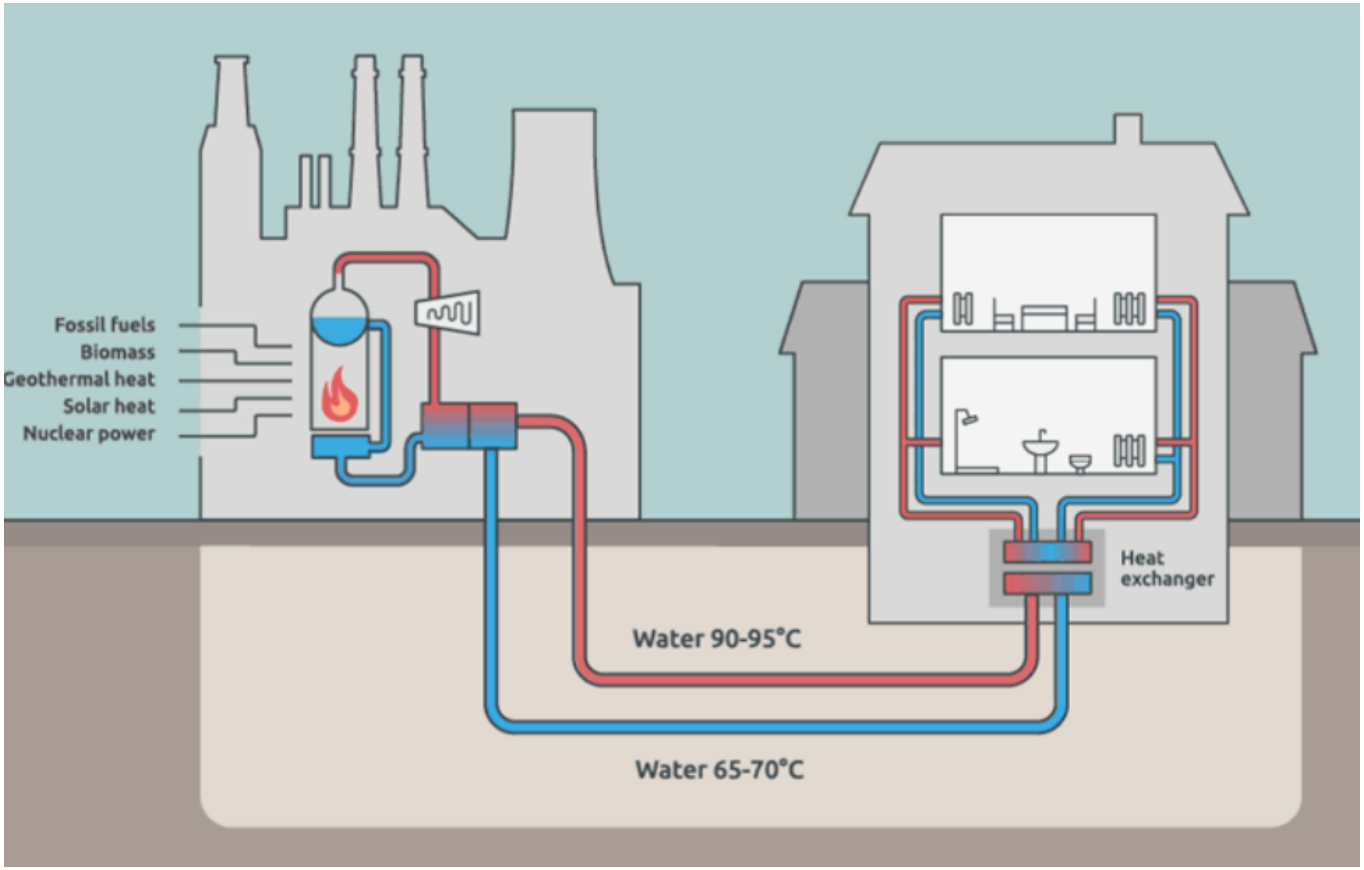
IndMeas
Industrial Measurements

Using weather data to the benefit of district heating systems

Ville Laukkanen

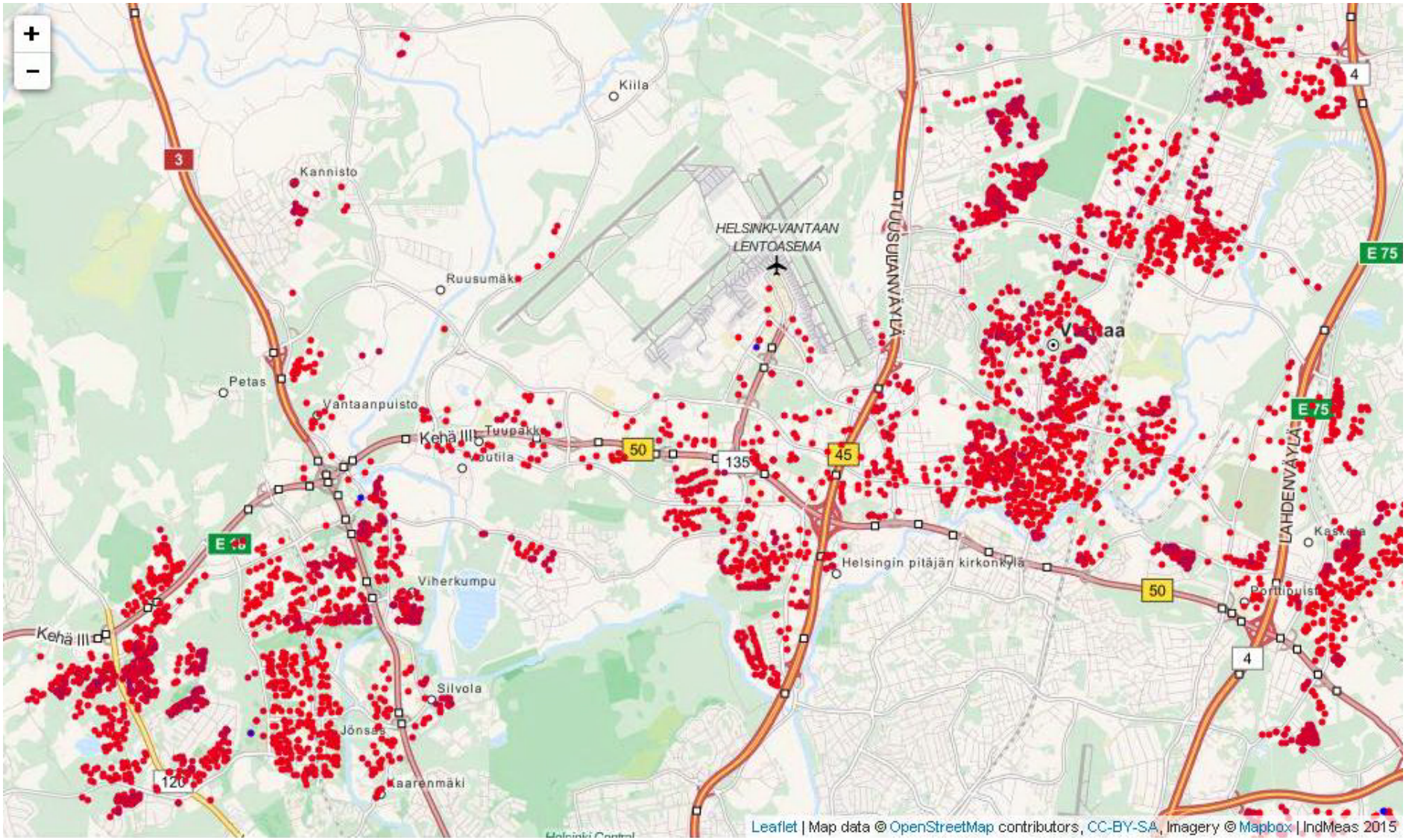
IndMeas
Industrial Measurements

District heating



IndMeas
Industrial
Measurements

IndMeas
Industrial Measurements



IndMeas
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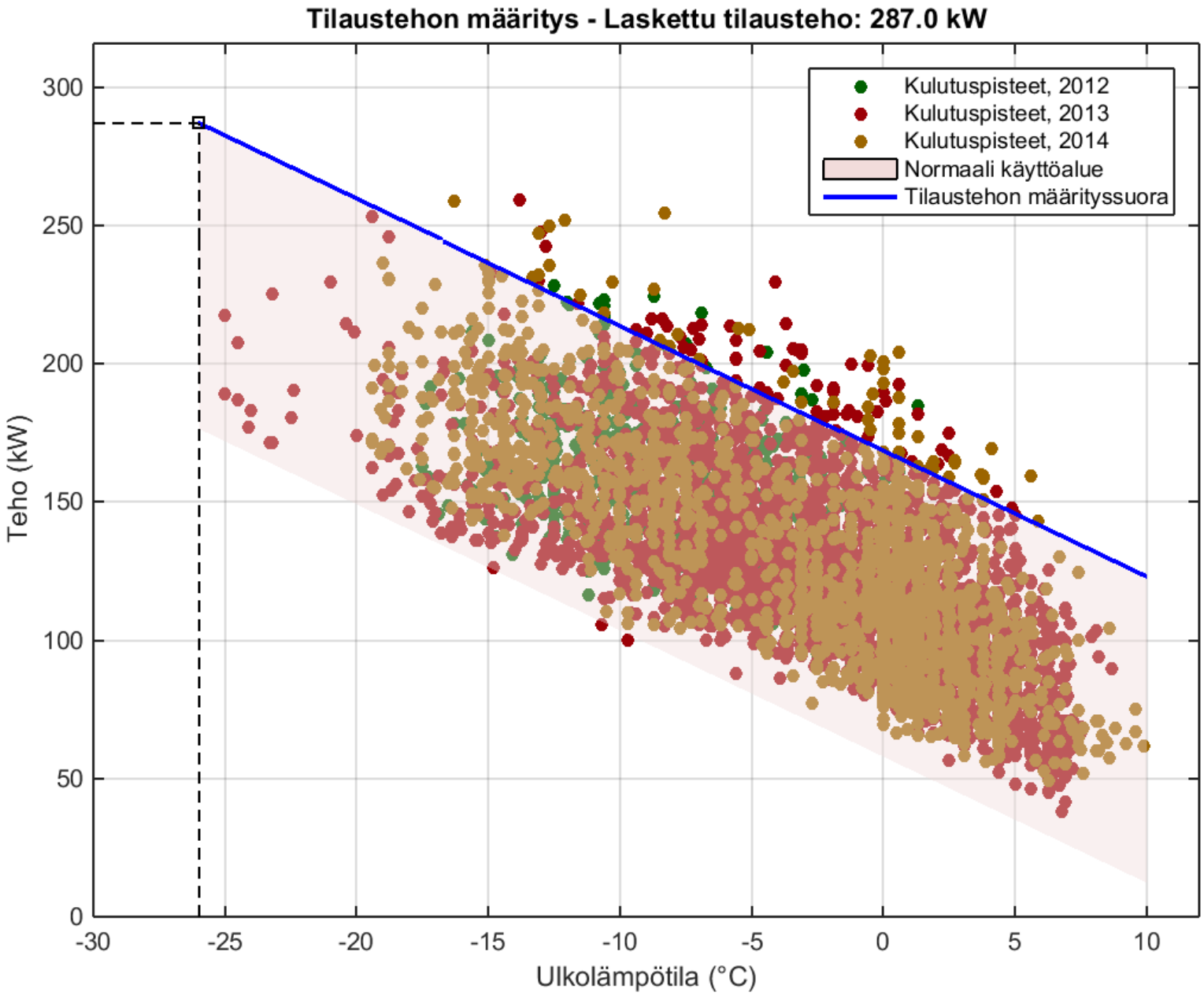
Tilaustehon määritys - Laskettu tilausteho: 287.0 kW
Kulutuspisteet, 2012
Kulutuspisteet, 2013
Kulutuspisteet, 2014
Normaali käyttöalue
Tilaustehon määrityssuora
Teho (kW)
Ulkolämpötila (°C)
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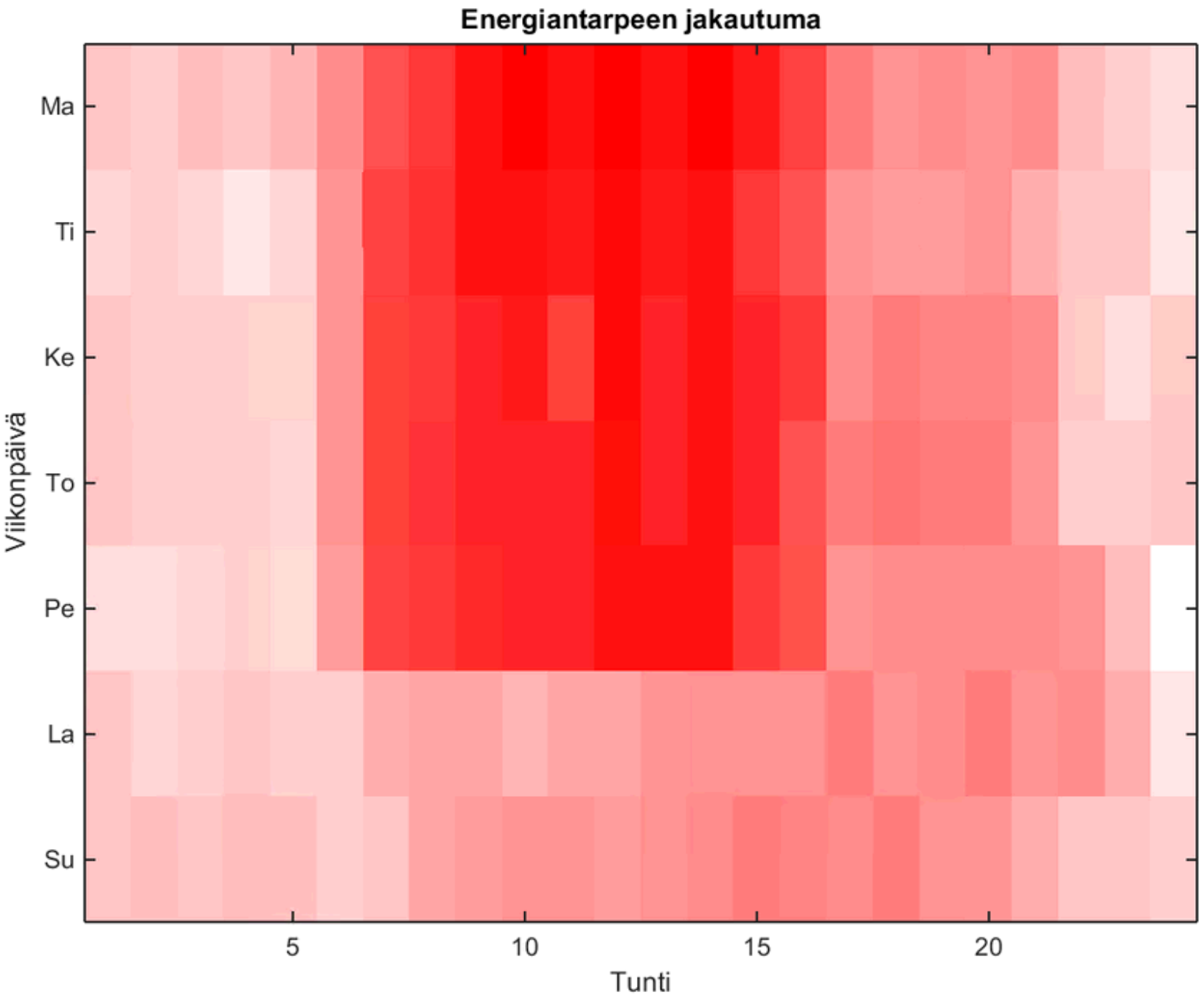
10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Industrial
Measurements

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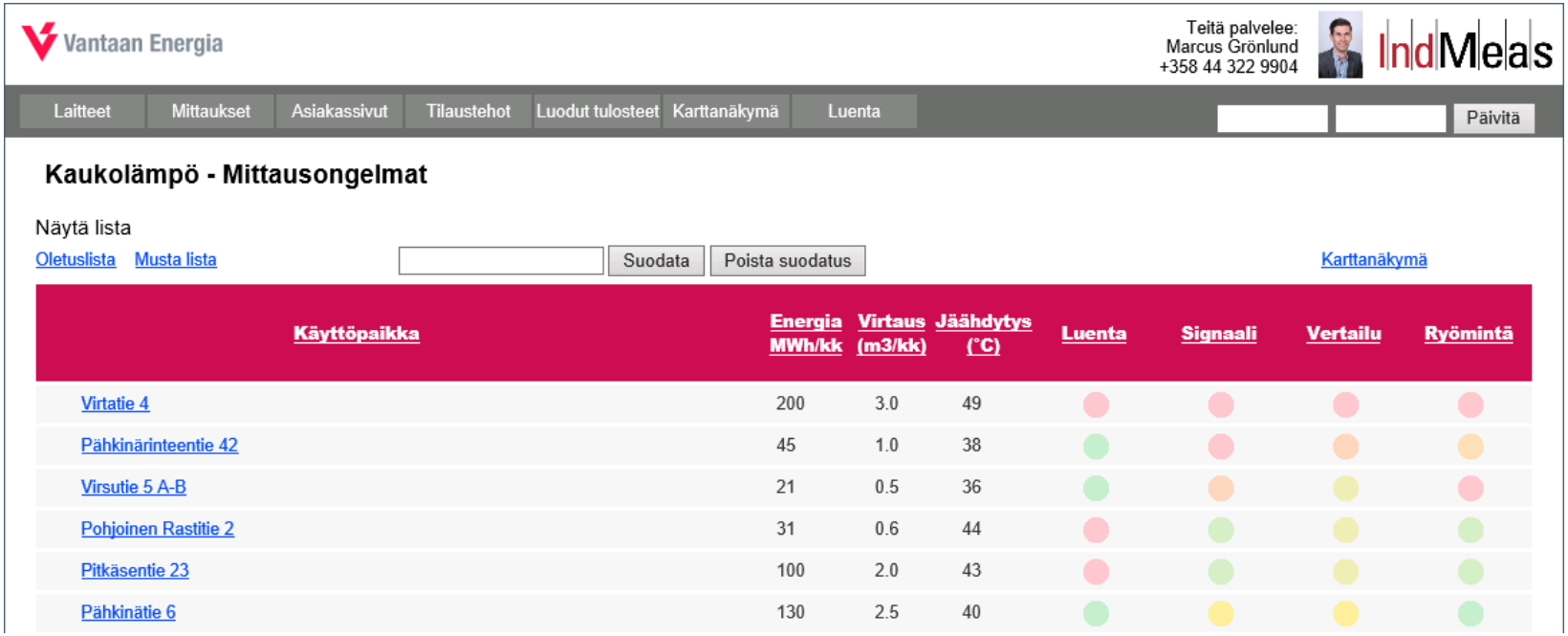
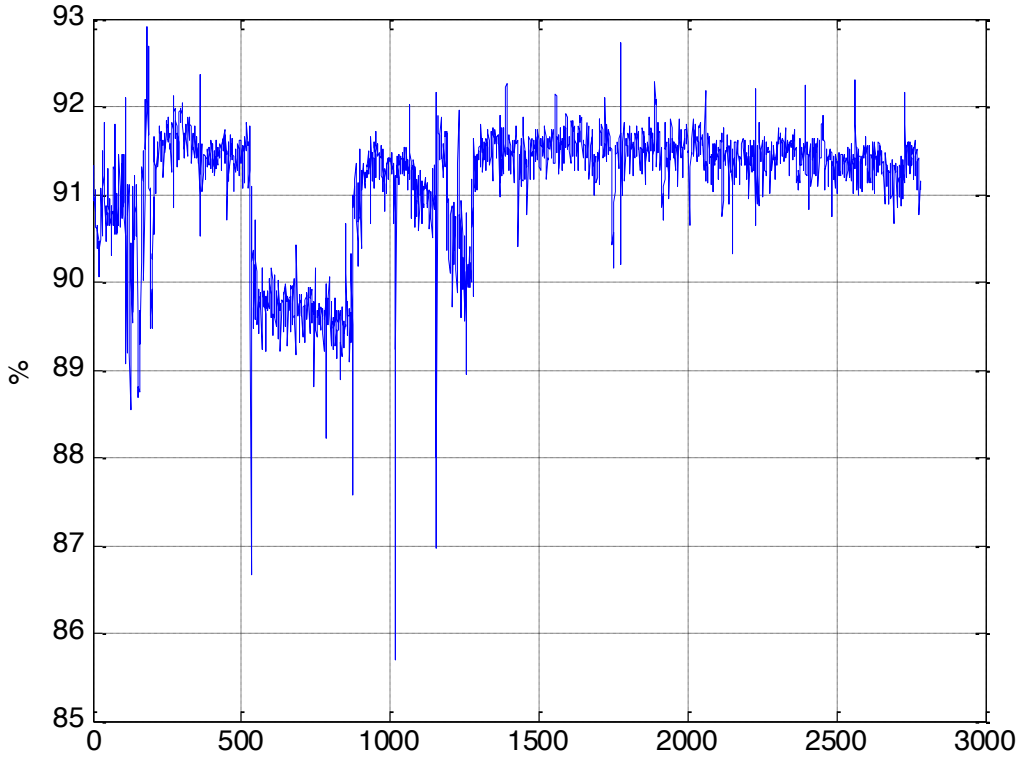
Industrial Measurements

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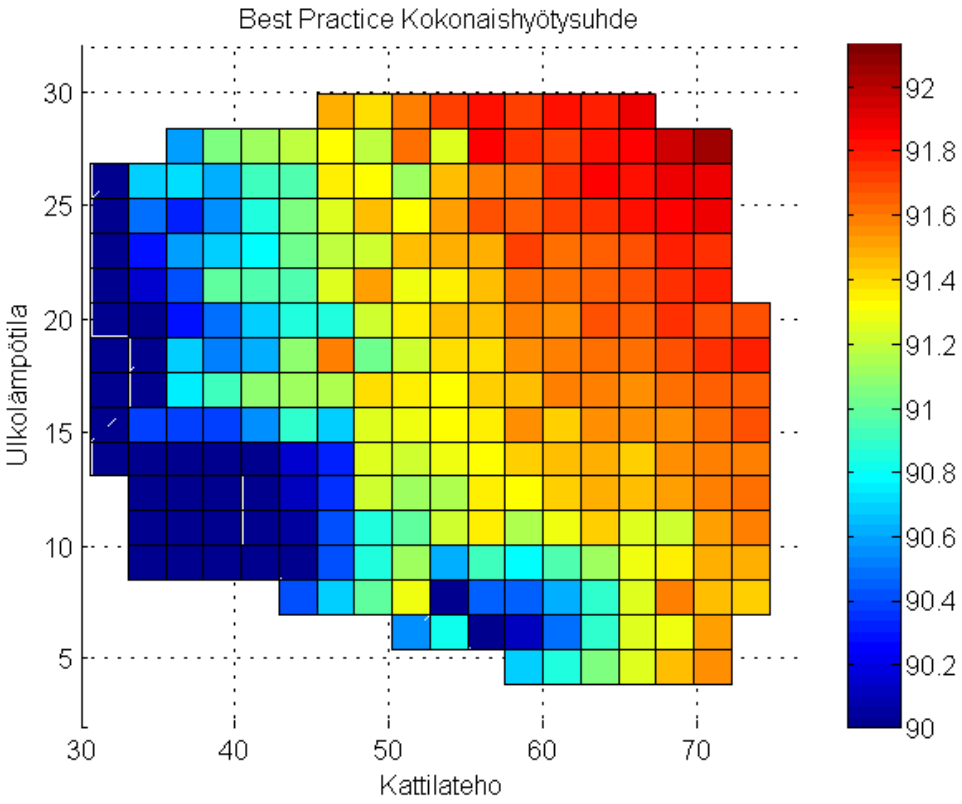
IndMeas
Industrial
Measurements


Best Practice Kokonaishyötysuhde
Ulkolämpötila
Kattilateho
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60
70
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91.8
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91.4
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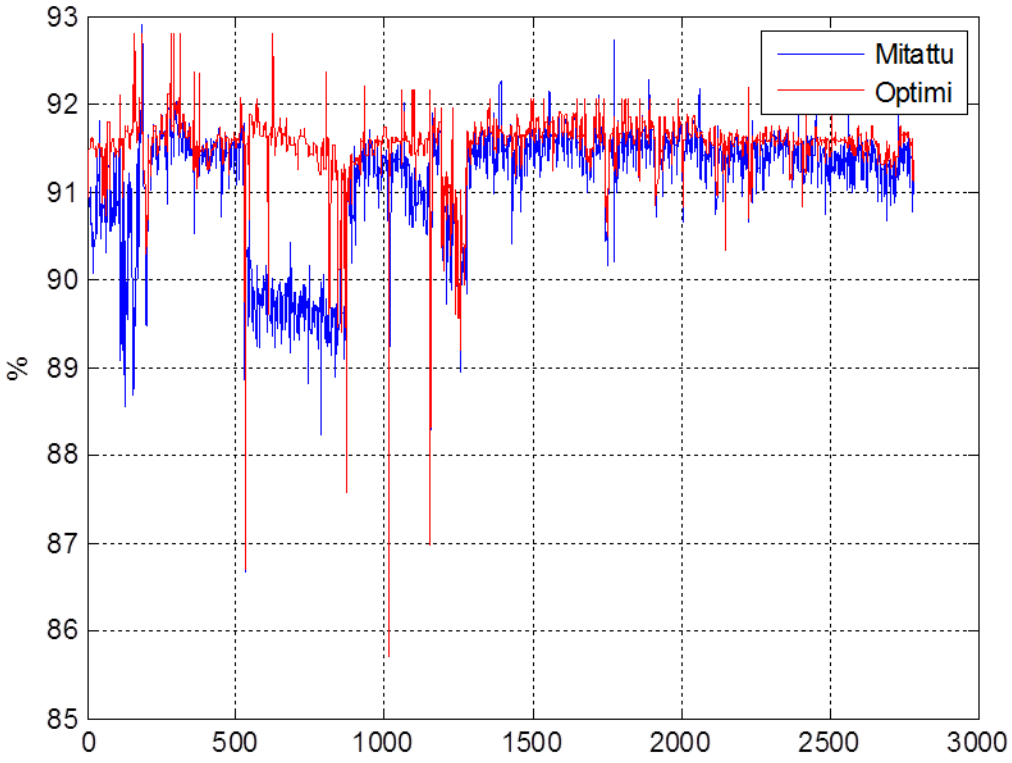
90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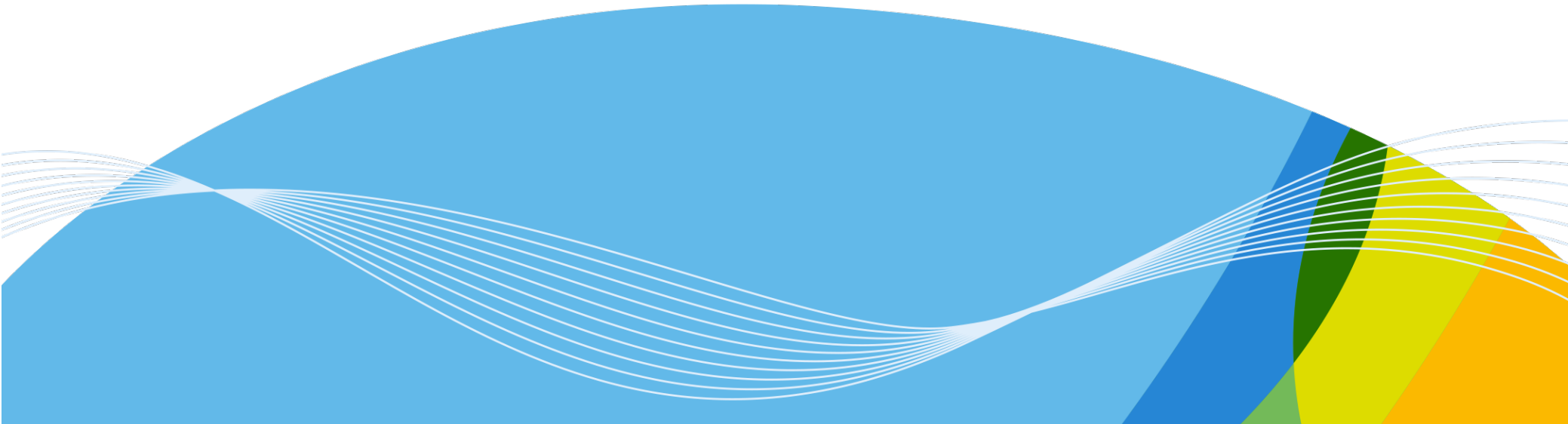
FINNISH METEOROLOGICAL INSTITUTE

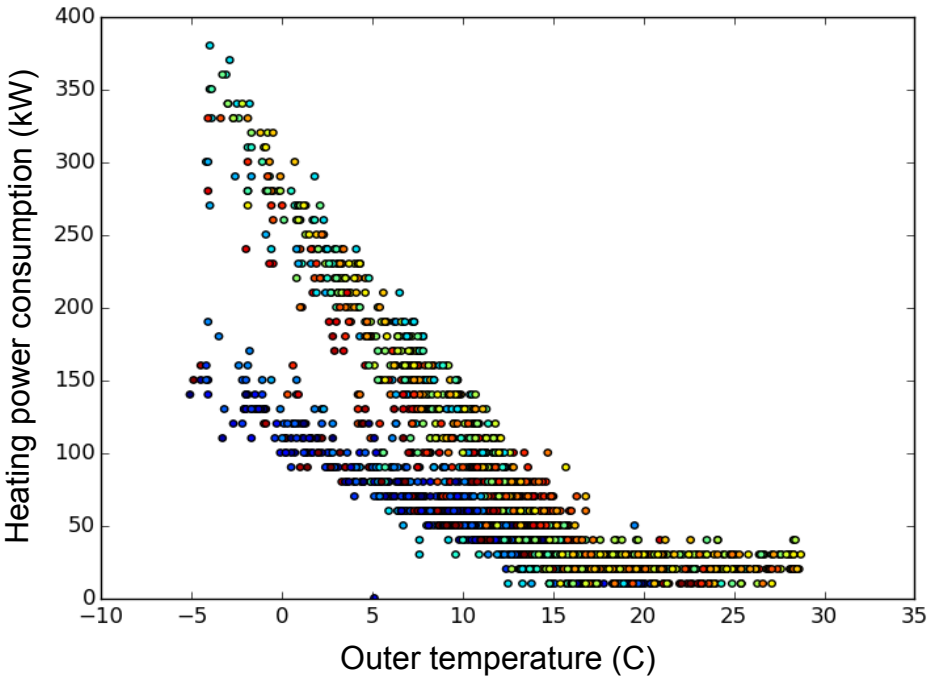
Improved District Heating Model

Seppo Pulkkinen, Annakaisa von Lerber and Jarmo Koistinen (FMI)



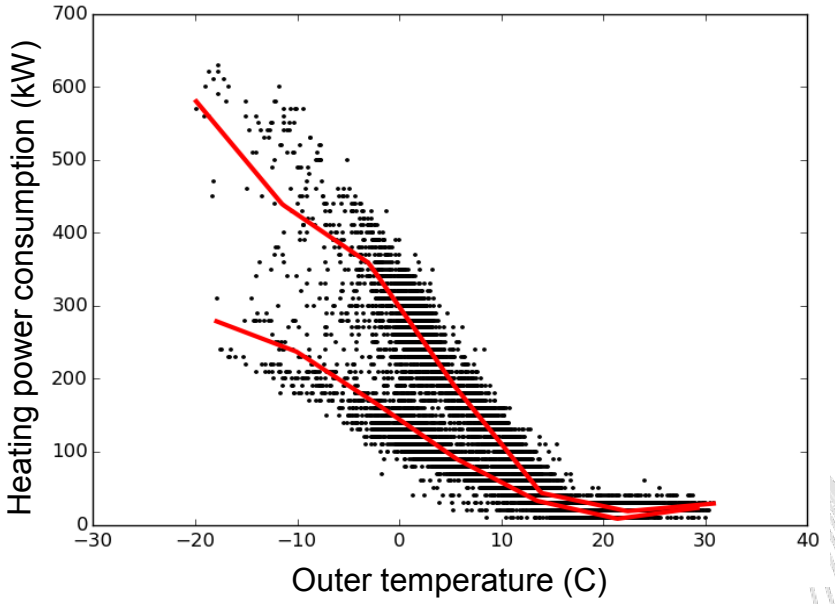
Multiple Piecewise Linear Regression Model

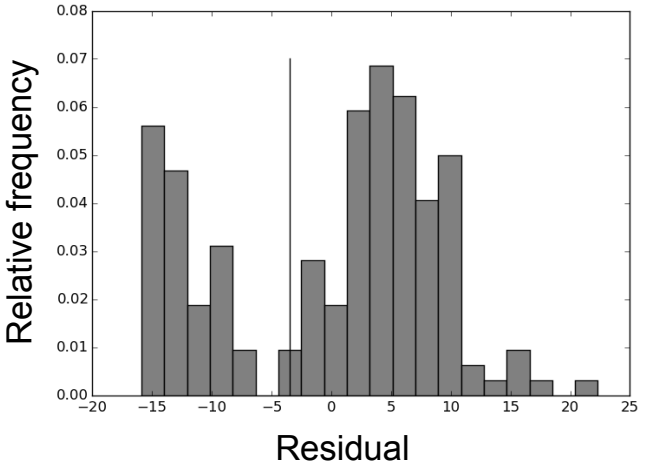
- **Piecewise linear regression** to outer temperature explains 60% of the variance in heating power consumption.
- However, there can be multiple consumption profiles. In this example:
  - Blue colors represent nighttime consumption.
  - Other colors represent daytime consumption.



Piecewise Linear Multiple Regression (PLMR) Model

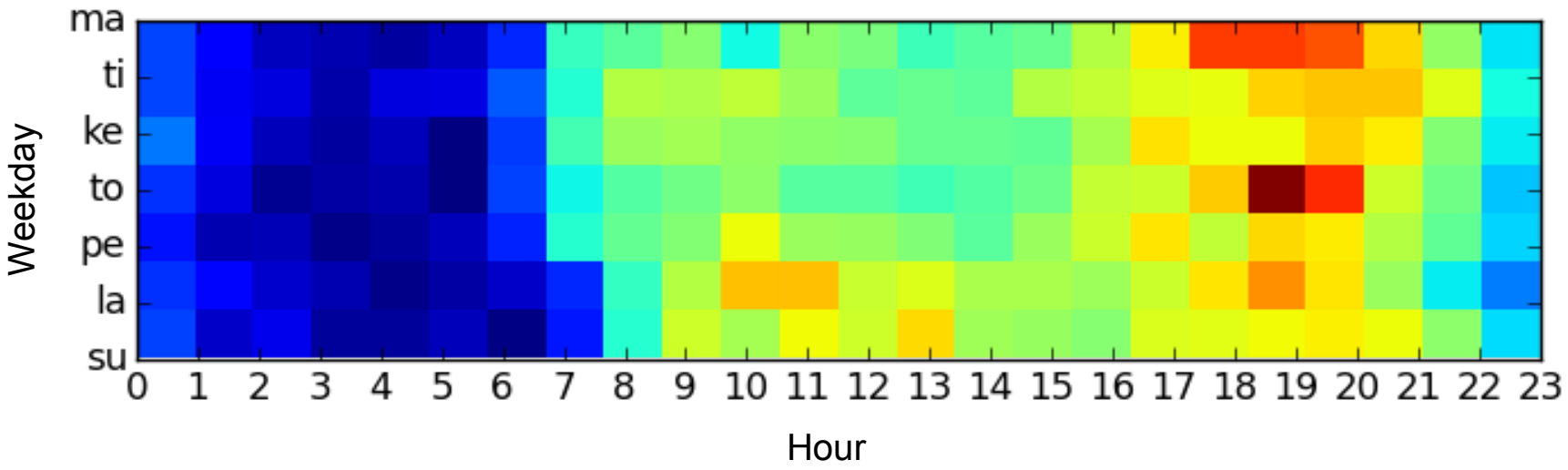
- **Piecewise linear regression** to outer temperature explains 60% of the variance in heating power consumption.
- However, there can be multiple consumption profiles. In this example:
  - Blue colors represent nighttime consumption.
  - Other colors represent daytime consumption.
- Statistical tests are done to **automatically** determine clusters in the data.
- The **multiple regression** model may explain up to 70% of the variance.





Dependence on Time (Social Model)

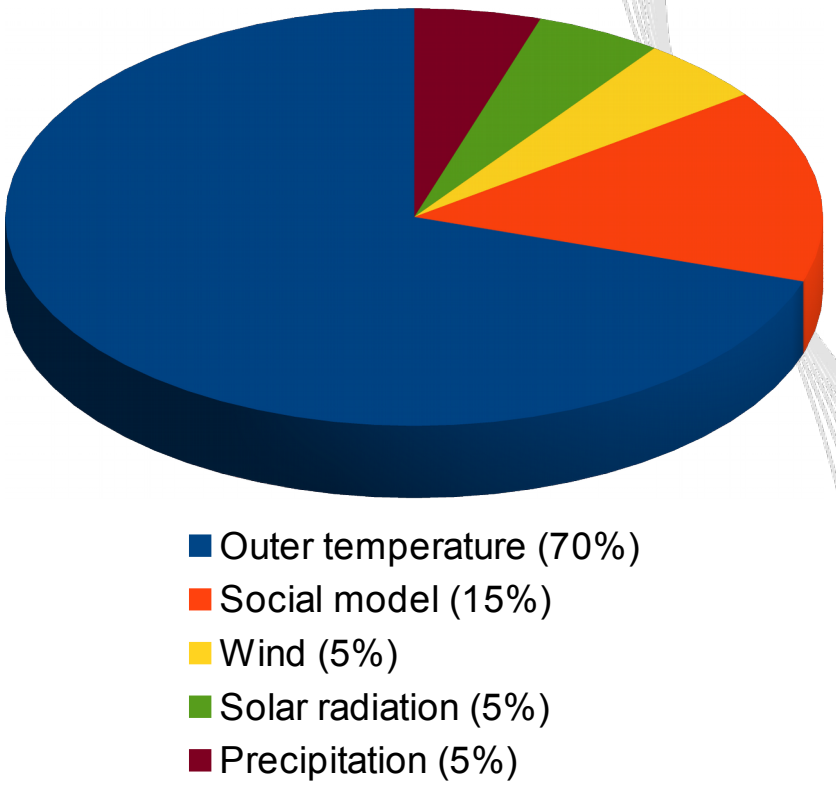
- A "social model" describing the time dependence of heating power consumption.
  - In this example, nightly and daily profiles are different (weekday/weekend).
  - The social model is applied to residuals (the remaining variance after regression).
- The **combined PLMR and social** model can explain up to 85% of the variance.
- The combined model is in operational use at Indmeas (a MATLAB implementation).



Ongoing Work

- Incorporating meteorological variables to the model (provided by FMI):
  - Wind
  - Solar radiation
  - Precipitation
  - Snow coverage?
- A multivariate extension of the regression model is under development.
- The contribution of weather parameters to the explained variance is highly situation-dependent: more research is needed.

Explained variances (rough estimates)



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