Domestic Heat Demand Prediction and the Implications for Designing Community Heat Network

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Trent Basin
Trent Basin

3rd international conference on
SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING
Copenhagen, 12-13 September 2017
Project SCENE
SCENe: monitoring at community
SCENe: monitoring at home

- Temperatures
- Relative Humidity
- Carbon Dioxide
- Occupancy
- Electrical Energy
  - Total Electricity
  - Circuits
  - Significant Appliances
- Thermal Energy
  - Hot Water
  - Space Heating

Cloud Server

HUB

GSM
Aim & Objectives

Aim: to improve the prediction of heat demand of a community for designing a communal heat network

- **Objective 1**: a model for space heating of a community
- **Objective 2**: a model for hot water of a community
- **Objective 3**: validation of the models
State of the art: Stochastic models

• Archetype approach
  – Limited archetypes
  – Representative of building stock
Limitations of current models

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  – Limited archetypes
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• Lumped capacitance model
  – Based on simplified hourly method
  – Pre-calibrated capacitances and coefficients
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• Validation datasets
  – Annual average values / rule-of-thumb
  – A specific archetype
  – Measured datasets not for the simulated dwellings
SCENe Model: space heating

• Dynamic thermal modelling: EnergyPlus

• Stochastic heating schedules: Richardson’s model
Result: annual space heating demand

2,000 stochastic heating schedules
Result: space heating diversity factor

No. of simulation = 100
Result: hourly space heating demand

No. of dwellings = 100; No. of simulations = 100
SCENe model: hot water

• Volume prediction: stochastic CREST Demand Model

• Energy calculation: stochastic sampling measured outlet and inlet water temperatures

(McKenna et. al., 2016)

\[ T_{\text{out\_mean}} = 52.9 \, ^\circ\text{C} \]
\[ T_{\text{in\_mean}} = 15.2 \, ^\circ\text{C} \]

(Energy Saving Trust, 2008)
Result: hot water daily volume

No. of simulation = 100

$\mu = 109.5, \sigma = 7.2$

$\mu_{crest} = 117.5$

$\mu_{est} = 122$
Result: hot water daily volume & energy

\[ \mu = 109.5, \sigma = 7.2 \]

\[ \mu = 15.5, \sigma = 1.0 \]

\( \mu_{est} = 122 \)

\( \mu_{est} = 16.8 \)
Result: hot water hourly volume

No. of dwellings = 100; No. of simulations = 100
Result: hot water hourly energy

No. of dwellings = 100; No. of simulations = 100
Result: hot water diversity factor

No. of simulation = 100
Result: hot water minutely volume

No. of simulation = 100

No. of simulation = 1000
Validation of models

• Using data measured at community and dwelling levels – future work
Summary

**Aim:** to improve the prediction of heat demand for designing a community heat network

- **Objective 1:** a model for space heating demand
- **Objective 2:** a model for hot water demand
- **Objective 3:** validation of the models