Hypothetical heating grid modelling with graph theory. A decision support tool for planning.

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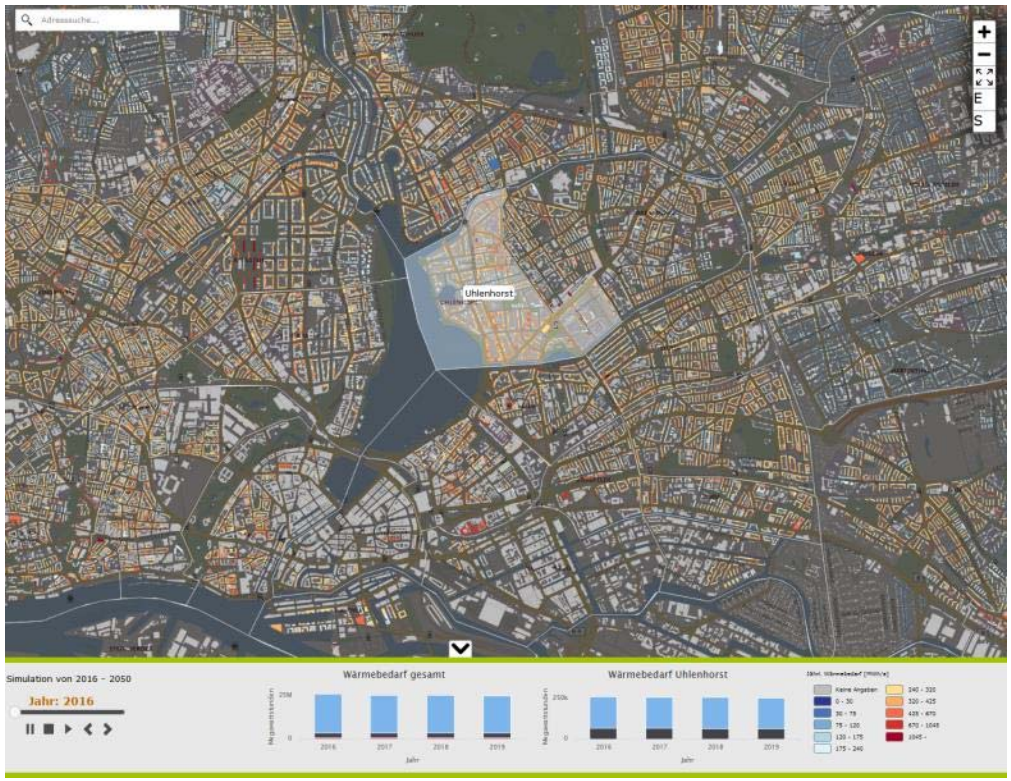
GEWISS Project Hamburg

GEographical Heat- Information and Simulation System (2014-2018)

GIS to support the energy planning by bringing together heat demand, waste heat potential, heating grids and urban development aspects (urban densification, new developments, building renovations) with the possibility to model future scenarios.



GEWISS Project

GEographical Heat- Information and Simulation System (2014-2018)

Linear Heat Density

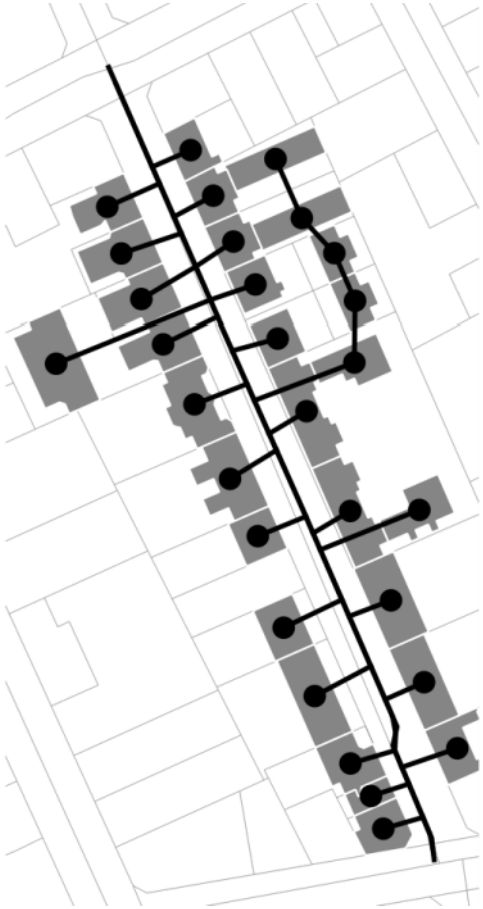
(Wärmebelegungsdichte)

$$LHD = \frac{Q_a}{l}$$

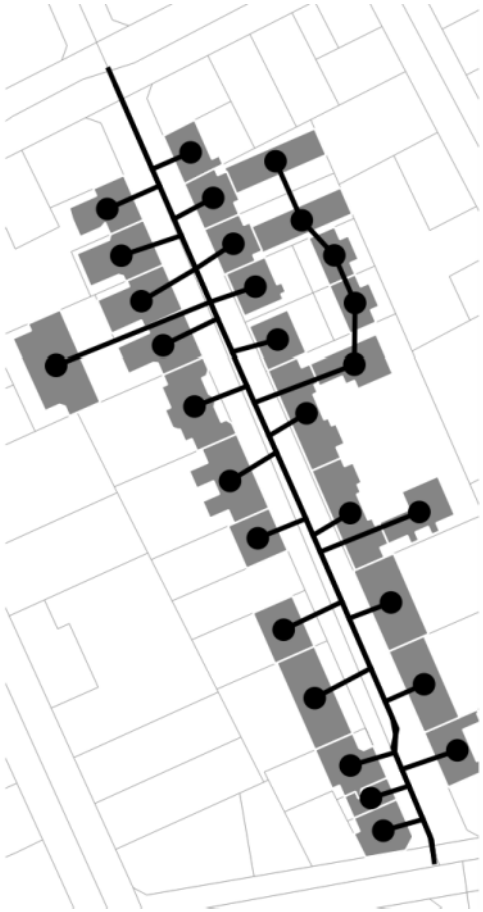
where:

Q_a = Total heat demand of all heat users in MWh/a

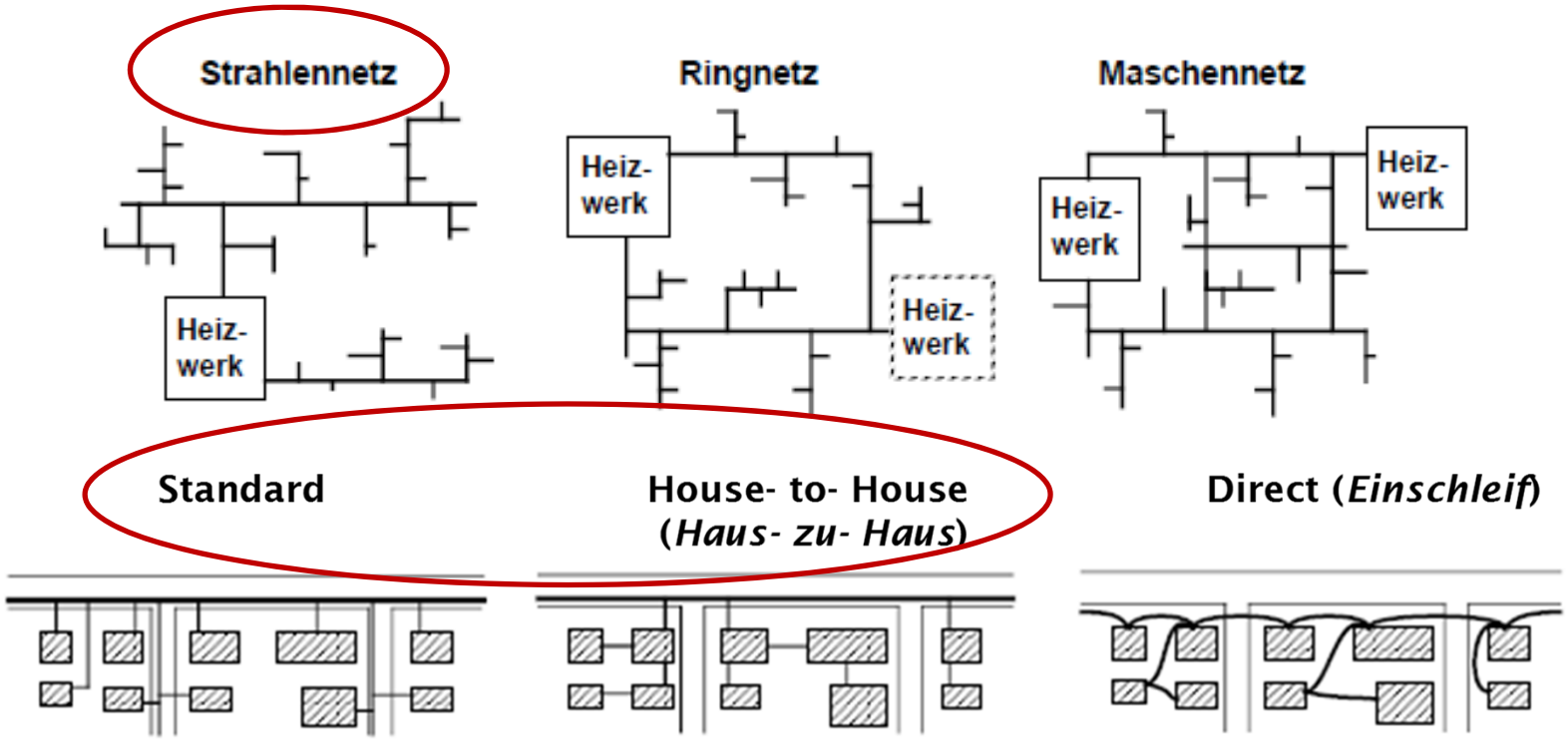
l = Total length of heating grid in meters, supply and return pipes counted as one.



Linear Heat Density at scale?



Types of grid layout



Source: (Fraunhofer Institut für Umwelt-, Sicherheits- und Energietechnik UMSICHT, 1998, p. 37)

Hypothetical grid geometry generation

Making use of Graph Theory – A python numpy implementation of a Minimum Spanning Tree algorithm (Prim's Algorithm). Weights applied to give preference to standard connections.

Example of hypothetical grids

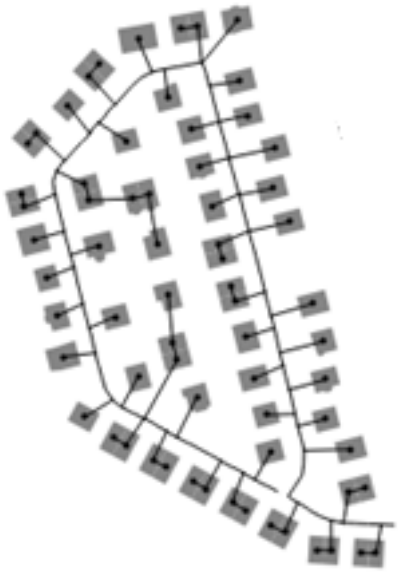
Plausibility

Comparison with two real heating grids (built and operational)

Real length	Hypothetical length	% Diff
1061	951	10%
1493	1280	14%

real

hypothetical



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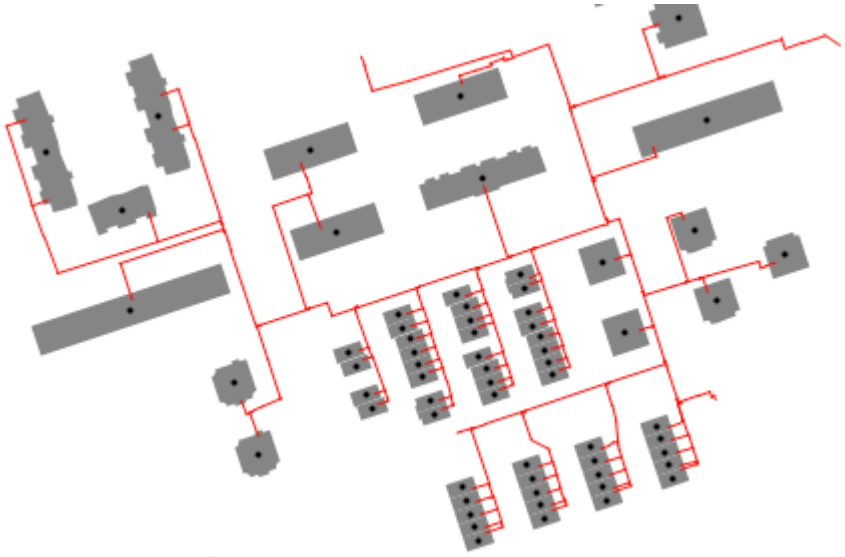
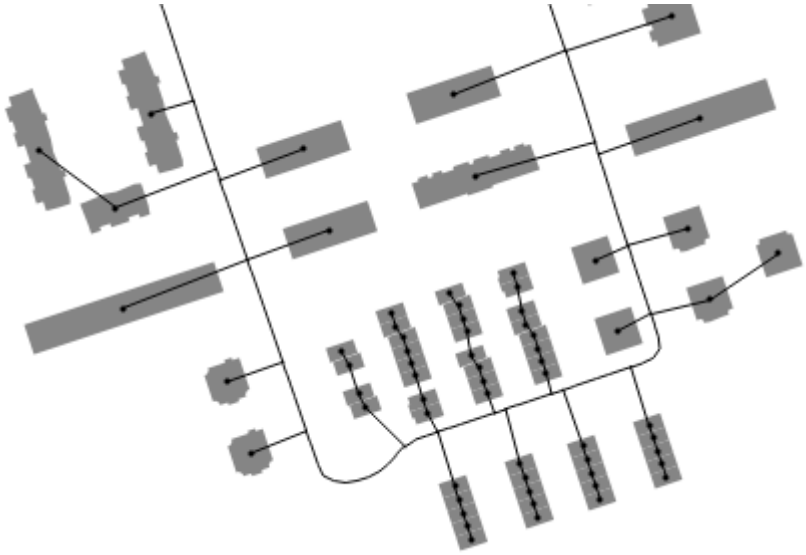
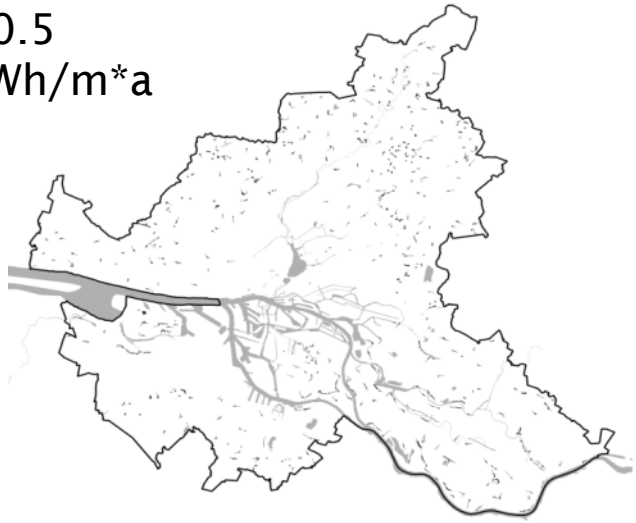


hypothetical

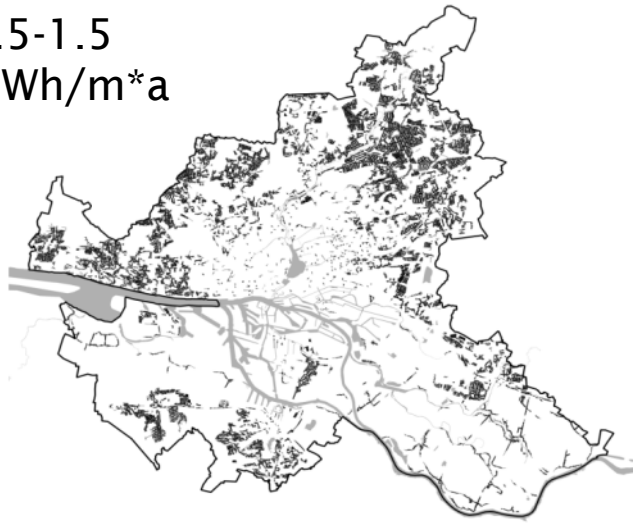


Linear Heat Density Analysis- Spatial Pattern

0-0.5
MWh/m*a

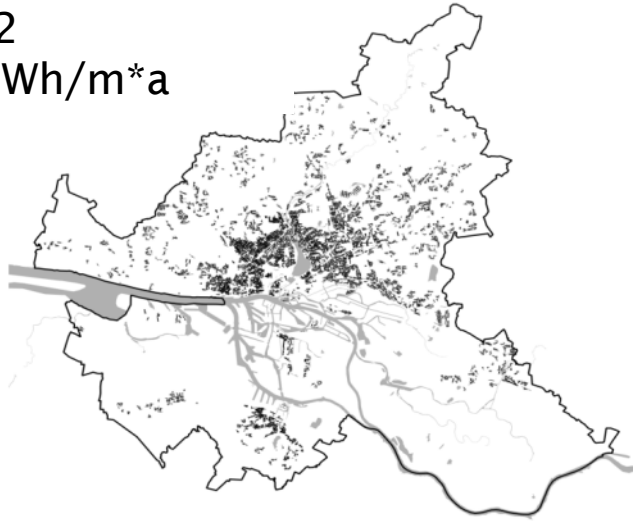


0.5-1.5
MWh/m*a

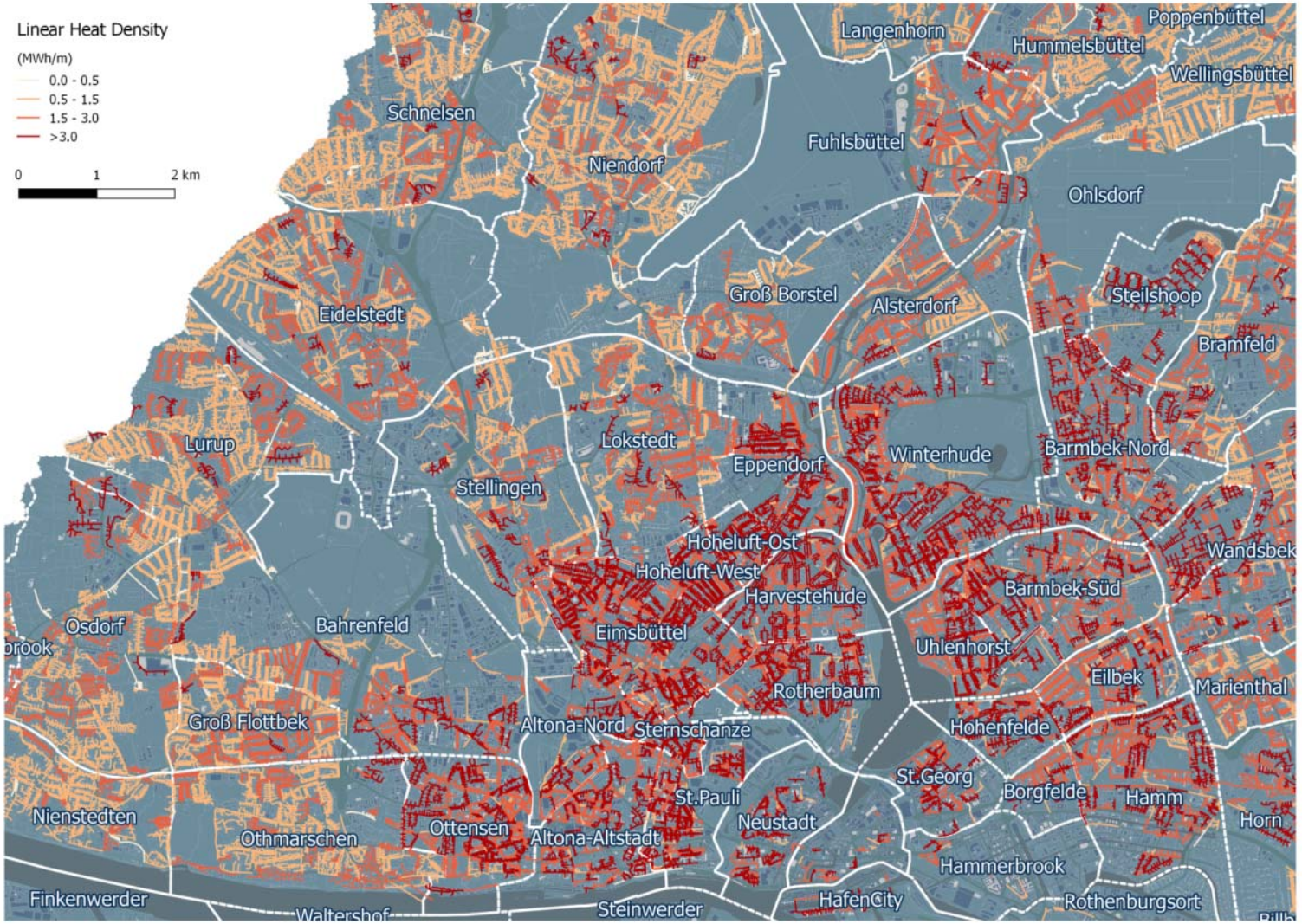


1.5-2
MWh/m*a

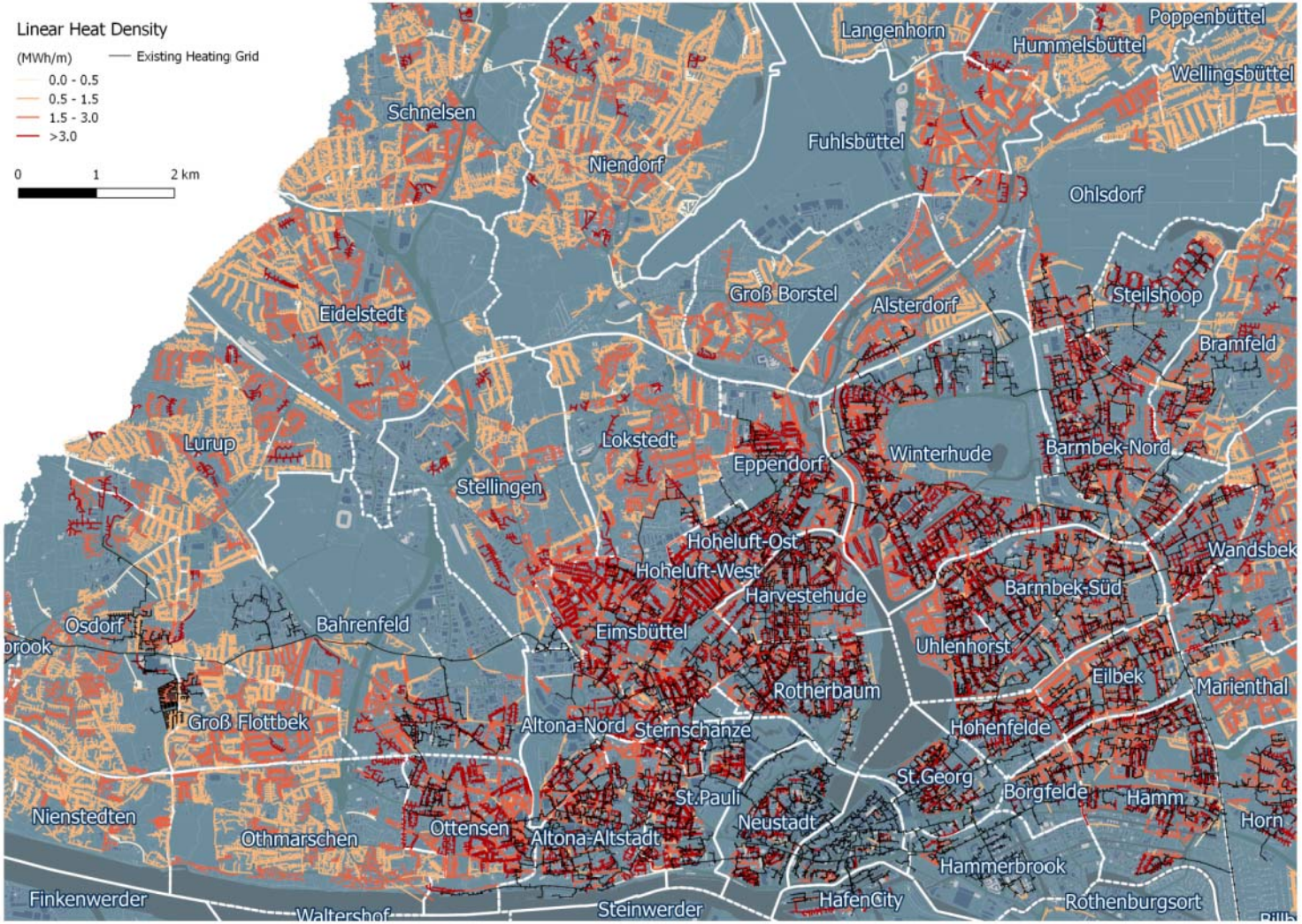
>2
MWh/m*a



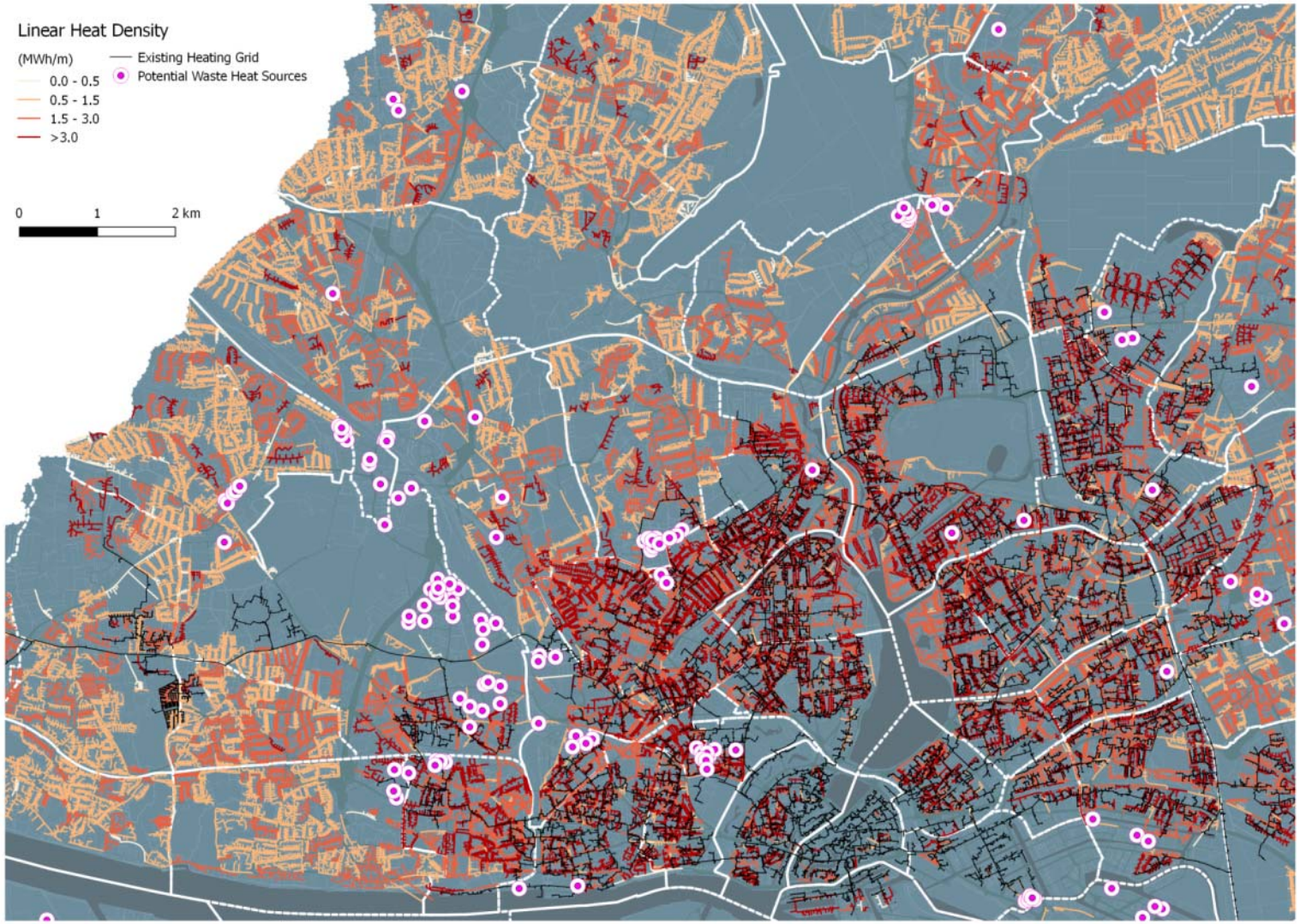
Application – decision support



Application – decision support (2)



Application – decision support (2)



HCU HafenCity University Hamburg

4DH
4th Generation District Heating Technologies and Systems

Thank you for the attention