Chair of Energy Systems
TUM School of Engineering and Design
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Tools for Urban Heating Demand Estimation on a District Scale

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The (digital) Urban Energy Planning Process

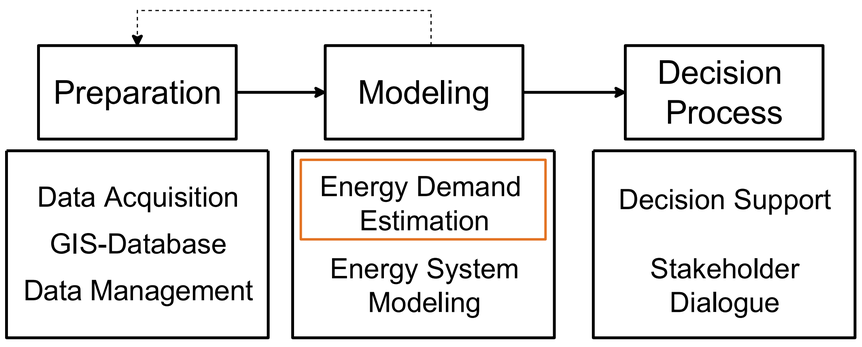


Figure 1. Urban Energy Planning Process, adapted from [1].

Method Classification

Several heating demand estimation methods exist [1]. Classifying them can be challenging due to the breadth of available tools and models. In this work, they are classified into three broad categories. First, **physics-based** models are mathematical representations of real-world phenomena grounded in fundamental physics principles. A commonly used model is, for example, City Energy Analyst (CEA) [3]. Second, **data-driven** models use empirical data to identify patterns, relationships, and predictions within a system without explicitly incorporating underlying physical principles. Therefore, they provide predictions based solely on observed data patterns, often called black-box models. Lastly, **hybrid** models integrate elements from different modeling approaches, such as physics-based and data-driven methods, to leverage their respective strengths.

Granularity of Models

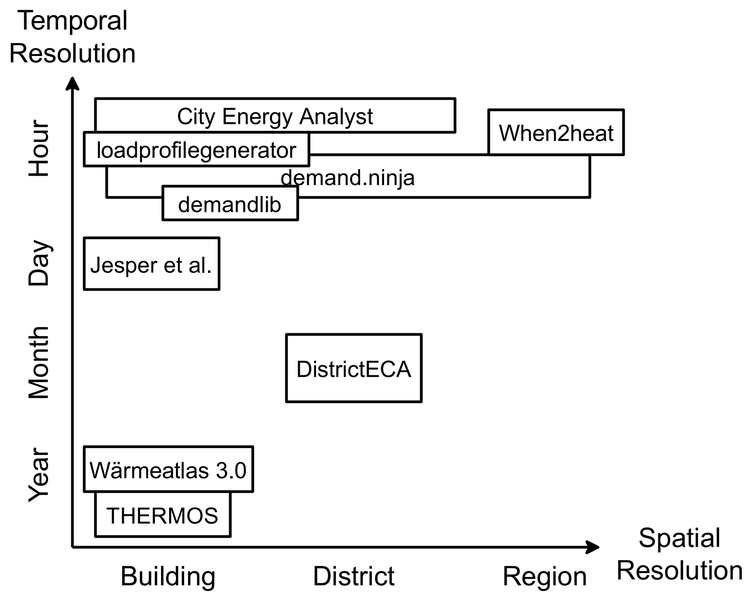


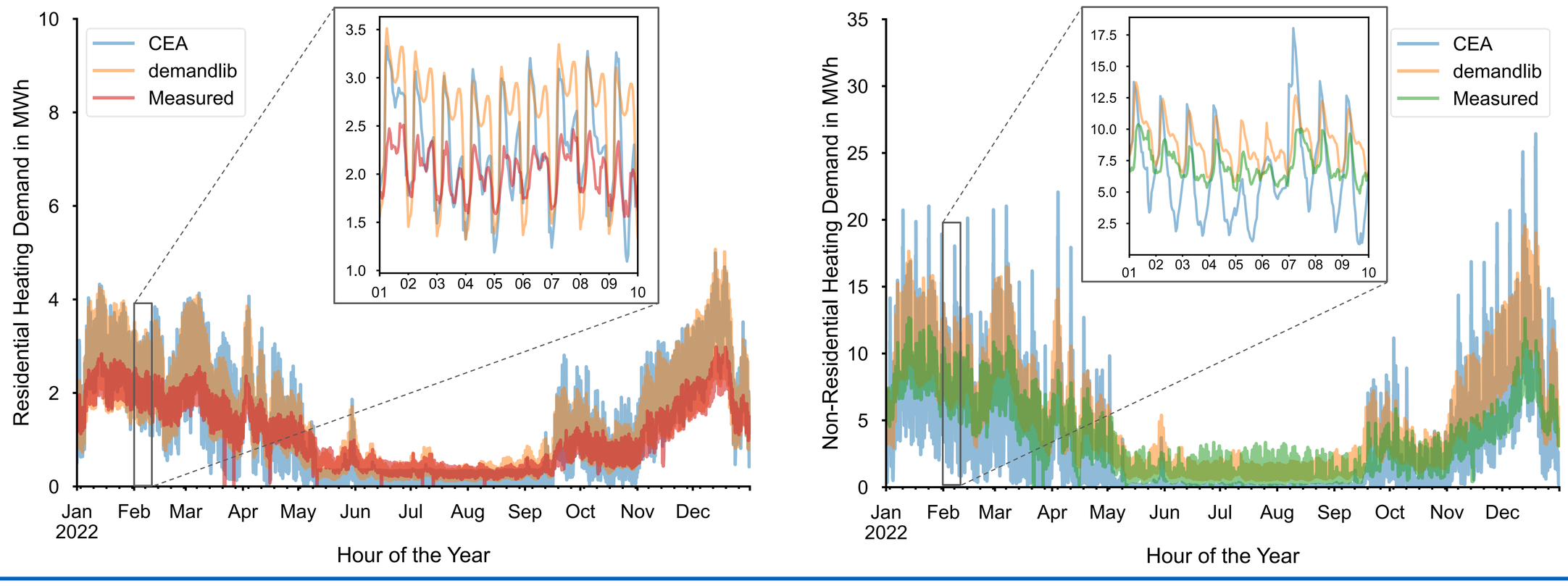
Figure 2. Spatial and temporal resolution of selected heating demand estimation models.

Urban Heating Demand Estimation Models

Table 1. Overview of selected heating demand estimation methods.

Name	Method	Spatial Resolution	Temporal Resolution	Open-source	Reference
demandlib	Data-driven	Building	Hourly	Yes	[3]
City Energy Analyst (CEA)	Physics-based	Building – District	Hourly	Yes	[2]
THERMOS	Data-driven	Building	Yearly	Yes	[4]
Demand.ninja	Data-driven	Building – Region	Hourly	Yes	[5]
LoadProfileGenerator	Hybrid	Building	Hourly	Yes	[6]
When2heat	Data-driven	Region	Hourly	Yes	[7]
Jesper et al.	Data-driven	Building	Daily	Yes	[8]
District-ECA	Physics-based	District	Monthly	No	[9]
Wärmeatlas 3.0	Hybrid	Building	Annual	No	[10]

Validation with Measured Data from 250 District Heating Consumers



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