A review of modeling approaches for analyzing building energy demand in district heating systems

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PhD Research Project

**Objectives:**

1) develop a fit-for-purpose simulation testbed for new generation district heating systems;
2) validate the virtual testbed with measured data.

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**Step 1**

Project Phases

Stakeholders

**Step 2**

- Model Complexity +
- Model selection
- Confidence Interval +

**Step 3**

KPIs

- G
- D1
- D2

KPI- Key Performance Indicator

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Introduction

**Purpose:**
summarizes the most commonly used building energy demand models with specific objectives from different stakeholders
Building Energy Demand Modelling in DHS

- Method 1 - Fixed demand profile
  - Yearly → Hourly

- Method 2 - Dynamic demand simulation
  - Hourly or even less

Demand

Generation

- kWh

Generation

- $T$
- $\dot{m}$
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Method 1-Fixed profile

**Top-down**
- Fixed profile

**Data requirements**
- Energy price, CO₂ emission
- Historical energy consumption

**Application**
- Authorities
- Policy development

**Energy demand**
- Energy price
- Household income
- HDD
- Σ
- ...

**Data sources**
- Annual
- Regional
- National
Method 1 - Fixed profile

Statistical approach

- Normalization of measurements
- Regression

Application

Service providers

Technological alternatives

Source: New Buildings Institute

Source: U.S. Energy Information Administration, Annual Energy Review 2011, Table 1.9 (September 2012)

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Method 1-Fixed profile

• Steady-state modelling
• Dynamic modelling

Application
- Service providers
- Technological alternatives
- Design optimization
- Control strategies

4th Generation District Heating Technologies and Systems

Bottom-up

Analytical approach

Steady-state modelling

Time

SUBSURROUNDS

Statistical approach

SYSTEM

BOUNDARY

Hourly District

Sub-Hourly Building

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Method 2- Dynamic demand simulation

Samiliar approach as dynamic modelling in M1

**Application**

**Consumers**
Indoor thermal comfort level;

**Service provider**
Operational optimization;
Control strategy;
Demand response management.
Challenges in new generation DHS

Facts in DHS

- Complexity

Interaction

Challenges

- Viable sources?
- Most suitable system capacities?
- Operational control strategy?

Solution

Footprint and dollar symbol

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Complex model – not always good

LEAST COMPLEX model within certain CONFIDENCE LEVEL for different QUESTIONS

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THE BEST WAY TO HAVE A GOOD IDEA IS TO HAVE A LOT OF IDEAS.

– Dr. Linus Pauling

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