# GEOGRAPHICAL REPRESENTATION OF HEAT DEMAND, EFFICIENCY AND SUPPLY

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# Project data

- Started September 1st 2014
- Finish August 31 2017

- Supervisor: Bernd Möller
- Co-supervisors: Henrik Lund and Steffen Nielsen

# Start-up period (first few months)

- Writing 2-month studyplan

- Doing courses (17 ECTS by end of December)
  - Focus on statistics and programming

- Actual registered heat consumption data received

# Objectives

- Investigate the difference in the expansion potential of district heating depending on the economic science approach

- Identify inaccuracies in the current heat atlas based on a statistical analysis comparing the results with real-world data

- Develop methods to identify patterns in the inaccuracies and correlations between the inaccuracies and for example demographic data. Develop methods that improve the accuracy of the heat atlas based on the patterns identified

- Contribute to the development of the next generation of heat atlases
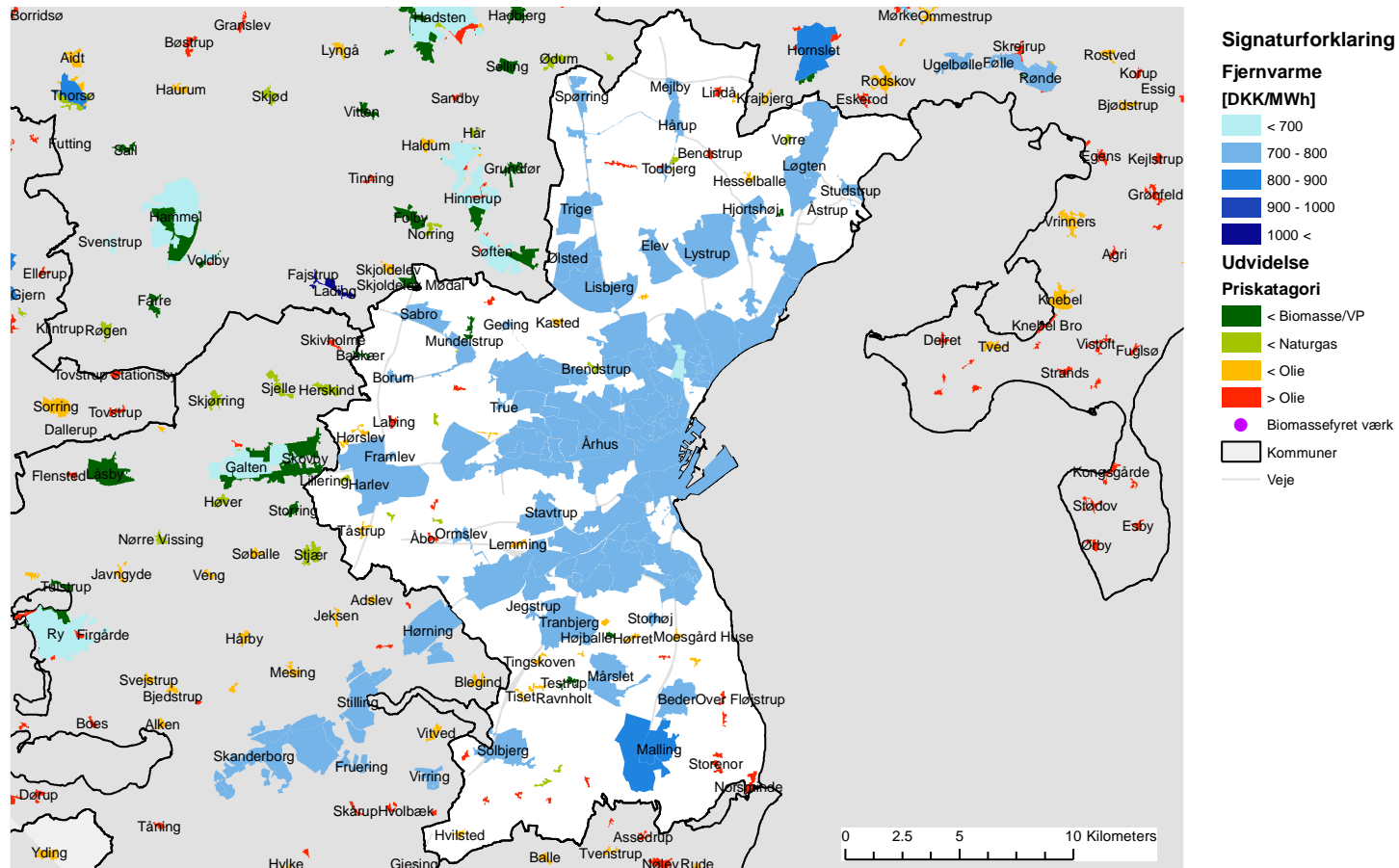
# Study 1

- Comparison of district heating expansion potentials based on private/business consumer economy or socio economy
  - Aim: Identifying the consequences for the **expansion potential** of district heating depending on the **economical approach** used.
  - Data: Current heat atlas
  - Methodology:
    - The expansion potential for each of the current district heating networks to nearby towns and villages is calculated.
    - The calculations include the costs of transmission, distribution and building installation, as well as, heat production costs.
    - The heating costs per year are compared with individual alternatives, e.g. biomass or heat pumps.
    - The calculations are done as both **private/business economy** and **socio economy** and the **different potentials are compared**.

# Example of Study 1 model output (Aarhus municipality)

# Study 2

- Comparison of heat atlas results with real-world measurements
  - Aim: Investigation of the **accuracy of the current heat atlas** by comparing the results with **real-world data**. Identification of areas in need of improvement.
  - Data: Current heat atlas and FIE data
  - Methodology:
    - Statistical analysis of correlation between the two datasets.
    - Identify areas where the heat atlas has a high accuracy
    - **Identify building types or areas where the need for improvement is high** and **search for patterns** in the differences.

# Study 3

- Methods on improving heat atlas results based on real-world measurements
  - Aim: Identify methods for improving the heat atlas.
  - Data:
    - FIE data and results from current heat atlas.
    - Possibly demographic data which can be used to explain the differences or data on property value from for example BBR.
  - Methodology:
    - Areas with inaccuracies are further investigated with a focus on **revealing patterns** that can explain the differences.
    - Investigate the covariance of the **relationship between area and heat consumption** or **location/property value and heat consumption**.

# Study 4

- Accuracy of real-world adjusted heat atlas applied on case-study
  - Aim: Statistical analysis of the updated heat atlas compared with the FIE dataset. Identify improved areas as well as further areas in need of improvement.
  - Data: Updated heat atlas and FIE dataset
  - Methodology: Statistical analysis comparing the correlation between the datasets.

# Study 5

- Accuracy improvements on heat atlases based on real-world data input
  - Aim: Description of methods used in the work on improving the accuracy of the heat atlas.
  - Data: Heat atlas, FIE dataset
  - Methodology: Mostly descriptive to summarize the methods used. Literature study to compare the methods with other studies.

# Expected outcome of PhD

- 5 papers based on the studies

- A new edition of the heat atlas with more clear overview of the accuracy

- Participation in developing the heat atlas into a tool useful for engineering consultants, municipalities, utilities and research institutions

# Collaboration & Presentation of results

- At the moment no final agreements on collaboration, but first talks has be initiated

- Results of the studies will be presented in the 4DH conferences and other conferences

- 4DH conference 2015: Results of Study 1 and preliminary results of study 2