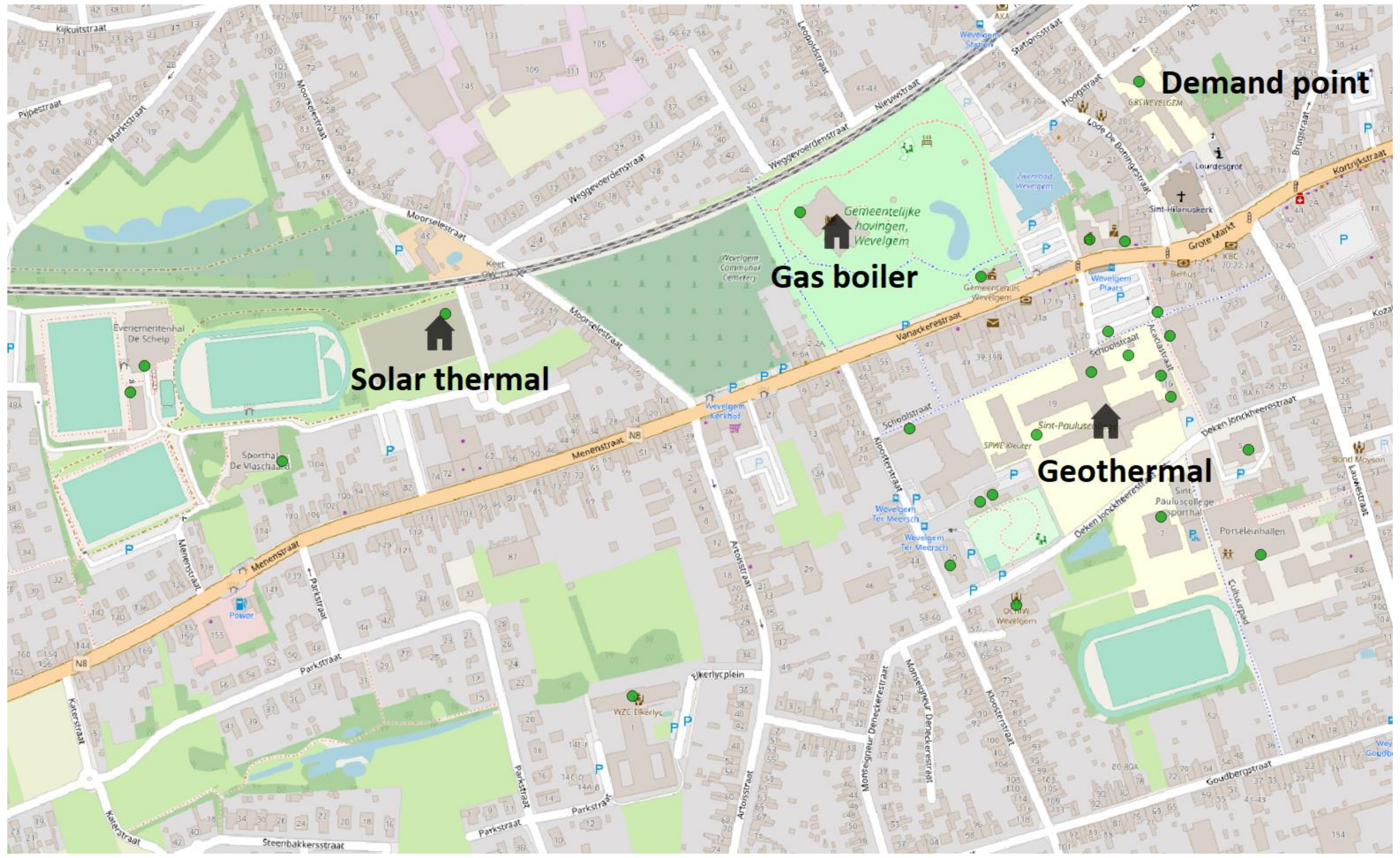


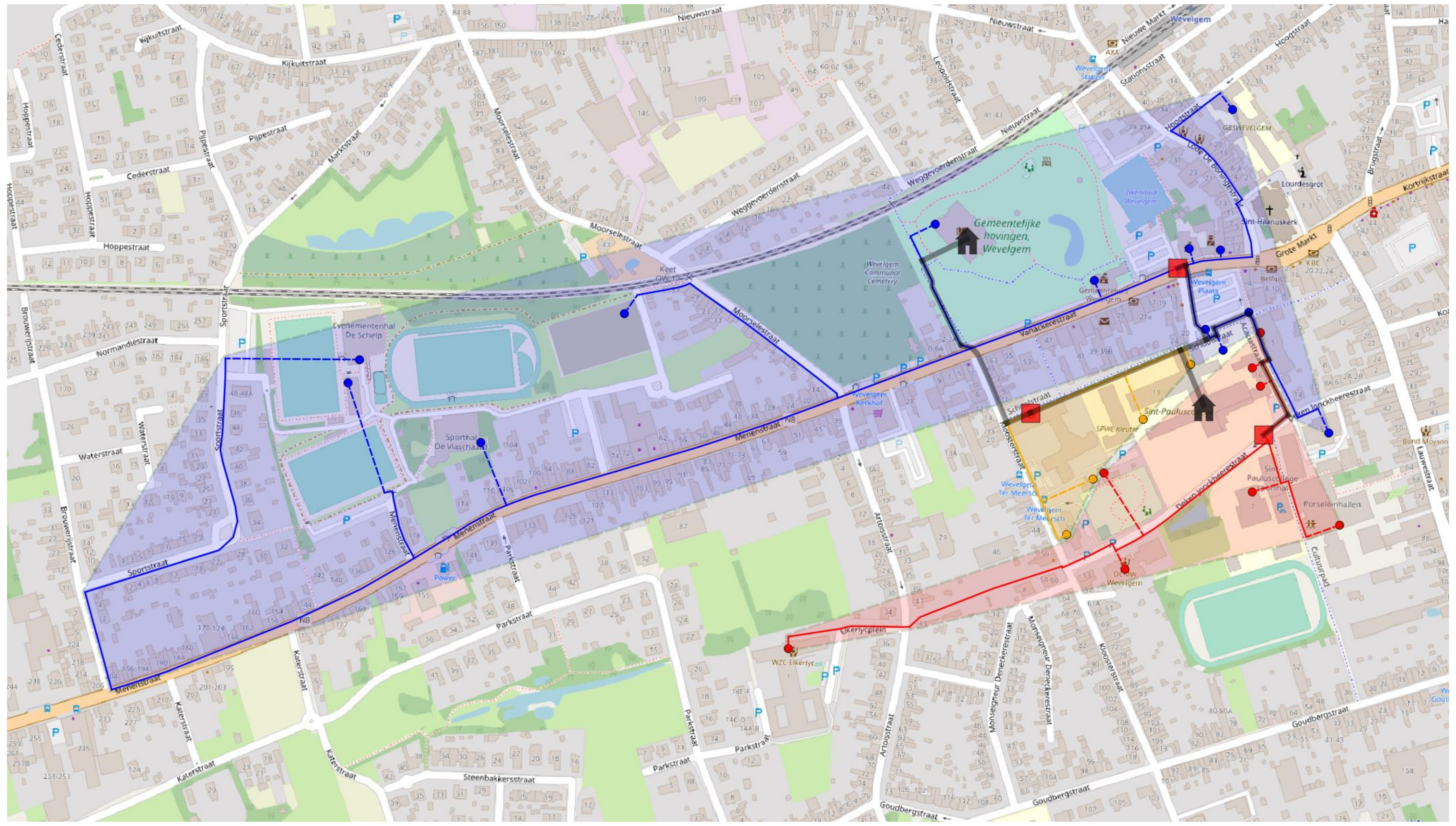
DESIGN SCENARIO

Supply is greater than demand – Source selection

Source selection:

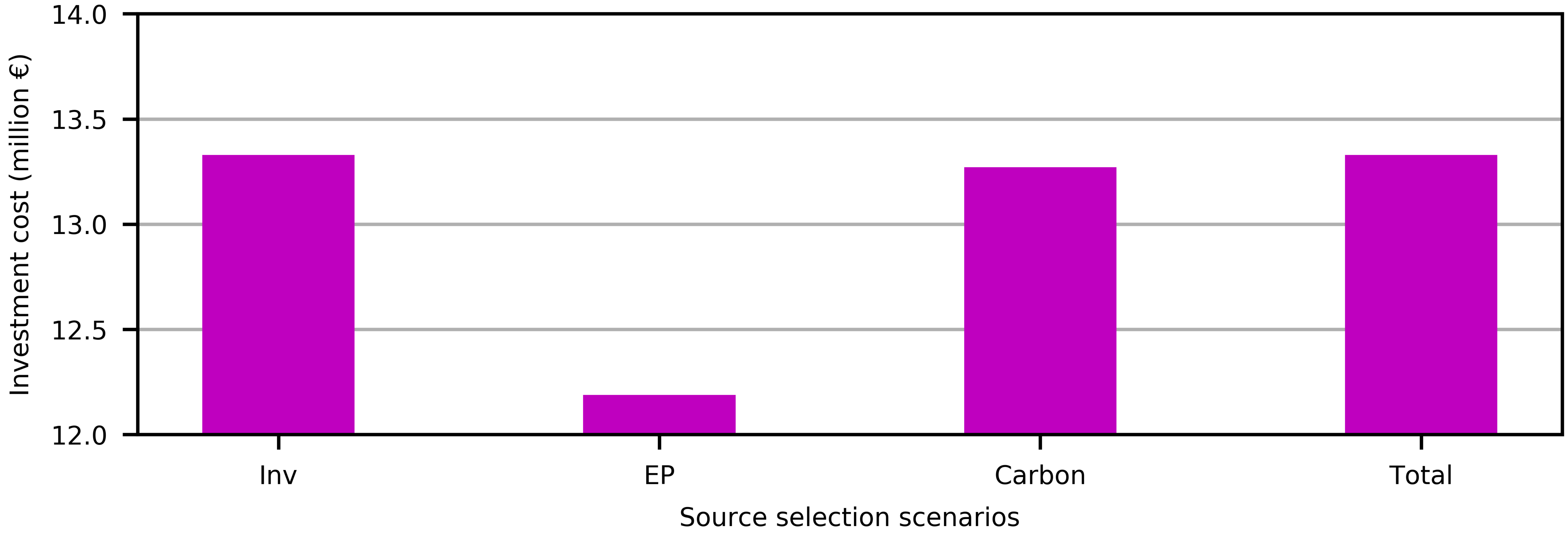
- Investment cost
- Energy production cost
- CO2 cost
- Combinations





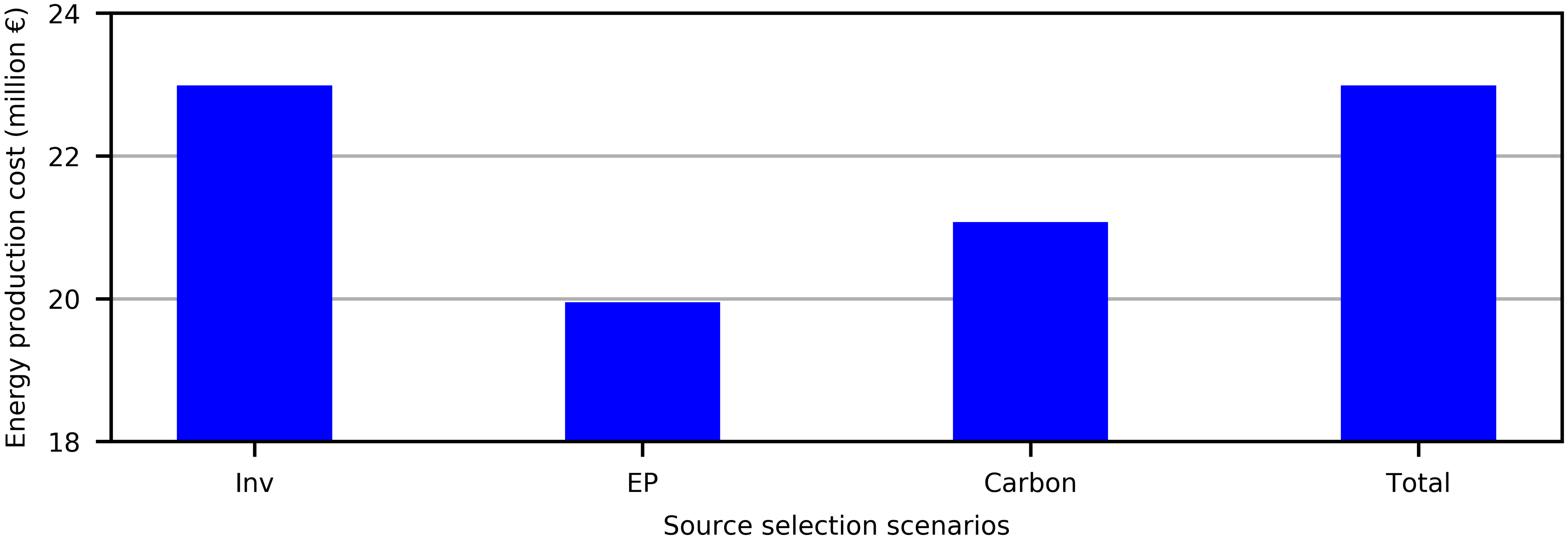
SCENARIOS

Source selection



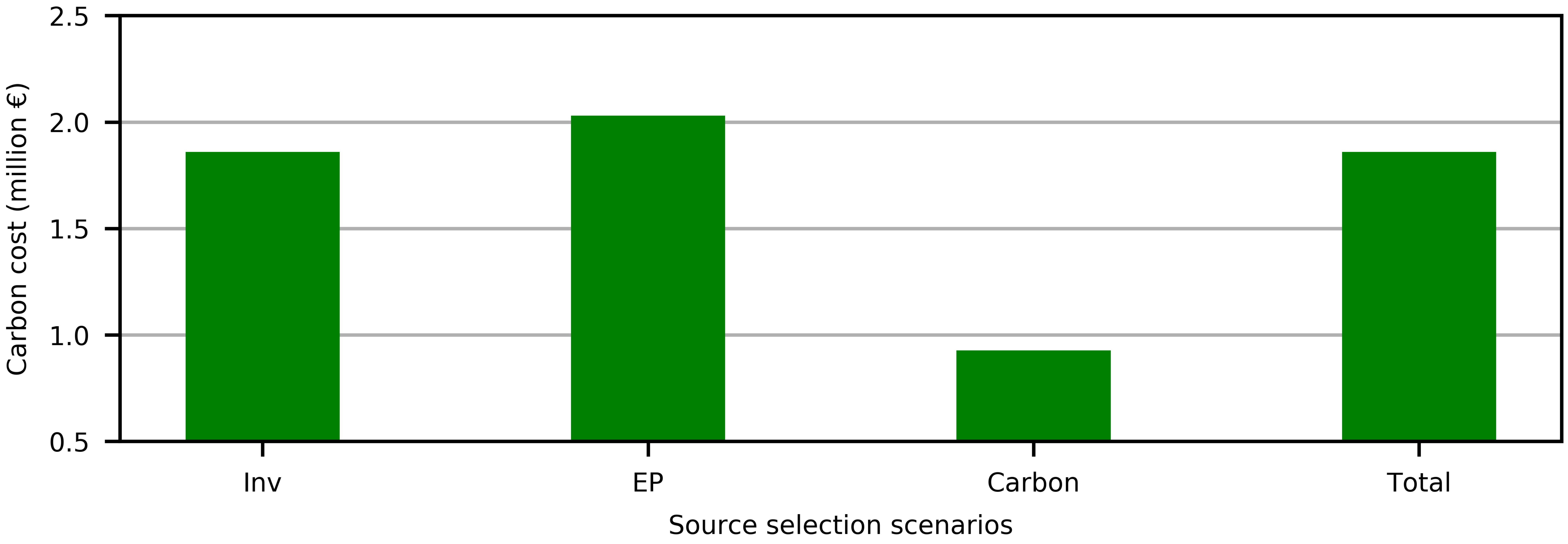
SCENARIOS

Source selection



SCENARIOS

Source selection



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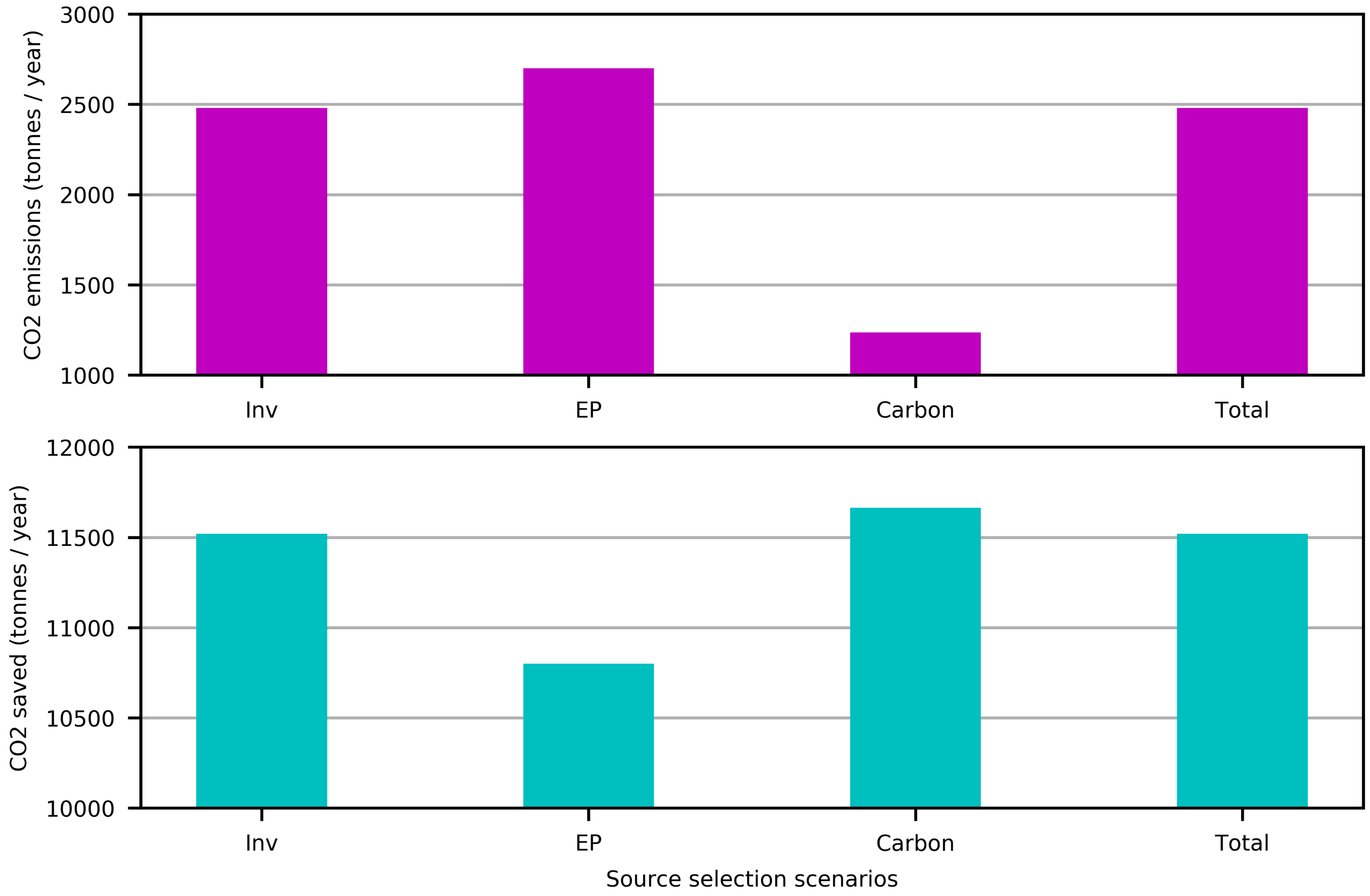

CONCLUSION

Overview and future work

- Developed a method to design multiple sources district heating network automatically.

- A case study is developed using Comsof Heat to design multiple source district heating networks for different KPIs and design choices
  - Effect on investment cost, energy production cost, carbon cost and emissions

- Source selection with different KPI scenarios → Low carbon sources have higher investment and energy production costs.

- With the current carbon cost scenario, optimizing for costs is not favoring low carbon sources.

FUTURE WORK:

- Improve the connection algorithms → Flow algorithms

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