2050

Heat Roadmap Europe

A low-carbon heating and cooling strategy

Matching district heat demand and excess heat supply using network allocation analysis

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Smart Energy Systems and
4th Generation District Heating
Conference, Copenhagen 2017

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Agenda

- Problem statement
- Analytical framework
- Heat demand densities, DH areas and heat distribution capital costs
- Network allocation analysis
- Outlook

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Problem statement

To which extent can excess heat from power plants (CHP), industry and waste incineration (WtE) be used for district heating?

Possible limiting factors:

- spatial distribution of demand and supply
- seasonal mismatch between heat demand and available excess heat
- scale effects and competition between large and small consumers and producers

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Finding answers: Results and future research

- Workpackage 2
  - Urban Persson, Halmstad University (SE)
  - Bernd Möller, Europa-Universität Flensburg (DE) and Aalborg University (DK)
  - Eva Wiechers, Europa-Universität Flensburg
  - others
- Workpackage 6

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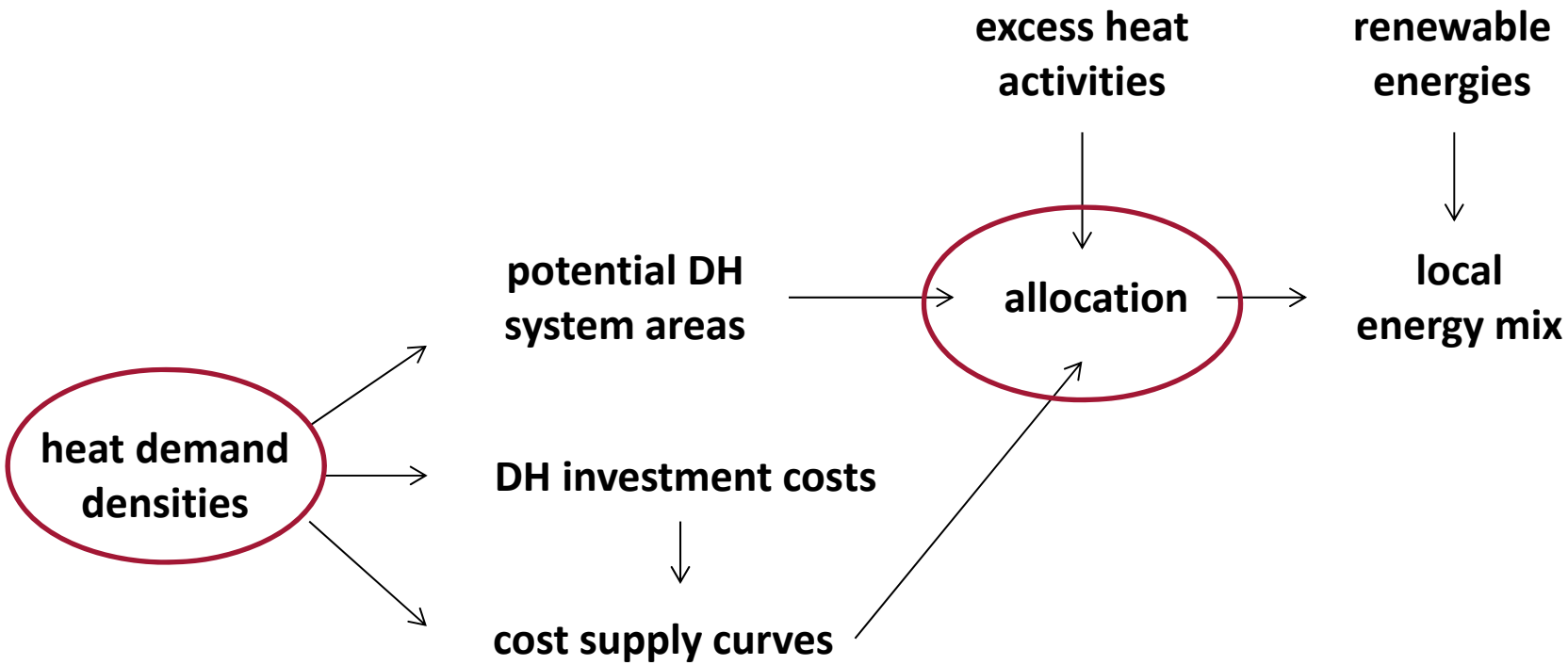
Analytical framework



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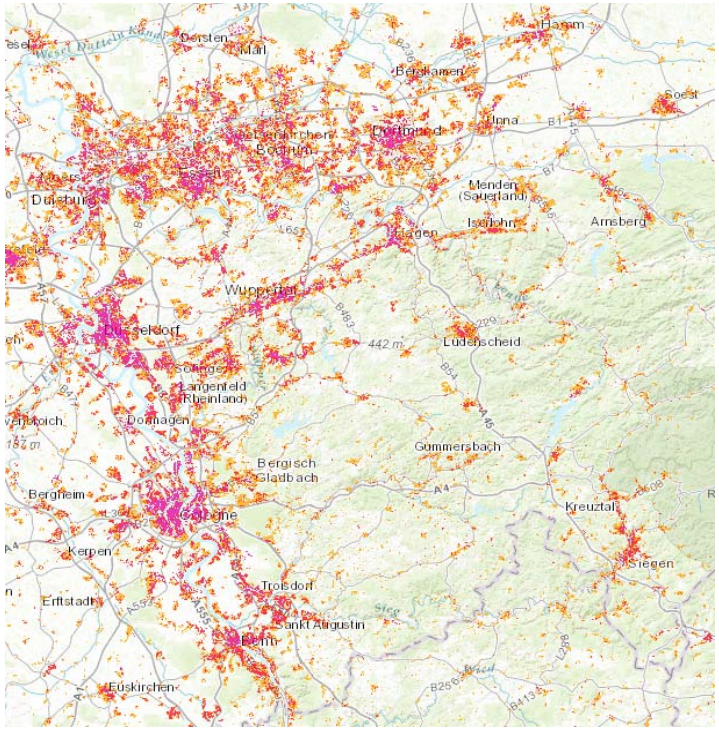
Heat demand densities



Source: Peta4.2

- heat demand per hectare
  - based on multiple linear regression analyses
  - one method for all European countries

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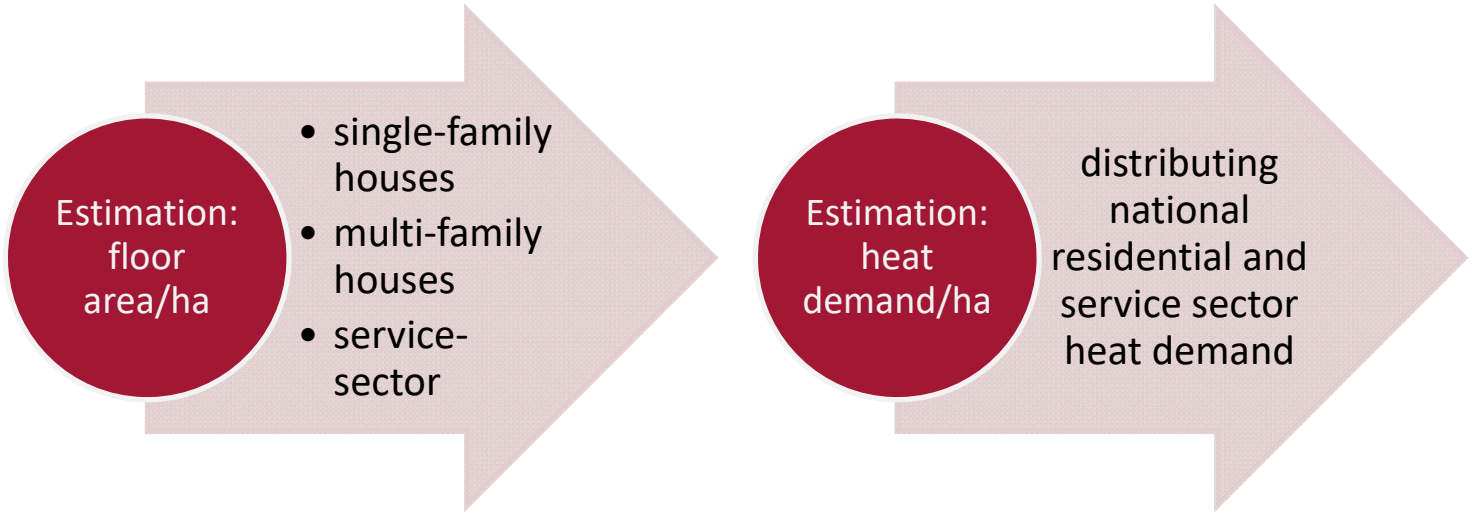
Heat demand densities: Scope and Approach

- Residential heat and cold demand
- Service-sector heat and cold demand



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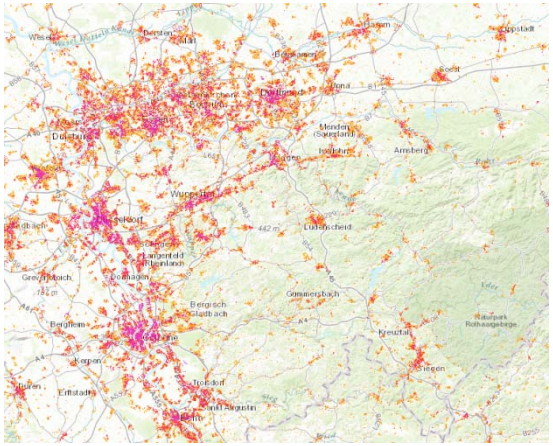
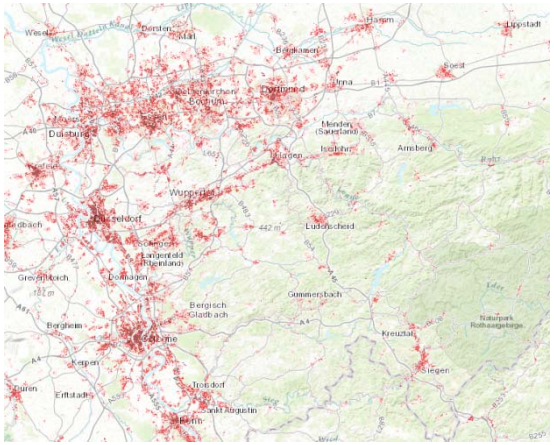
Inputs for local cost-supply curves

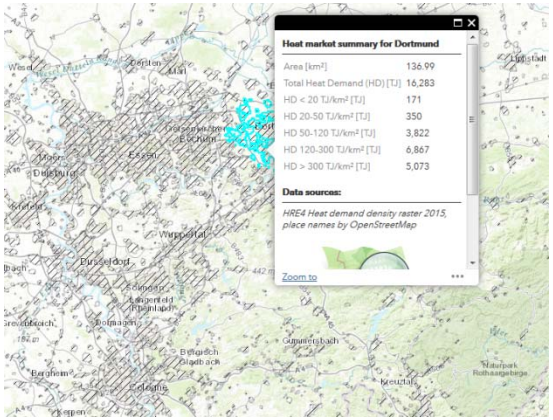
Heat demand density
100x100m



Marginal distribution capital costs
100x100m



Prospective
supply areas



Source: Peta4.2

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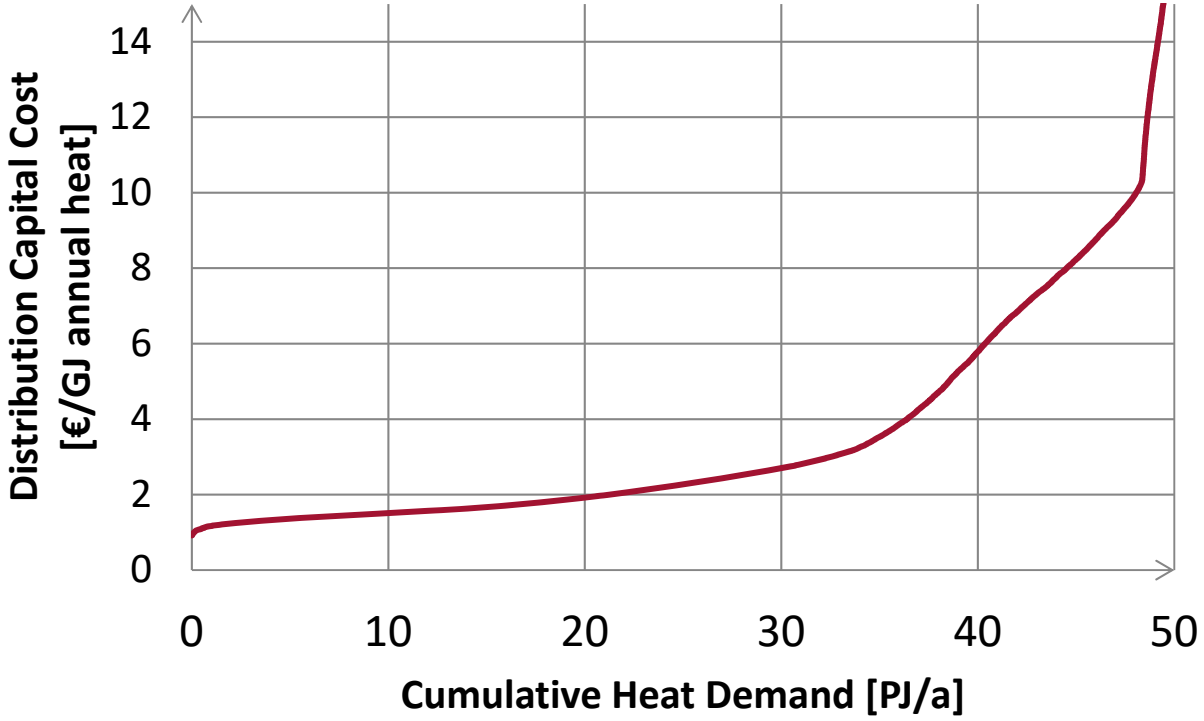
Local cost-supply curves

Example: Hamburg



Source: own figure

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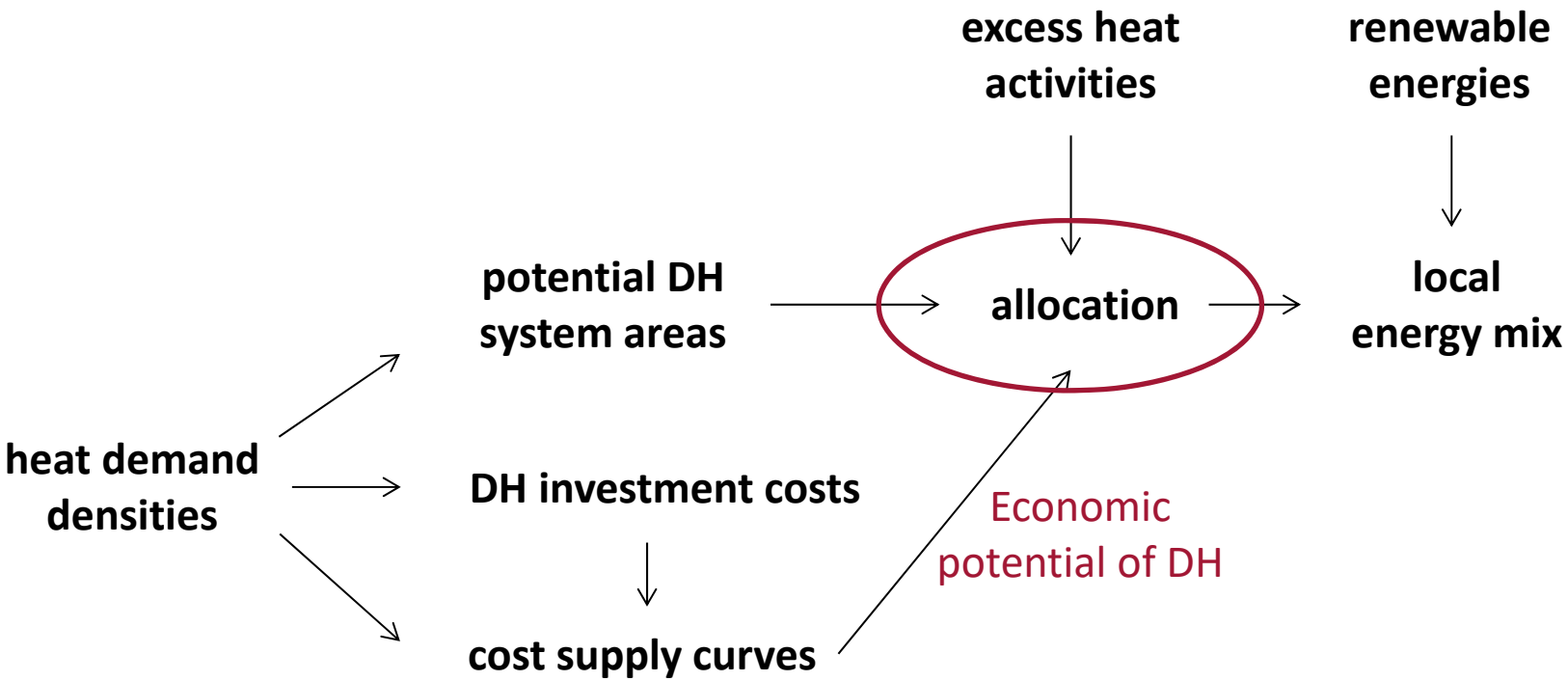
Analytical framework



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Network allocation analysis

Maximizing the use of excess heat while minimizing piping distance

- Distributing excess heat from more than 2,000 facilities
- To almost 50,000 prospective supply areas
- ArcGIS location-allocation solver „Maximise Capacitated Coverage“

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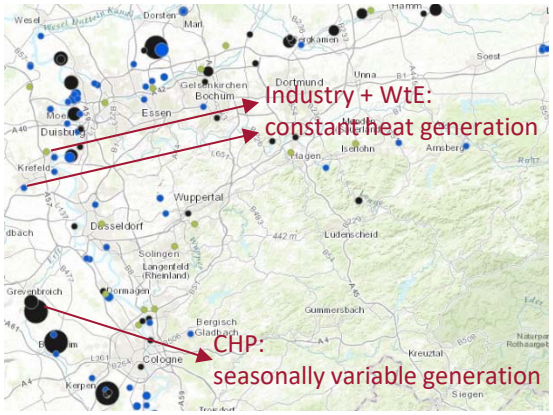
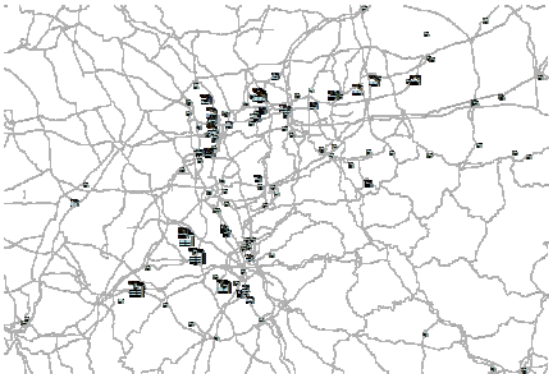
Network allocation analysis
Inputs

Excess heat activities



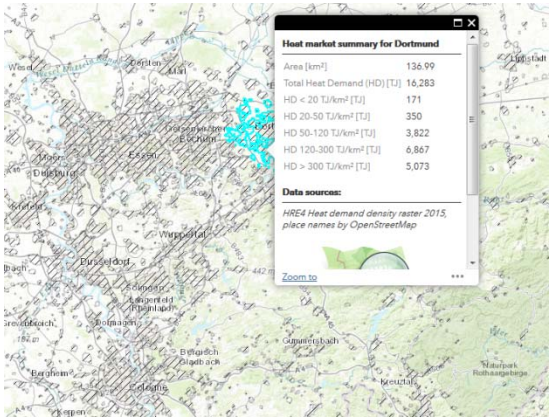
Source: Peta4.2

Network (gROADS)



Source: own figure, gROADS_v1_EU28 (CIESIN, Columbia University & ITOS - University of Georgia, 2013)

Prospective supply areas



Source: Peta4.2

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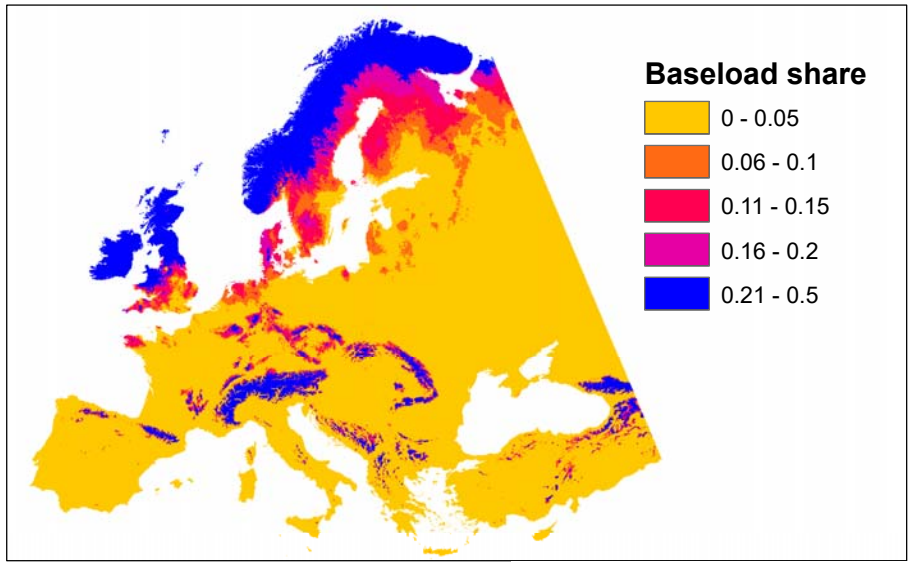
European baseload shares in heat supply

Monthly degree days have been used to identify the annual share of the lowest heat demand. Network losses have to be added.



Source: Own figure,
based on University of Alberta data, created with ArcGIS

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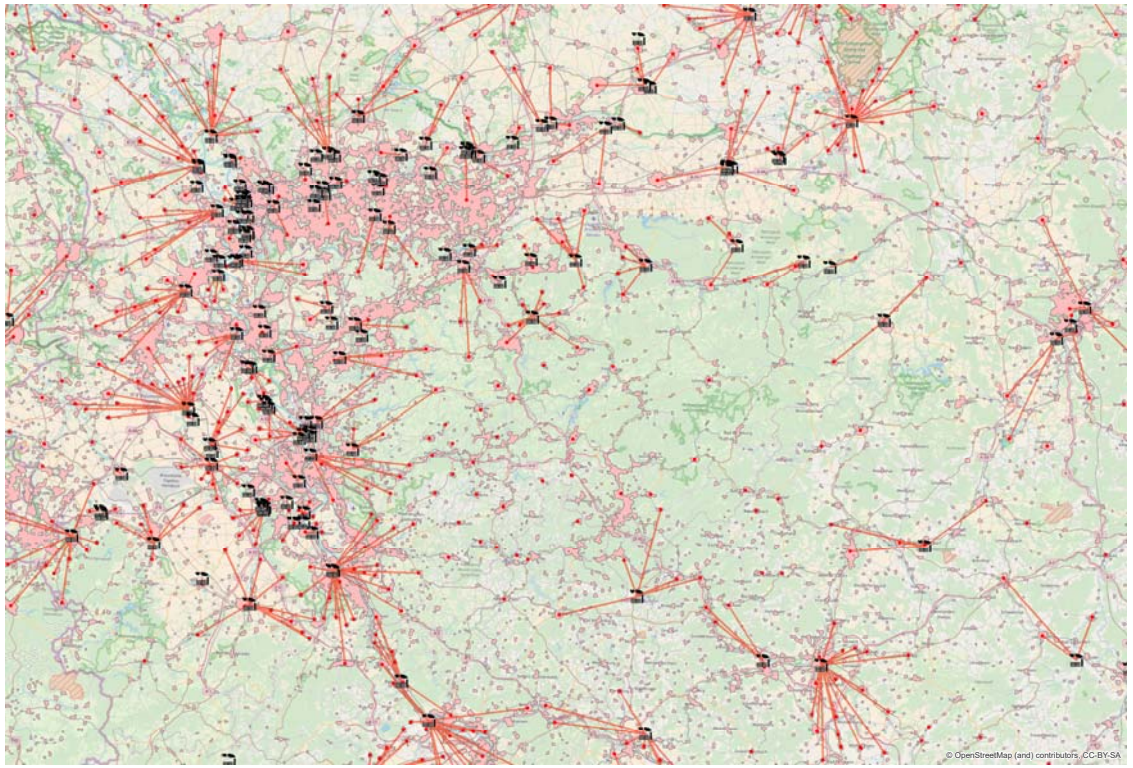
Allocation of excess heat to prospective district heating areas



Example for the Ruhr-district in Germany
Source: Own figure, created with ArcGIS

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Network allocation analysis
Tabular output

Facility table

Facility ID	Capacity [PJ/a]	No. of allocated DHS	Connected demand [PJ]	Distance [m]
43815	2.38	1	5.6746	9,185
43884	2.65	2	2.91393	12,685
43895	0.85	1	0.235465	1,971
189170	0.54	0	0	-
43871	0.20	1	0.006573	27,297
43932	7.02	0	0	-
44291	0.28	0	0	-
74041	11.60	0	0	-
44246	3.99	1	2.26636	3,782
237270	0.20	1	0.096805	1,328

„Pipe“ table

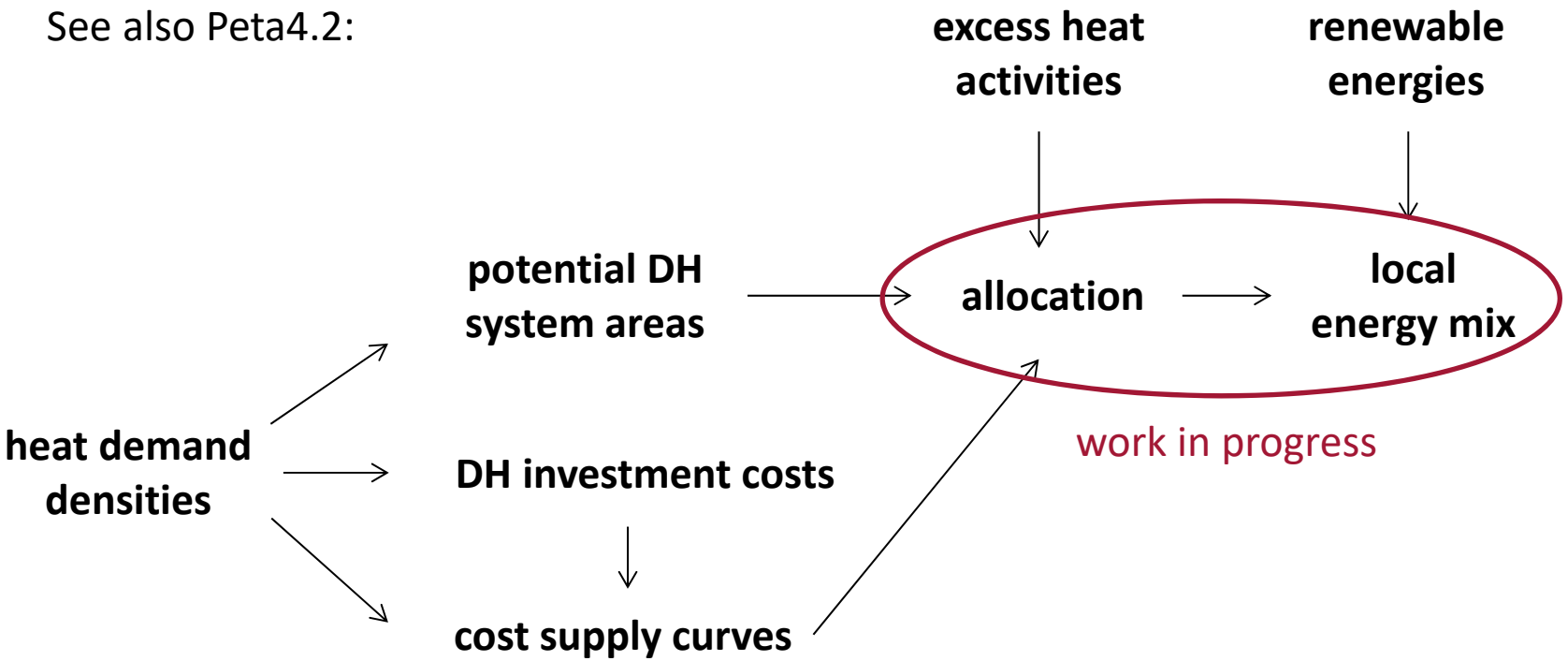
Facility ID	DHS ID	Heat transported [PJ/a]	Length [m]
1438	2787	5.675	9,185
1441	2788	1.013	10,832
1441	2789	1.901	1,852
1442	2922	0.235	1,971
1708	2751	0.084	17,780
1740	3011	0.007	27,297
1741	2786	4.016	1,055
1767	2799	2.266	3,782
1825	2894	0.097	1,328
1836	2919	0.004	2,754

District heating system table

DHS ID	Demand [PJ]	Supply facility ID	Allocated demand [PJ]	Allocated demand %
410968	0.016	1843	0.016	100%
411823	0.004	1843	0.004	100%
412021	0.084	1708	0.043	51%
412630	0.001	1851	0.001	100%
413398	0.295	1843	0.295	100%
414926	0.032	1884	0.032	100%
415147	4.016	1741	4.016	100%
415147	5.675	1438	5.675	100%
415147	1.901	1441	1.901	100%
415147	0.420	1848	0.420	100%

Analytical framework

See also Peta4.2:



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Thank you for listening.

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