



PROS & CONS OF USING EFFECTIVE WIDTH CONCEPT FOR ESTIMATION OF DISTRICT HEATING DISTRIBUTION GRID COSTS

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Motivation

Motivation

- Effective width is the relationship between a given land area (plot ratio, e) and the length of the district heating pipe network within this area.
- The concept was first introduced by Persson & Werner* and since then, it has been used widely.
- It is used for analytical calculation of linear heat density and subsequently DH distribution grid costs.



* 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.

Approach I: Effective Width

Grid cost calculation based on effective width concept

- 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.
- 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.









Possible answer to the raised question





DHMIN*

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

<u>Inputs</u>

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

<u>Outputs</u>

- 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.

Approach II: DHMIN Model





Steps take for the case study

- Case study: Brasov, Romania.
- Inputs:
 - Horizon: 16 years
 - Market share: start \rightarrow 16% ; end \rightarrow 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





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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