sEEnergies Webinar: Energy Efficiency, Spatial Potentials and Possible Future Developments

sEEnergies Webinar 2022-04-21

Halmstad University (HU), Europa-Universität Flensburg (EUF), Swedish Environmental Institute (IVL), Aalborg University (AAU)

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sEEnergies Webinar: Zoom link

This project has received funding from the European Union's Horizon 2020 Research and Innovation Action under Grant Agreement No 846463.

Outline

sEEnergies webinar: Energy Efficiency, Spatial Potentials and Possible Future Developments

- Overview
  - 09:00 **Welcome**
    - by Brian Vad Mathiesen, Aalborg University
  - 09:05 **The low temperature district heating perspective**
    - Presented by Kristina Lygnerud, Swedish Environmental Institute
  - 09:15 **Modelling investment costs for future district heating systems in Europe**
    - Presented by Urban Persson, Halmstad University
  - 09:30 **Spatial analytics and the sEEnergies Index**
    - Presented by Bernd Möller, Europa-Universität Flensburg
  - 09:45 **Discussion and feedback**
  - 10:00 **Webinar end**

The low temperature district heating perspective

Webinar on Energy Efficiency, Spatial Potentials and possible future developments

April 21,2022

Kristina Lygnerud
Associate Professor
Industrial and Financial Economics
Halmstad University
Swedish Environment Research Institute, IVL

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant ageement No 767429

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Who is presenting to you? - *Kristina Lygnerud*

Assistant professor in energy technology at Halmstad University since 2015

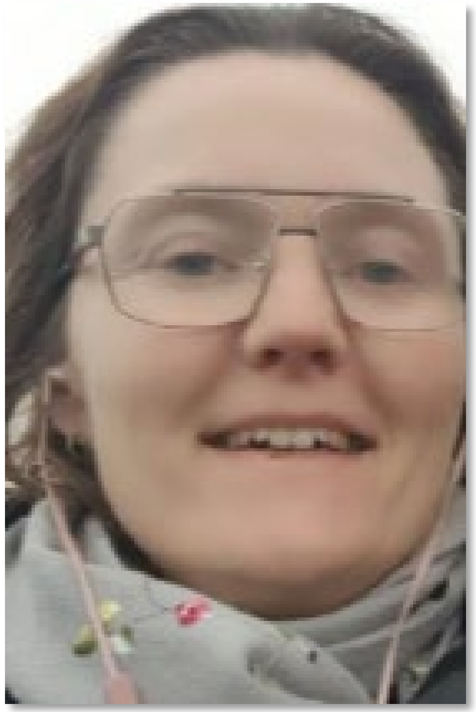
Intraprenur in district energy at the Swedish Environment Research Institute since 2021 (earlier energy group manager)

Been **active with district heating research since 2004**. PhD in 2010 with ”Risk management in district heating systems”- NOT AN ENGINEER ☺

Coordinate ReUseHeat (H2020: EU)

Active in the research field of **business model innovations**

On the **DHC+ board** since 2018 (chair since 2021)



REUSEHEAT

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Agenda

1. The waste heat recovery potential
2. ReUseHeat demonstrators and their key learnings
3. 9 factors to consider when installing low temperature district heating from the IEA-DHC project “Annex TS2- low temperature district heating implementation”
4. Conclusions

1. The waste heat potential

Industrial waste heat in the EU

- 25% of the EU heating demand/yr
- A small fraction is recovered into DH

Table 1
Survey of annual volumes of recovered industrial excess heat supplied to national district heating sectors during 2014, and the corresponding proportions of the heat supply to these national district heating sectors. Sources for this information are referenced in the text.

	Industrial heat recovery, PJ	Proportion of total heat supply
Denmark	2.6	2.1%
Finland	2.9	2.3%
France	2.2	2.4%
Germany	4.0	1.6%
Russia	330.8	6.0%
Sweden	17.8	9.0%

Low temperature waste heat in the EU

- 10% of the EU heating demand/yr
- A very small fraction is recovered into DH

Sources: Lygnerud & Werner 2018, Risk assessment of industrial excess heat recovery in district heating systems samt www.reuseheat.eu

The low temperature district heating perspective

by Kristina Lygnerud, Swedish Environmental Institute

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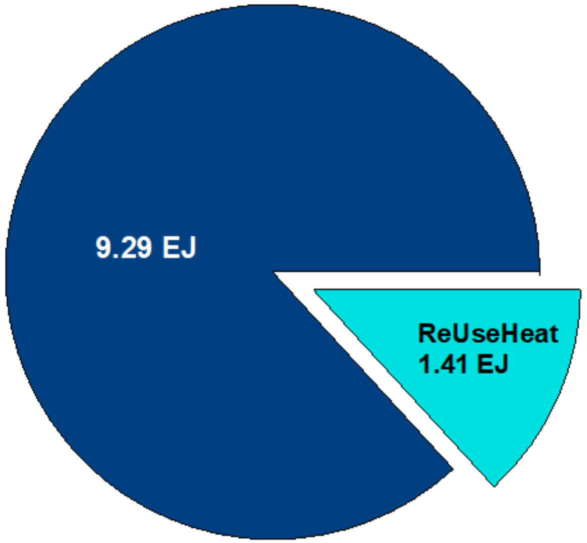
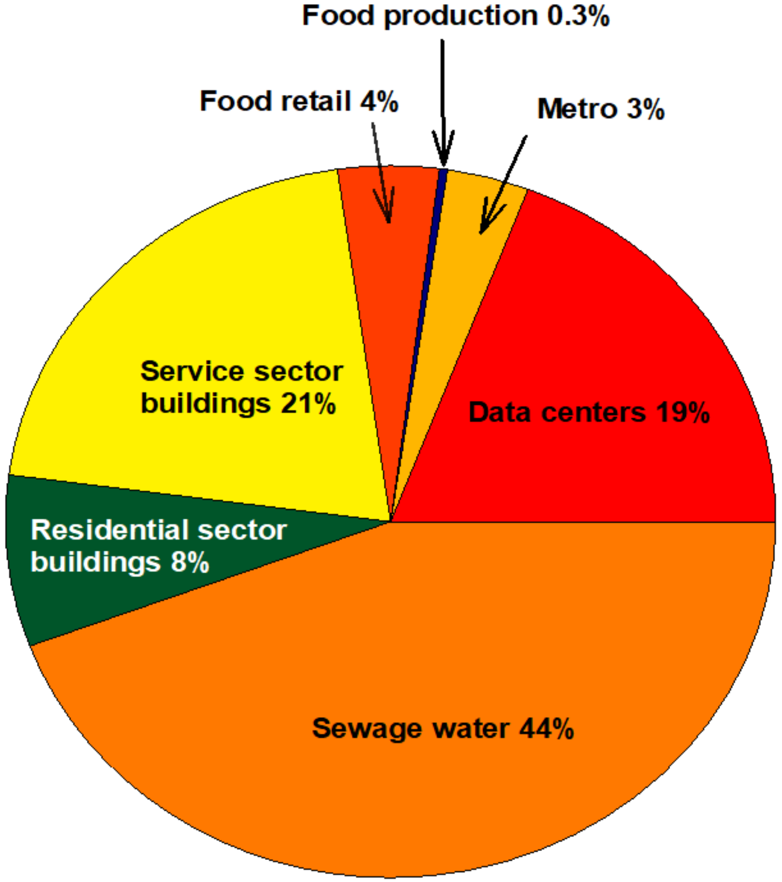
1. The waste heat potential

The urban heat sources

- 25% of the EU heating demand/yr
- A small fraction is recovered into DH





Source: www.reuseheat.eu: Handbook

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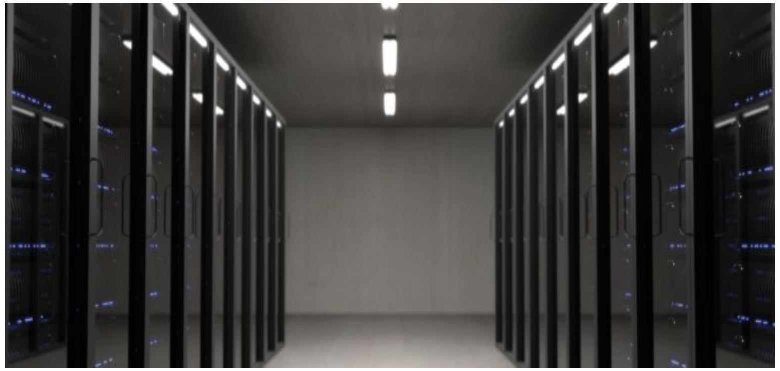
2. ReUseHeat demonstrators and key learnings

Datacenter heat recovery



Key learnings

- Keep distance between heat source & customer as short as possible
- A low temperature DHN is needed for making use of the heat
- Replicability is limited: copy paste solutions are rare
- Heat recovery is not the core business of the datacenter and therefore of limited interest
- Heat recovery is news to datacenter owners, enegy companies and installers (leads to long pay backs)
- Risk management was applied in a connection to the high temperature DHN
- Datacenters scale up gradually, a ready building does not equal full IT loads
- There will be more waste heat than can be used
- Hot water installations need to be agreed with the construction company for maximized efficeincy

2. ReUseHeat demonstrators and key learnings

Service Sector Building heat recovery (hospital)

Key learnings

- Special attention should be given to agreement with public entities (extended terms and deadlines)
- Sensors and control equipment are important to recognize deviances quickly
- Cooling towers exist in many buildings, the potential is large
- Full year heat recovery is the efficient level, seasonal heat recovery is not sufficient
- Replicability is limited: copy paste solutions are rare
- In depth knowledge of building needed to fit installation
- The equipment will need a long fitting period
- Pandemic and extreme weather complicated the installation

2. ReUseHeat demonstrators and key learnings

Infrastructure heat recovery (metro)

Key learnings

- Keep distance between heat source & customer as short as possible
- Security regulation is heavy in metro systems: permits can take long
- Heat recovery is not the core business of the metro operator and therefore of limited interest
- Metro tunnels have metal dust in the air, this must be managed for efficient operation of heat pump
- Heat recovery in tunnels is highly modular and replicable
- Surrounding soil conditions will impact the heat of the system (clay versus other)
- The best point in time to install metro tunnel heat recovery is when a station is built or rebuilt

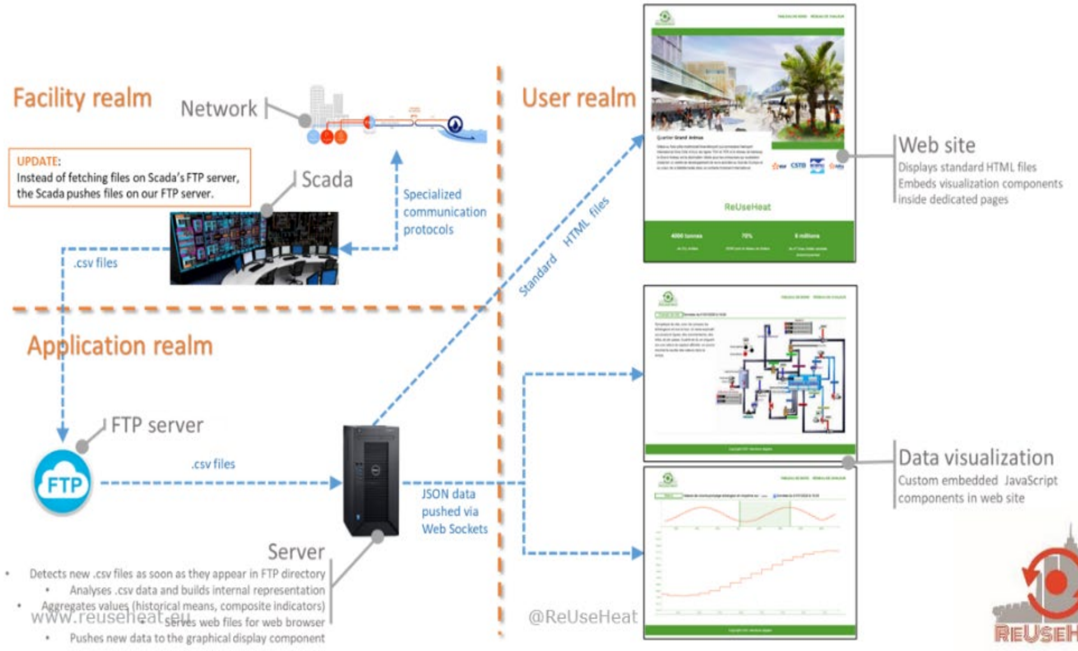
2. ReUseHeat demonstrators and key learnings

Awareness building demo (dashboard)

Key learnings

- Information must be kept as simple as possible
- Data must be visualized and contextualized in a way that the viewer understands
- Design thinking approach was efficient (collecting feedback in multiple stages)
- Dashboard feeds on data, datastreams must be avaliable and data management systems able to provide the requested data - in ReUseHeat errors in datastreams were detected (cross- fertilization)

… awareness can lead to end user demand for low temperature district energy



3. Key learnings from IEA-DHC work on low temperature Implementation guidebook

Definition of low temperature district heating

Our definition of 4GDH in this guidebook applies to all new technological features and concepts using low temperatures, which are considered best available from 2020 onward. As experienced in previous technology generations, a wide diversity of technology choices in 4GDH is expected. Hence, cold district heating systems are also included in our definition of 4GDH. The corresponding technology comprises all heat distribution technologies that will utilise supply temperatures below 70 °C as the annual average. 4GDH technology is a family of many different network configurations for heat distribution. Notably, cold and warm networks are siblings in this family of configurations.

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3. Key learnings from IEA-DHC work on low temperature Implementation guidebook

9 cost impacts from heat supply to heat use

1. **More geothermal heat extracted from wells** since lower-temperature geothermal fluid can be returned to the ground.
2. **Less electricity used in heat pumps** when extracting heat from heat sources with temperatures below the heat distribution temperatures **since lower pressures can be applied in the heat pump condensers.**
3. **More industrial excess heat extracted** since lower temperatures of the excess heat carrier will be emitted to the environment.
4. **More heat obtained from solar collectors** since their heat losses are lower, thereby providing higher conversion efficiencies.

The low temperature district heating perspective

by Kristina Lygnerud, Swedish Environmental Institute

5. **More electricity generated per unit of heat recycled** from steam CHP plants

   since higher p-t-h ratios are obtained with lower steam pressures in the turbine condensers

6. **More heat recovered from flue gas condensation** since the proportion of vaporised water (steam) in the emitted flue gases can be reduced.

7. **Higher heat storage capacities** since lower return temperatures can be used in conjunction with high-temperature outputs from high-temperature heat sources.

8. **Lower heat distribution losses** with lower average temperature differences between the fluids in heat distribution pipes and the environment.

9. **The ability to use plastic pipes** instead of steel pipes to save cost.

4. Conclusions on low temperature waste heat recovery

It….

- is a global trend
- is technically feasible
- can enrich the heat mix of DH companies
- lowers CO_2 emissions
- is necessary in a future where combustion is no longer an option (fossil fuels, biomass? and waste)
- necessitates standardization (contracts and permits)
- necessitates incentives to make investments comparable to investments in RES
- necessitates stakeholders to interact in new ways
- necessitates a waste heat legislation in the EU
- necessitates end user awareness and demand
- necessitates a cost of carbon that reflects the true costs of its externalities

Thank you for listening!

Modelling investment costs for future district heating systems in Europe

by Urban Persson (Halmstad University) and Bernd Möller (Europa-Universität Flensburg)

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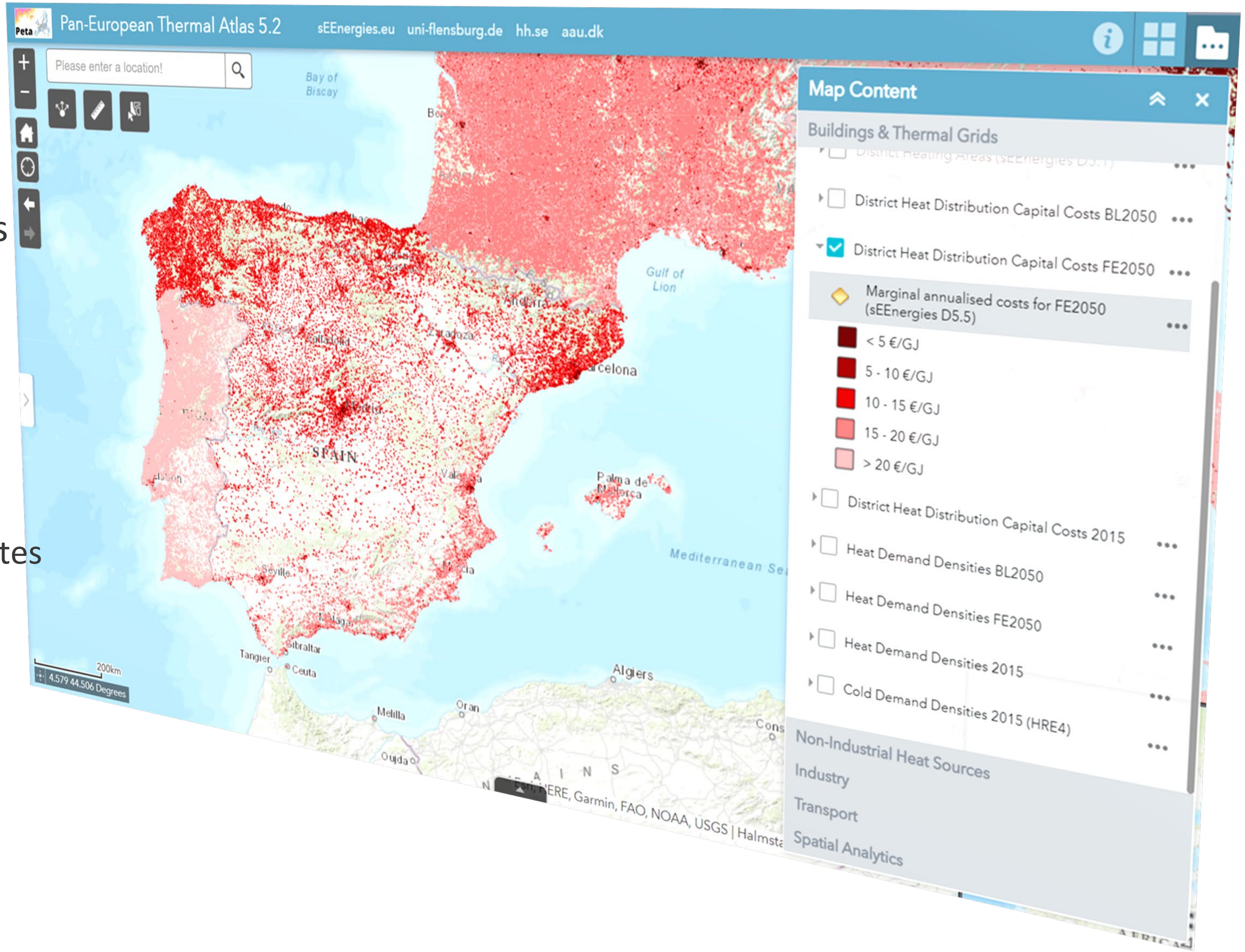
    - e-mail: urban.persson@hh.se

- Personal information
  - Bernd Möller
    - Professor in Energy Systems Management
    - Europa-Universität Flensburg (DE)
    - Phone: +49-461-805 2506
    - e-mail: bernd.moeller@uni-flensburg.de

Modelling investment costs for future district heating systems in Europe

by Urban Persson, Halmstad University

- Brief overview
  - Model background:
    - Quantities and structure
    - Previous developments and results
  - Model development:
    - Physical suitability
      - Future population model
    - Economic suitability
      - Effective width and plot ratio
      - Construction costs by Member States
      - Distribution and service pipes
  - sEEnergies model results
    - EU cost curves



Modelling investment costs for future district heating systems in Europe

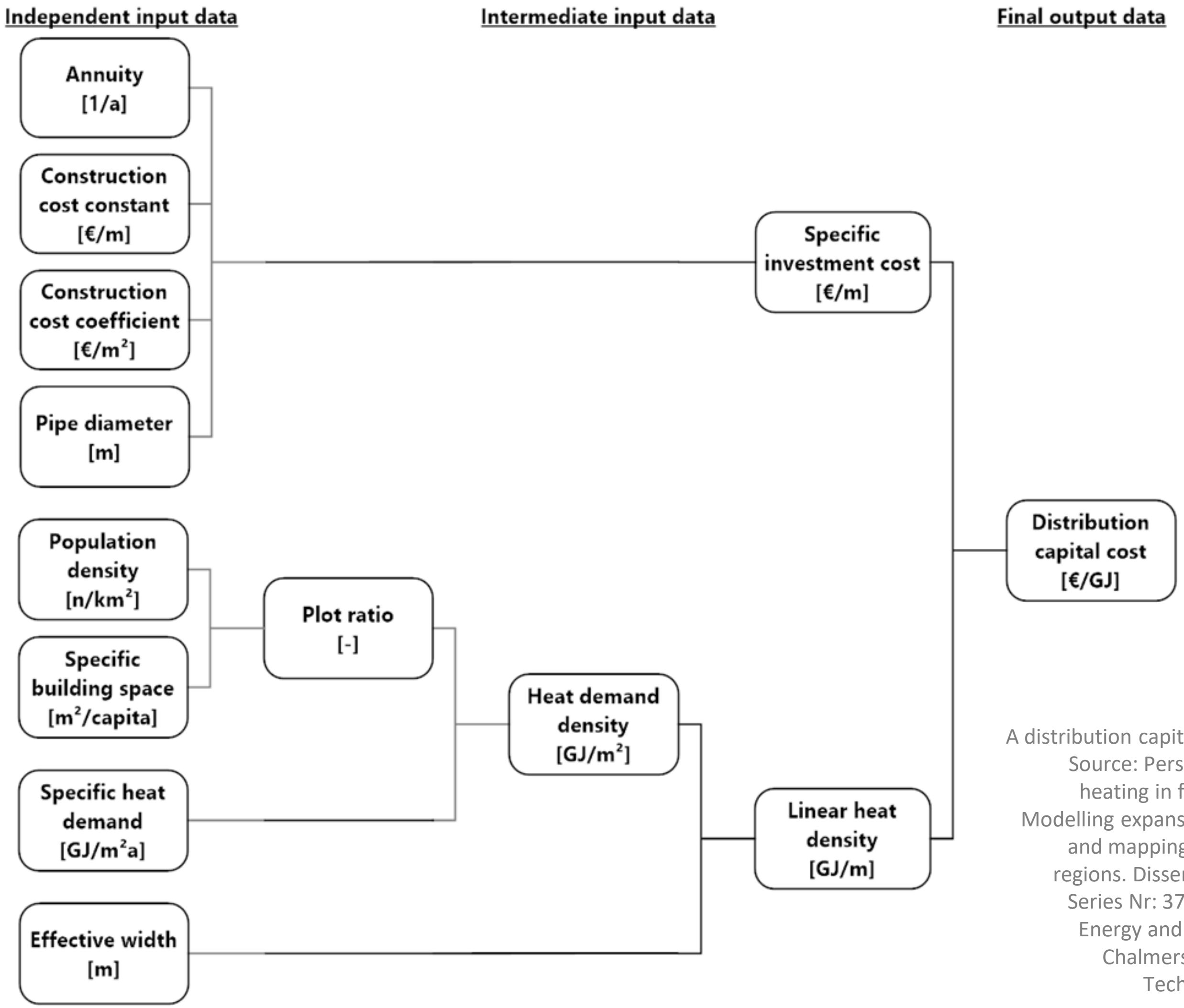
by Urban Persson, Halmstad University

- Model background:
  - Quantities and structure
    - The District Heating Distribution Capital Cost (DHDCC) model
      - Distribution system
        - Network pipes circulating a media fluid
      - Main output:
        - The specific distribution capital cost

$$\text{The specific distribution capital cost } (C_d)$$
$$= a \cdot \frac{I}{Q_S} = Annuity \cdot \frac{\text{Total network investment cost } [€]}{\text{Annually sold district heat } [\frac{GJ}{a}]} \left[\frac{€}{GJ}\right]$$

- Basic equation, introducing trench length (L):

$$C_d = a \cdot \frac{I}{Q_S} = a \cdot \frac{\left(\frac{I}{L}\right)}{\left(\frac{Q_S}{L}\right)} \quad \left[\frac{€}{GJ}\right]$$



A distribution capital cost model. Source: Persson U. District heating in future Europe: Modelling expansion potentials and mapping heat synergy regions. Dissertation Thesis. Series Nr: 3769. Göteborg: Energy and Environment, Chalmers University of Technology, 2015.

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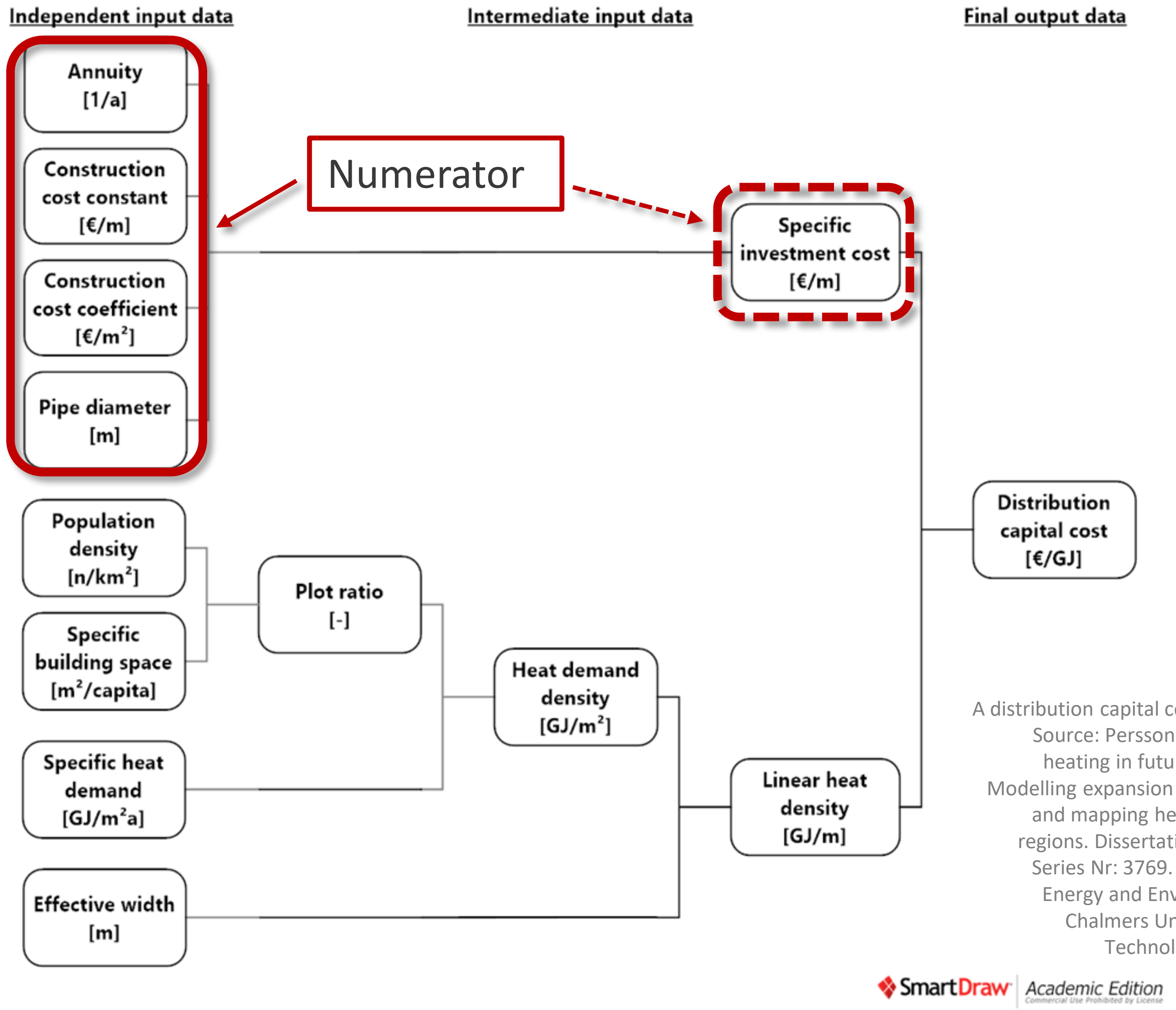
- Numerator independent input data:

$$C_d = a \cdot \frac{(C_1 + C_2 \cdot d_a)}{\left(\frac{Q_S}{L}\right)} \quad \left[\frac{€}{GJ}\right]$$



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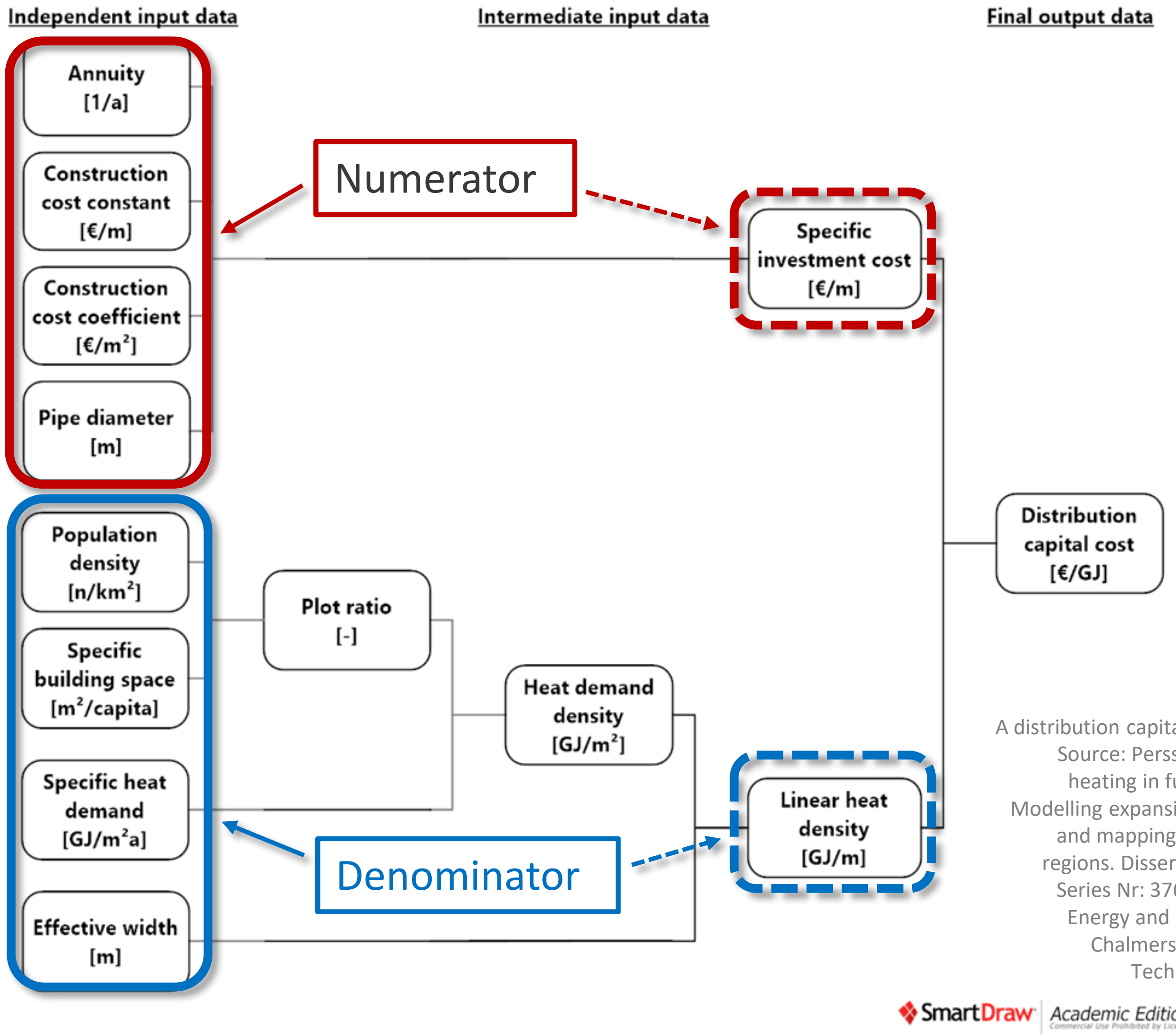
  - Denominator independent input data:

$$C_d = a \cdot \frac{(C_1 + C_2 \cdot d_a)}{p \cdot \alpha \cdot q \cdot w} \quad \left[\frac{€}{GJ}\right]$$



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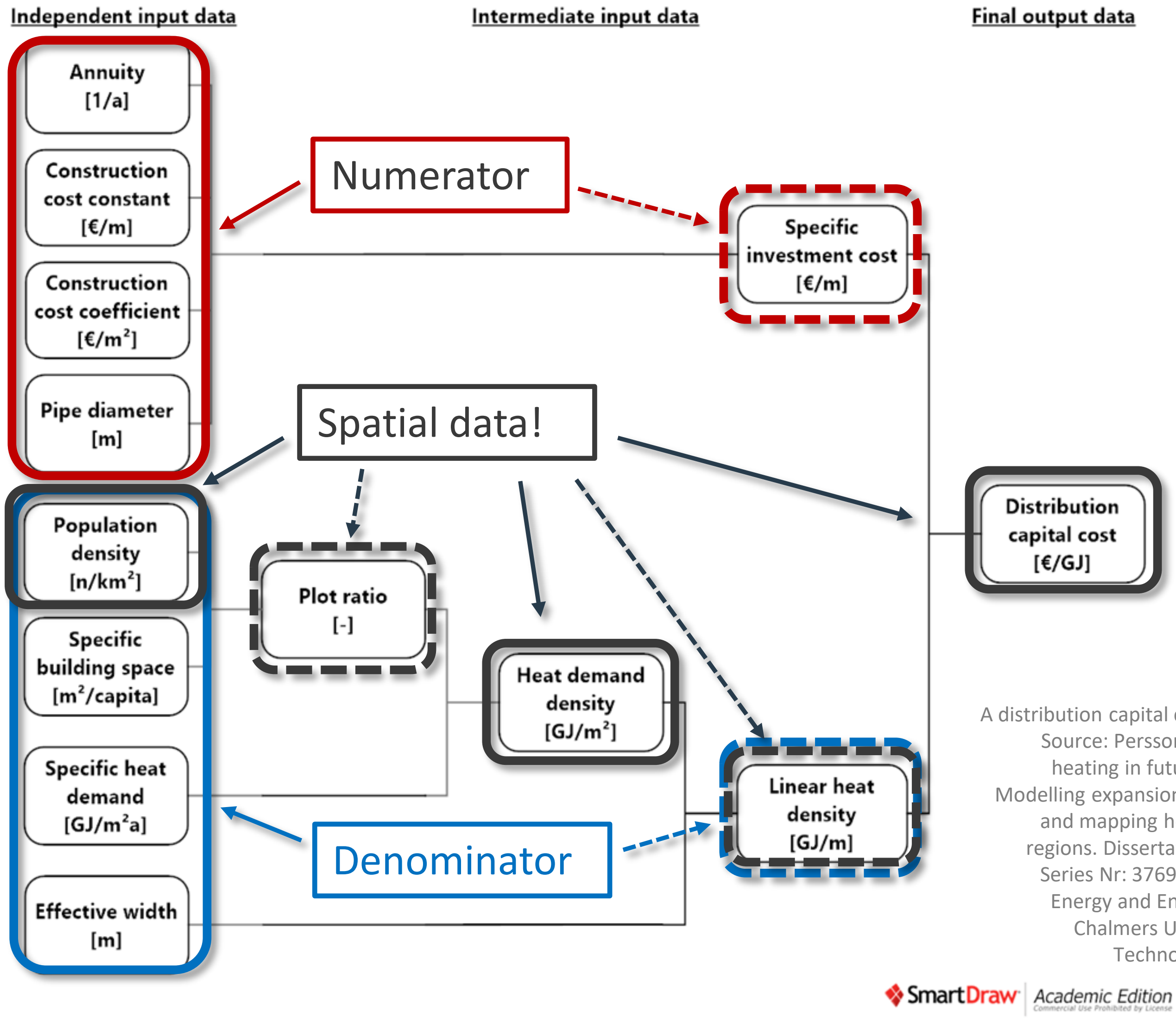

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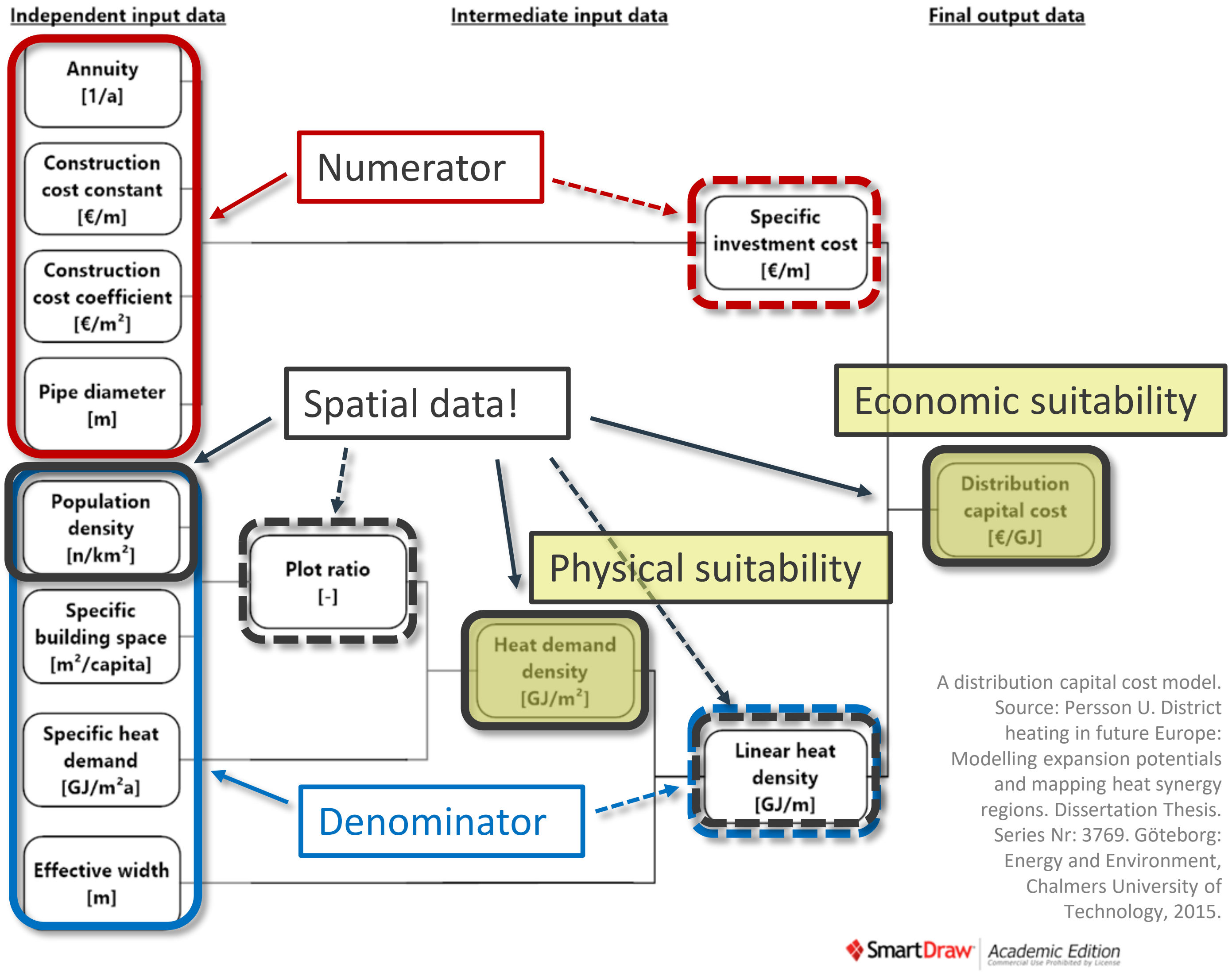

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- Model background:
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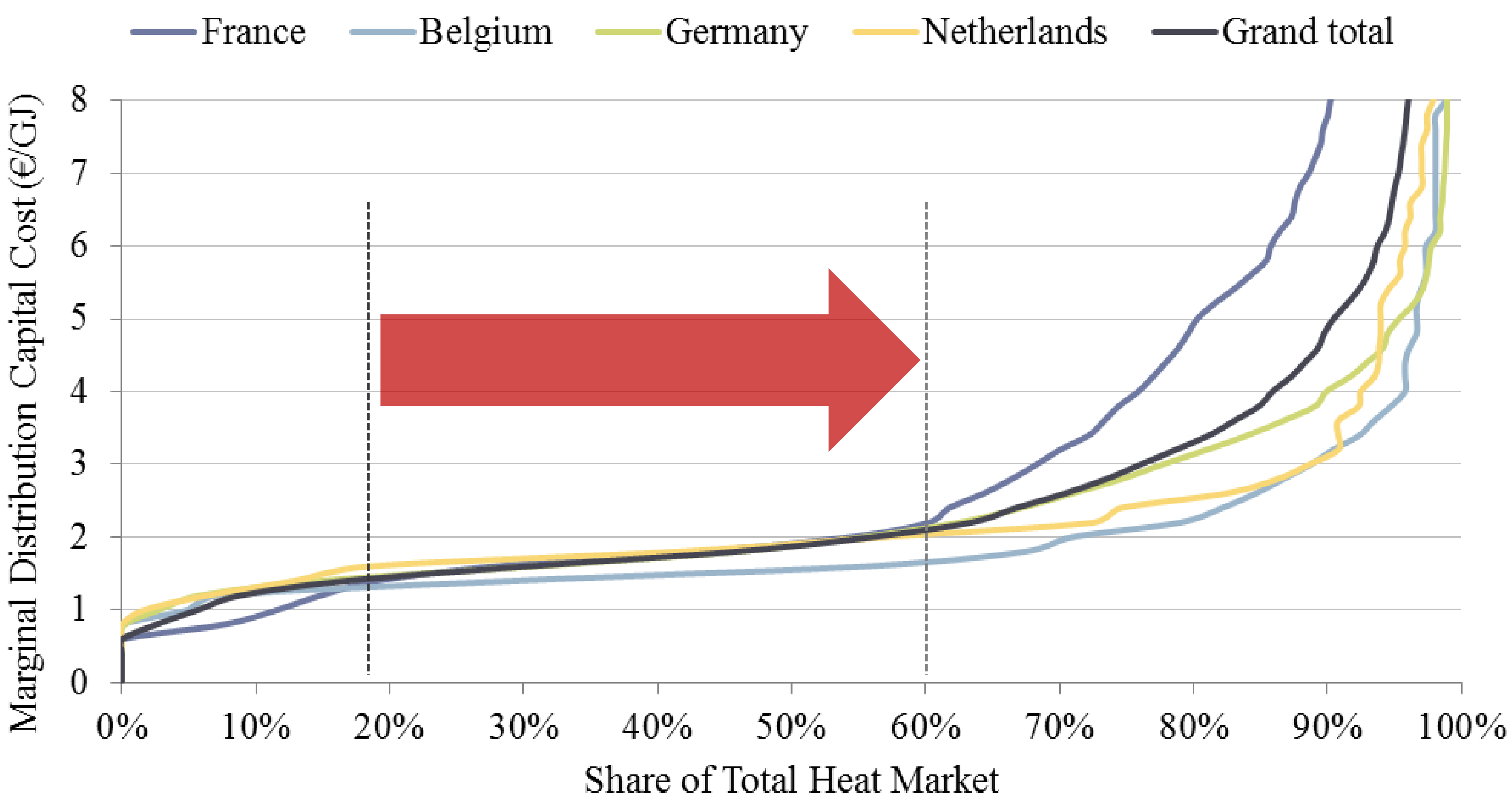

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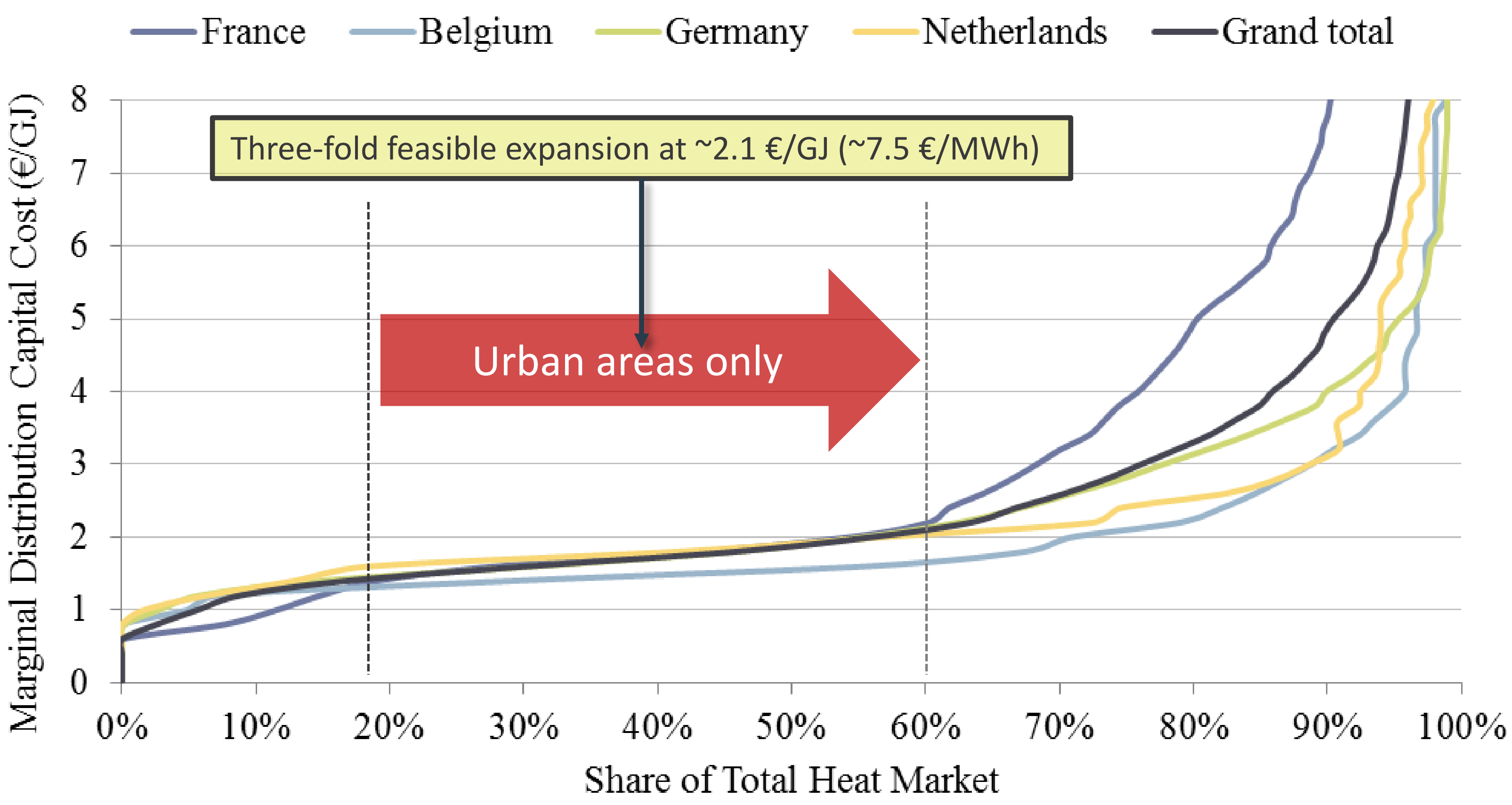

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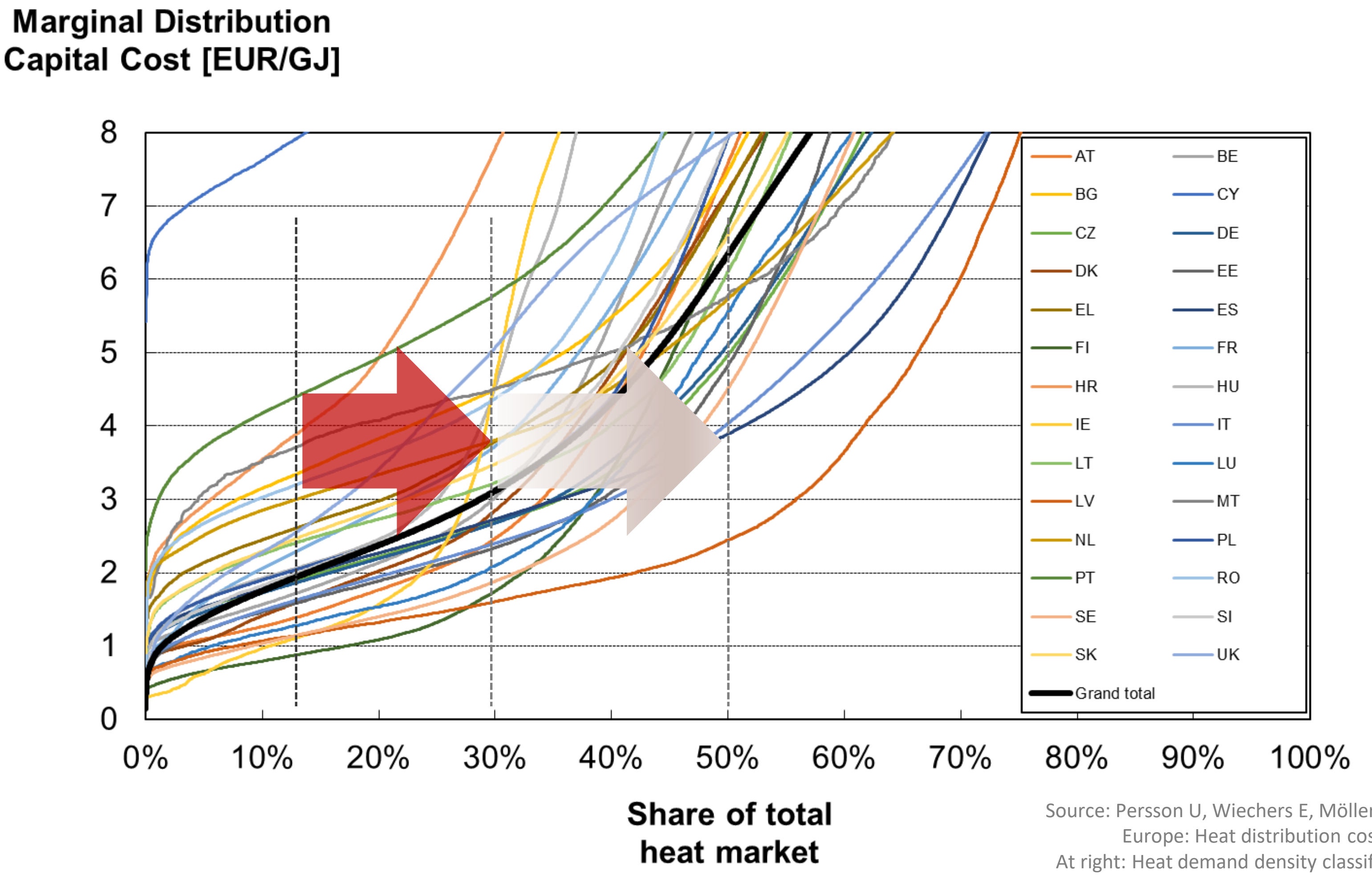

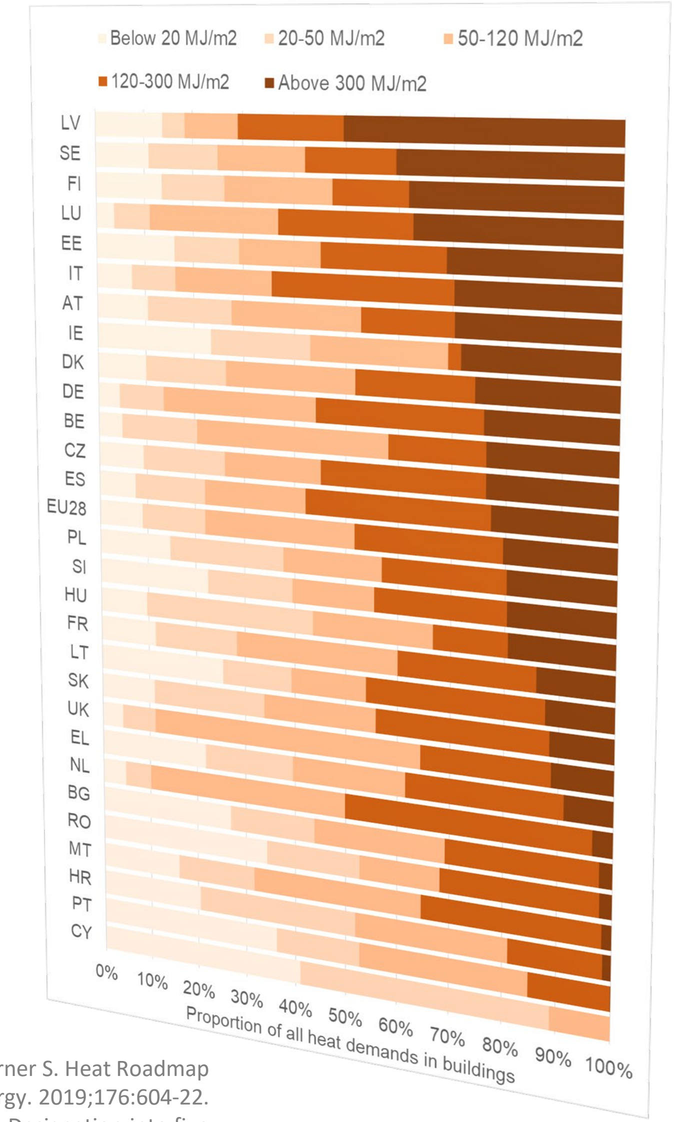

Source: Persson U, Wiechers E, Möller B, Werner S. Heat Roadmap Europe: Heat distribution costs. Energy. 2019;176:604-22.
At right: Heat demand density classification: Designation into five classes corresponding to "Very sparse", "Sparse", "Moderate", "Dense", and "Very dense" conditions.

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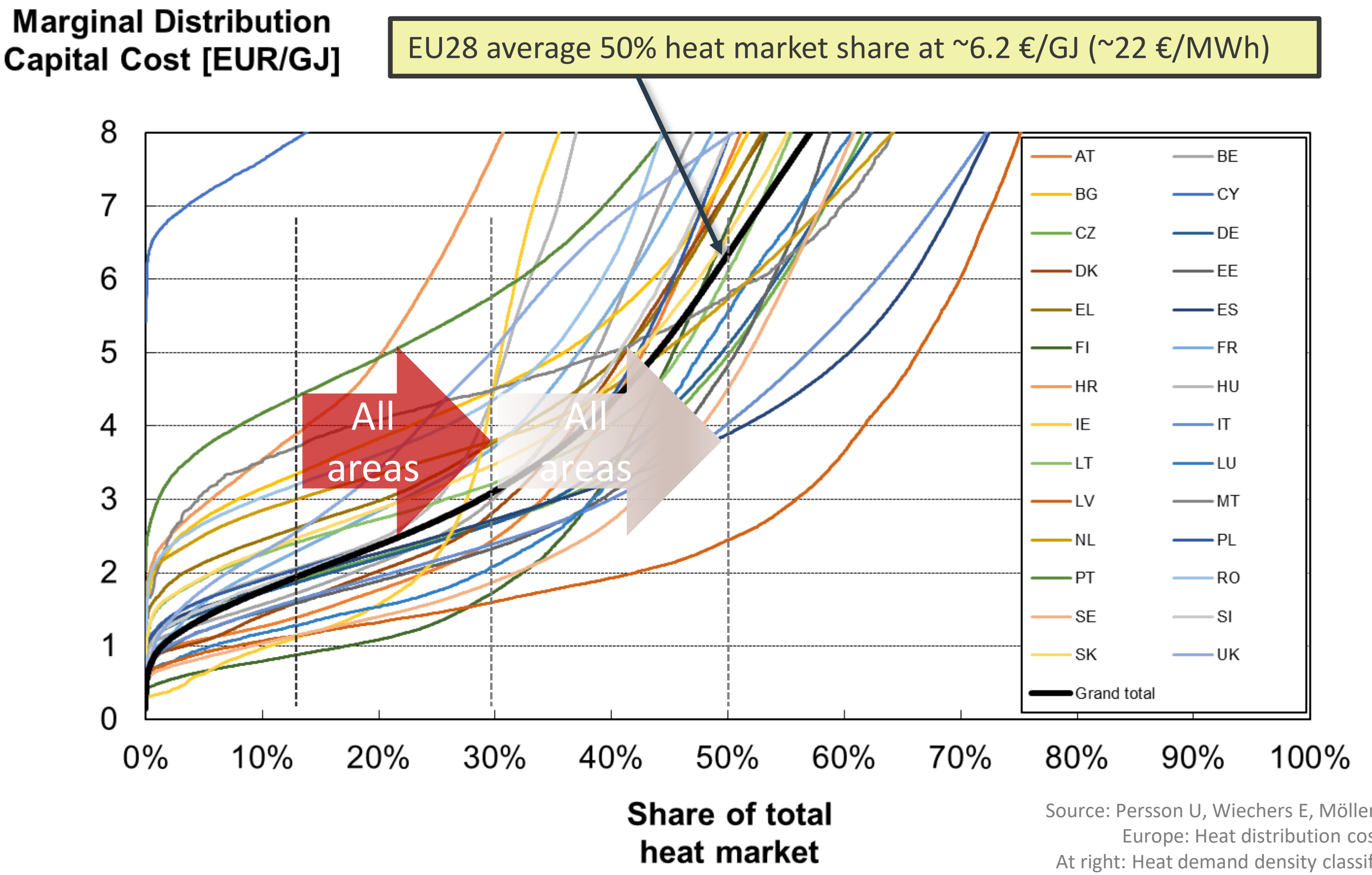

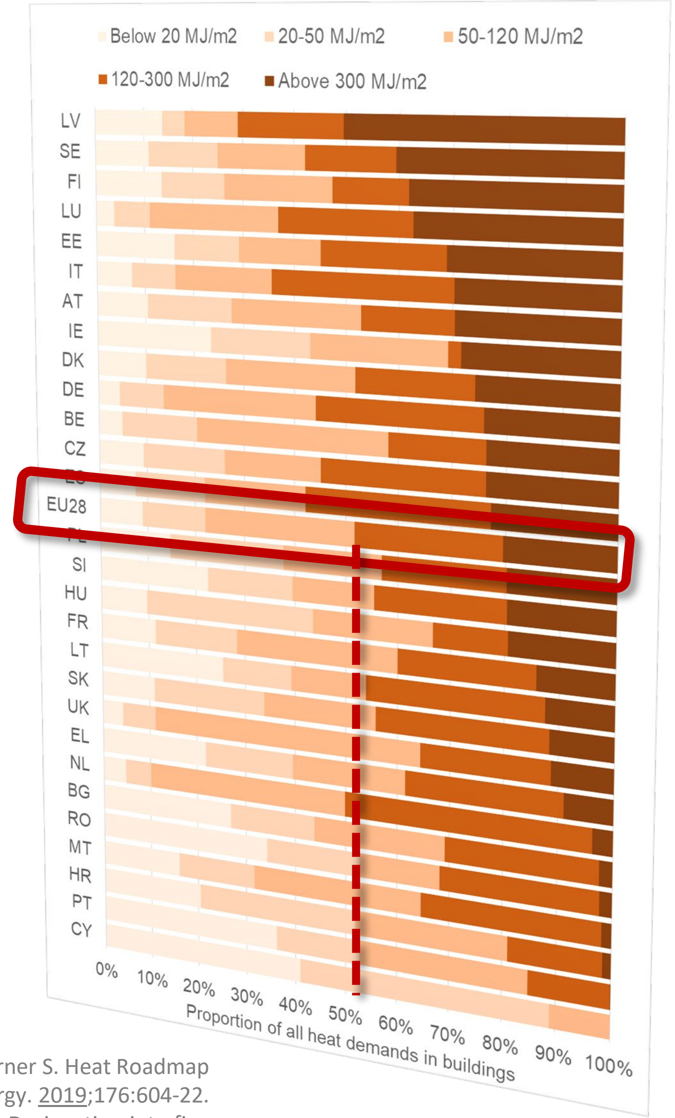

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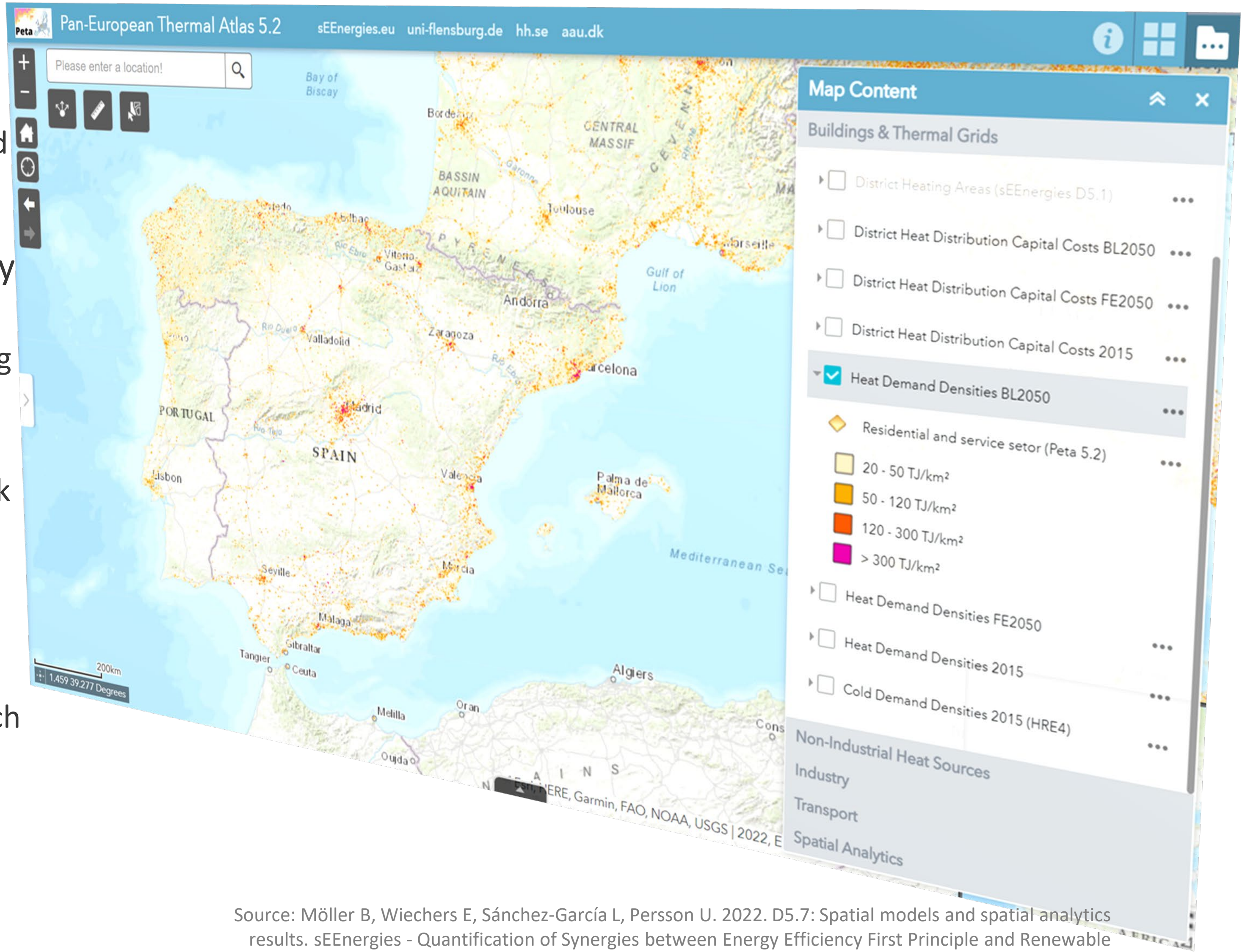
- Model development:
  - Physical suitability
    - Future population model: Forecasting and mapping of floor areas and heat demand densities
  - Future heat demands, efficiency and supply depend on:
    - The energetic development of the existing building mass
    - The intensity at which buildings are used
    - The replacement of existing building stock
    - The expansion of urban areas with new building stock.
  - An assessment of future population distribution may help describing:
    - Where to expect new-build areas, at which density
    - Where to anticipate a further decline in population
    - Where to foresee urban economic development: „booming areas“.



Source: Möller B, Wiechers E, Sánchez-García L, Persson U. 2022. D5.7: Spatial models and spatial analytics results. sEEnergies - Quantification of Synergies between Energy Efficiency First Principle and Renewable Energy Systems. Horizon 2020 Project No. 846463.

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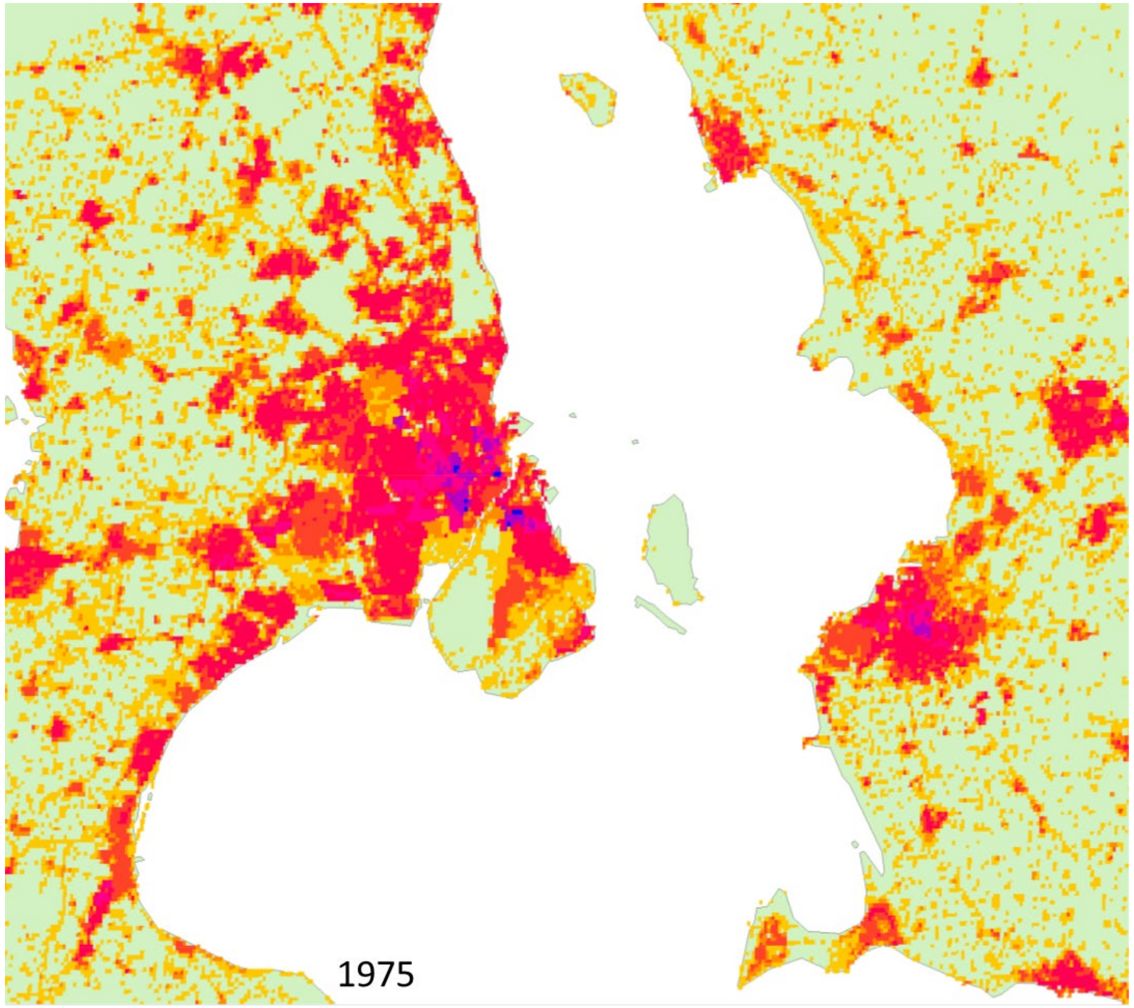
- Model development:
  - Physical suitability
    - Future population model: Forecasting and mapping of floor areas and heat demand densities
  - Thoughts on population development
    - There are significant differences of population development across Europe and its regions
    - In the past 30 years, structural change has driven population development, e.g.:
      - Trending metropolitan areas keep growing
      - Transition economies of the East experience shrinking city centres
      - Rural Europe continues to be de-populated
    - A myriad of causalities and heterogeneities, rooted in the great diversity of European countries, drives population development
    - The remotely sensed evidence of the past may be key to understand future urban development.



The Global Human Settlement (GHS) multitemporal population grid has been resampled to 100m resolution. It comprises a synthetic distribution of historical census data to remotely sensed built-up areas and their built-up intensity. Therefore, GHS reflects urban tissue as well as demography.
Source: Möller B, Wiechers E, Sánchez-García L, Persson U. 2021. An empirical high-resolution geospatial model of future population distribution for assessing heat demands. 7th International Conference on Smart Energy Systems, 21-22 September, Copenhagen, Denmark.

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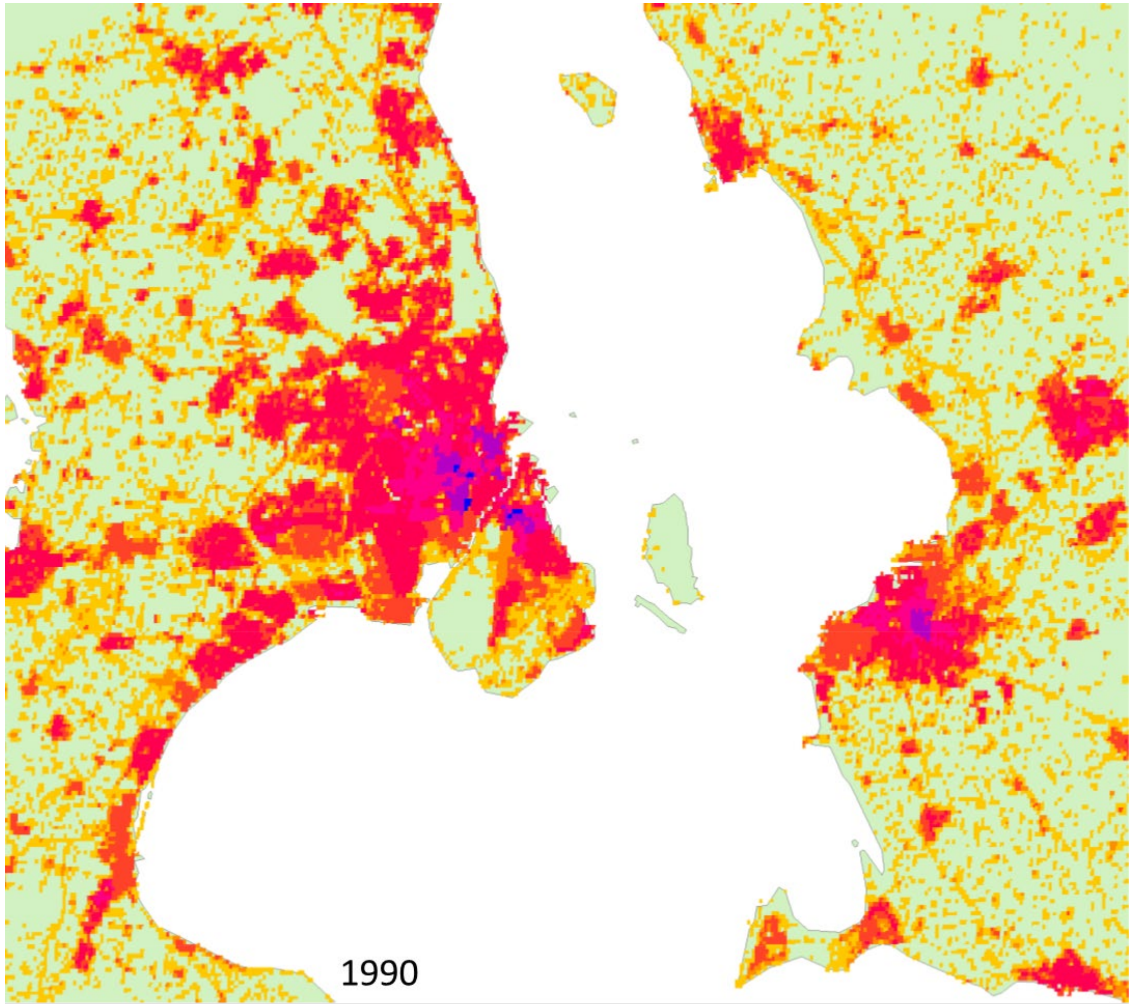

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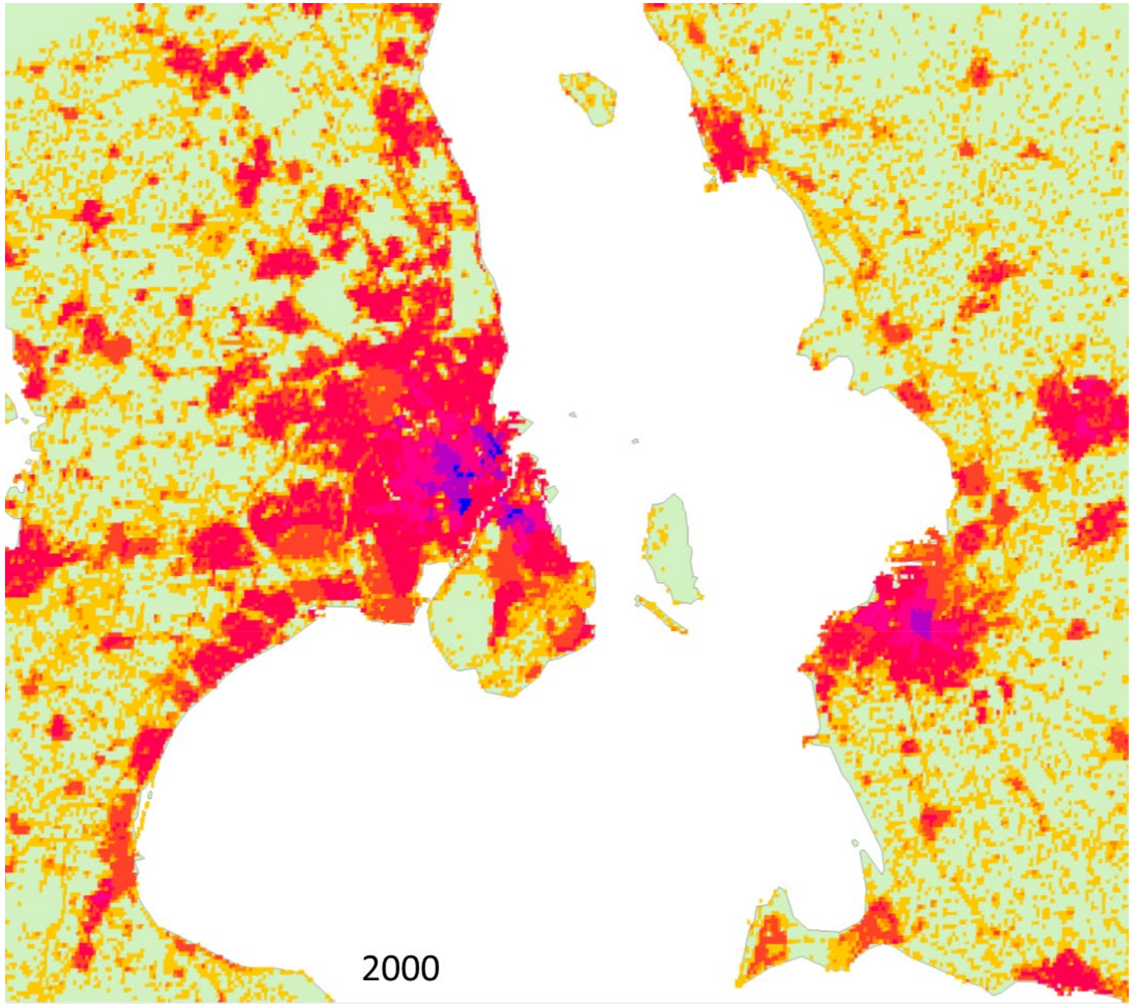

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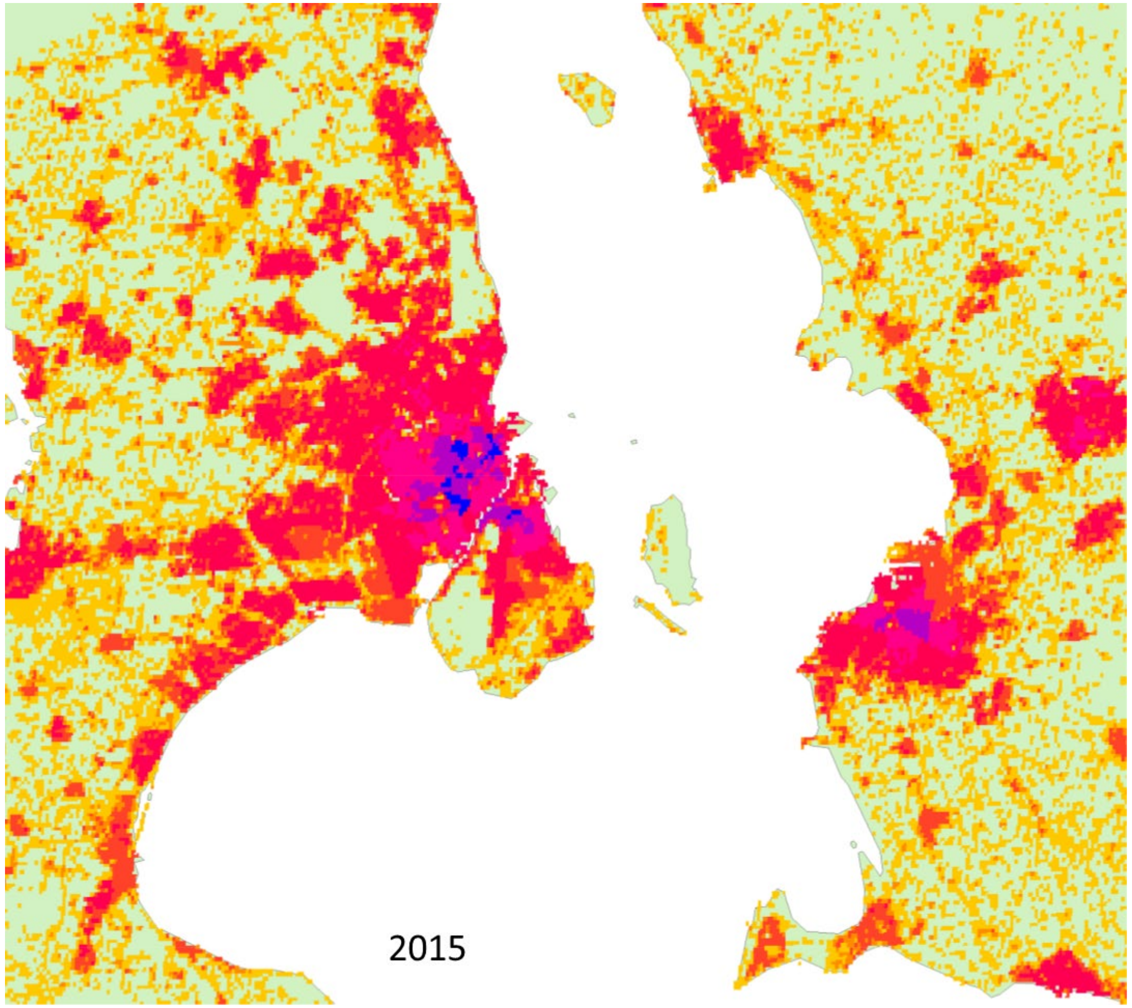


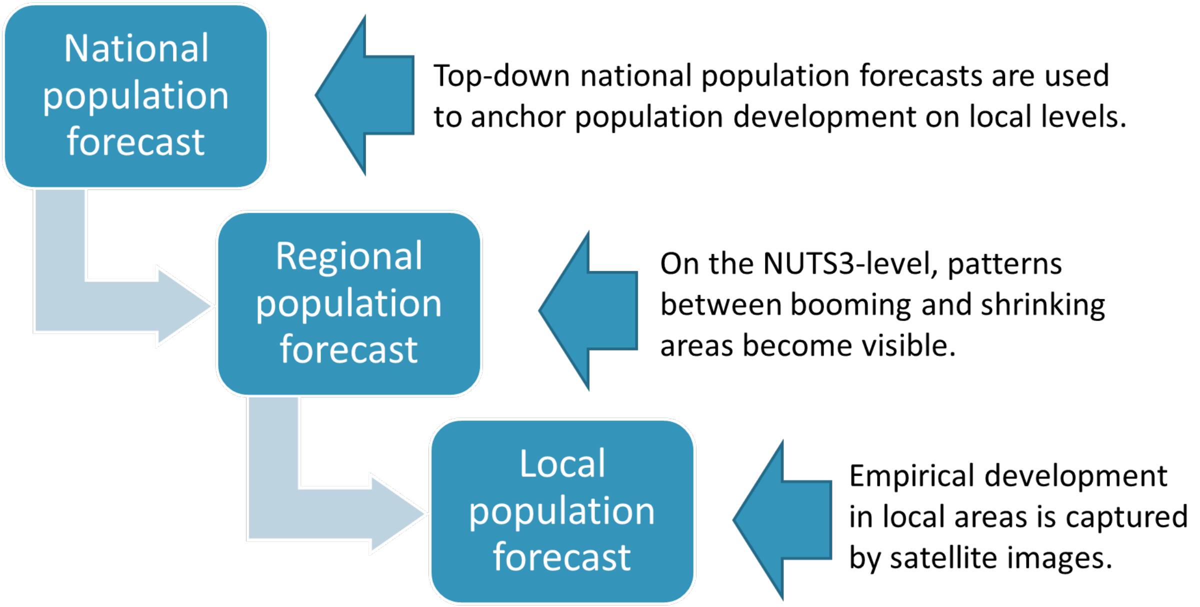
The Global Human Settlement (GHS) multitemporal population grid has been resampled to 100m resolution. It comprises a synthetic distribution of historical census data to remotely sensed built-up areas and their built-up intensity. Therefore, GHS reflects urban tissue as well as demography.
Source: Möller B, Wiechers E, Sánchez-García L, Persson U. 2021. An empirical high-resolution geospatial model of future population distribution for assessing heat demands. 7th International Conference on Smart Energy Systems, 21-22 September, Copenhagen, Denmark.

Modelling investment costs for future district heating systems in Europe

by Bernd Möller, Europa-Universität Flensburg

sEEnergies

- Model development:
  - Physical suitability
    - Future population model: Forecasting and mapping of floor areas and heat demand densities
  - A (bold) attempt to model the future distribution of population on the hectare level
    - Basic hypothesis: past population development in places drives future development in their neighbourhood:
      - Places that have experienced significant growth or decline influence locations nearby, which expose a similar trend
      - If areas near existing growth areas are suitable, then the attractiveness of growth areas rubs off on these
      - The past population increment within a defined neighbourhood can be used to calculate future population in each location



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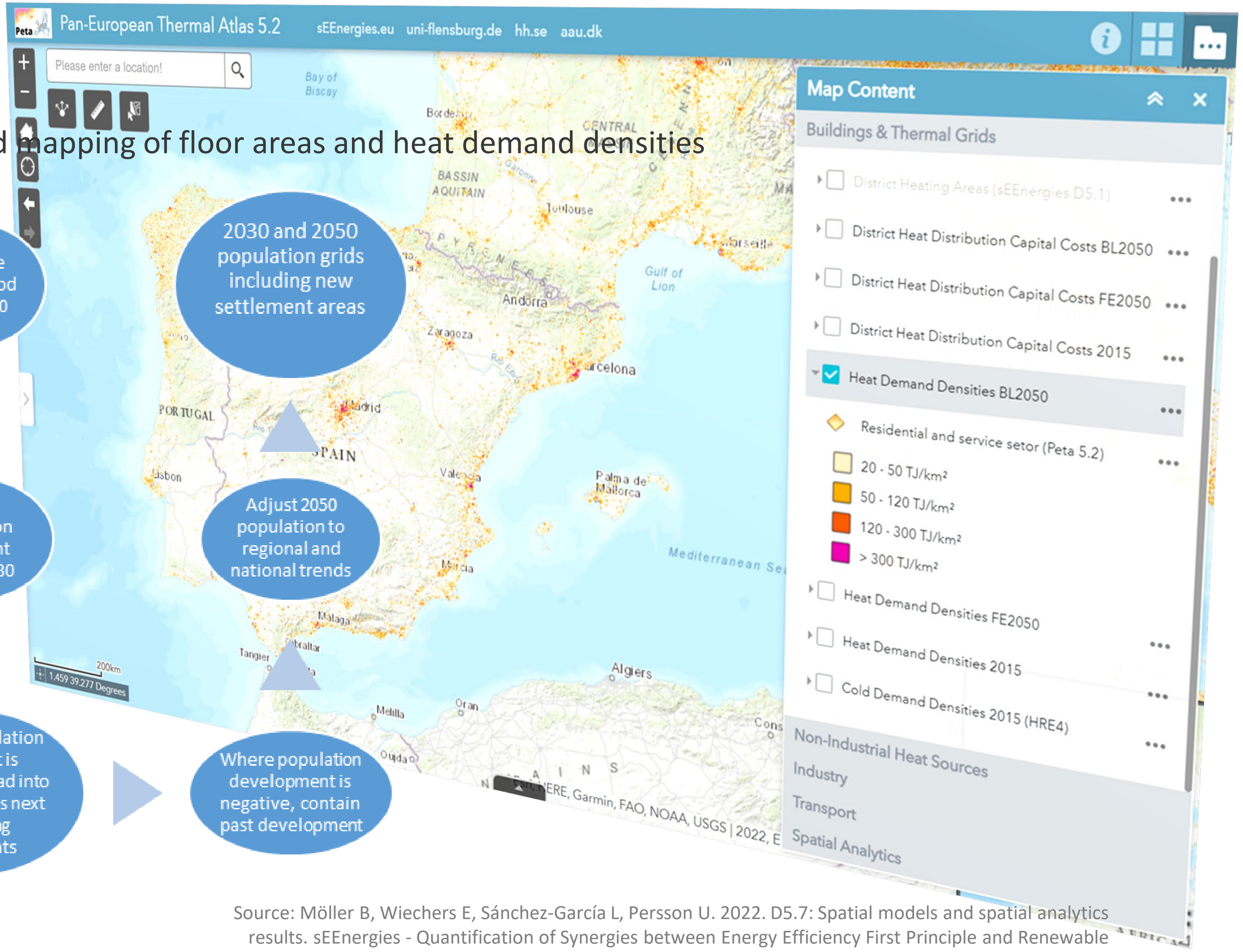
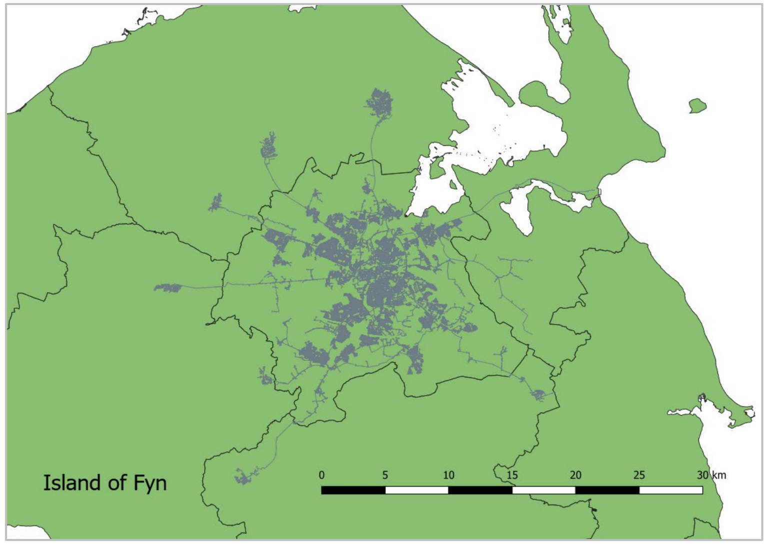


Source: Möller B, Wiechers E, Sánchez-García L, Persson U. 2022. D5.7: Spatial models and spatial analytics results. sEEnergies - Quantification of Synergies between Energy Efficiency First Principle and Renewable Energy Systems. Horizon 2020 Project No. 846463.

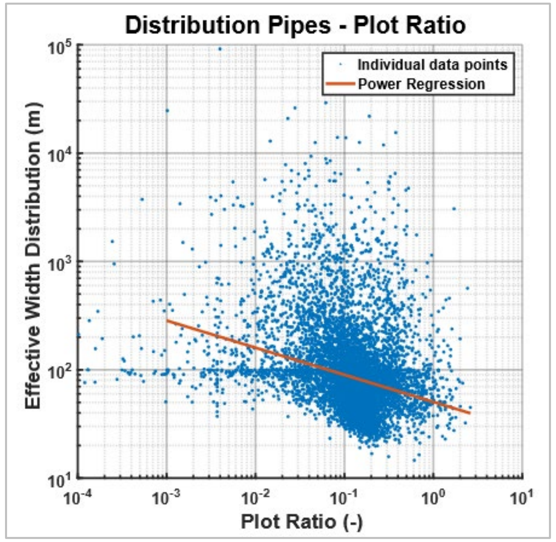
Modelling investment costs for future district heating systems in Europe

by Urban Persson, Halmstad University

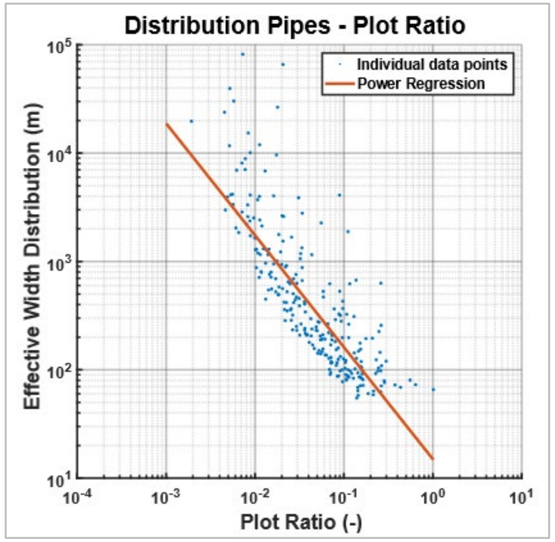
- Model development:
  - Economic suitability
    - Effective width and plot ratio
      - Effective width: w, the relative demand for district heating pipe lengths (quota of land area and pipe length)
      - Plot ratio: e, a city planning parameter describing the fraction between building space area and land area (product of p and α)



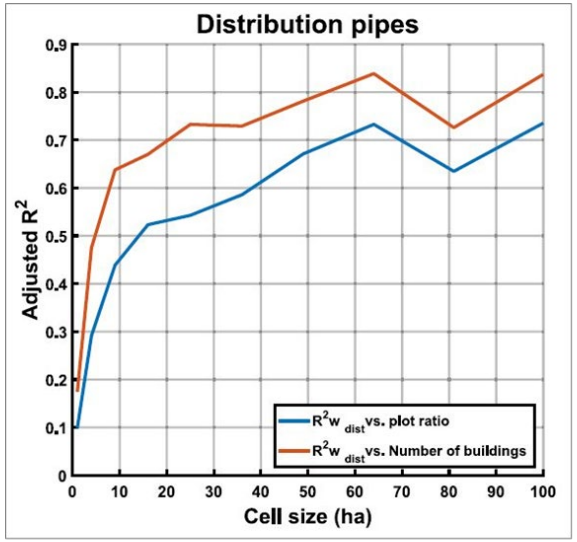
Cell size of 1 ha



Cell size of 100 ha



Chosen cell size of 16 ha



Source: Sánchez-García, L., Averfalk, H., Persson, U., 2021. Further investigations on the Effective Width for district heating systems. Energy Reports 7, 351-358 (Conference presentation at the 17th International Symposium on District Heating and Cooling, Nottingham Trent University, 6–9 September 2021, Nottingham, UK).

Left: Overview image of the Odense city district heating network of Fjernvarme Fyn (Odense, Denmark), from which input data was used for 2.264 km of trench length.

Centre: Analysis of optimal cell size for assessment of effective width at low plot ratio conditions (cell size of 1 hectare at centre left, cell size of 100 hectare at centre right)

Right: Distribution of adjusted coefficients of determination for different cell sizes to assess optimal cell size. Effective width as function of plot ratio and of number of buildings.

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sEEnergies

$$w = \max(\kappa \cdot x^{\eta}, w_{min})$$

Pipe Type	Plot Ratio		Number of Buildings per ha		wmin [m]
	η	κ	η	κ	
Distribution	-0.7541	28.2	-0.7903	696.4	~55
Service	-0.8366	35.35	-0.9917	1 592	~45

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  - Economic suitability
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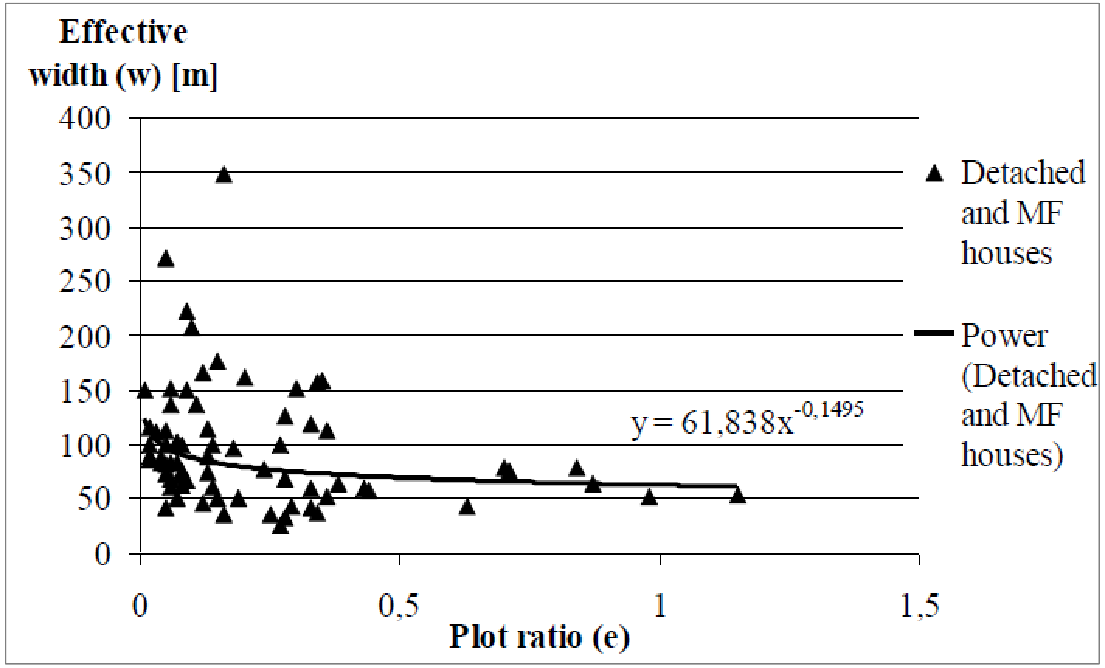
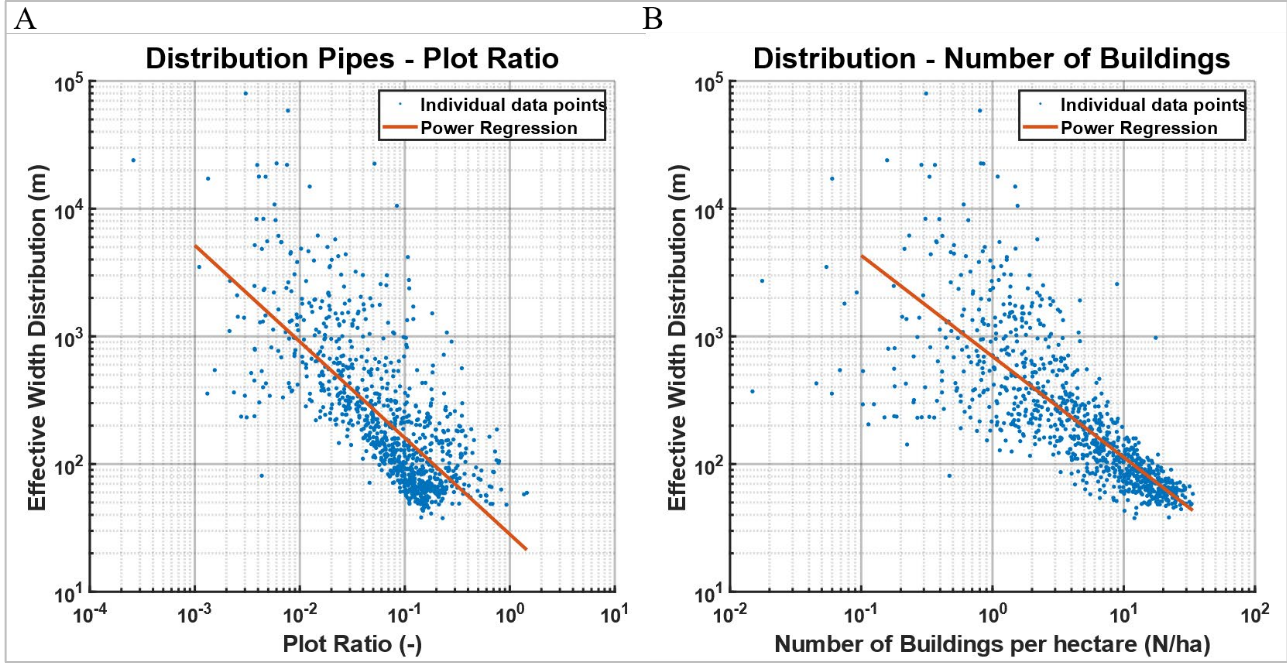


Source: Persson U, Werner S. Effective Width - The Relative Demand for District Heating Pipe Lengths in City Areas. 12th International Symposium on District Heating and Cooling, 5th to 7th of September, Tallin 2010. p. 128-31.



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Modelling investment costs for future district heating systems in Europe

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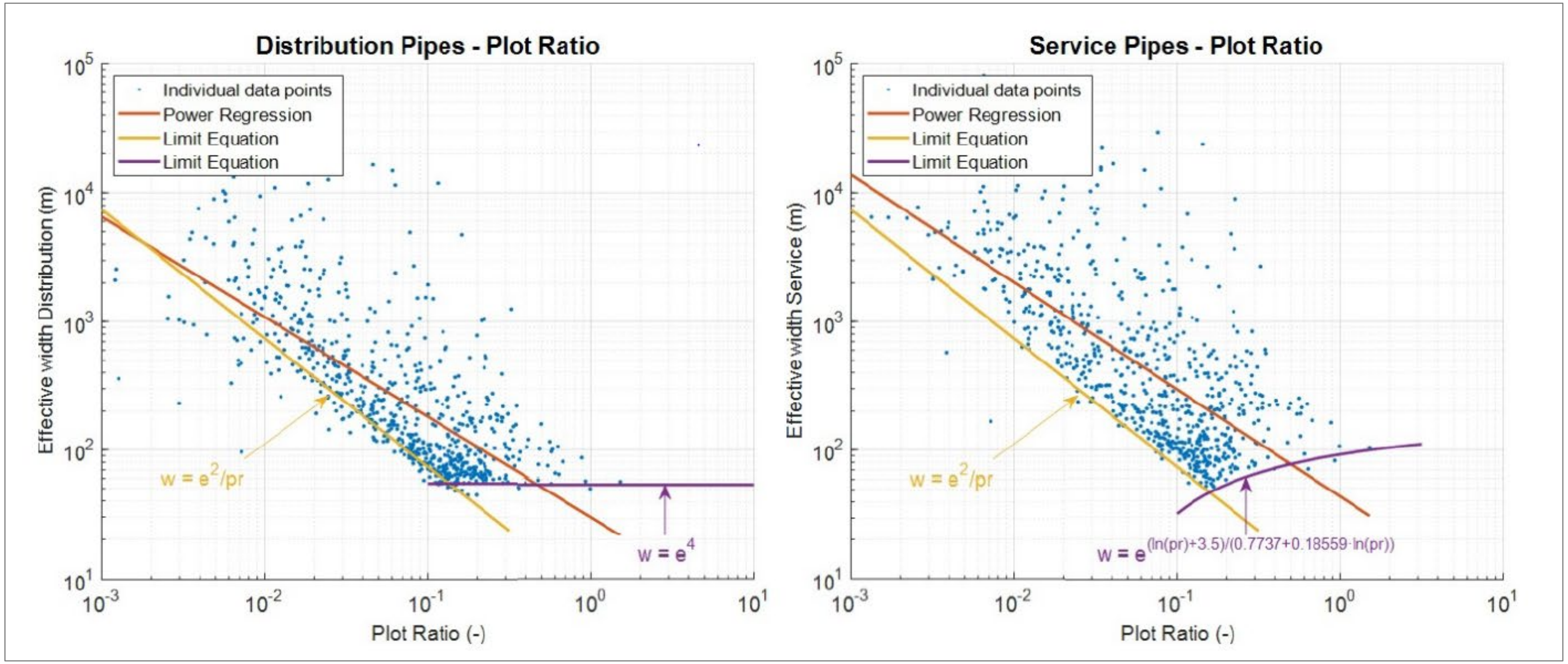
- Model development:
  - Economic suitability
    - Distribution and service pipes
    - Effective Width for a cell size of 16 ha with limit equations



Effective width as a function of plot ratio; for distribution pipes at left and for service pipes at right. Source: Persson U, Möller B, Sánchez-García L, Wiechers E. D4.5 District heating investment costs and allocation of local resources for EU28 in 2030 and 2050. sEEnergies - Quantification of Synergies between Energy Efficiency First Principle and Renewable Energy Systems. Horizon 2020 Project No. 846463. https://doi.org/10.5281/zenodo.48922712021

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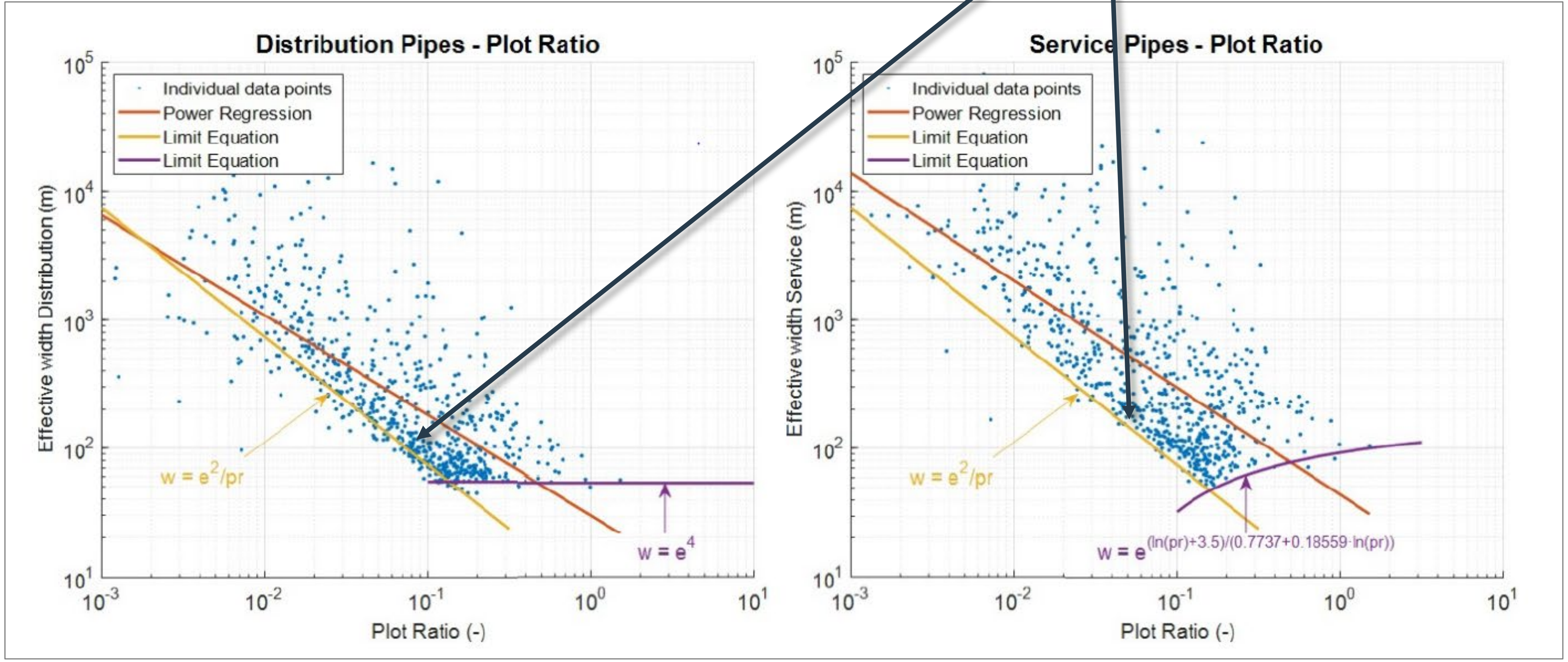
    - Effective Width for a cell size of 16 ha with limit equations

Limit equations at low value edges rather than power regression mean to maintain conservative assessment of distribution costs!



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Modelling investment costs for future district heating systems in Europe

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sEEnergies

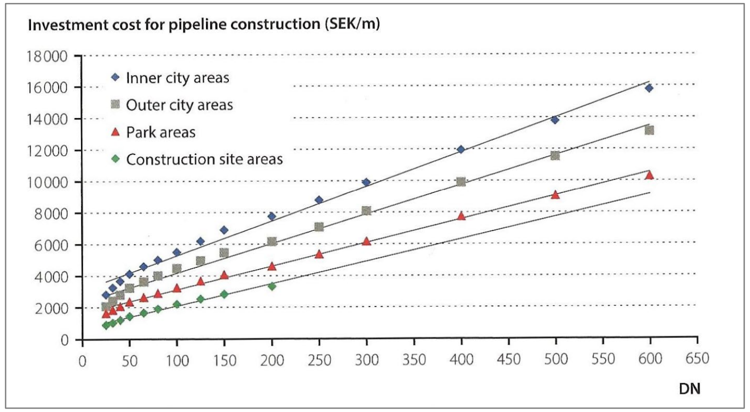
- Model development:
  - Economic suitability
    - Construction costs by Member States

Table 2. Construction cost curve parameters for eleven European countries, with reference to previous assessment and sources

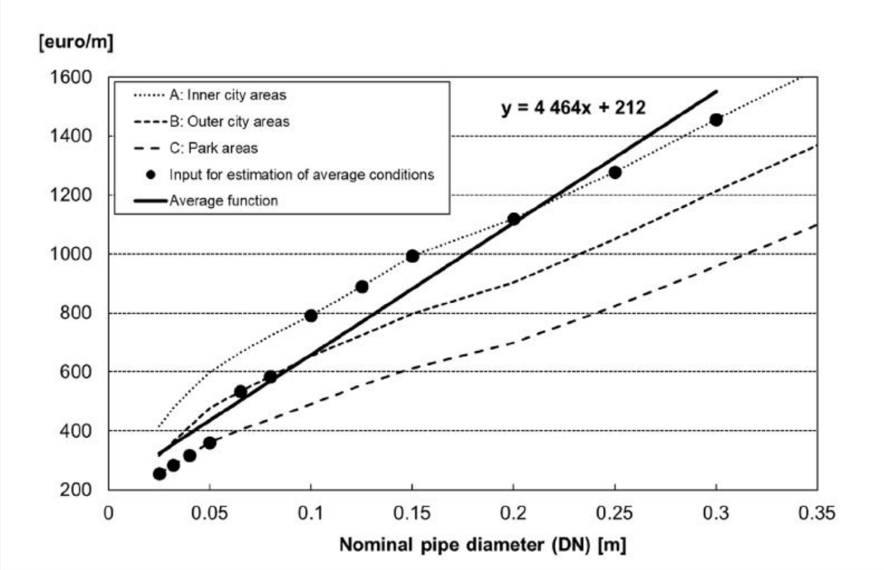
Country Code	Range validity (Pipe diameter [mm])		Intercept	Slope	D4.5 status	Applied to	Source
	Min	Max	€/m	€/m²			
DE	25	300	664	2810	Updated	AT, DE	(AGFW, 2021)
DK			60	10000	Updated	DK	(COWI, 2017, 2020; Kristiansen, 2021; R. Lund, 2021; Niras A/S, 2018; Rambøll, 2018, 2020, 2021a, 2021b; Rambøll & Glostrup Forsyning, 2021; Trefor Varme, 2021)
ES	65	125	354	4314	Same	ES, PT	(Cuesta, 2020)
FR	65	450	*	*	Same	FR	(Roger, 2020)
HR	25	250	*	*	Same	HR, SI (x2)	(Dorotić, 2020)
HU	25	200	*	*	Same	BG, CZ, HU, PL, RO, SK	(Edit, 2020)
IT	50	400	540	2087	Same	CY, EL, IT, MT	(Denarie, 2020)
LT	70	600	71	3262	Same	EE, LT, LV	(Gurklienė, 2020)
NL	65	250	549	3370	Same	BE, LU, NL	(Schepers et al., 2019)
SE	50	400	439	4073	Same	FI, SE	(Sánchez-García, 2017; Svensk Fjärrvärme AB, 2007)
UK	25	500	549	2236	Same	IE, UK	(AECOM et al., 2017)

* Provided data on construction cost curve parameters from France (FR), Croatia (HR), and Hungary (HU), cannot be published due to confidentiality agreements.

Source: Möller B, Wiechers E, Sánchez-García L, Persson U. 2022. D5.7: Spatial models and spatial analytics results. sEEnergies - Quantification of Synergies between Energy Efficiency First Principle and Renewable Energy Systems. Horizon 2020 Project No. 846463.



Typical construction investment costs for district heating pipes per route length. Source: Frederiksen S, Werner S. District Heating and Cooling: Studentlitteratur AB, Lund, 2013.



Average construction cost function based on assessed 2015 investment costs for district heat distribution systems for three characteristic area categories: (A) Inner city areas, (B) Outer city areas, and (C) Park areas. Source: Persson U, Wiechers E, Möller B, Werner S. Heat Roadmap Europe: Heat distribution costs. Energy. 2019;176:604-22.

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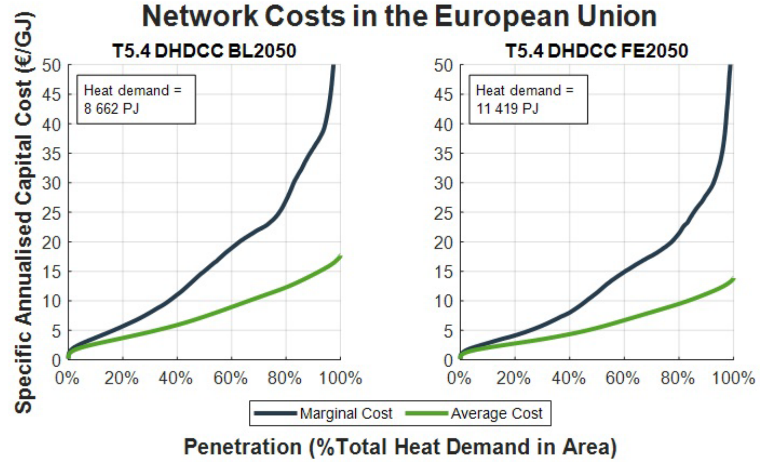

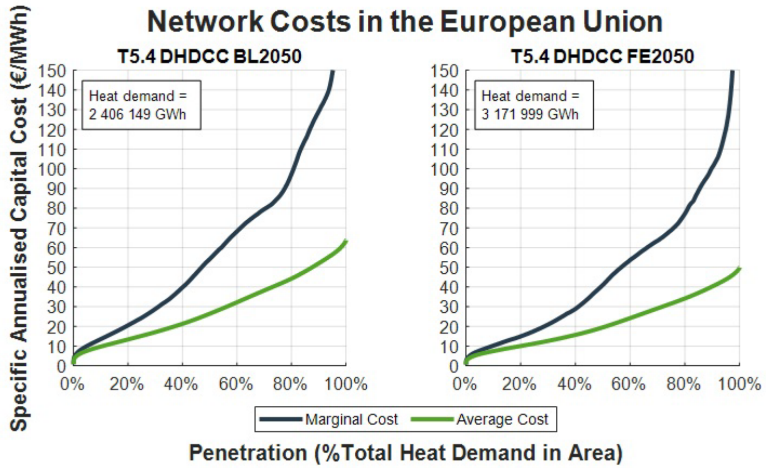

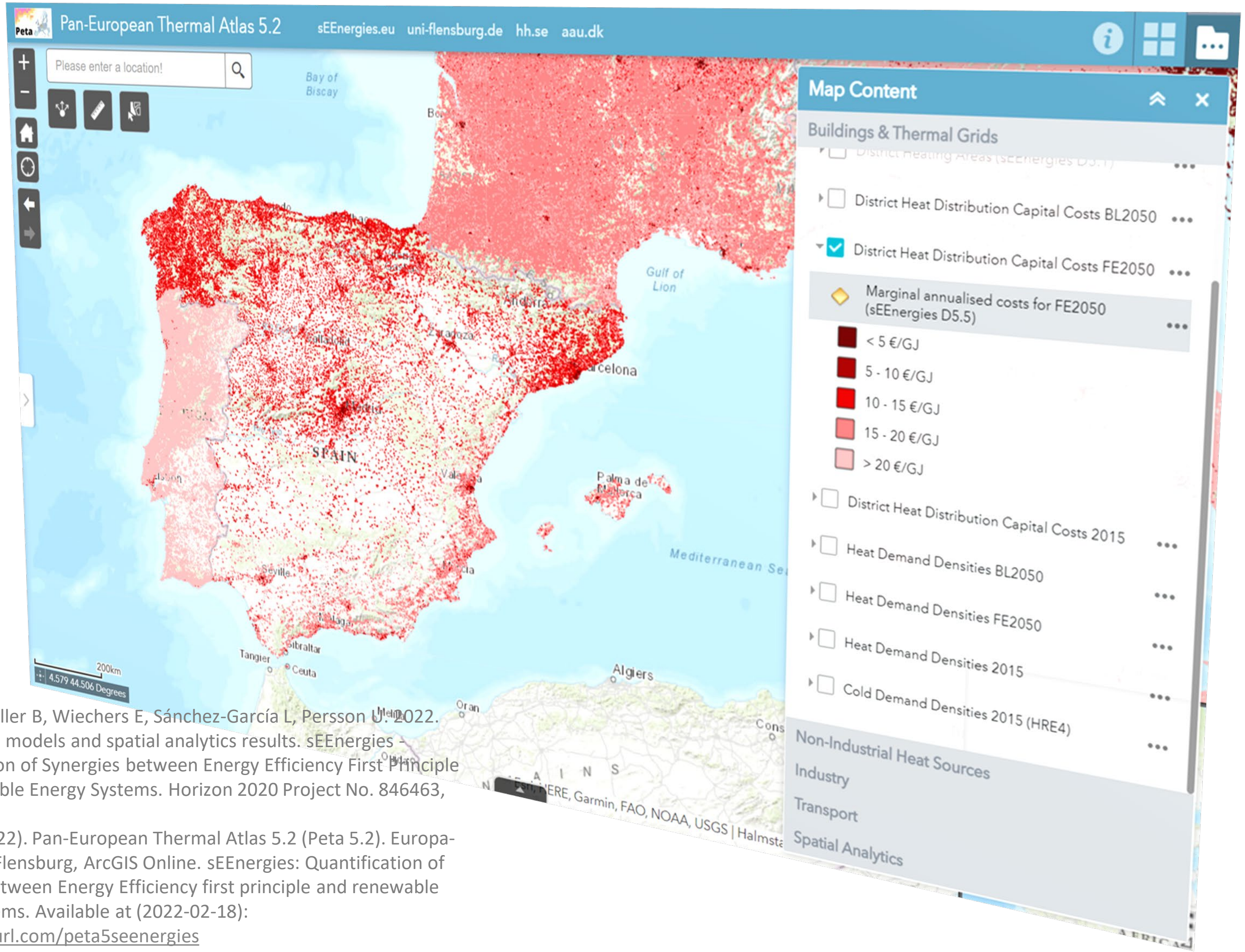

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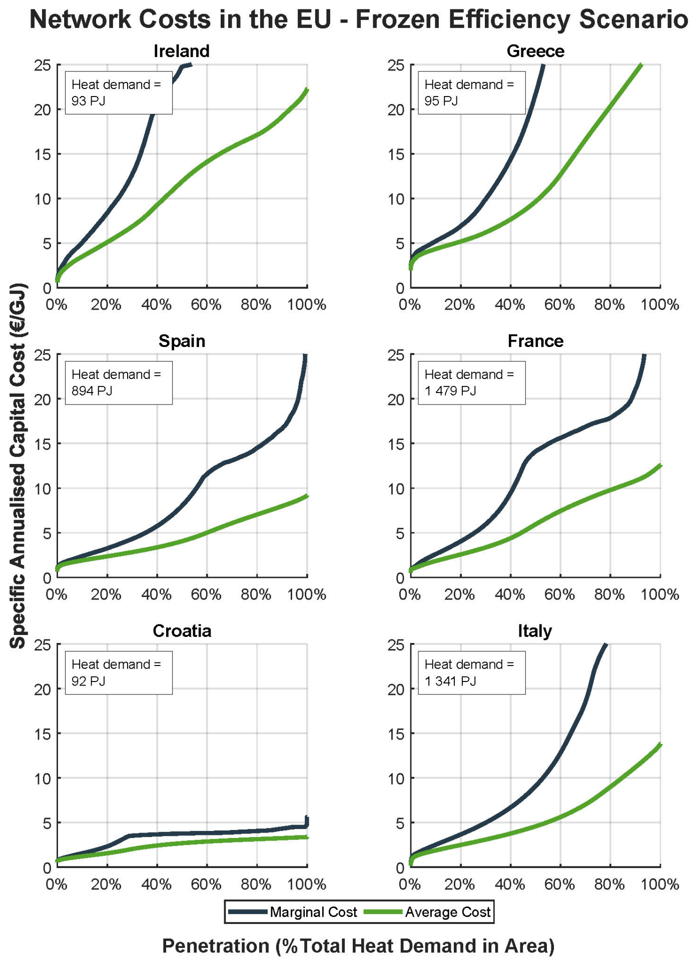

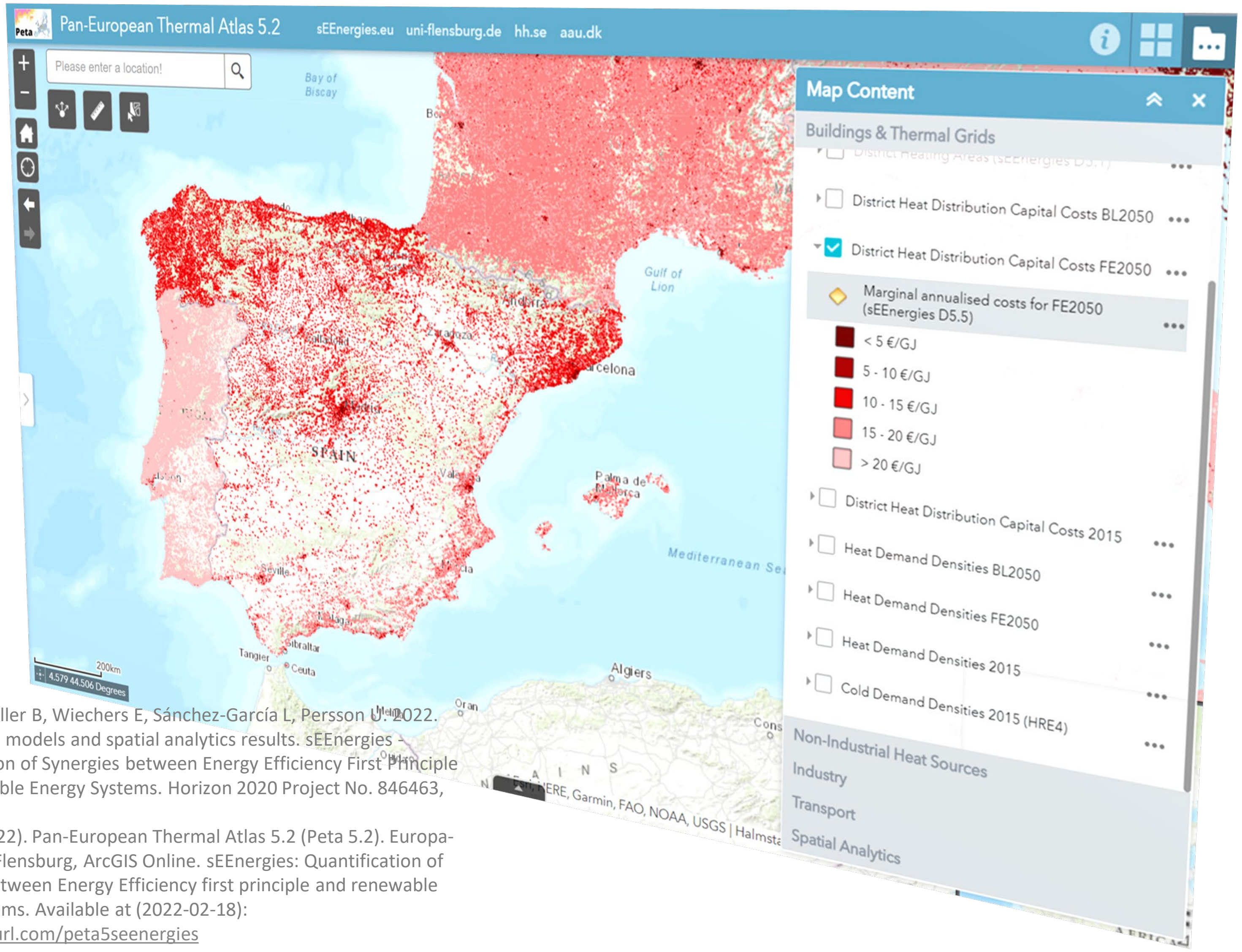

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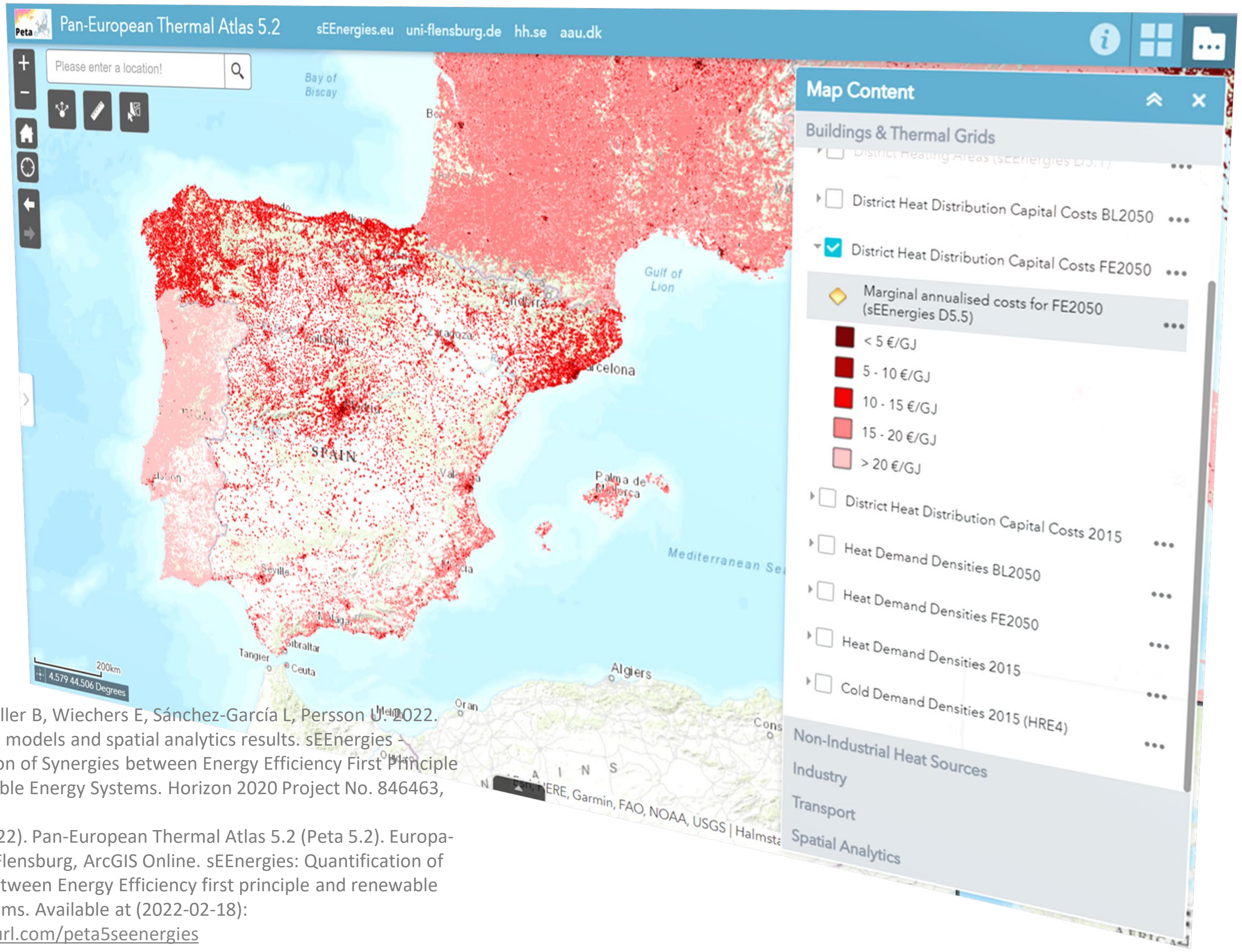
MS	Marginal cost [€/GJ]		Average cost [€/GJ]		Acc. heat demand [PJ/a]		Total investment [M€]	
Scenario	BL2050	FE2050	BL2050	FE2050	BL2050	FE2050	BL2050	FE2050
AT	6.96	5.44	4.05	3.17	44.2	56.3	3,513	3,502
BE	7.3	5.06	4.44	3.13	64.9	86.5	5,649	5,303
BG	4.72	4.04	3.59	3.09	23.7	27.0	1,669	1,633
CY	46.13	34.97	32.05	24.59	1.3	1.9	835	898
CZ	6.29	4.65	4.36	3.30	47.3	61.0	4,043	3,941
DE	8.48	5.56	5.56	3.72	407.2	569.1	44,343	41,520
DK	7.56	6.66	4.61	4.05	47.5	55.6	4,287	4,416
EE	2.25	1.82	1.42	1.20	9.0	12.1	249	283
EL	8.79	8.12	6.04	5.63	22.8	23.8	2,695	2,619
ES	4.3	3.76	2.94	2.59	194.6	223.5	11,195	11,342
FI	4.06	3.04	2.59	1.91	44.8	52.5	2,275	1,972
FR	6.33	4.89	3.82	2.95	279.4	370.1	20,911	21,399
HR	4.38	2.96	2.95	1.78	9.7	23.0	559	801
HU	7.49	4.62	4.78	3.04	39.9	54.8	3,736	3,267
IE	23.27	10.25	13.26	5.93	14.1	23.3	3,657	2,705
IT	5.34	4.28	3.45	2.78	280.5	335.5	18,961	18,313
LT	4.52	2.61	3.08	1.75	11.5	25.1	693	862
LU	5.96	3.01	3.71	1.96	4.9	10.7	353	409
LV	1.92	1.45	1.23	0.97	14.0	18.7	338	353
MT	5.72	3.81	2.52	1.78	0.9	1.1	47	38
NL	11.88	9.08	8.43	6.51	84.0	106.3	13,877	13,567
PL	5.96	4.52	4.17	3.13	111.3	162.5	9,106	9,983
PT	17.24	15.57	11.77	10.63	15.7	17.8	3,632	3,706
RO	11.78	8.01	7.92	5.68	35.9	47.5	5,571	5,289
SE	6.33	4.74	3.84	2.90	60.4	73.2	4,548	4,162
SI	4.93	2.59	3.03	1.60	7.5	17.4	444	545
SK	13.16	5.4	8.38	3.49	14.3	42.3	2,354	2,899
UK	9.12	6.12	5.73	3.84	275.1	358.2	30,904	26,961
Max. value	**46.13**	**34.97**	**32.05**	**24.59**	**407.2**	**569.1**	**44,343**	**41,520**
Min. value	**1.92**	**1.45**	**1.23**	**0.97**	**0.9**	**1.1**	**47**	**38**
Avg. value	**9.01**	**6.32**	**5.85**	**4.18**	**77.4**	**102.0**	**7,159**	**6,882**



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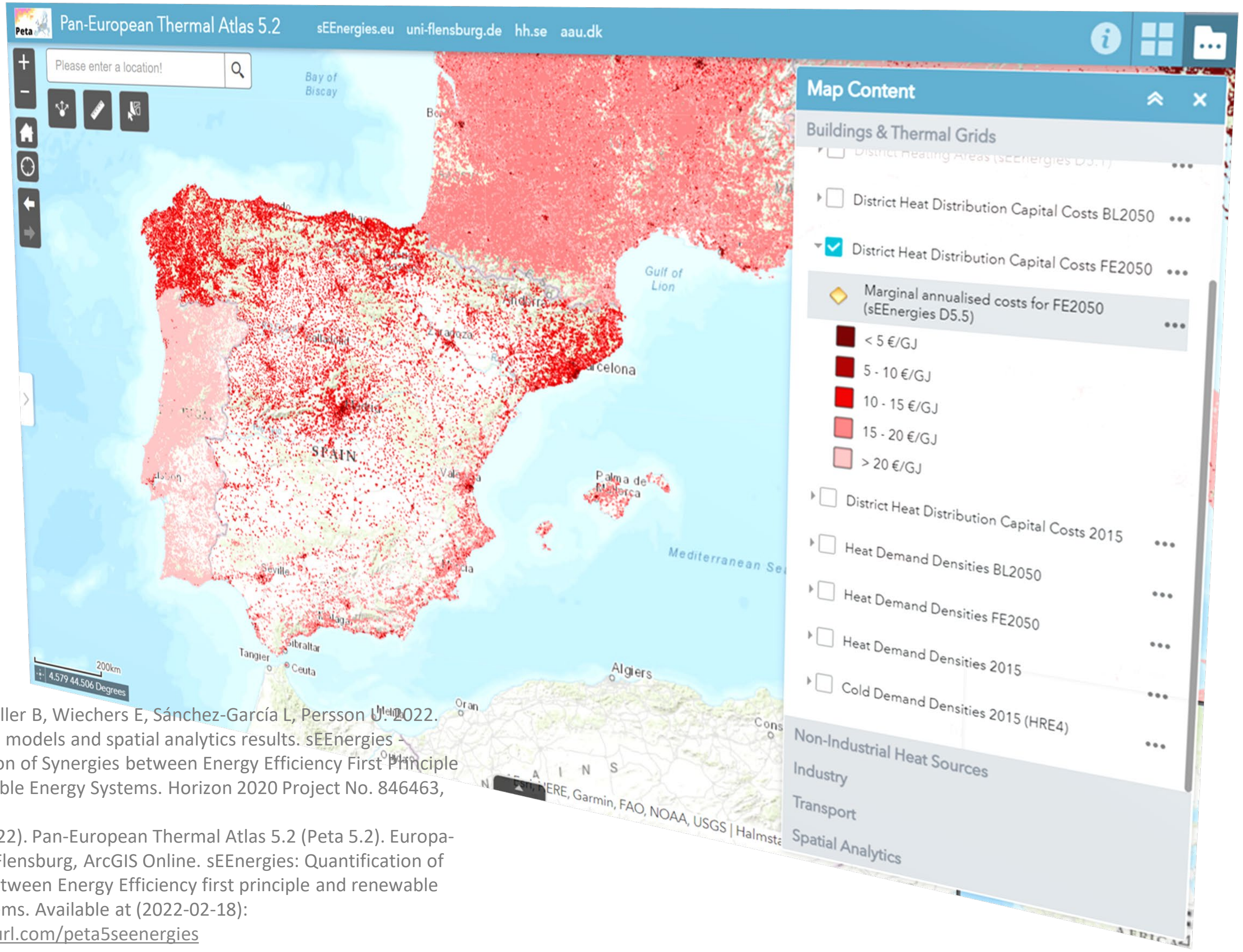

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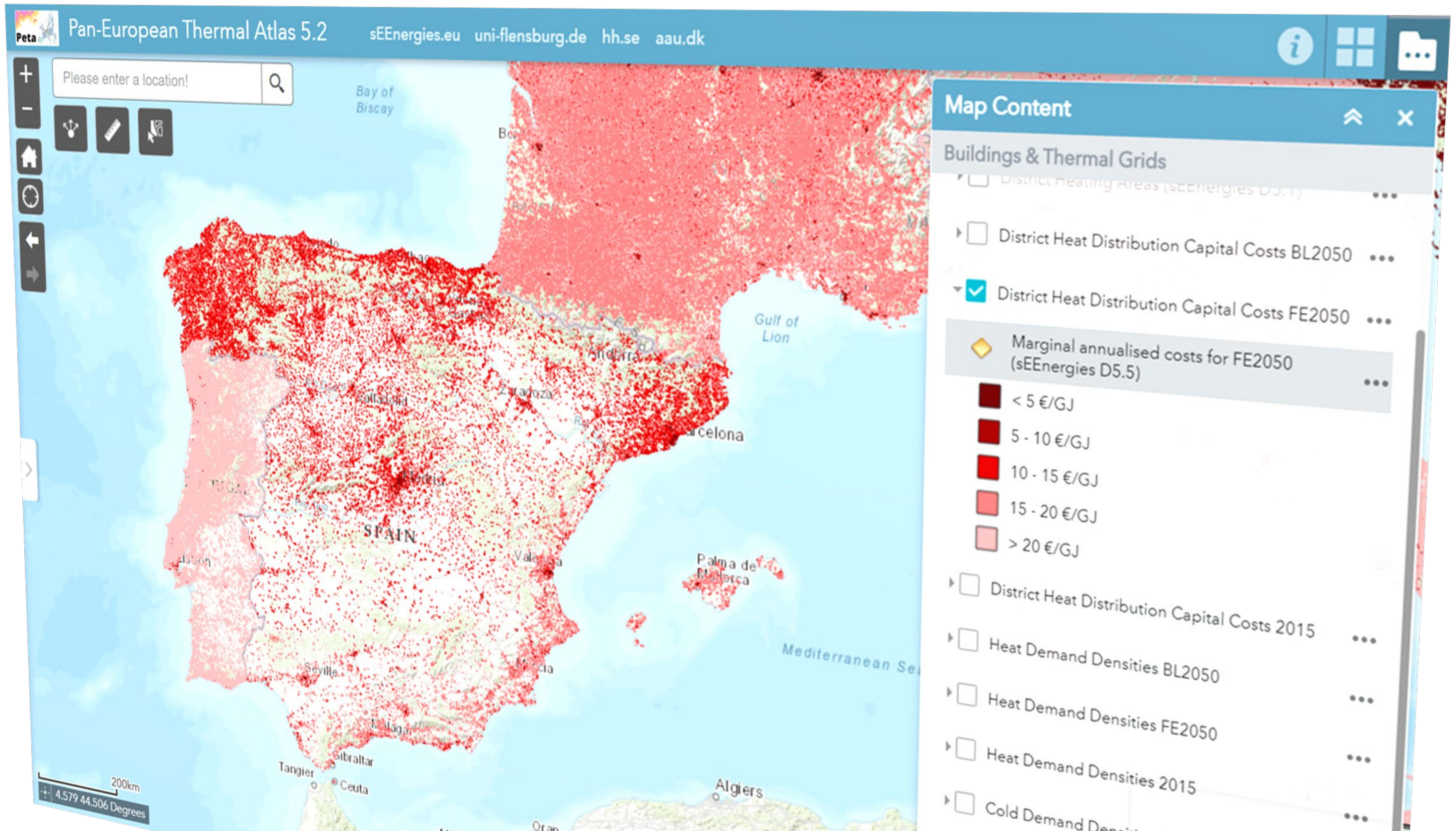
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ES	4.3	3.76	2.94	2.59	194.6	223.5	11,195	11,342
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FR	6.33	4.89	3.82	2.95	279.4	370.1	20,911	21,399
HR	4.38	2.96	2.95	1.78	9.7	23.0	559	801
HU	7.49	4.62	4.78	3.04	39.9	54.8	3,736	3,267
IE	23.27	10.25	13.26	5.93	14.1	23.3	3,657	2,705
IT	5.34	4.28	3.45	2.78	280.5	335.5	18,961	18,313
LT	4.52	2.61	3.08	1.75	11.5	25.1	693	862
LU	5.96	3.01	3.71	1.96	4.9	10.7	353	409
LV	1.92	1.45	1.23	0.97	14.0	18.7	338	353
MT	5.72	3.81	2.52	1.78	0.9	1.1	47	38
NL	11.88	9.08	8.43	6.51	84.0	106.3	13,877	13,567
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PT	17.24	15.57	11.77	10.63	15.7	17.8	3,632	3,706
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SE	6.33	4.74	3.84	2.90	60.4	73.2	4,548	4,162
SI	4.93	2.59	3.03	1.60	7.5	17.4	444	545
SK	13.16	5.4	8.38	3.49	14.3	42.3	2,354	2,899
UK	9.12	6.12	5.73	3.84	275.1	358.2	30,904	26,961
Max. value	46.13	34.97	32.05	24.59	407.2	569.1	44,343	41,520
Min. value	1.92	1.45	1.23	0.97	0.9	1.1	47	38
Avg. value	9.01	6.32	5.85	4.18	77.4	102.0	7,159	6,882



Sources: Möller B, Wiechers E, Sánchez-García L, Persson U. 2022. D5.7: Spatial models and spatial analytics results. sEEnergies - Quantification of Synergies between Energy Efficiency First Principle and Renewable Energy Systems. Horizon 2020 Project No. 846463, and
Peta 5.2 (2022). Pan-European Thermal Atlas 5.2 (Peta 5.2). Europa-Universität Flensburg, ArcGIS Online. sEEnergies: Quantification of synergies between Energy Efficiency first principle and renewable energy systems. Available at (2022-02-18): https://tinyurl.com/peta5seenergies

Modelling investment costs for future district heating systems in Europe

by Urban Persson, Halmstad University

sEEnergies

- sEEnergies model results
  - EU cost curves
    - HRE4 2015 anticipated the total market value for a 50% EU28 MS heat market share saturation at 318 G€ (distribution pipes only)
    - Given a 65% share for the distribution pipe cost investment, the 50% level in the FE2050 scenario, would correspond to ~394 G€
    - Noteworthy, the relative accumulated share of distribution pipe costs decreases with higher levels of heat market shares.

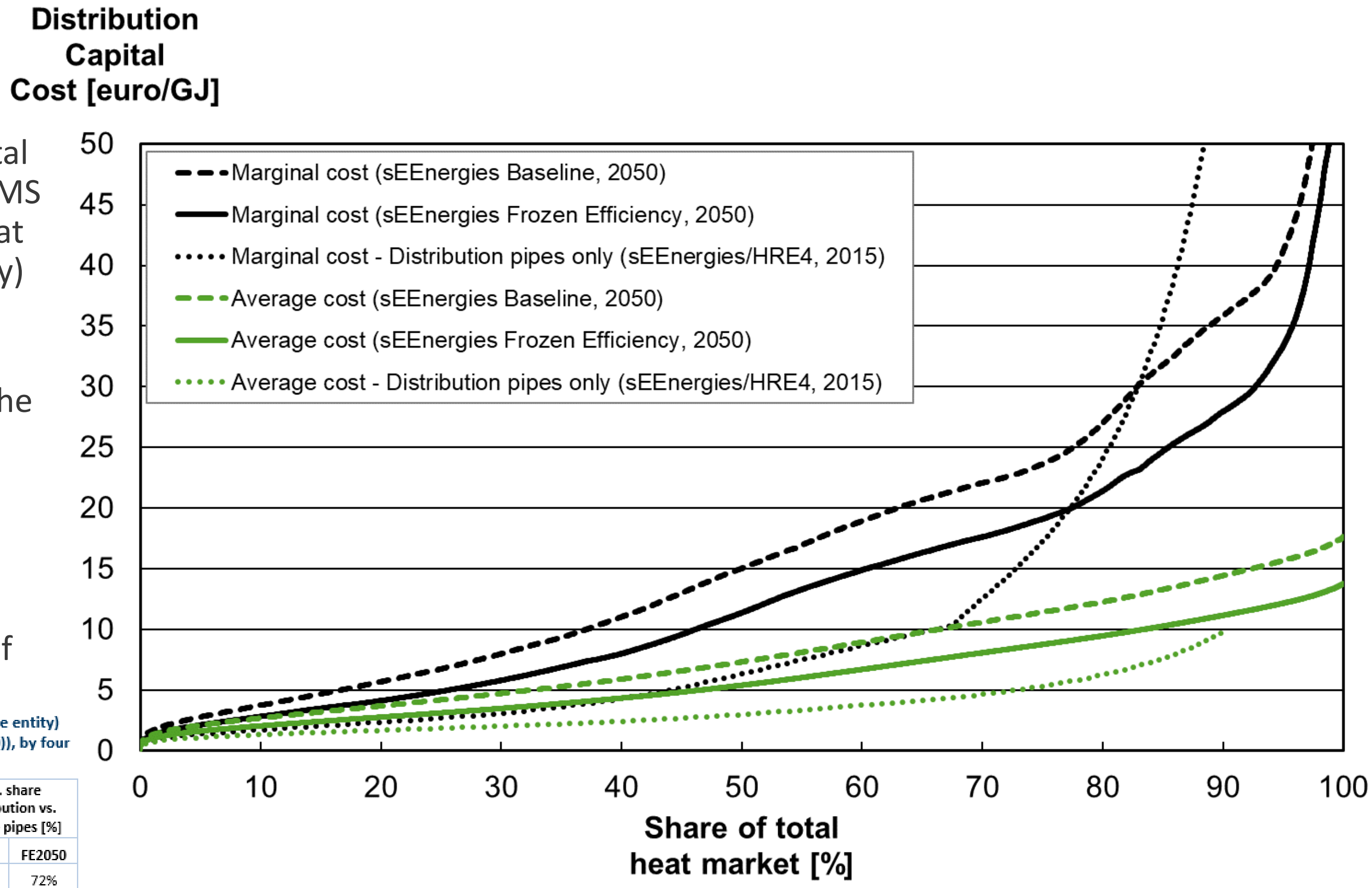


Table 4. District heating network investment costs on average for EU27+UK (modelled as one single entity) under the two sEEnergies 2050 scenarios (Baseline (BL2050) and frozen efficiency (FE2050)), by four anticipated levels of total heat market shares for district heating

DH heat market share [%]	Marginal cost [€/GJ]		Average cost [€/GJ]		Acc. heat demand [PJ/a]		Total investment [M€]		Acc. share distribution vs. service pipes [%]	
Scenario	BL2050	FE2050	BL2050	FE2050	BL2050	FE2050	BL2050	FE2050	BL2050	FE2050
25%	6.76	4.91	4.21	3.13	2166	2854	178,899	175,235	70%	72%
50%	15.04	11.39	7.34	5.41	4331	5711	622,950	605,677	64%	65%
75%	23.65	19.12	11.43	8.77	6497	8566	1,455,450	1,473,280	57%	59%
100%	377.58	305.28	17.67	13.83	8662	11419	3,000,203	3,095,727	54%	55%

Sources: Möller B, Wiechers E, Sánchez-García L, Persson U. 2022. D5.7: Spatial models and spatial analytics results. sEEnergies - Quantification of Synergies between Energy Efficiency First Principle and Renewable Energy Systems. Horizon 2020 Project No. 846463, and Persson U, Wiechers E, Möller B, Werner S. Heat Roadmap Europe: Heat distribution costs. Energy. 2019;176:604-22.

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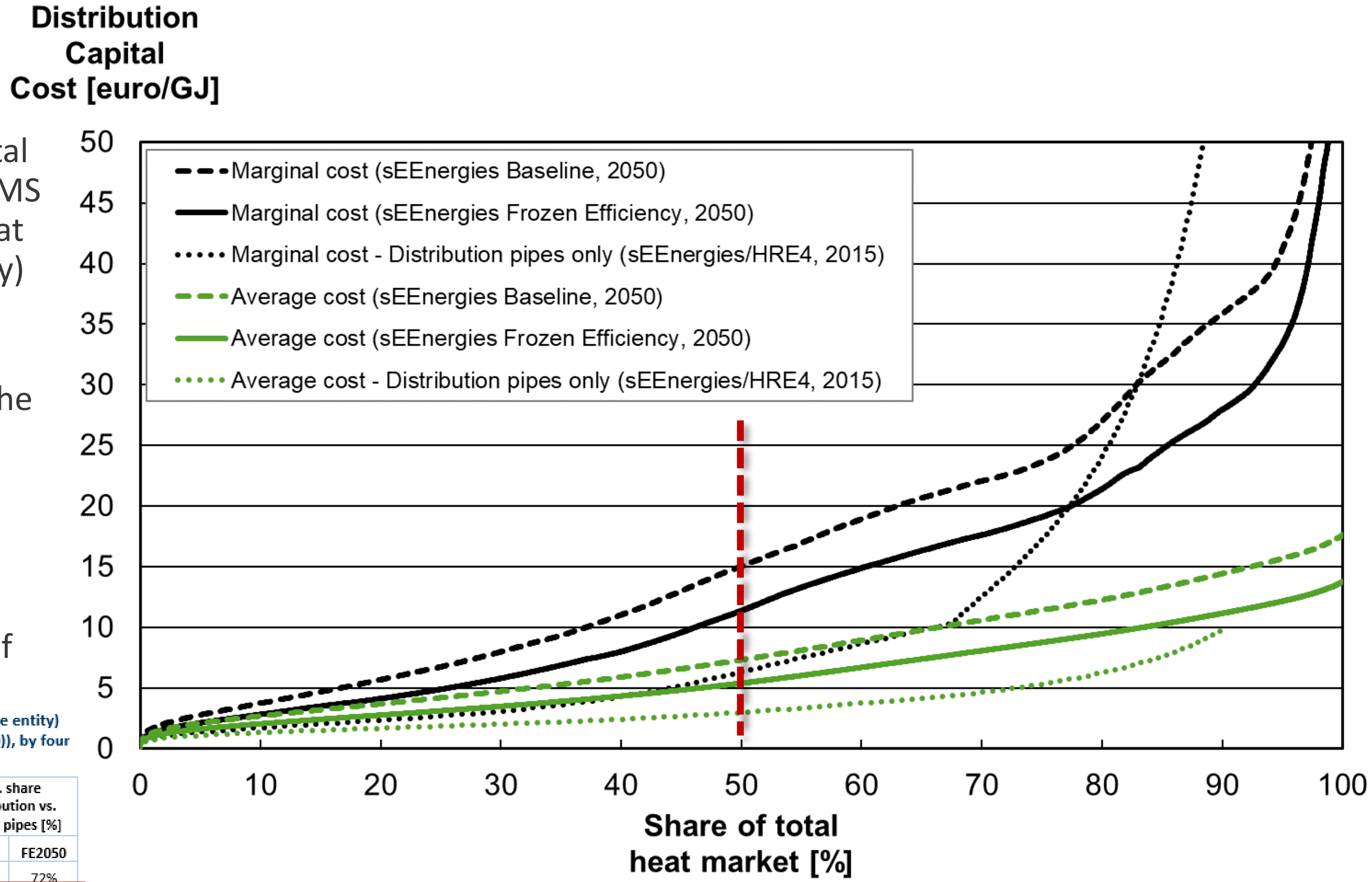

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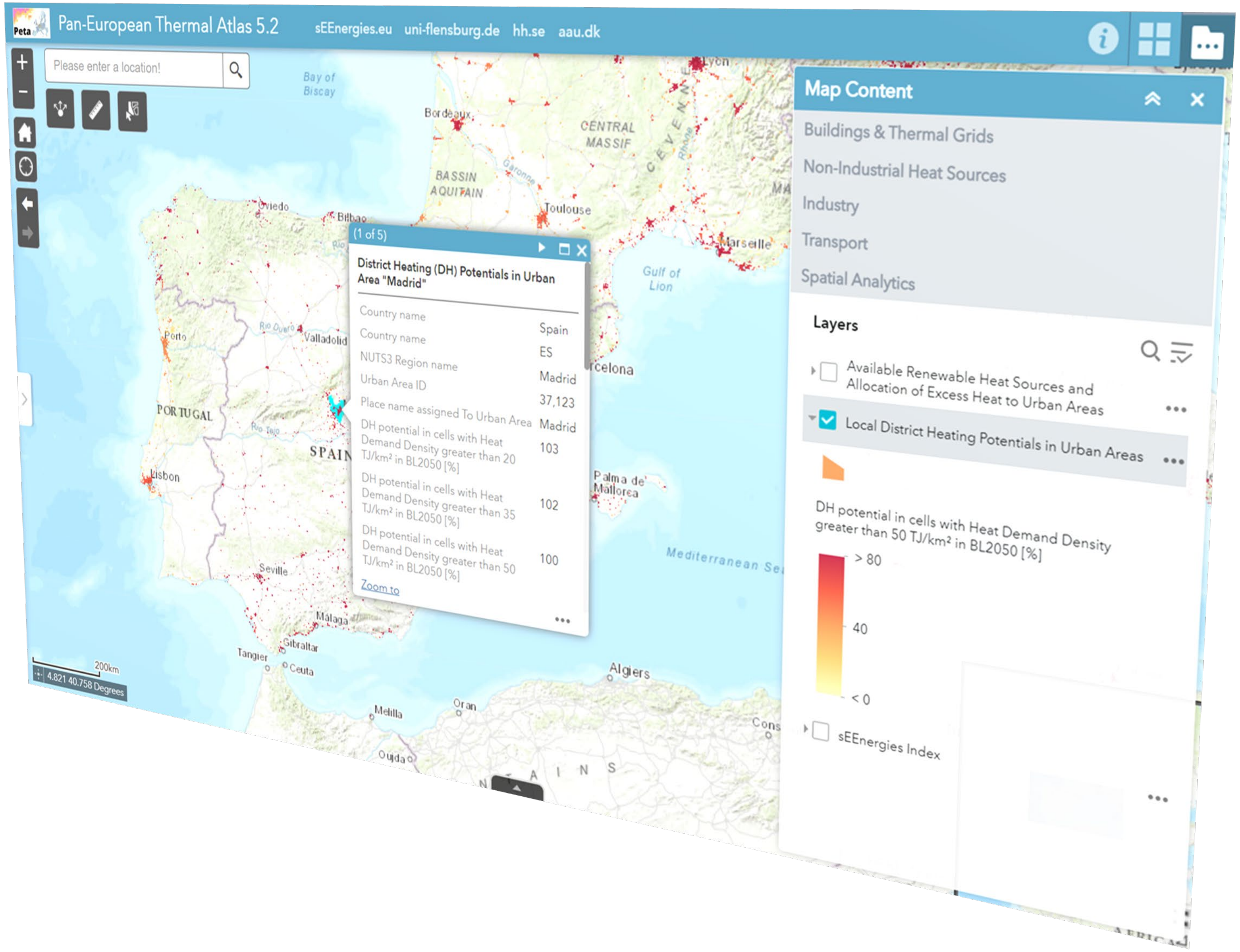
Spatial analytics and the sEEnergies Index

by Bernd Möller, Europa-Universität Flensburg

sEEnergies

The Pan-European Thermal Atlas ver. 5.2

- Key features:
  - Mapping of localised energy system data for the EU27+UK
  - Highly detailed information down to the 1-hectare level
  - Integration of building, industrial and transport sectors
- Value added:
  - Cross-sectoral mapping of energy efficiency
  - Easier access of attributes, better selection and map sharing
  - Open Data hub for data sharing
  - Illustrative Story Maps



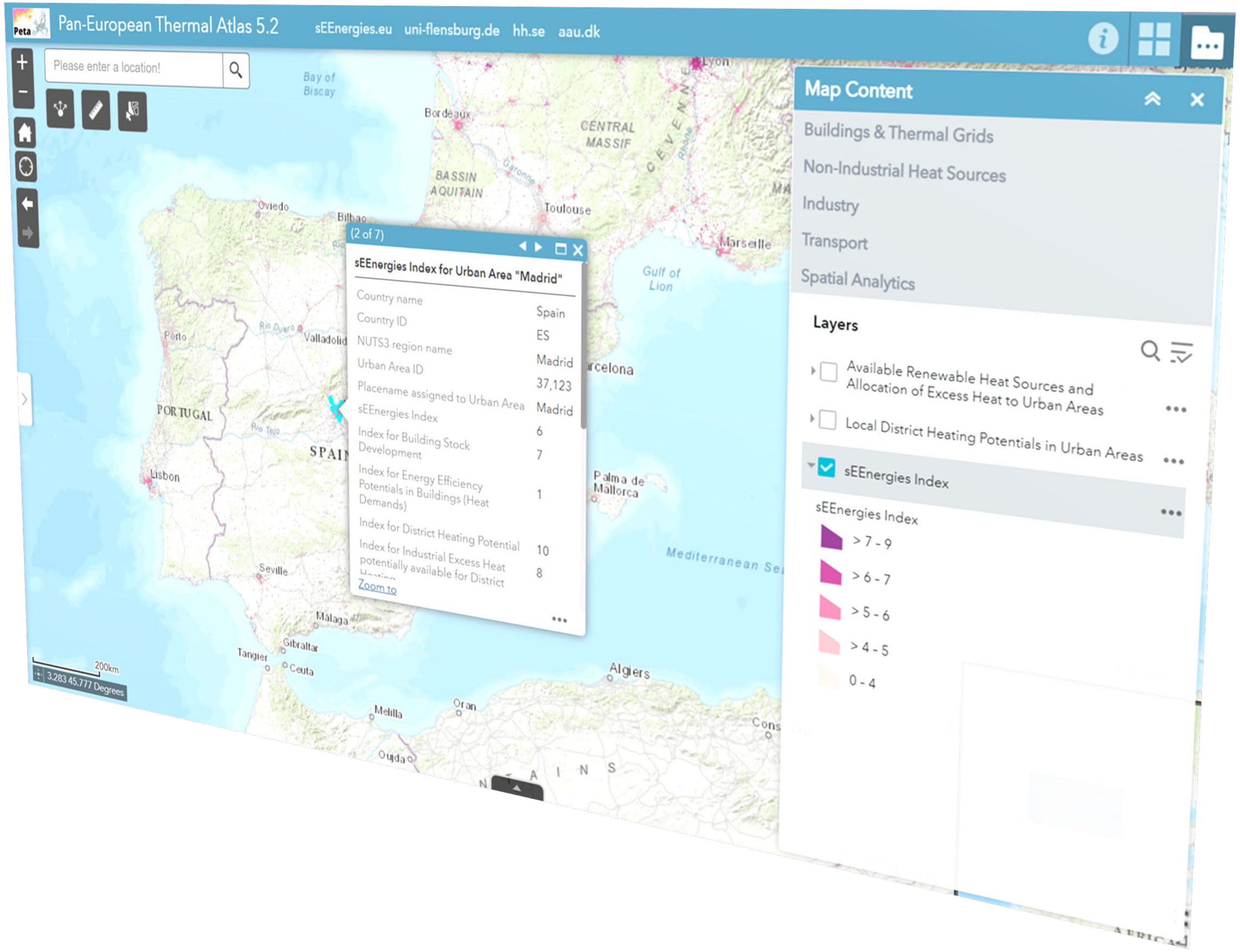
Spatial analytics and the sEEnergies Index

by Bernd Möller, Europa-Universität Flensburg

sEEnergies

Combining spatially distributed information on energy efficiency to identify local synergies

- Cases:
  - Energy efficient buildings and future district heating
  - Sustainable heat sources for local heat supply strategies
  - Urban development, socio-economics and energy efficiency
  - Combining multisectoral efficiency potentials to a local sEEnergies Index



Discussion and feedback

sEEnergies webinar: Energy Efficiency, Spatial Potentials and Possible Future Developments

sEEnergies

- Overview
  - 09:00 **Welcome**
    - by Brian Vad Mathiesen, Aalborg University
  - 09:05 **The low temperature district heating perspective**
    - Presented by Kristina Lygnerud, Swedish Environmental Institute
  - 09:15 **Modelling investment costs for future district heating systems in Europe**
    - Presented by Urban Persson, Halmstad University
  - 09:30 **Spatial analytics and the sEEnergies Index**
    - Presented by Bernd Möller, Europa-Universität Flensburg
  - 09:45 **Discussion and feedback**
  - 10:00 **Webinar end**

Thank You!

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