

CITY-SCALE BUILDING ENERGY MODELLING USING METERED DISTRICT HEATING DATA

CITIES, AffaldVarme Aarhus & Aarhus University

Joint workshop on value creation by use of smart city data



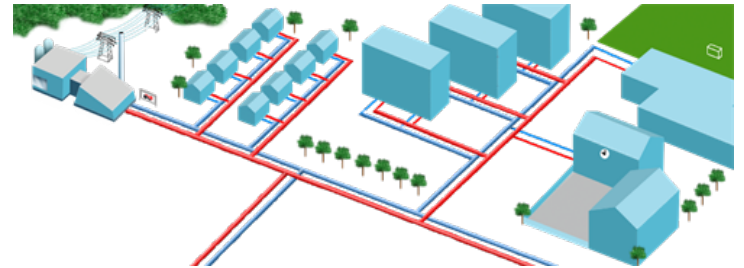
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THE IDEA

- ▶ To set up a platform/model for stochastic assessment of urban-scale retrofit scenarios
- ▶ The model should be used for assessment of both demand-side (buildings) operation and supply-side (district energy) operation



METHODOLOGY

1. Identification of typological building archetypes (10 in total)

Bygningstypologierne

Byggeperiode	Enfamiliehuse	Rækkehuse	Etageboligbyggeri
Før 1850	EFH.01	RH.01	EB.01
1851-1930	EFH.02	RH.02	EB.02
1931-1950	EFH.03	RH.03	EB.03
1951-1960	EFH.04	RH.04	EB.04
1961-1972	EFH.05	RH.05	EB.05
1973-1978	EFH.06	RH.06	EB.06
1979-1998	EFH.07	RH.07	EB.07
1999-2006	EFH.08	RH.08	EB.08
2007-2010	EFH.09	RH.09	EB.09
2011-	EFH.10	RH.10	EB.10

Following typologies from
TABULA/EPISCOPE projects

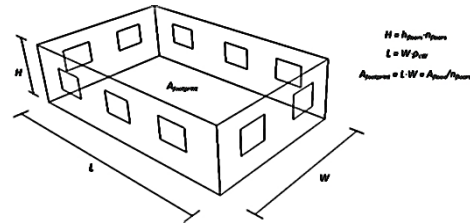
<http://www.sbi.dk/miljo-og-energi/energibesparelser/tabula>

METHODOLOGY

2. Setup hourly dynamic building energy models for each archetype to quantify the required energy demand
 - 10 models are constructed in total (1 for each archetype)
 - ISO 13790 standard approach is applied
 - Simple scalable geometry



Example of an archetype

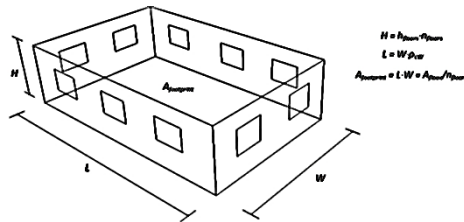


METHODOLOGY

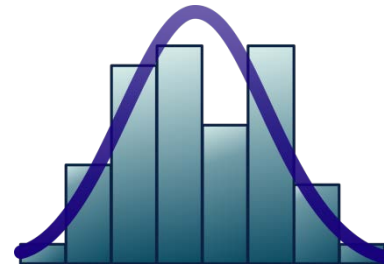
3. Calibrate each archetype model using field data
 - The models contain many unknown parameters
 - Bayesian calibration using Gaussian process regression is used to link physics-based model to field data



Field data



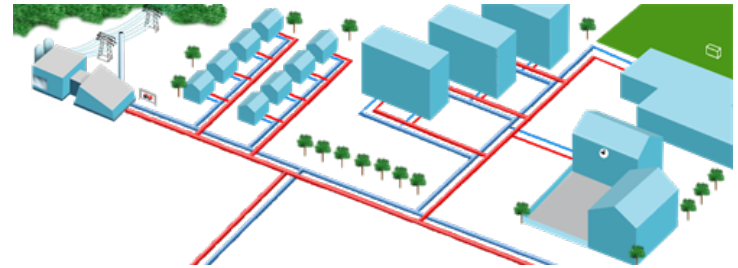
Archetype building model



Energy predictions

METHODOLOGY

4. Use calibrated archetype models as puzzle pieces to compose urban-scale district models



METHODOLOGY

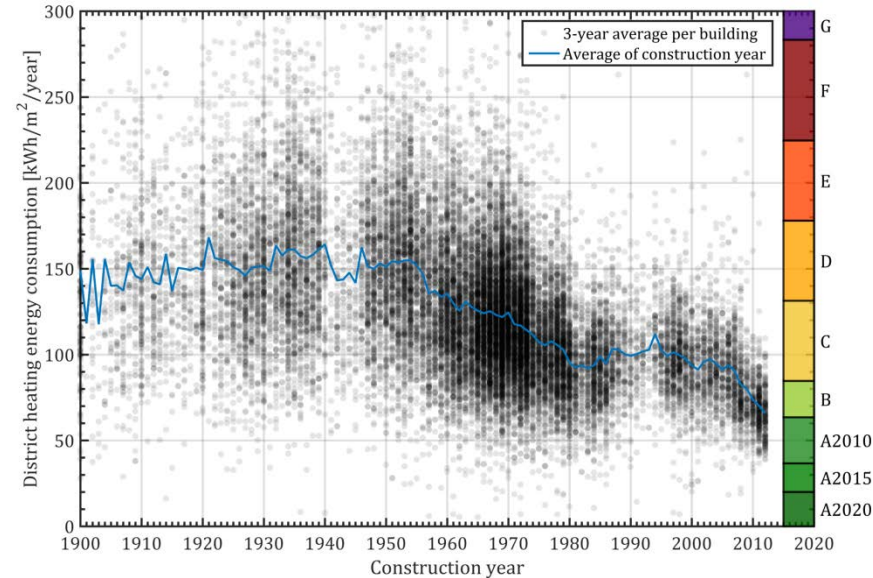


5. Use urban-scale model for:

- Estimating energy use in city districts
- Assessing overall retrofit potential of buildings in districts
- Assessing effect on district energy supply-side operation in districts when changing demand-side conditions
- Assessing effect on demand-side operation when changing supply-side operation, e.g. effect on user comfort if lowering supply temperature
- As a planning tool for sizing district energy networks
- Much more ...

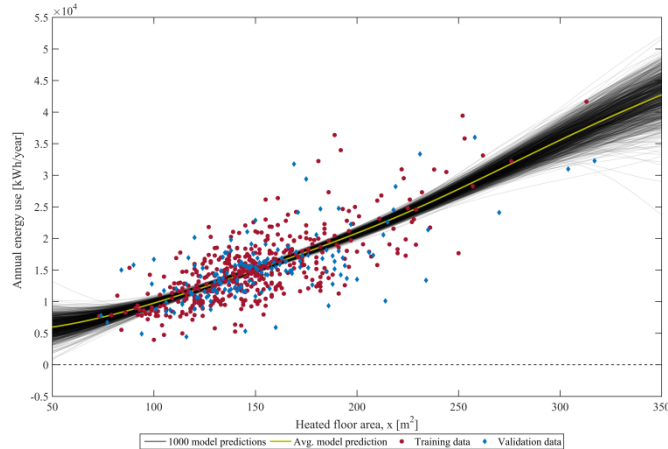
FIELD DATA

- ▶ Approx. 29,000 detached single-family houses
- ▶ Annually metered district heating use [kWh/year] for last three years per building
- ▶ BBR data (heated floor area, construction year, etc.)
- ▶ https://www.youtube.com/watch?v=Opd_hJMQBos&feature=youtu.be (video in Danish)



RESULTS

- ▶ Paper submitted to IBPSA Building Simulation 2017 conference in San Francisco, August 2017.



- Mean error < 2.5% (1000 buildings)
- Mean absolute error < 22% (1 building)
- “Error” or variability is caused by occupant behaviour and failing of clustering assumption



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