District heating distribution grid costs: a comparison of two approaches

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7th International Conference on Smart Energy Systems
21-22 September 2021
#SESAAU2021

Contents

Motivation

THE 16th INTERNATIONAL SYMPOSIUM on District Heating and Cooling

HOTMAPS

The open source mapping and planning tool for heating and cooling

ELSEVIER

Energy Procedia

Volume 149, September 2018, Pages 141-150

Impact of distribution and transmission investment costs of district heating systems on district heating potential

Mostafa Fallahnejad [a], Michael Hartner [a], Lukas Kranzl [a], Sara Fritz [b]

How well the obtained values for pipe costs and pipe length based on the effective width concepts fit the reality?

Energy Economics Group

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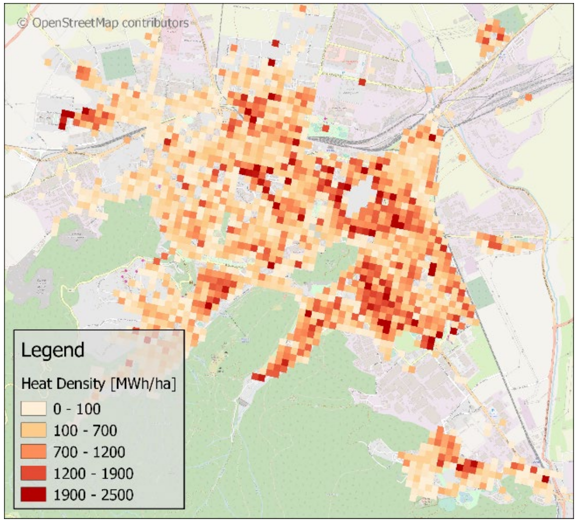
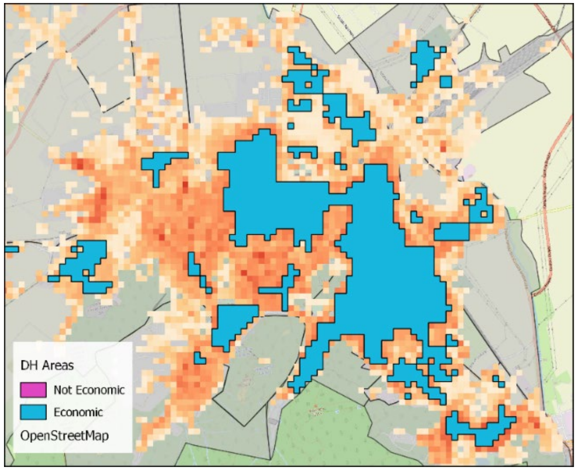
What did I do in my paper?

- Input GIS layers:
  - Heat demand density map – 1ha resolution
  - Gross floor area density map – 1ha resolution



- Consideration of evolving market share and heat demand on DH areas

- Use the concept of effective width for the calculation of investment costs in each hectare.
  - **Effective width**: relationship between a given land area (plot ratio, e) and the length of the district heating pipe network within this area.

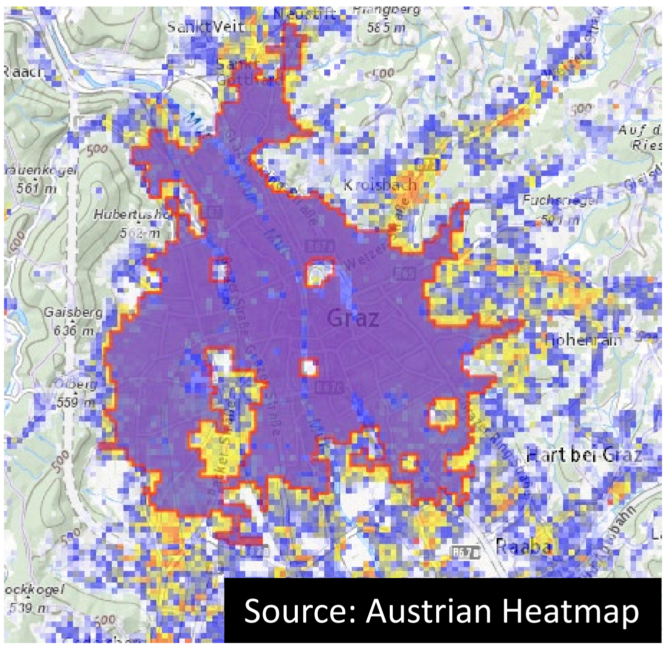


- Calculate potential DH areas (coherent areas) with
  - an average distribution grid costs below a certain level, and
  - annual heat demand of above a given threshold.

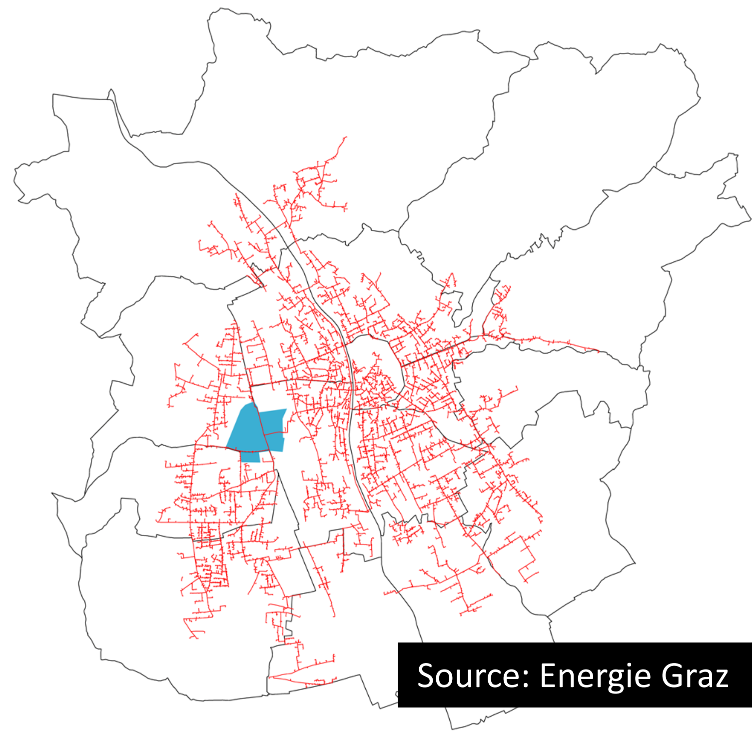
* Persson U, Wiechers E, Möller B, Werner S. Heat Roadmap Europe: Heat distribution costs. Energy 2019;176:604–22. doi:10.1016/j.energy.2019.03.189.

Possible answer to the raised question

Get Potential DH areas → **Compare with Existing DH grids**

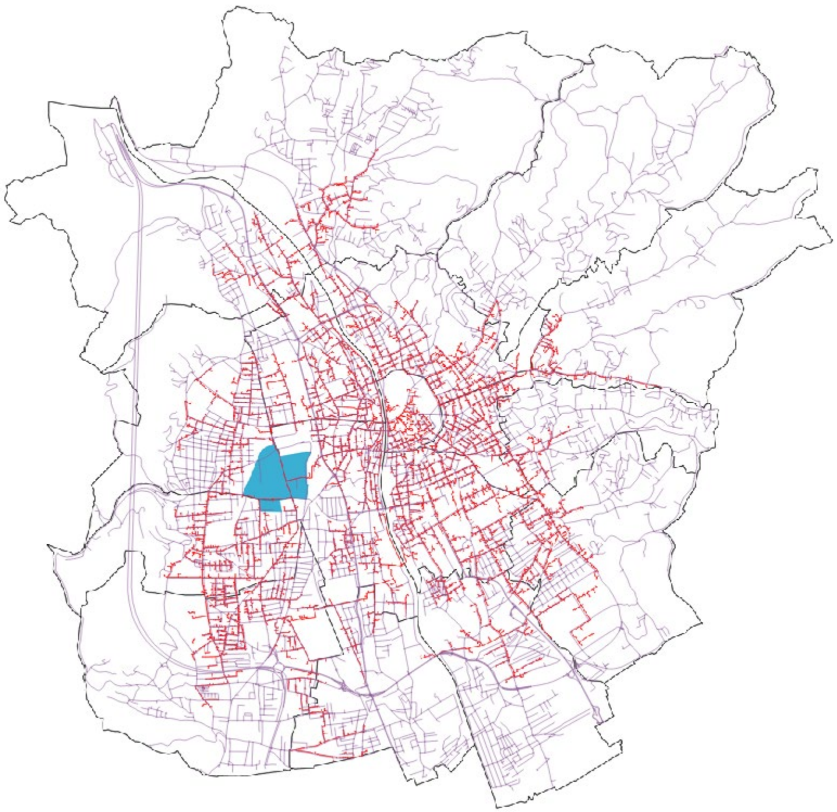


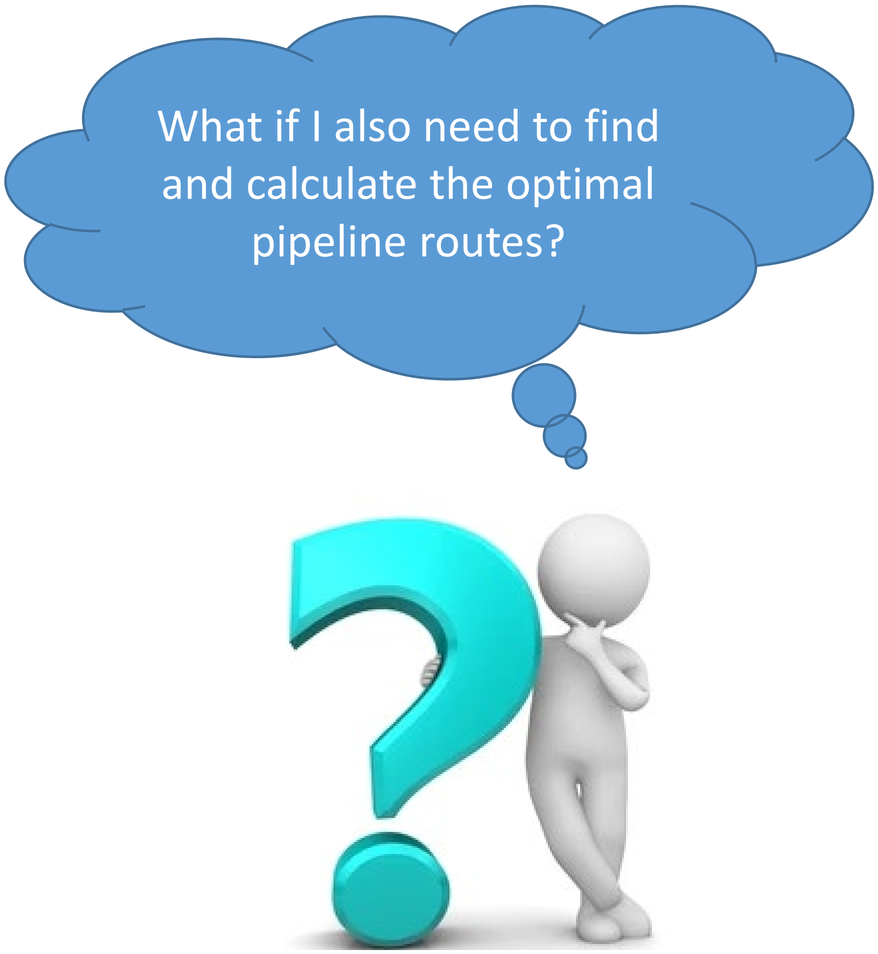
Source: Austrian Heatmap


Source: Energie Graz

What's the challenge?

- Data of DH grid is not available everywhere.
- Having sufficient data on grid, I still need to estimate the costs… and…





DHMIN*

- MILP model for single-commodity energy infrastructure network systems
- It finds maximum revenue tradeoff for the size of network
- I/O & main features:

Inputs

- Peak loads,
- Heat source availability & redundancy,
- Existing pipelines,
- Oblige pipe construction on certain routes,

Outputs

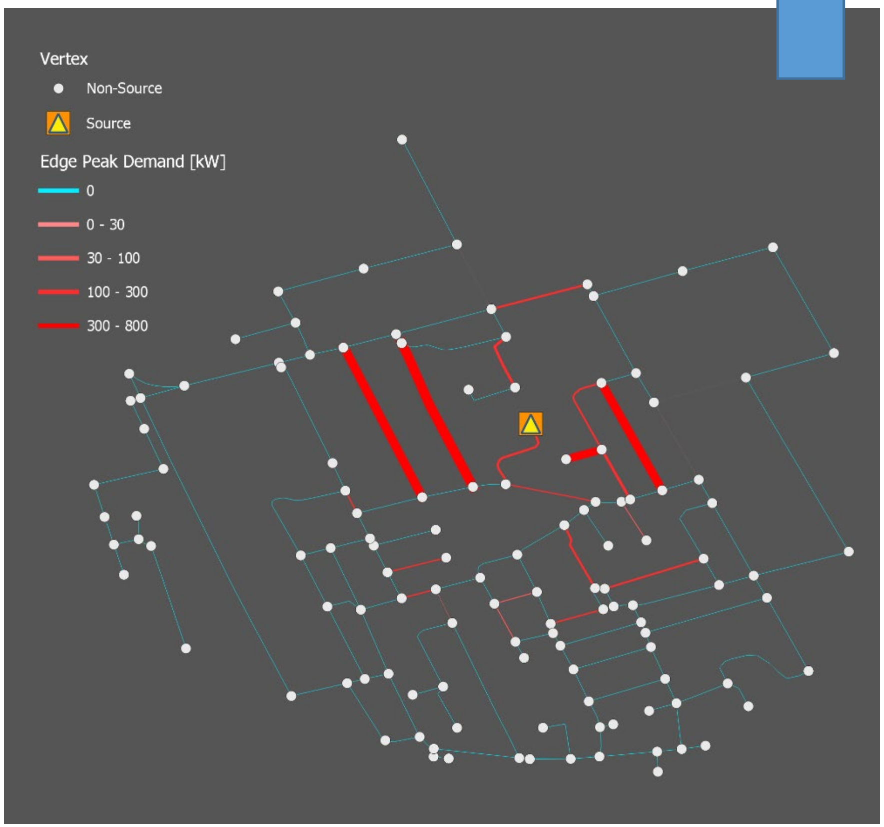
- Grid topology
- Heat sale [MWh]:
  supply – heat_losses
- Revenue made via heat sale [€]
  FED * heat_sale_price
- Distribution grid investment (annuity) [€]

* Reference: Dorfner, Johannes."Open Source Modelling and Optimisation of Energy Infrastructure at Urban Scale”, 2015.

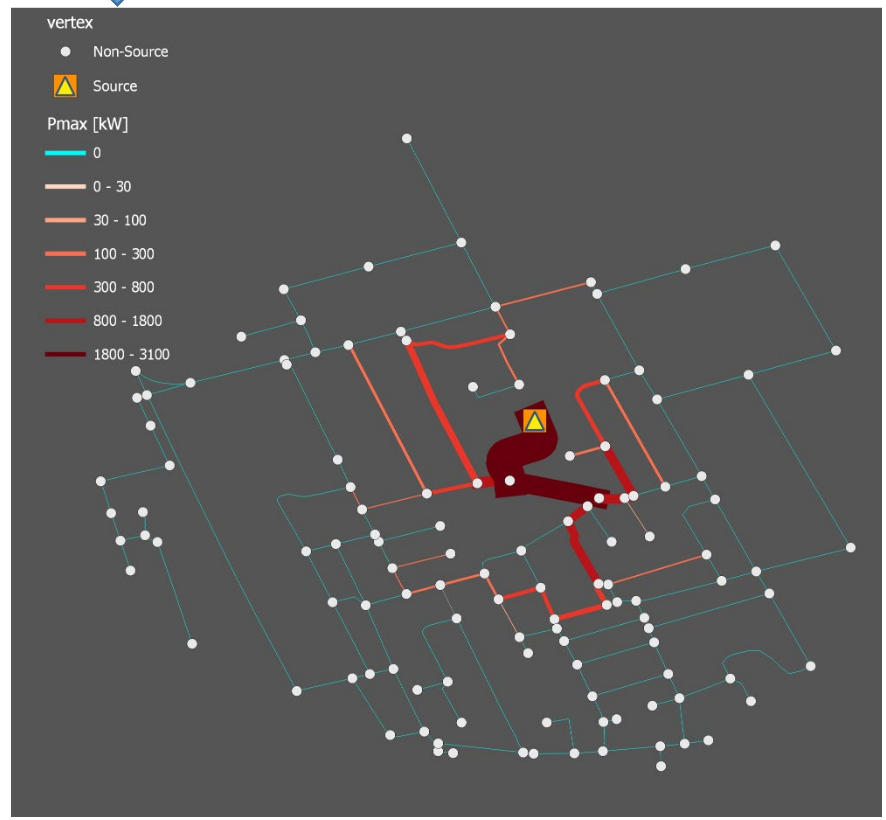
DHMIN Model

Calculation by DHMIN

Edges' Peak Demands [kW]



Max Power Flow [kW]



Steps take for the case study

- Case study: Brasov, Romania.

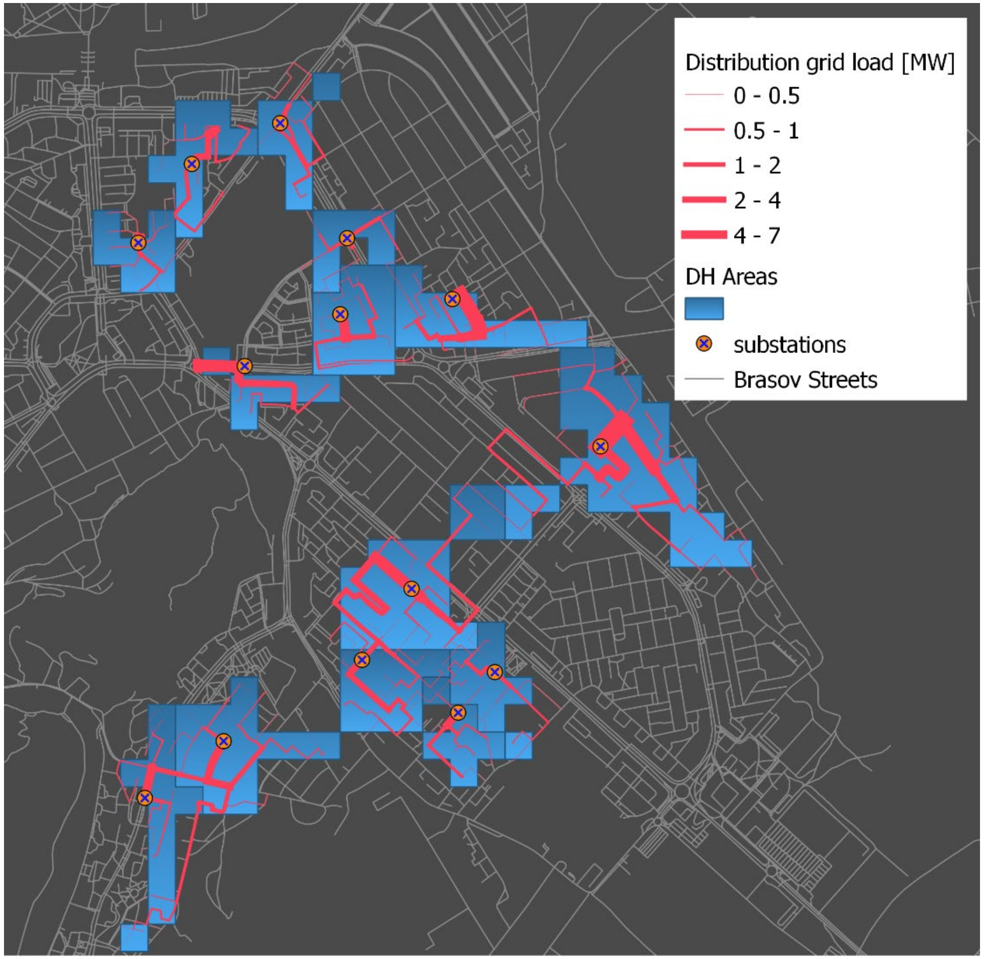
- Inputs:
  - Horizon: 16 years
  - Market share: start → 16% ; end → 62%
  - Grid cost ceiling: 27 EUR/MWh

- Run the model for DH potential areas obtained by approach based on the effective width concept.

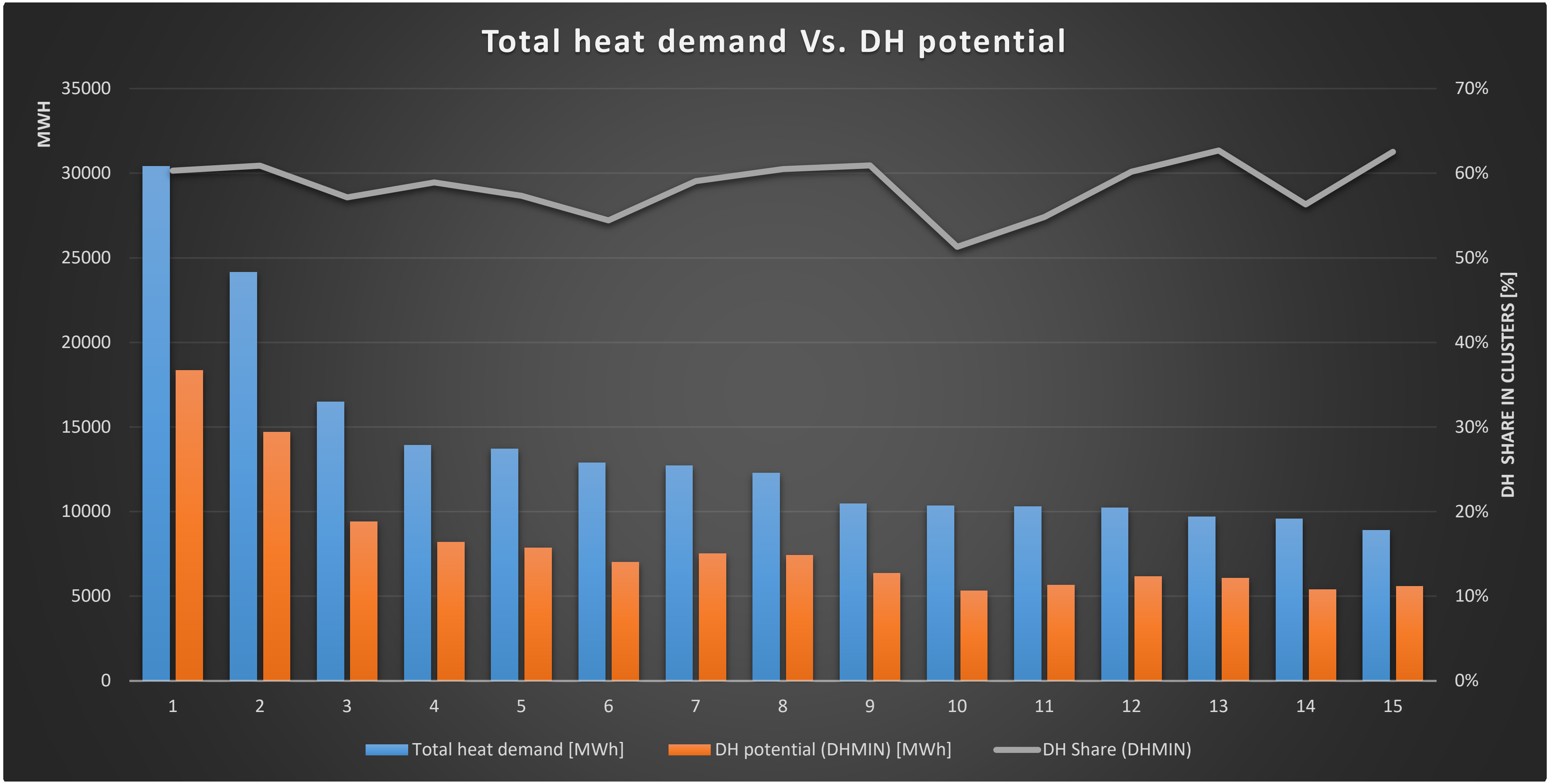
- To do the calculation by DHMIN in a reasonable time, coherent areas obtained by the first approach were broken to smaller areas with a minimum peak load of 3.5 MW (for a substation).

Coherent areas & distribution grid

- Blue regions are obtained from the first approach (15 areas).
- Based on the 1st approach, the DH potential in these areas are set to 62% of the total demand.
- For each region, DHMIN was run separately.
- Red lines show the extension of grids and line capacities obtained from DHMIN.
- The grids are extended as long as they are economic.



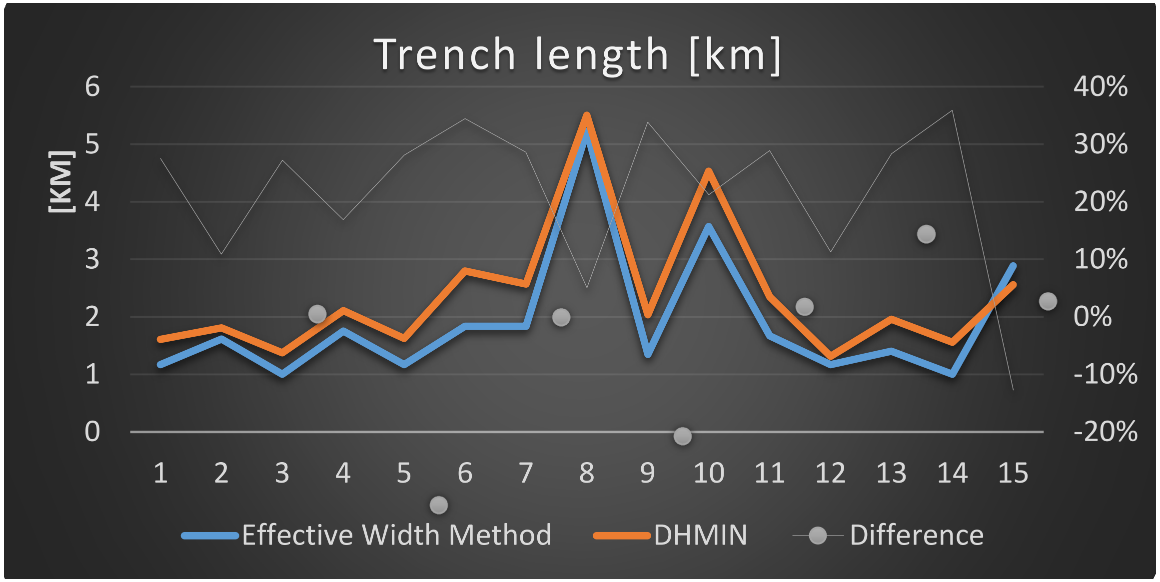
Indicators



Total heat demand Vs. DH potential
MWH
35000
30000
25000
20000
15000
10000
5000
0
70%
60%
50%
40%
30%
20%
10%
0%
DH SHARE IN CLUSTERS [%]
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Total heat demand [MWh]
DH potential (DHMIN) [MWh]
DH Share (DHMIN)

Trench length

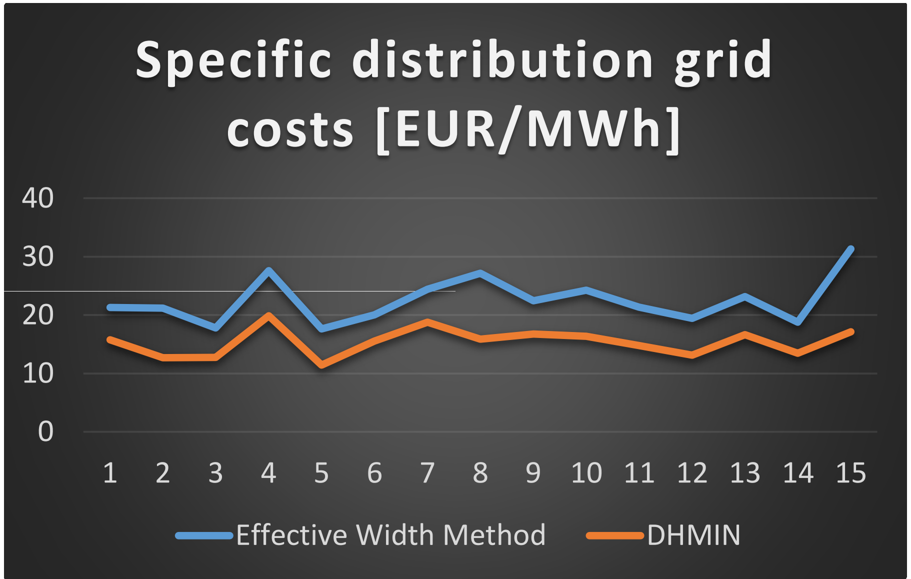
- DHMIN extend the pipelines as long as they are profitable (not all demand segments are covered)
- Both approach closely follow the same trench length pattern.
- The difference is larger in smaller areas
  - Impact from street routes.

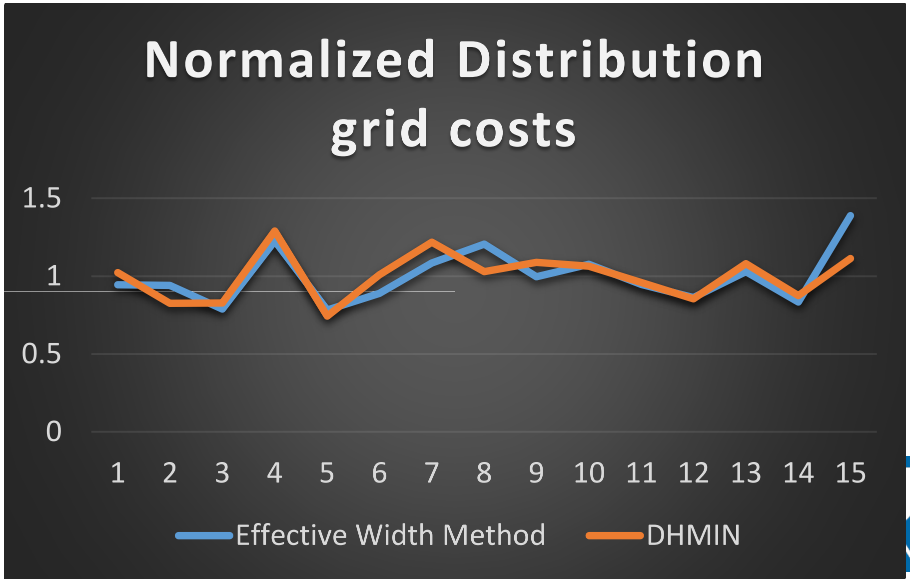


Specific distribution grid costs

- Two methods have different cost components, making their comparison difficult.
  - E.g. although DHMIN leads to higher pipe line length, it's lower specific costs:
    - Due to different input parameter structure.
    - Due to the optimization approach.

- The comparison would be easier if we normalize the specific costs to the average value of each set.
  - Both approaches follow similar pattern.





Conclusion

- Two approaches were compared in this presentation:
  - Approach I: based on the effective width concept
  - Approach II: based on detailed infrastructure optimization model

- The differences in the required input parameters, makes the comparison of two models difficult. However, it can be concluded that:

  "The results follow similar patterns and values."

- The approach I:
  - requires less data and no optimization solver.
  - can be applied to a large area while using approach II for large areas is time consuming.
  - Is suitable for quick analyses and provides acceptable results.
  - If cost parameters are tuned for the case study, provides more accurate results

- Approach II:
  - provides more detailed metrics and more accurate results
  - But requires more data as well as an optimization solver

- The results of this presentation needs to be confirmed by further data collection and analyses.

Thank you for your attention!

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Orig. Photo: Patrick Stargardt