ENERGY SAVINGS OF INTERCOMPANY HEAT INTEGRATION

Tapping potentials with spatial analysis

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Content

- Industrial waste heat
- Intercompany heat integration
- State of research
- Aim of publication
- Methodological approach
- Exemplary results

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Industrial waste heat

Side product *currently not utilized*

inefficiencies of hardware and processes

thermodynamic or environmental constraints

might be utilized for further applications

For Germany: With regard to the final energy necessary to generate process heat, Pehnt et al. (2011) estimate waste heat potentials of between 3% and 40% depending on the sector (over 140°C).

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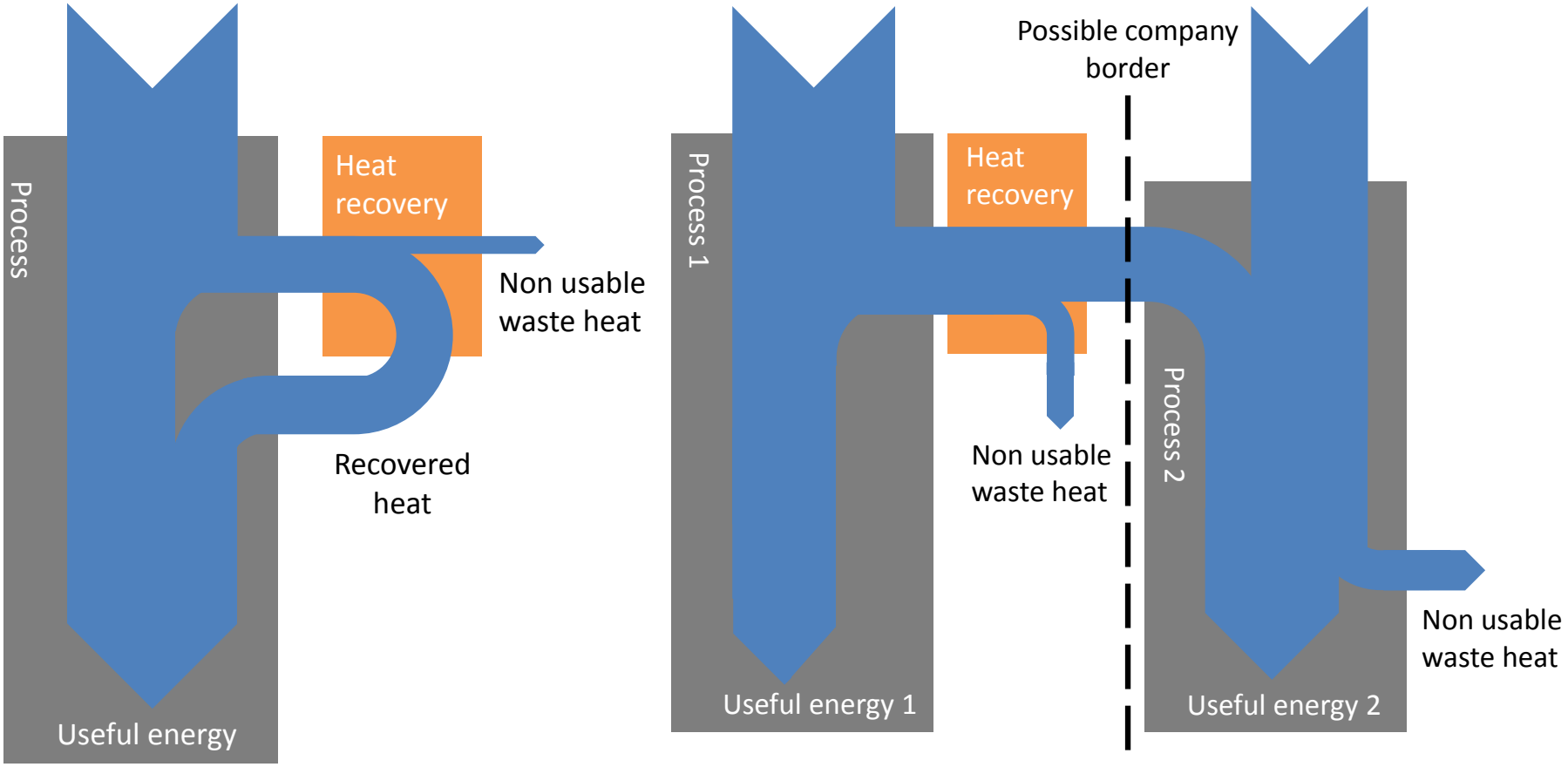
Increasing energy efficiency by using waste heat



Based on Hirzel et al. (2013)

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Heat integration
- in general -

- The design of optimal heat exchanger networks to recover heat is called heat integration. Optimal: various, e.g. maximize the amount of recovered heat.

  (Dunn et al., 2000)

- Process integration is a holistic approach to design, retrofit and operate industrial processes. It sets the unity of the overall process in the foreground, in contradiction to approaches where only the optimization of basic operations of the associated process is in focus.

  (Dunn et al. (2000), El-Halwagi (1997))

- Process and heat integration is treated often synonymic.

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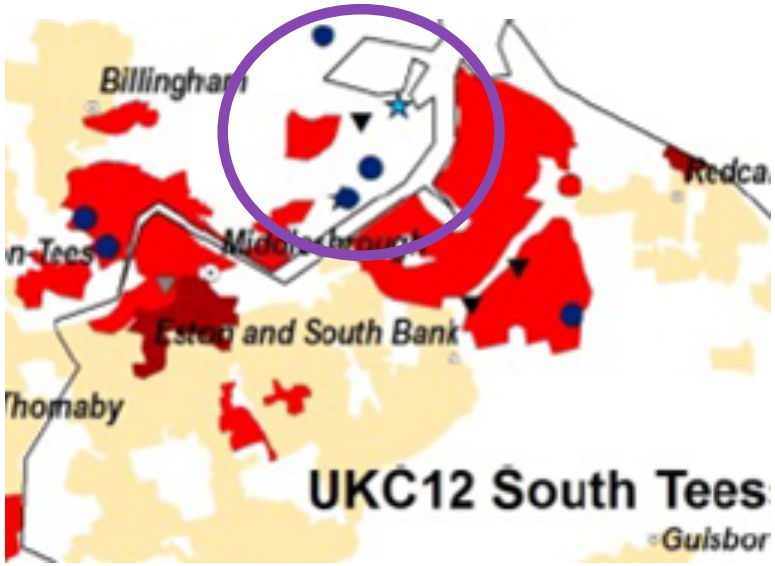
Intercompany heat integration
A special case of waste heat utilization



Excess heat activities
- Chemical and petrochemical
- Food and beverage
- Iron and steel
- Non-ferrous metals
- Non-metallic minerals
- Paper, pulp and printing
- Fuel supply and refineries
- Thermal Power Generation - AP
- Thermal Power Generation - MA
- Thermal Power Generation - WtE

Cities by Population
- 10k - 50k
- 50k - 200k
- 200k - 1000k
- > 1000k
- Continous urban fabric
- Industrial or commercial areas
- Discontinous urban fabric

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Intercompany heat integration
State of the research

- Case studies for interplant/-company heat integration (real, fictitious) [1]
- Spatial potential studies for the utilization of waste heat [2]

Open spots:

- No structured framework to estimate potentials beyond case studies
  - …nor to estimate waste heat potentials at all (cf. Brückner et al. 2014)
- No spatial potential study on intercompany heat integration for Germany

Overall aim:

- To develop a framework, combining methodologies from spatial analysis with methodologies from heat integration to estimate energy saving potentials by intercompany heat integration.

[1] Hackl et al. (2011), Ludwig (2012), Hiete et al. (2012), Morandin (2014)
[2] McKenna et al. (2010), elementenergy (2014), Hammond (2014)

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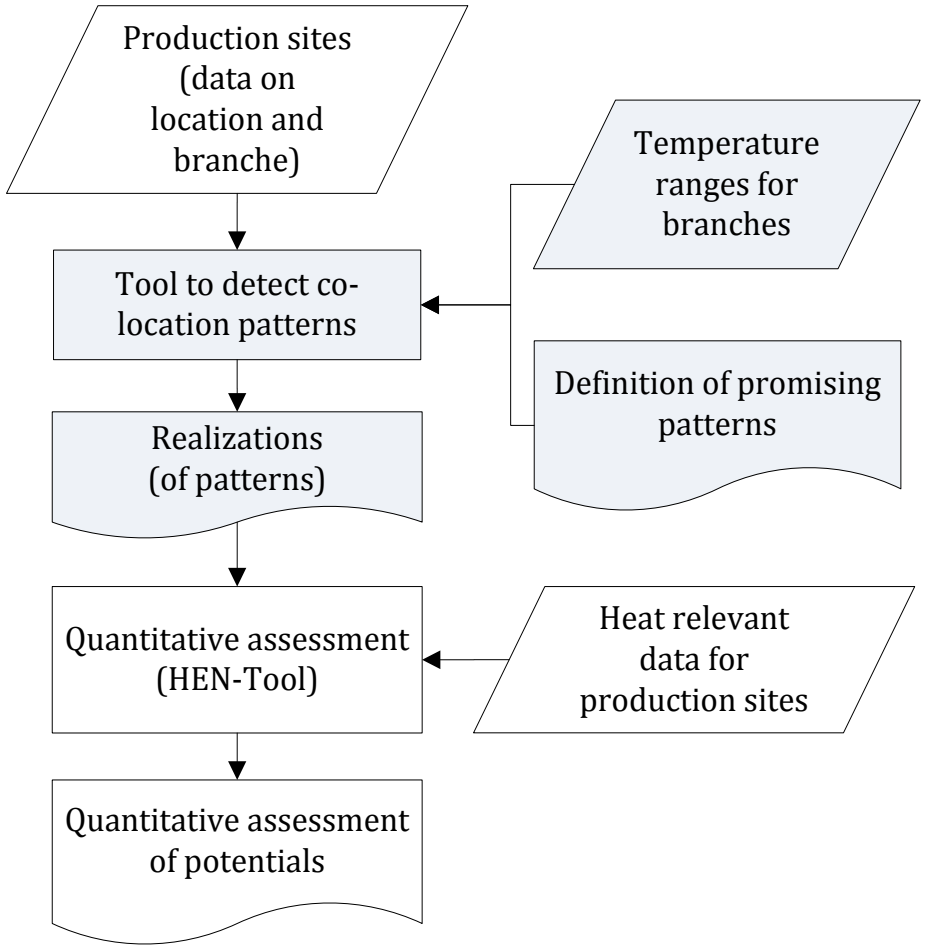
Intercompany heat integration
A potential framework



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Aim of the publication

- **Present a methodology from spatial analysis suitable for the question.**
- **Discuss the current applied ranking methodology with regard to the question.**
- **Apply the methodology on a generated data set.**
- **Present capabilities on a map and further steps.**

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Methodologies from spatial analysis (supposable)

- Regional-econometric models (Eckey et al. 2009):
  - Statistical approaches
  - Gini-coefficient (one sector)
  - Dependency between several sectors (Decay-function or the Bi-Square-function)

- Identifying co-location patterns (Van Canh et al. 2012):

Given a set of geographic object types categorized by features, a co-location pattern captures **which objects typically frequently** occur in **close geographical proximity** to each other. Examples for the discovery of such patterns can be found in many disciplines, e.g. in ecology, where the presence of different species in the same geographic area has been found for many species.

→

- Statistic based approaches
- Data mining based approaches (prevalences based on frequencies)

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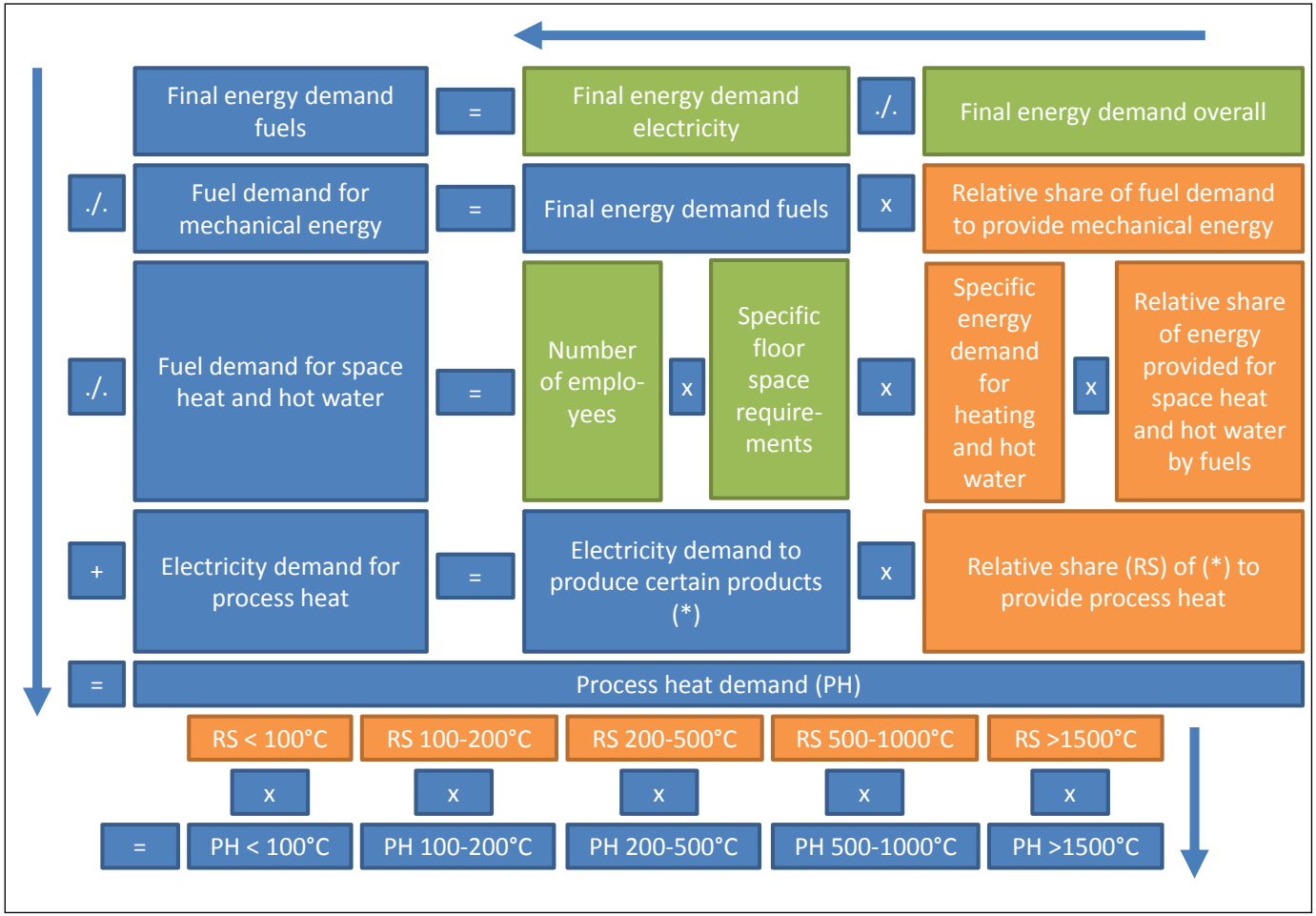
Case study: Database
E-PRTR + 'Datenbasis Energieeffizienz'



Concept to estimate the process heat demand in line with the study 'Datenbasis Energieeffizienz'; 'x' indicates a multiplication; './.' indicates a subtraction. Green: derived from statistics; Orange: derived from literature; Blue: calculated/modelled.

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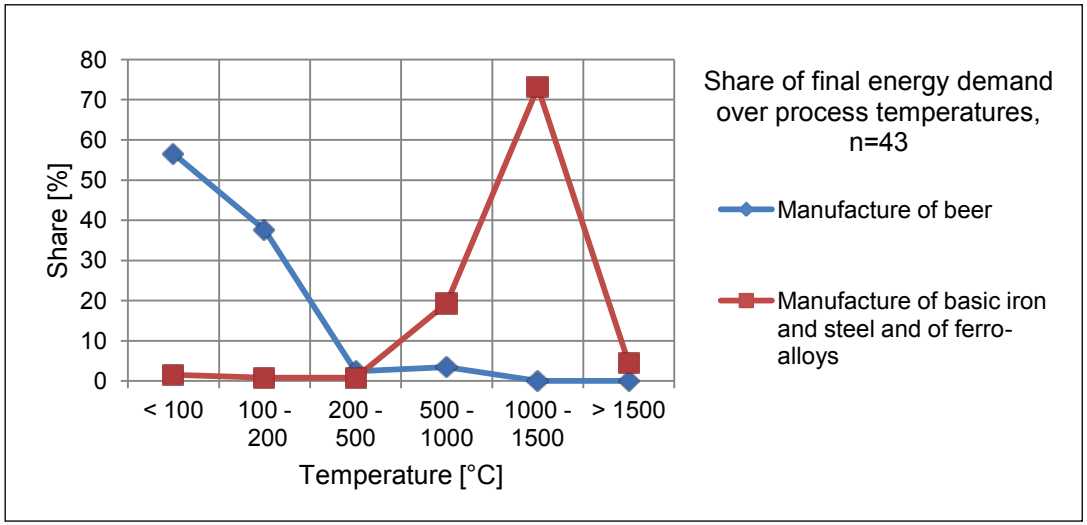
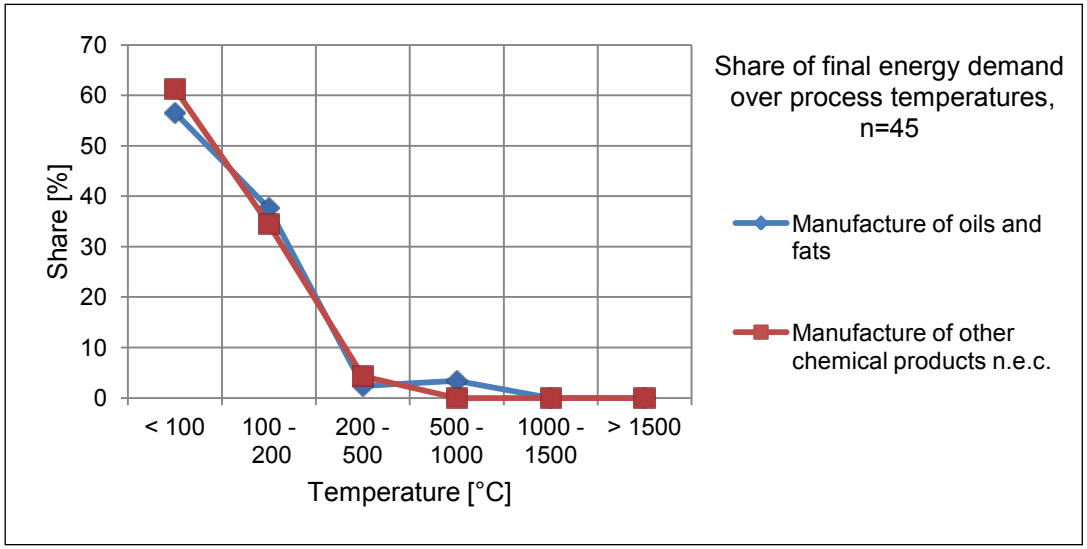
Case study observation





Criteria

$$\left| \sum_{T_i}^{T_n} RS_{Sector\,1,T_i} - RS_{Sector\,2,T_i} \right| \geq 0.3$$, for i = 1 to n=3 (lower end), and for i = 4 to n=6 (upper end).

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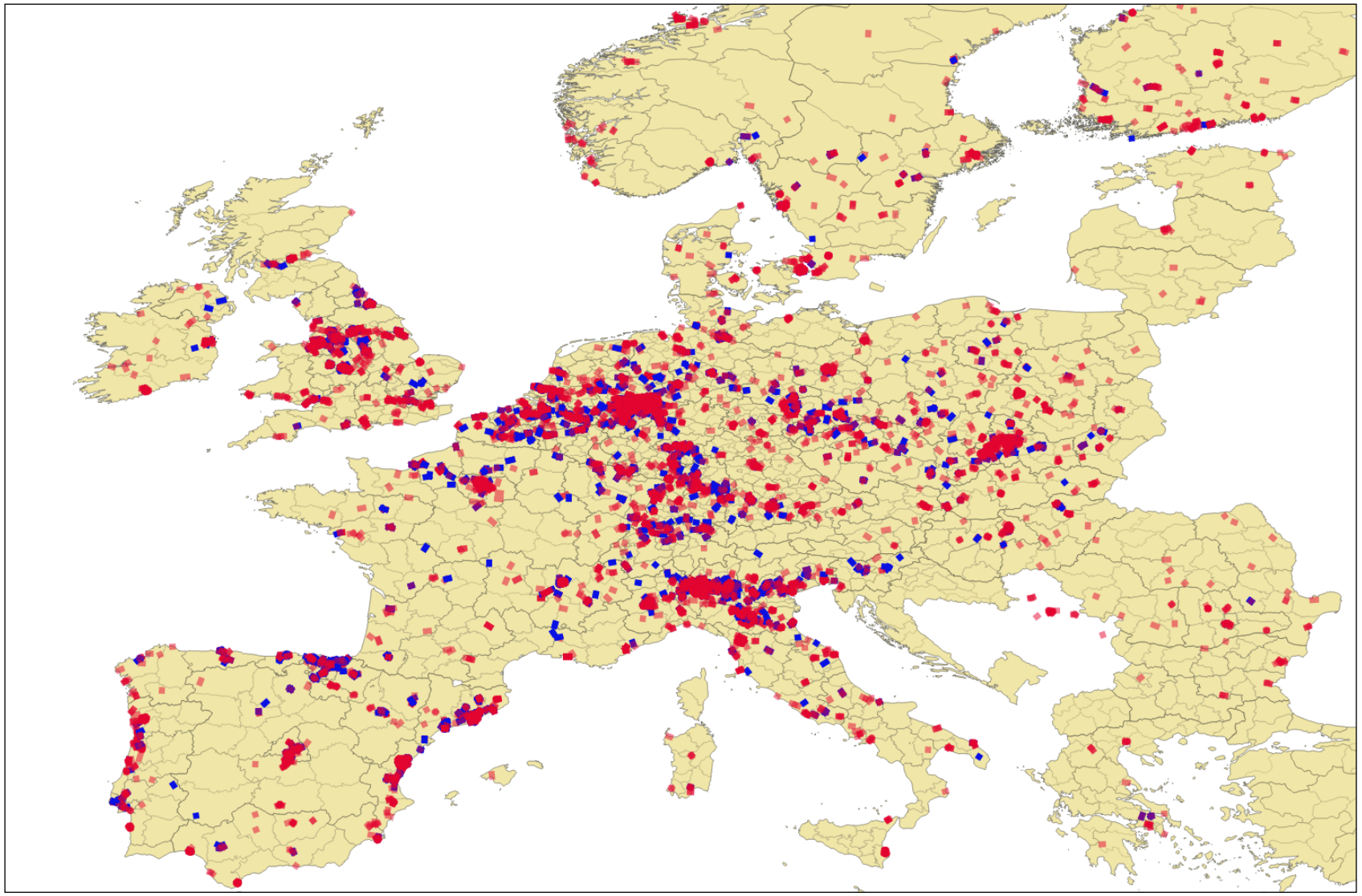
Exemplary map



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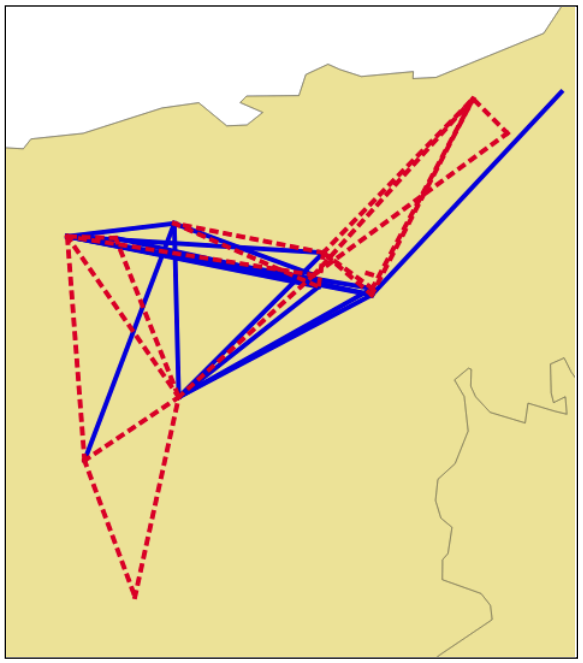
Section of exemplary filtering Gipuzkoa, Basque Country, Spain



Number of production sites	Sector
3	Manufacture of paper and paperboard
5	Manufacture of other inorganic basic chemicals
1	Manufacture of plastics in primary forms
1	Casting of light metals
1	Casting of iron
2	Treatment and coating of metals

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Conclusions

- Spatial co-location mining can help to identify promising agglomerations of production sites for inter-company heat integration.
- For the identification: prevalence measures beyond frequencies seem to be worth considering, as demonstrated in the case study (u-shapes).

Potential next steps:

- Validate the criteria applied to identify promising agglomerations. Are the u-shapes really promising constellations? Methodology: Expert interviews.
- Estimate energy savings by intercompany heat integration for selected sections.
  - HEN-Tool already developed taking dynamic loads and capital cost into account.
- Possible extension of tool to detect co-location patterns with more sophisticated prevalence indexes with regard to several topics (heat integration, material efficiency, etc.).

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Thank you for your attention!

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