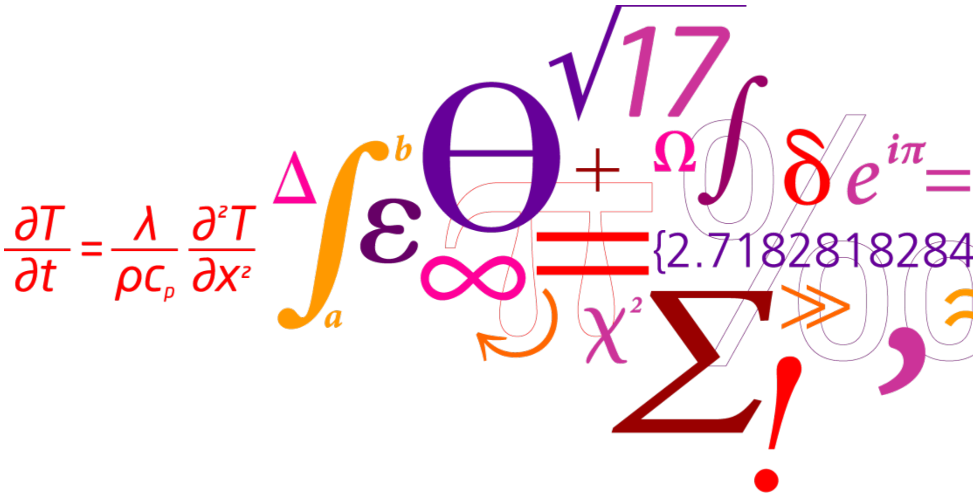
WP3 – INTELLIGENT ENERGY SYSTEM INTEGRATION

Prof. Carsten RODE
Technical University of Denmark



DTU Civil Engineering
Department of Civil Engineering


Mette Mylin
Danish Energy Agency

STATUS ON ENERGY USE IN EU

33%
of all energy in EU is used for **transport**

26%
of all energy in EU is used by **industry**

41%
of all energy in EU is used by **buildings**

2/3 of energy consumption in buildings is used for heating and cooling.

80% of energy consumption is used in small buildings < 1000 m2

ENERGY POLICIES

The government's energy policy milestones up to 2050

In order to secure 100 pct. renewable energy in 2050 the government has several energy policy milestones in the years 2020, 2030 and 2035. These milestones are each a step in the right direction, securing progress towards 2050.

2020

Half of the traditional consumptions of elec-tricity is covered by wind power

2030

Coal is phased out from Danish power plants

Oil burners phased out

2035

The electricity and heat supply covered by re-newable energy

2050

All energy supply – elec-tricity, heat, industry and transport – is covered by renewable energy

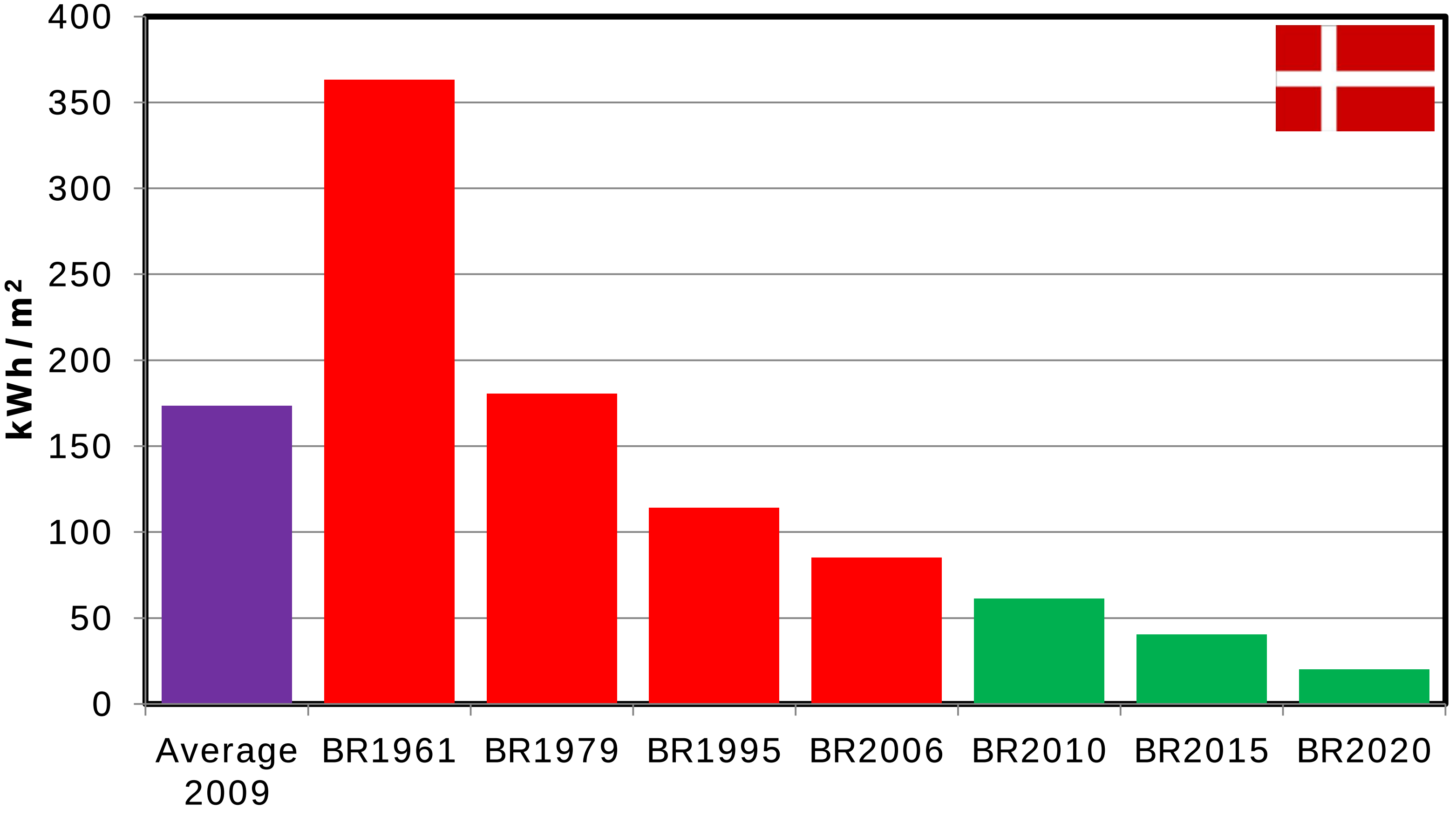
The initiatives up to 2020 will result in a greenhouse gas reduction by 35 pct. in relation to 1990.

Source: "Our Future Energy", the Danish Parliament, Nov. 2011

100 % share of RE in the heating sector by 2035

ADVANCED BUILDINGS

PERMISSIBLE ENERGY USE, RESIDENTIAL BUILDINGS



After: Lars Ostenfeld Riemann, Rambøll

Overarching Hypothesis for CITIES WP3

- We cannot achieve a non-fossil society only by optimizing the individual buildings.
- We need to analyse buildings in a community/society context looking to how energy is:
  - Produced,
  - Transmitted,
  - Stored
  - Converted
- PTSC

OPTIMIZATION

…NEEDS TO BE CARRIED OUT IN AN

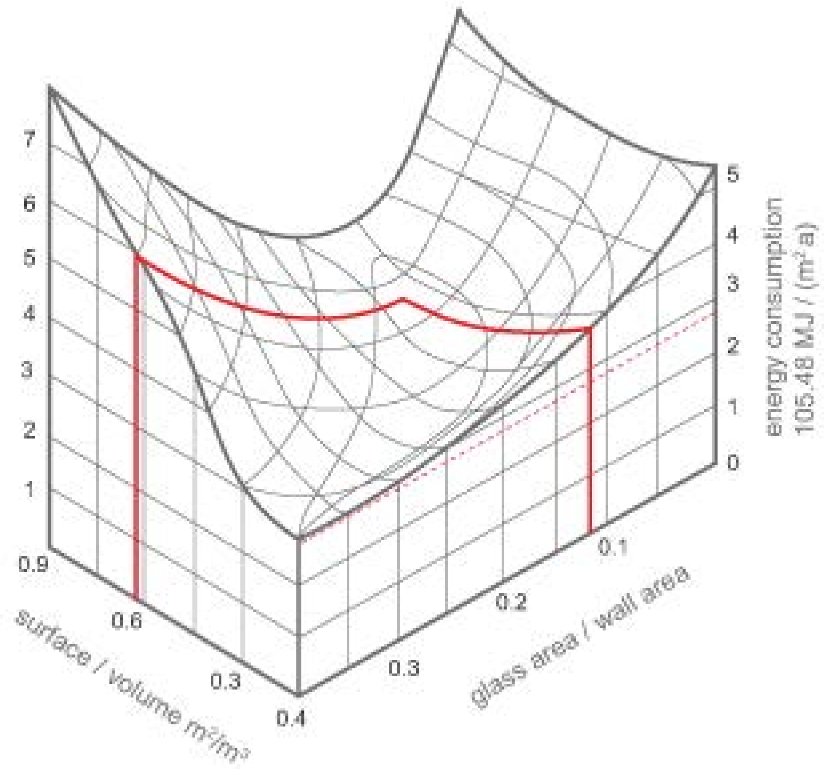
INTEGRATED “GLOBAL” WAY

PARAMETERS

BUILDINGS

CANNOT BE OPTIMIZED

FOR ONLY ONE PARAMETER AT A TIME!

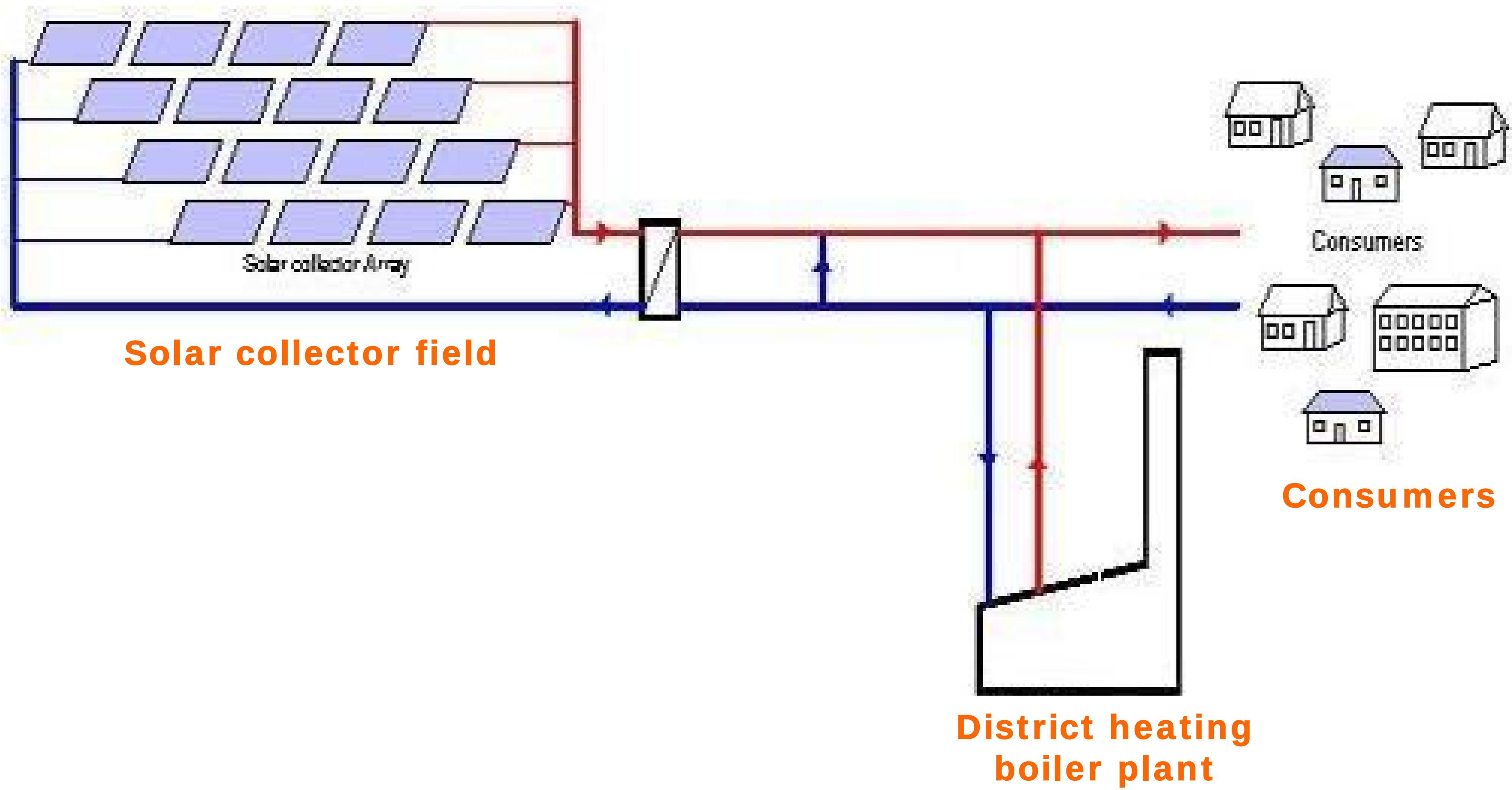


SOLAR DOMESTIC HOT WATER SYSTEM

Foto: Velux Solar Energy; Contractor: Velux Solar Energy, Denmark

SOLAR HEATING PLANT

SOLAR HEATING PLANT

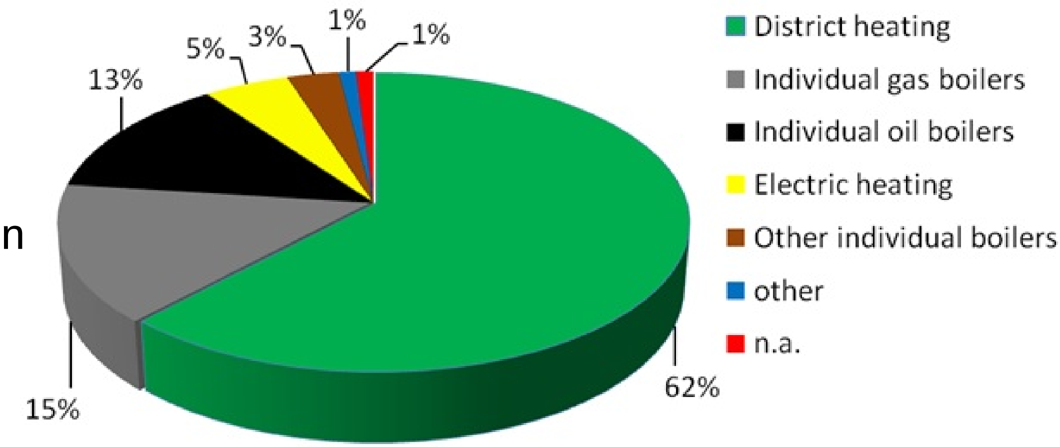


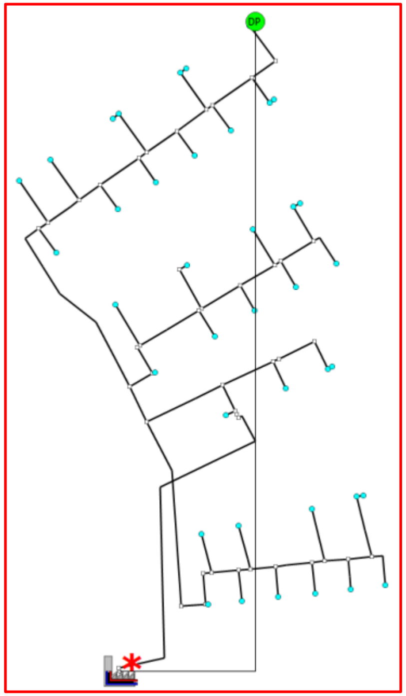
DISTRICT ENERGY IN DENMARK

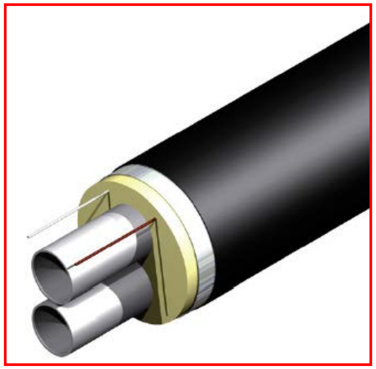
Approx. 450 DH schemes

27,000 km of pipelines

77% of heat from co-generation







NEW OPPORTUNITIES AND CHALLENGES?

SMART CONTROL OF ENERGY ”PROSUMPTION”

"SMART"

- Intelligent Buildings
- Smart Cities
- Grid connected community

EXISTING BUILDING STOCK

NEWER BUILDINGS

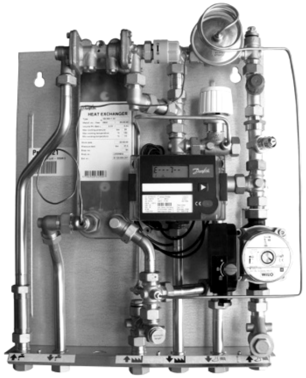
BUILDING ENVELOPE

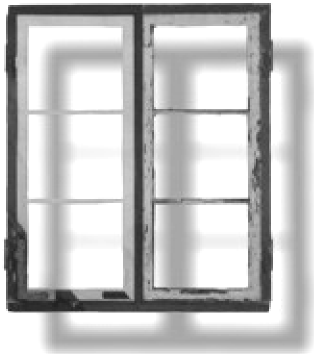
- Thermal insulation
- Windows
- Thermal bridges
- Thermal mass and Phase Change Materials (PCM)
- Utilized/additional attics
- Crawl spaces
- Shading systems
- Adaptation to climate change
- Durability
  (no moisture or mould)

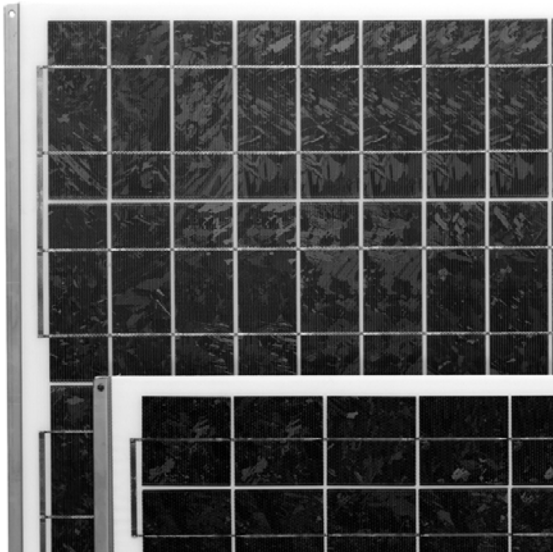
BUILDING SERVICES

- Low temperature heating
  (High temperature cooling)
- Shading / passive cooling techniques
- Lighting and daylight
- Ventilation
- Energy supply systems, incl. heat pump
- Domestic hot water
- Controls
- Integrated solutions

BUILDING PRODUCTS





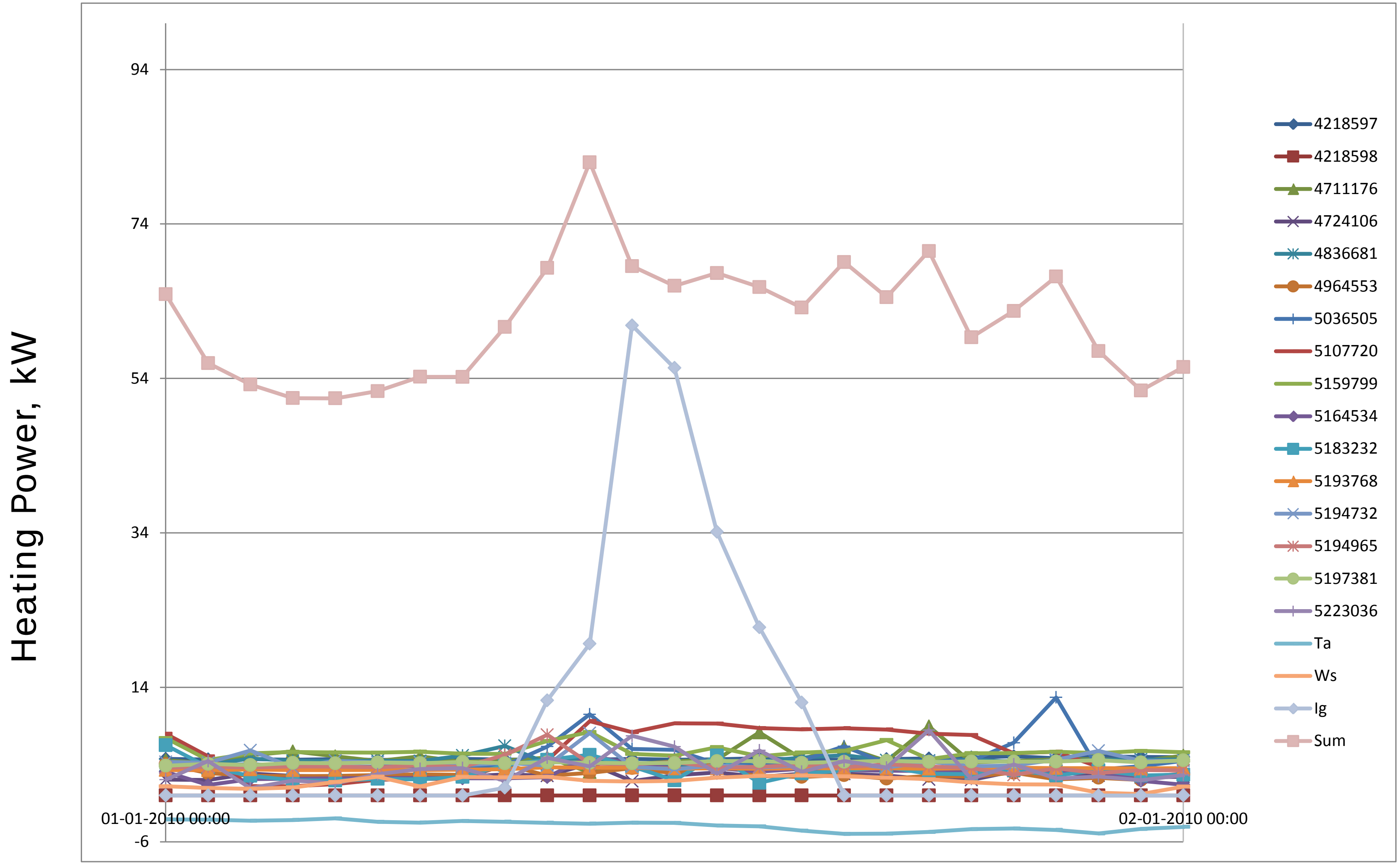


SHANGHAI 2012

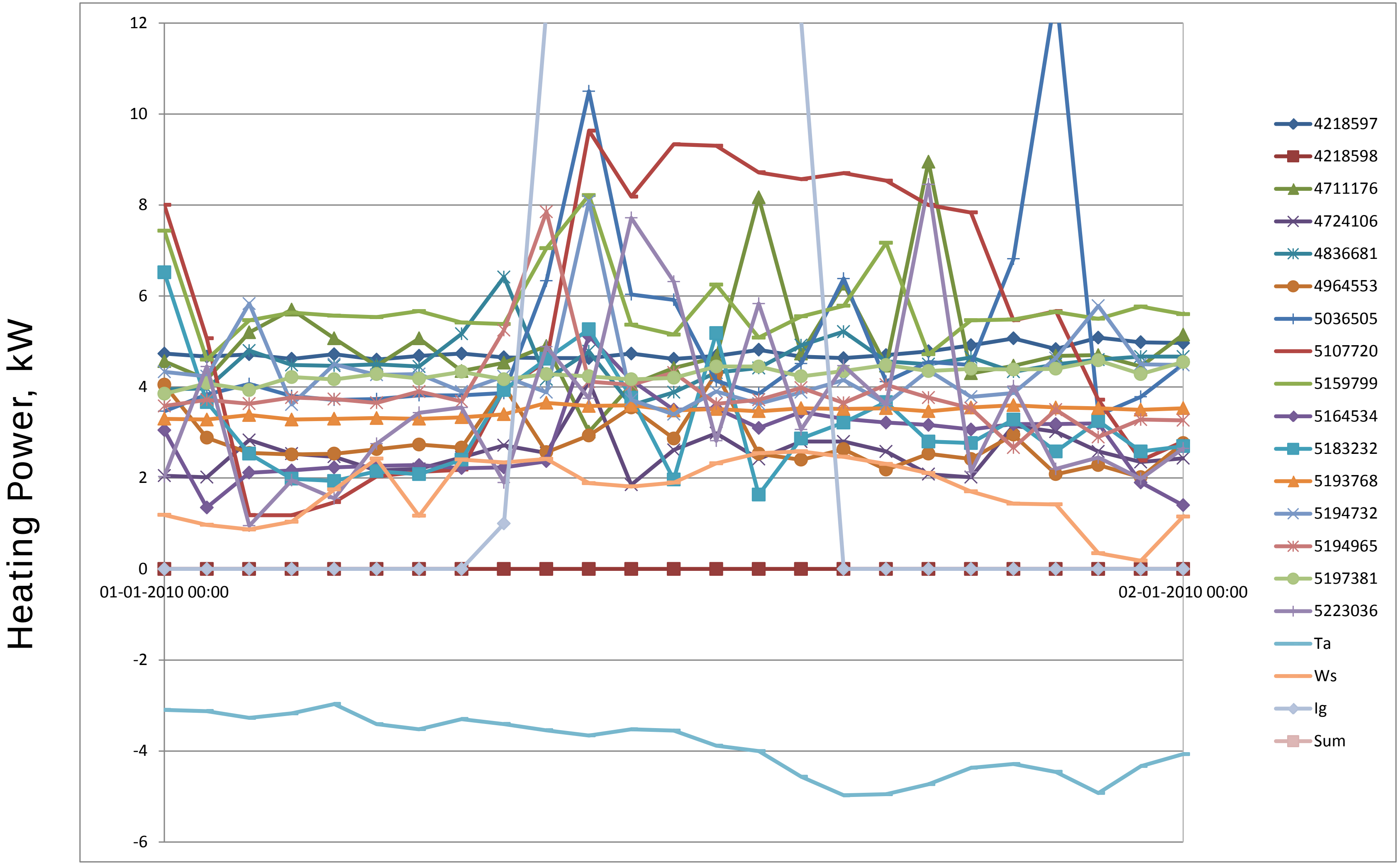
Low Energy House - Sisimiut, GL


Mette Mylin Danish Energy Agency

16 houses in Sønderborg, 1 Jan. 2010



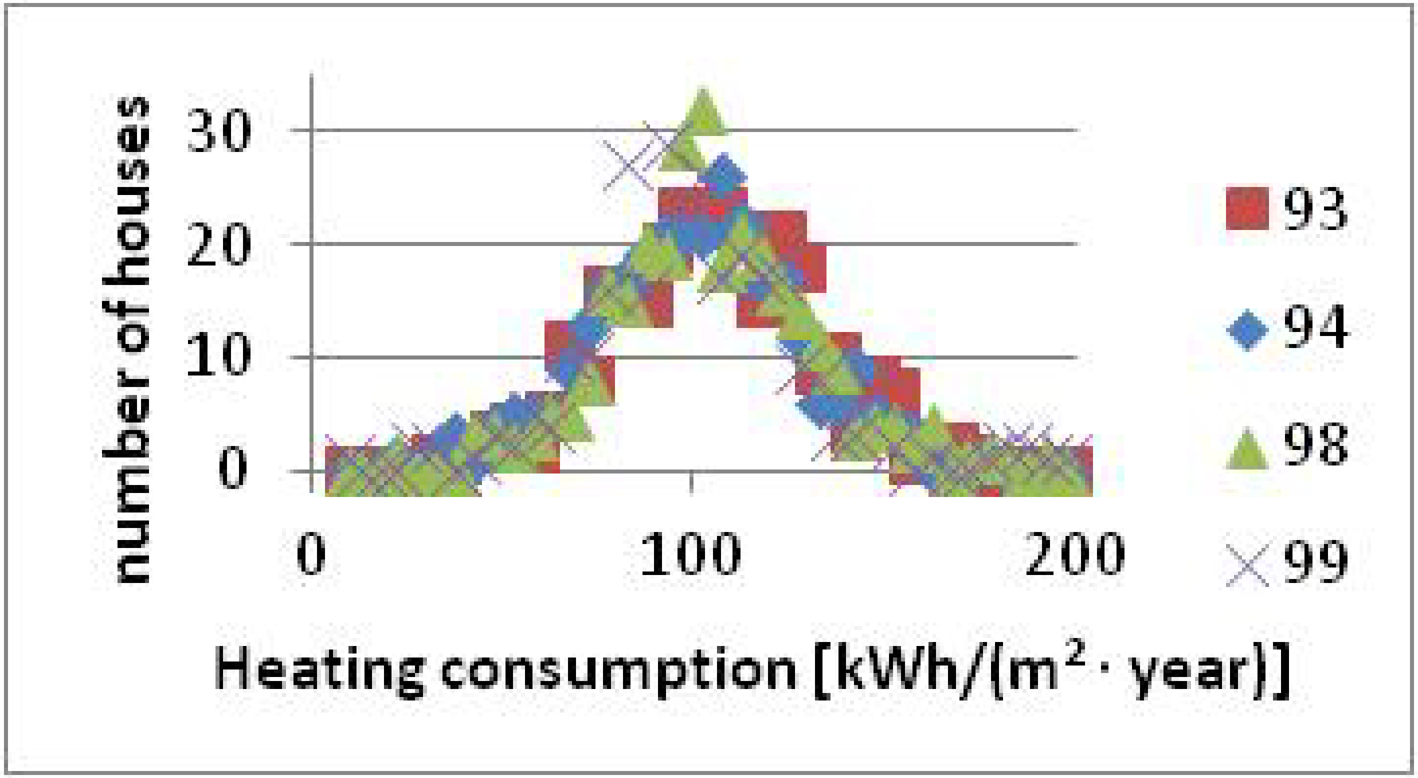
16 houses in Sønderborg, 1 Jan. 2010



BEHAVIOUR

MIN. **FACTOR 3** IN DIFFERENCE IN ENERGY CONSUMPTION

STOCHASTIC DISTRIBUTION



Distribution of heating consumption from 290 identical houses (Andersen 2012)

Building Performance Prediction
(Using Models)

NEW
BUILDING

FACTOR 2

BETWEEN **PREDICTED**
AND **REALISED**

ENERGY CONSUMPTION

References

International Building Performance Simulation Association

- IBPSA-Conferences – Australia (2011) & France (2013)

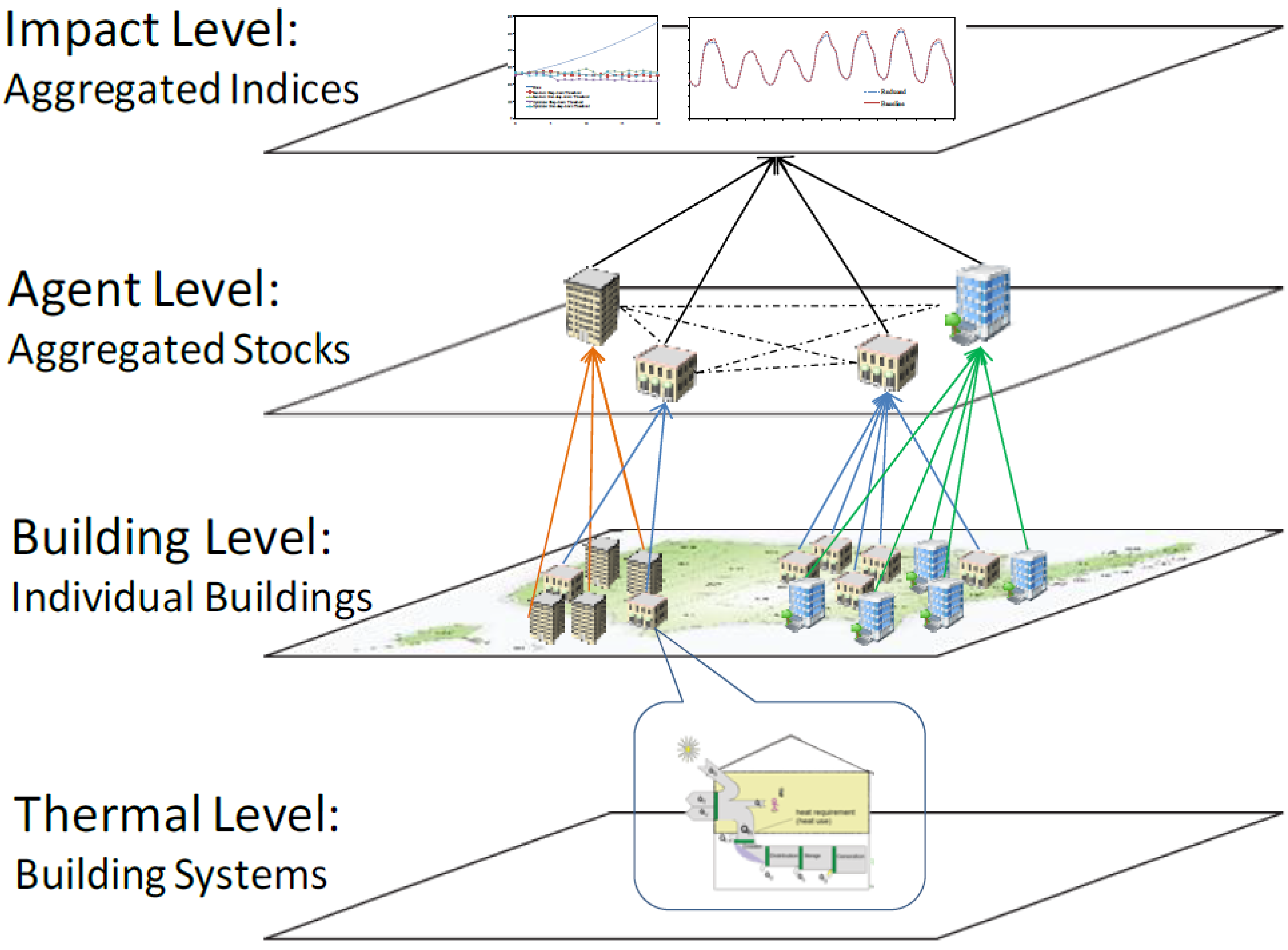


Figure 1 Four Levels of Aggregation

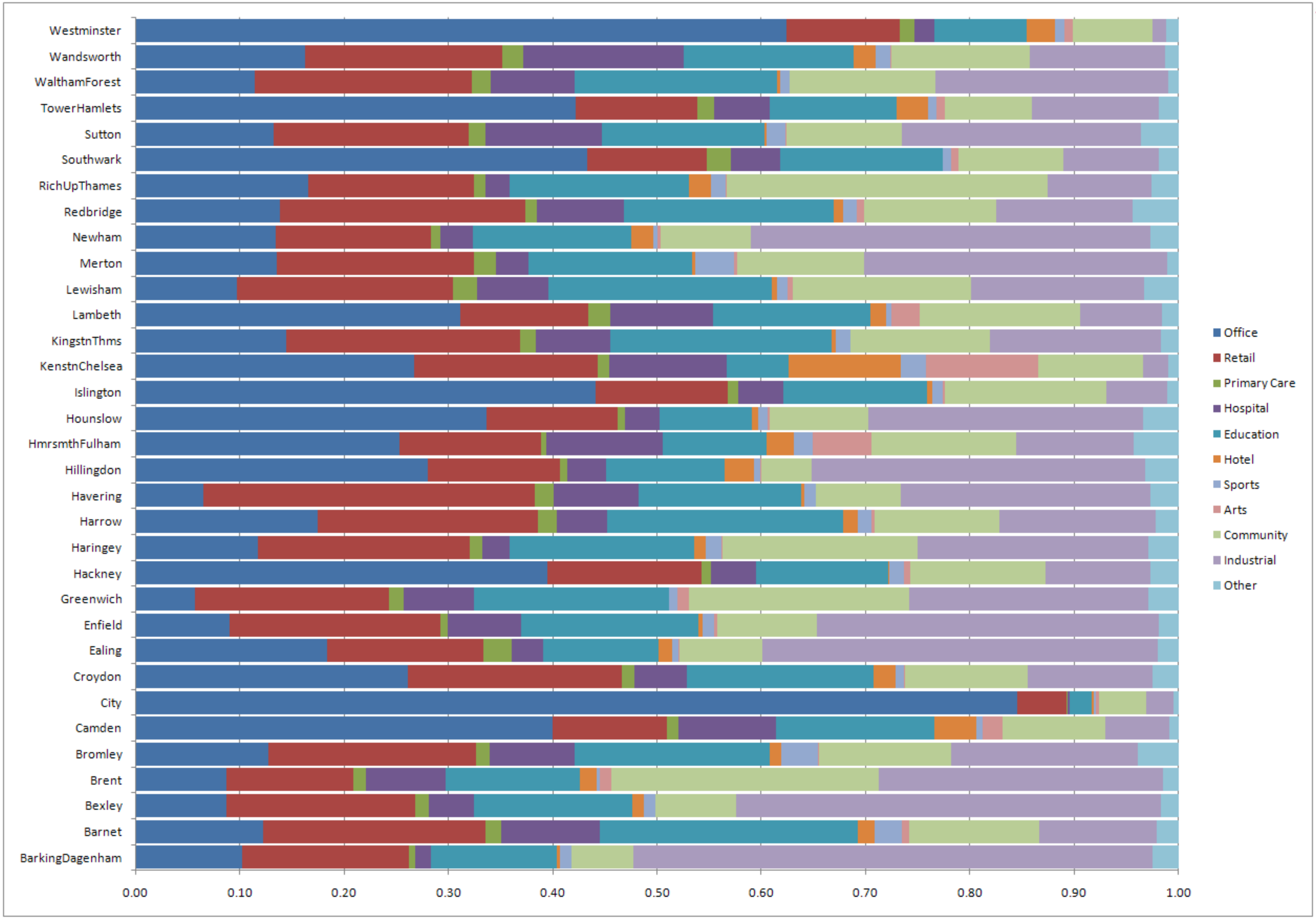
Zhao, Ignacio and Augenbroe, 2011

Commercial Buildings (London)

Table 1: Primary types of non-domestic buildings with their constituent sub-types and percentage share of total non-domestic built area in London

Primary Type	**% Area**	**Sub-Types**
Office	30%	government; private-sector; courts
Retail	16%	high-street; department stores; centres
Primary Care	1%	health centres; surgeries; clinics
Hospitals	6%	all hospitals; medical research; nursing homes
Education	14%	schools; colleges; universities
Hotel	2%	all hotels and boarding houses
Sports	1%	gymnasiums; pools; leisure centres; sport centres
Culture	1%	cinema; theatre; performance halls; museums; galleries; clubs
Community	11%	halls; religious buildings; centres; emergency services; community protection
Industrial	17%	transport terminals; factories; warehouses; storage
Other	2%	agriculture; unused buildings; freight handling

Choudhary, 2011



Choudhary, 2011

Commercial Buildings (Japan)

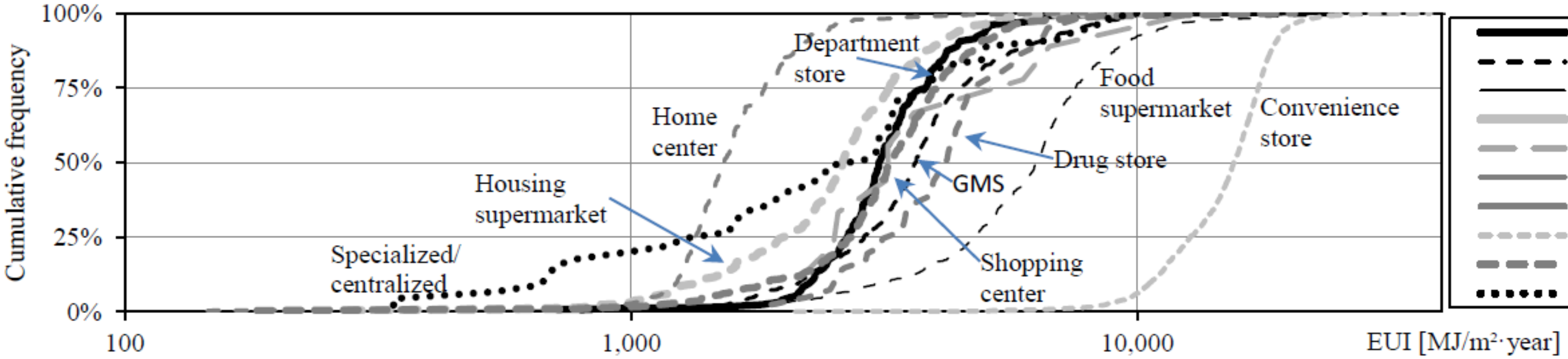
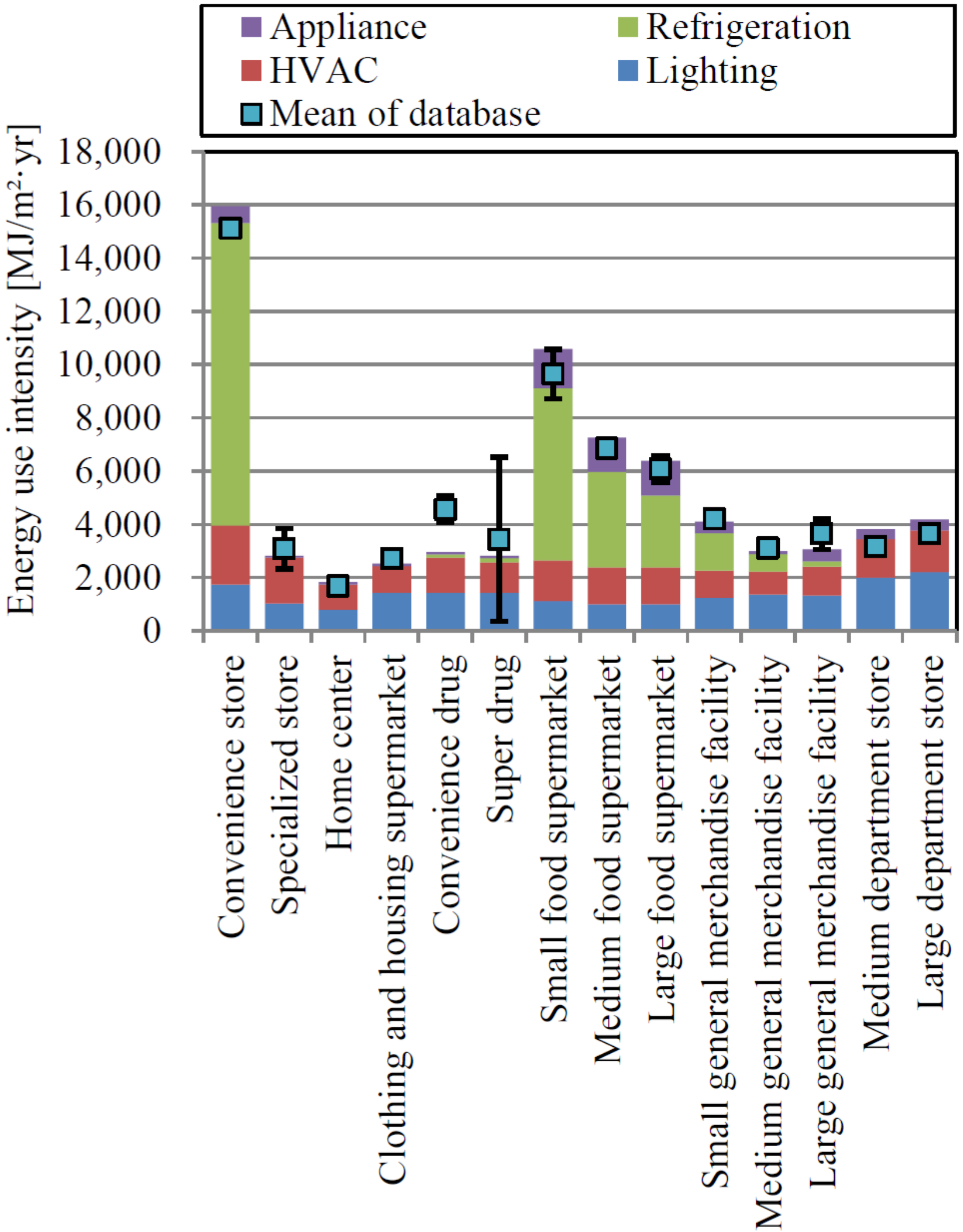


Figure 1 Distribution of total floor area and energy use intensity of the various types of commercial buildings in Japan

Matsuoka, Yamaguchi, Suzuki & Shimoda, 2013



Matsuoka, Yamaguchi, Suzuki & Shimoda, 2013

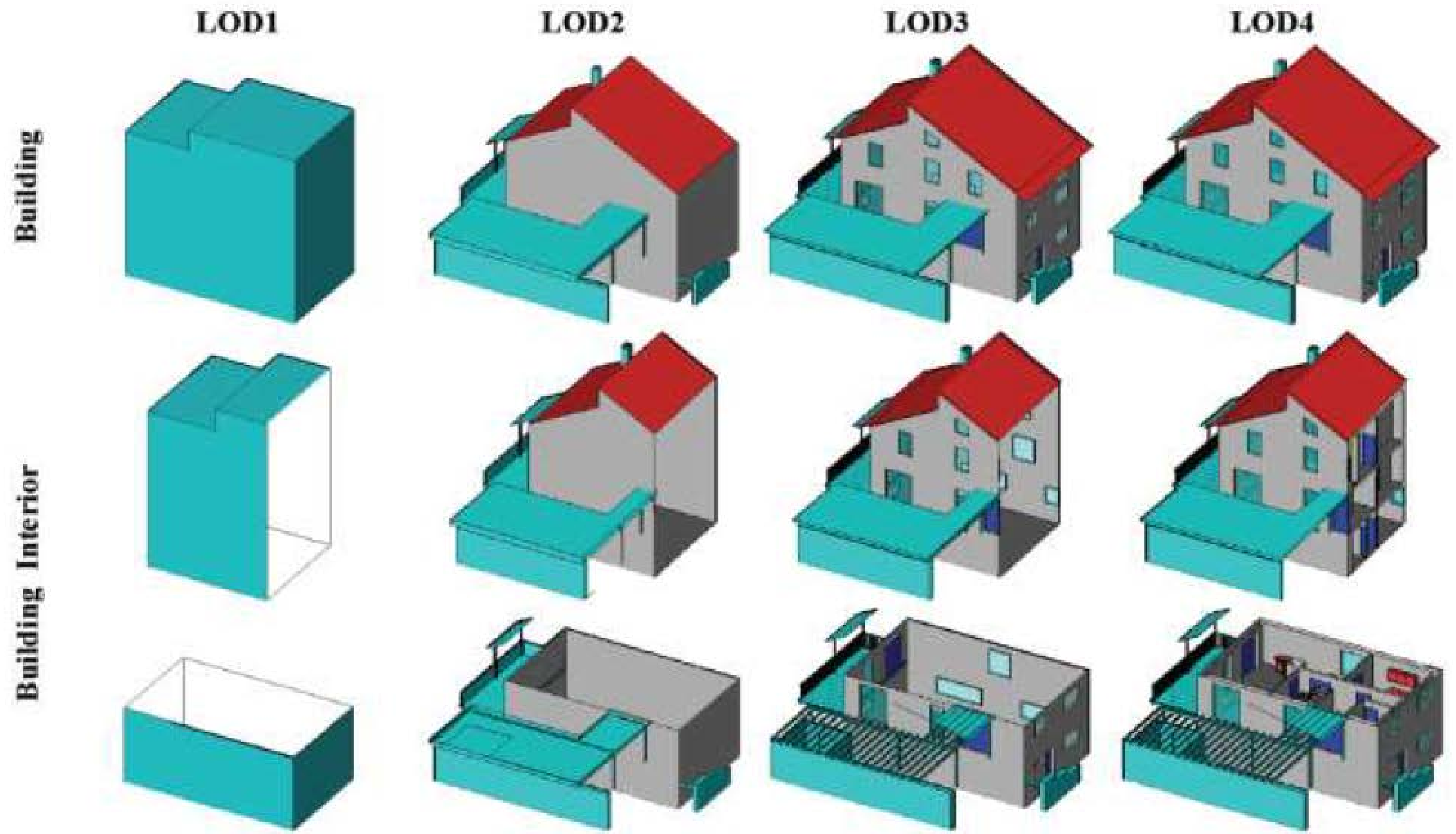


Figure 1 – The four Levels of Detail of CityGML (Groeger et al., 2012, page 72, Source: Karlsruhe Institute of Technology (KIT))

Proceedings of BS2013:
13th Conference of International Building Performance Simulation Association, Chambéry, France, August 26-28

REDUCTION OF BUILDING MODELS FOR USE IN URBAN ENERGY ANALYSIS

Eui-Jong Kim[1], Gilles Plessis[2], Jean-Jacques Roux[1], and Jean-Luc Hubert[2]

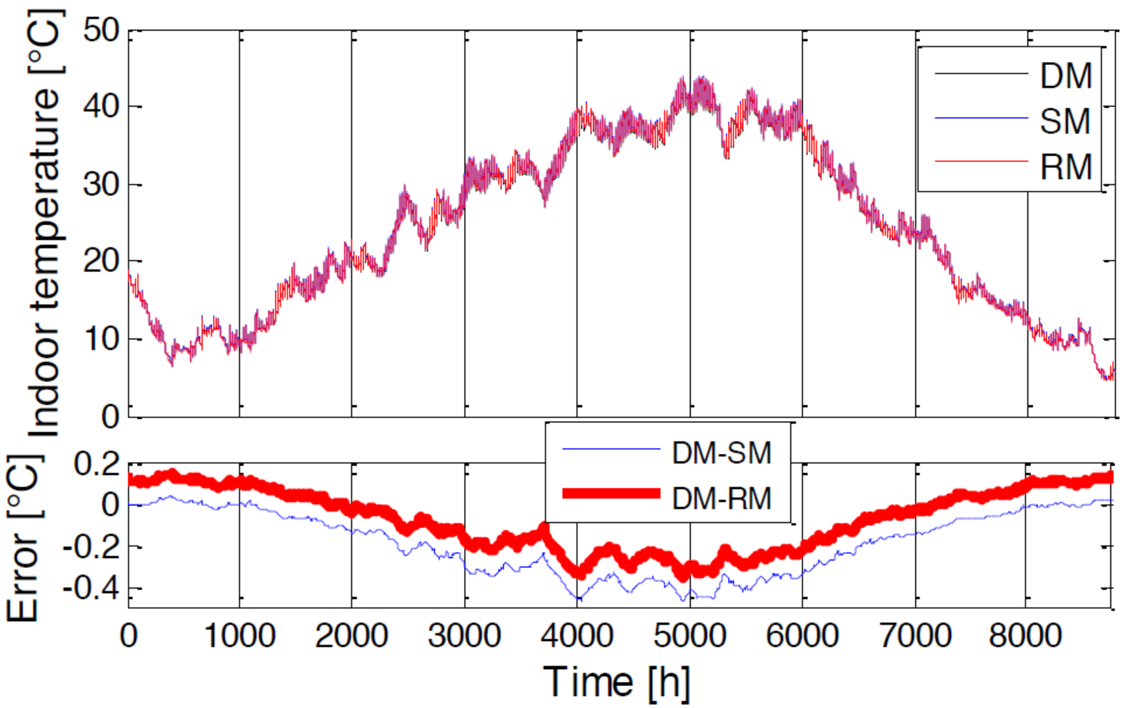


Figure 5. Indoor air temperatures

Detailed Model
Simplified Model
Reduced Model

DTU

Figure 2 – Simulated yearly heating demand, visualised in the 3D city model Grünbühl

Nouvel, Schulte, Eicker, Pietruschka & Coors, 2013

WP3 Outline

- This WP will explore possibilities to optimise the interaction and complementarity between low level PTSC resources, and consumers or groups thereof.
- Prosuming buildings (capable of consumption, storage and production) and their models will play an important role in this WP, reflecting their central role in an integrated city energy system.
- Efficient control mechanisms to achieve the identified interactions will be developed.
- Focus will be placed on developing more aggregate forms of modelling and simulation techniques than seen to date.

Resources:

2 PhD and 2 x 0.5 PostDocs

PTSC: Production, Transmission, Storage and Conversion

WP3 Sub-WorkPackages

- **WP3.1:** Investigate novel methods for aggregate modelling and simulation techniques. This study should furthermore address any interoperability issues between different energy modelling and optimisation tools, and investigate the capabilities of individual tools for modelling energy systems with multiple energy flows.
- **WP3.2:** Study low level aggregation techniques which facilitate the grouping of consumers with similar (or dissimilar) characteristics and consumption profiles.
- **WP3.3:** Detailed models from WP1 and WP2 will be employed to identify interactions between system components (PTSC and demand) on various spatiotemporal scales. Synergies will be identified at the component level and between aggregations of similar resources.
- **WP3.4:** Control, forecasting and optimisation tools will be developed based on data and models to optimise the interactions identified in WP3.3. Adaptive tools will be favoured to ensure relevance as the system evolves.
- **WP3.5:** ICT solutions will be developed to support monitoring, validation, analysis, optimisation and control capabilities at the system component level.

CONTACT:

Professor Carsten Rode

DTU • Byg

Phone: +45 45 25 18 52

car@byg.dtu.dk

Thanks to:
Asser Simon Chræmmer Jørgensen, Martin Kotol, Jørgen Erik Christensen, Sergio Vera, Rune Korsholm Andersen, Carl-Eric Hagentoft, and others.

Photo: Egil Borchersen