SMART ENERGY CITIES

Centre for IT-Intelligent Energy Systems in Cities (CITIES)

Assoc. Prof. Alfred Heller
Technical University of Denmark

CITIES
Centre for IT Intelligent Energy Systems

$$\frac{\partial T}{\partial t} = \frac{\lambda}{\rho c_p}\frac{\partial^2 T}{\partial x^2} \qquad \Delta \int_a^b \varepsilon \Theta^{\sqrt{17}} + \Omega \int \delta e^{i\pi} = \{2.7182818284 \quad \chi^2 \gg \sum !$$

DTU Civil Engineering
Department of Civil Engineering

ENERGY POLICIES – THE SOCIETAL MOTIVATION

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	2030	2035	2050
Half of the traditional consumptions of electricity is covered by wind power	Coal is phased out from Danish power plants Oil burners phased out	The electricity and heat supply covered by renewable energy	All energy supply – electricity, 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.

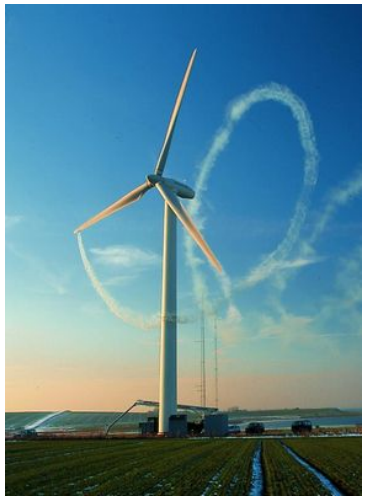
Source: "Our Future Energy", the Danish Parliament, Nov. 2011

100% share of RE in the heating sector by 2035

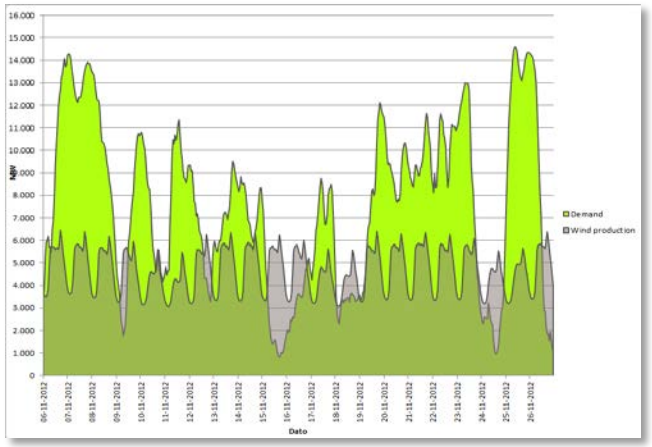
The proposed solutions

- Energy efficiency and savings

& Renewables

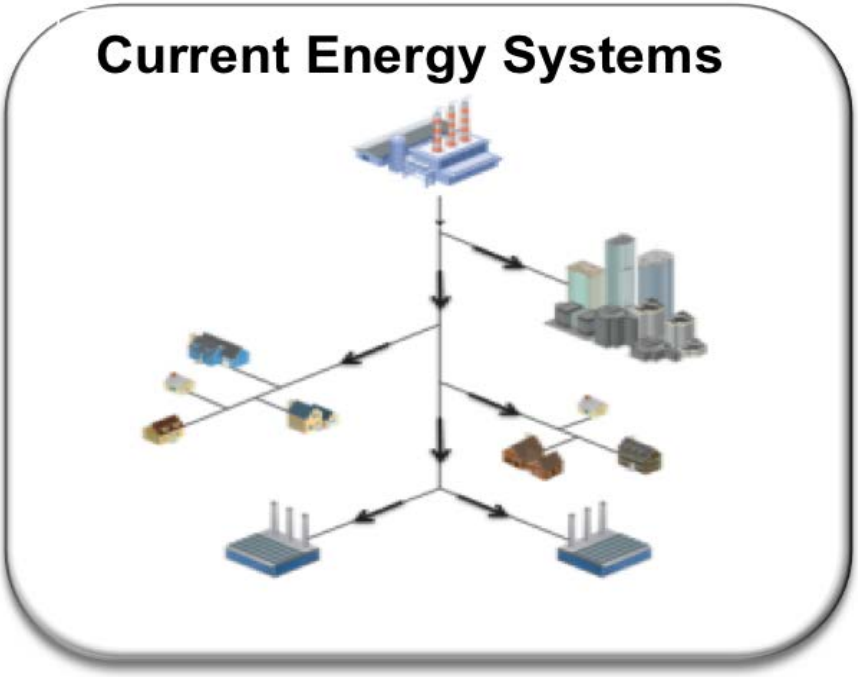


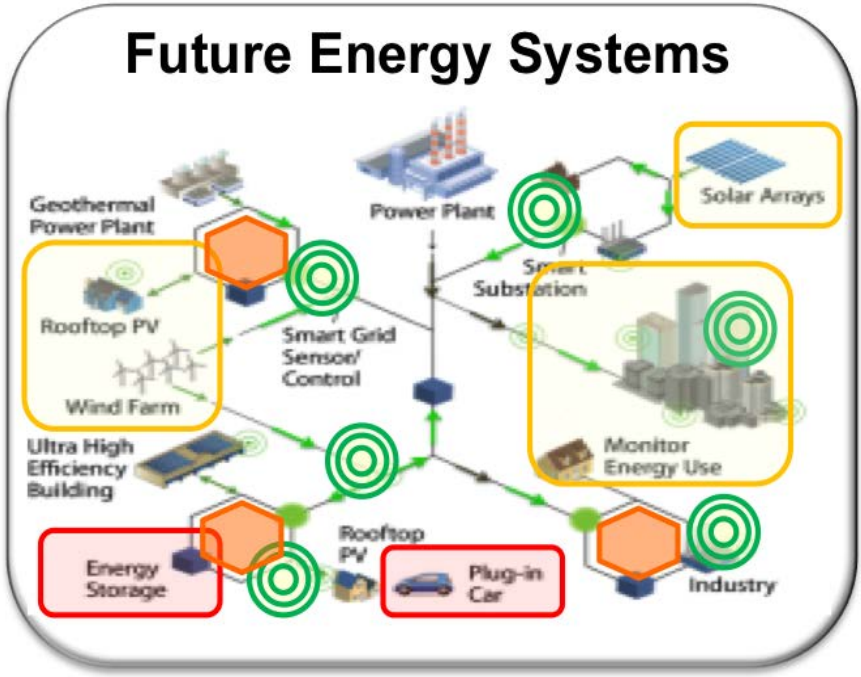
www.roennebaekskole.skoleintra.dk



The challenge

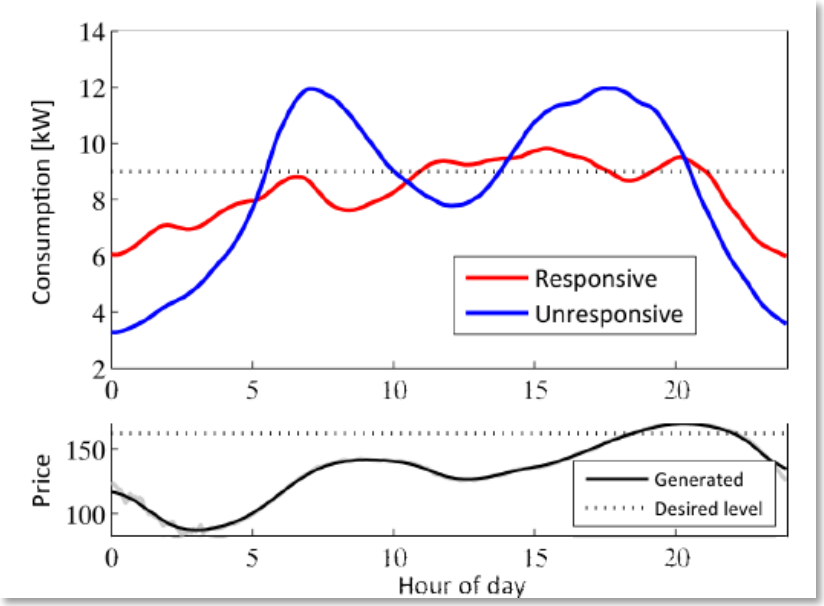
SMART GRID





The smart grid cannot solve the challenge of fluctuating energy production and demand by itself

The proposed solutions



- Demand Side Management

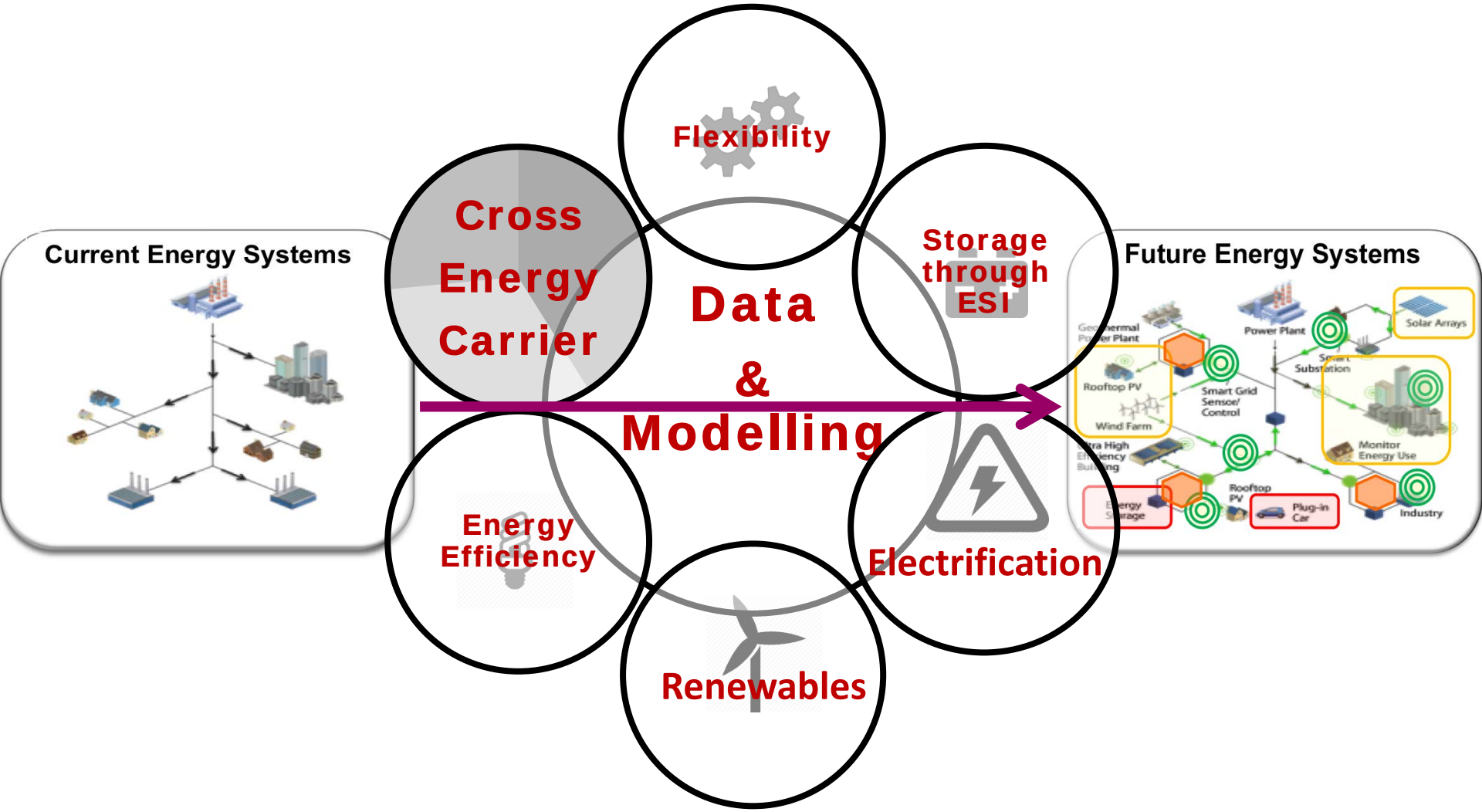
- **Fleksibility**

  The ability to shift energy demands in time and space

SMART ENERGY bowered by

CITIES
Centre for IT Intelligent Energy Systems

DTU

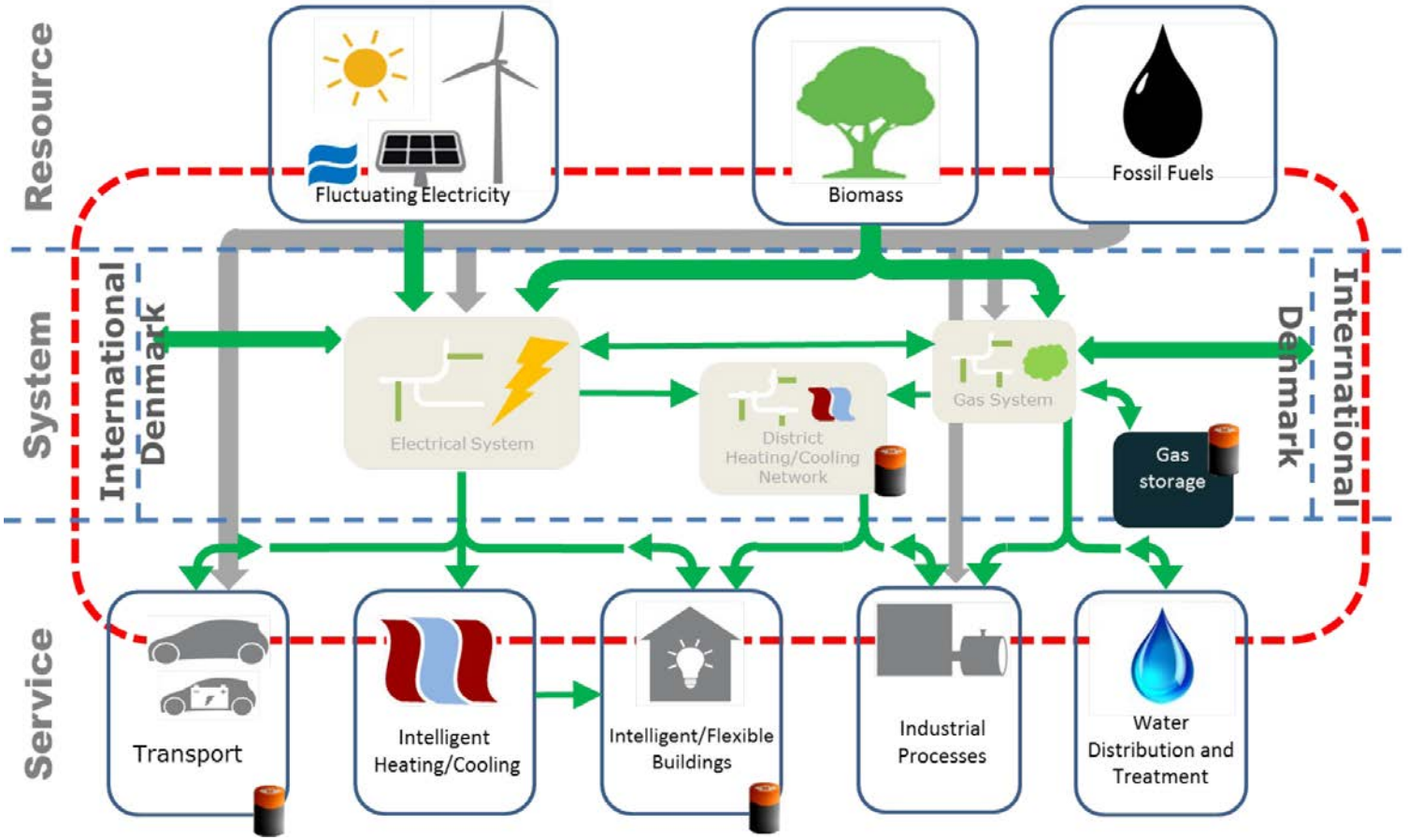


CITIES
Centre for IT Intelligent Energy Systems

DTU

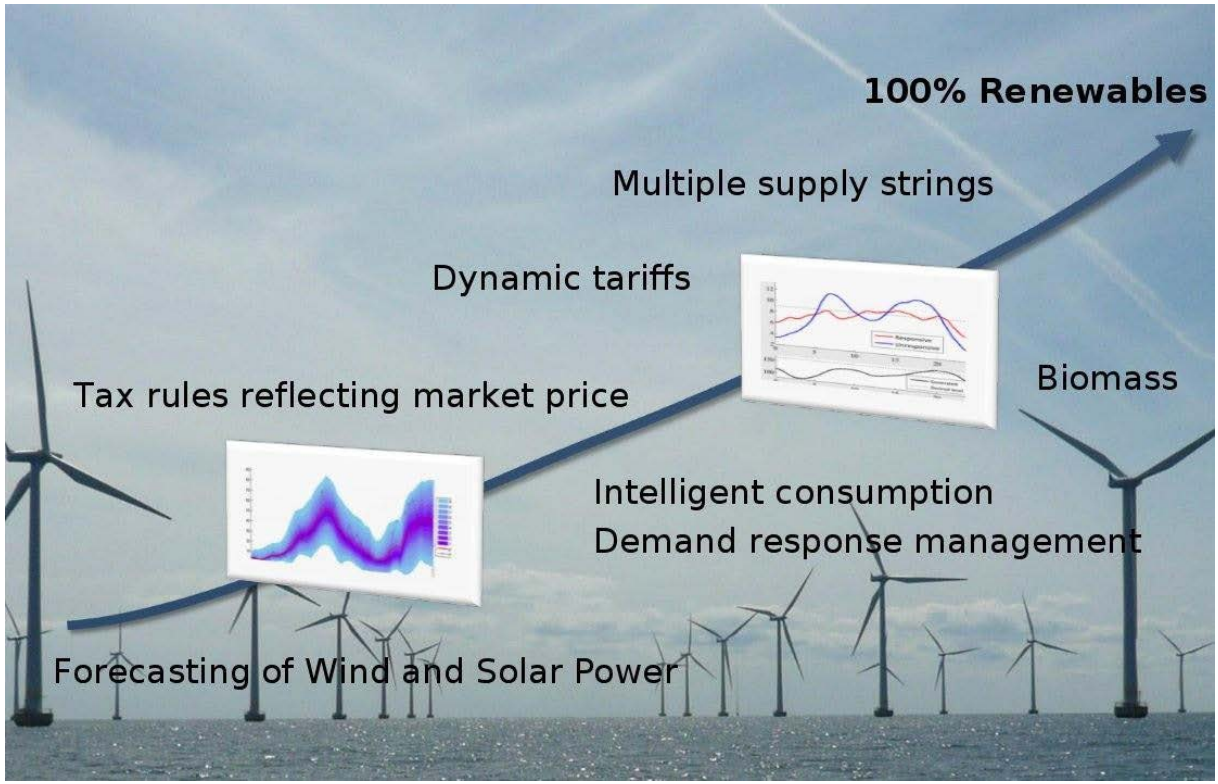
THE CONCEPT

Integration based on *ICT solutions* leading to methods for *operation* and *planning* for future energy systems



SOCIETAL OBJECTIVES

To establish methods and realistic scenarios for ultimately achieving independency from fossil fuels by harnessing the latent flexibility of energy systems in cities through *intelligence, integration*, and *planning*.

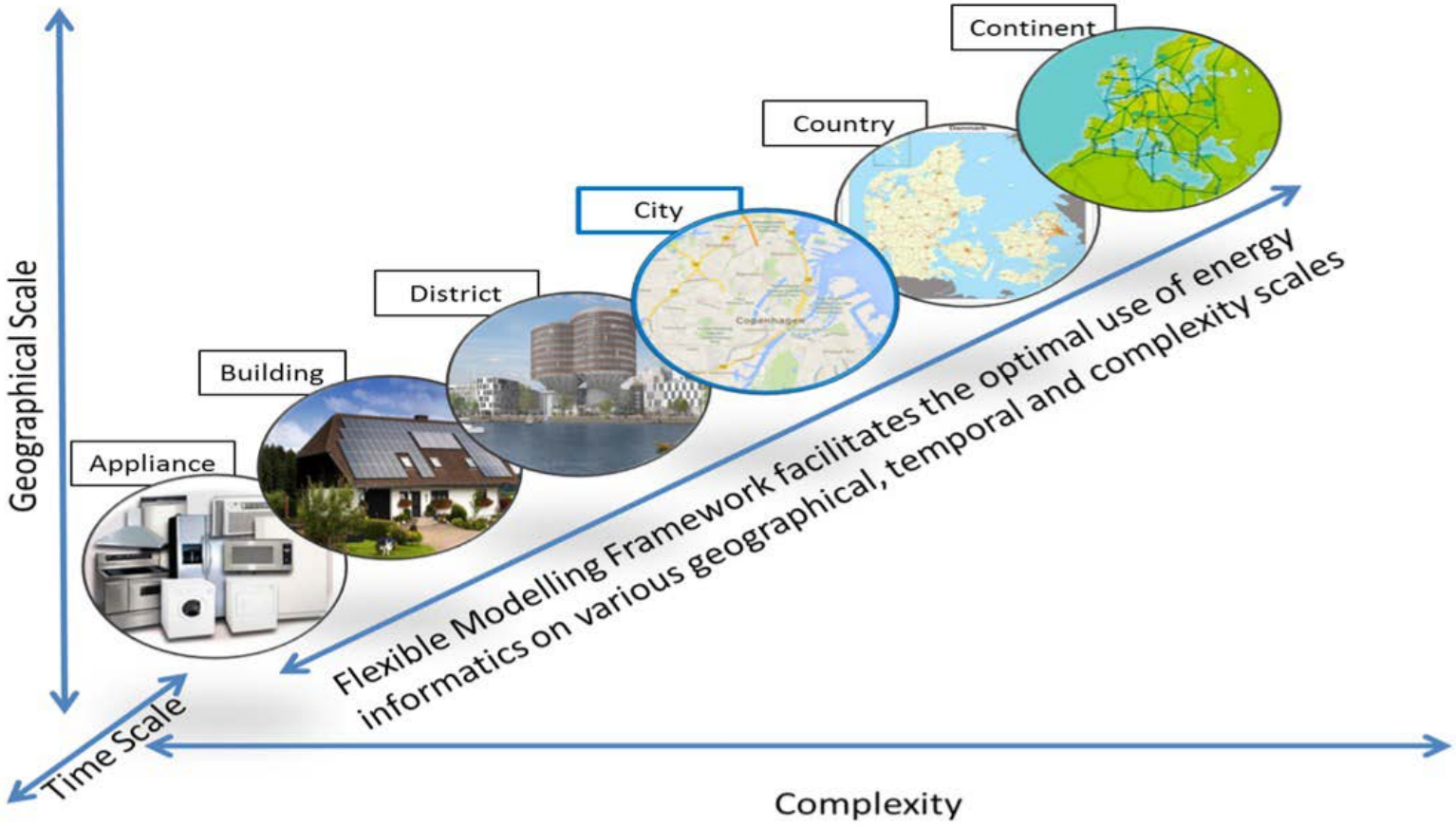


CITIES
Centre for IT Intelligent Energy Systems

DTU

SCIENTIFIC OBJECTIVES

To establish methodologies and ICT solutions for design and operation of integrated electrical, thermal, fuel pathways at all scales



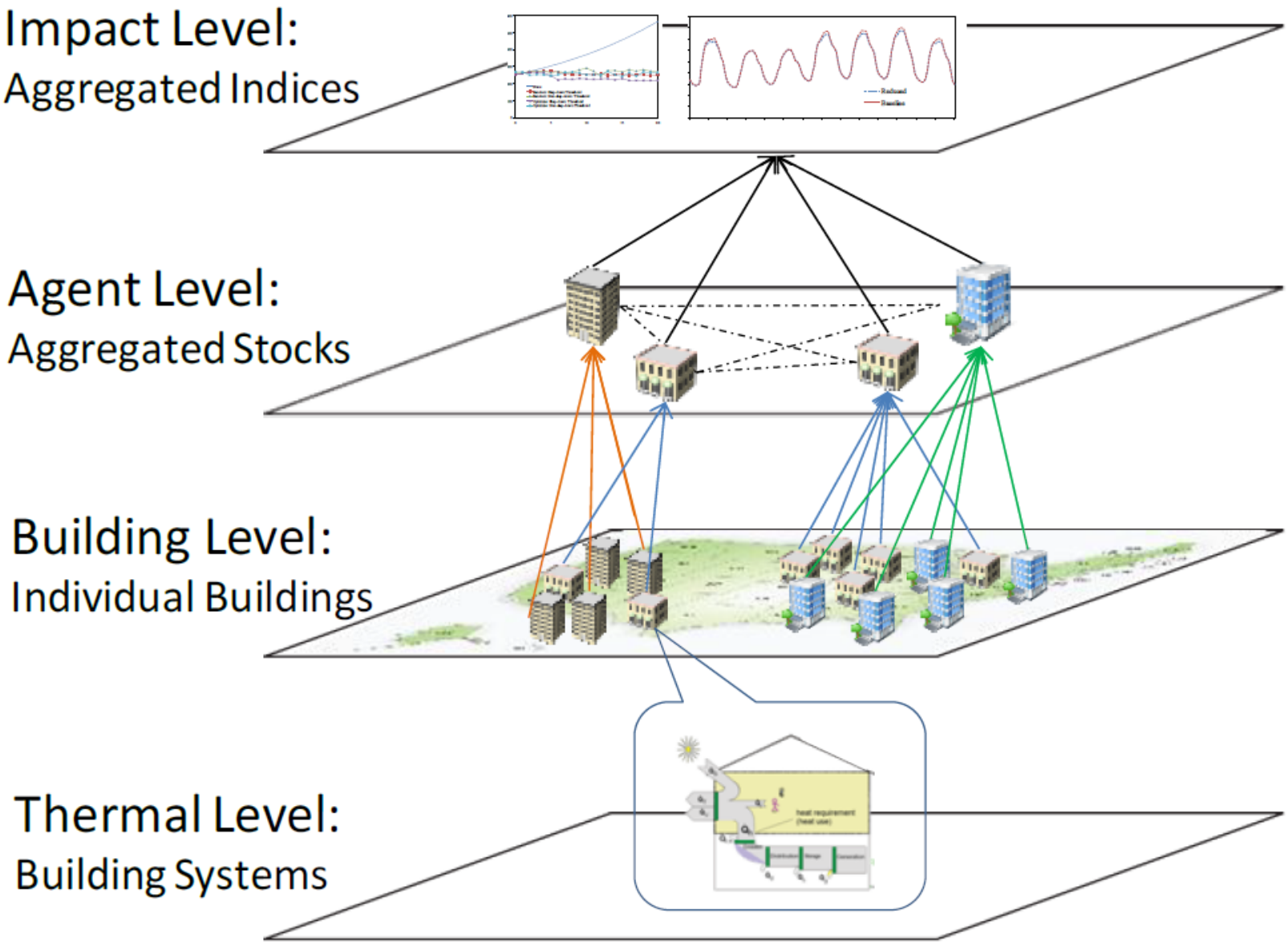


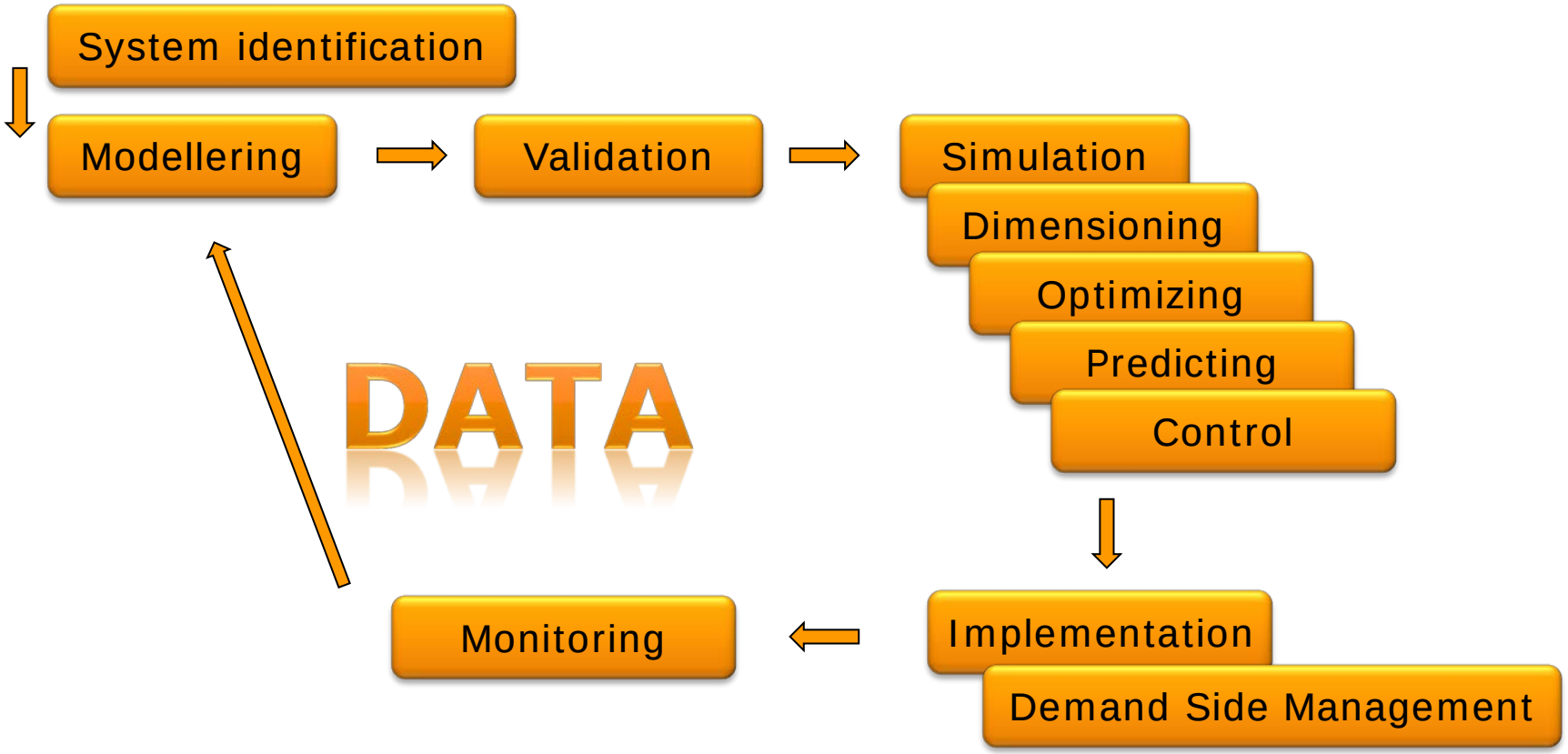
Figure 1 Four Levels of Aggregation

Zhao, Ignacio and Augenbroe, 2011

Scientific Method – Data

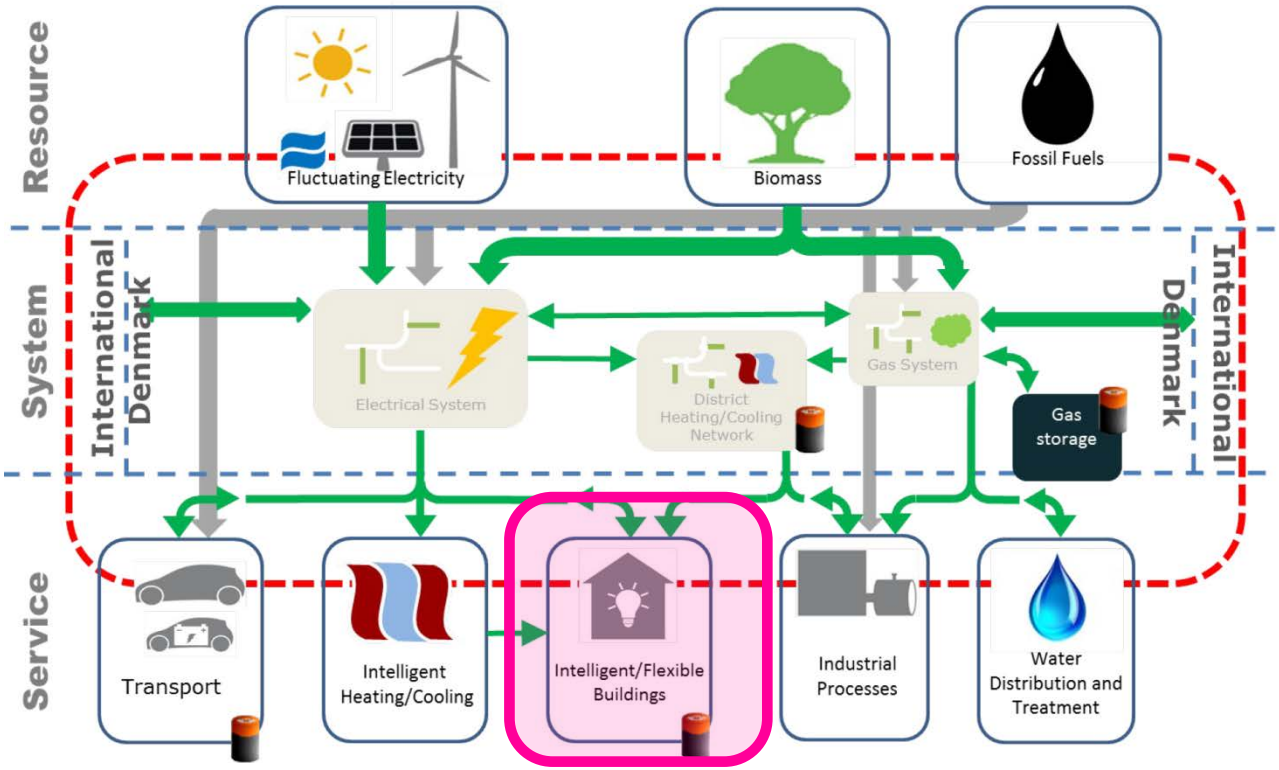
Because we cannot do the modelling (yet)

- The data research cycle



IMPACTS OF BUILDING

Can Buildings have an active role in the future energy system?



Can we store energy in the Building Mass?

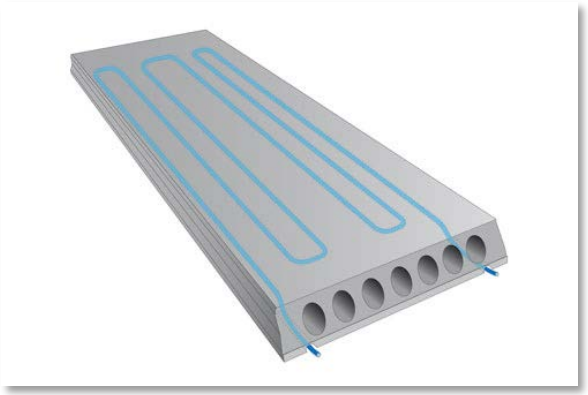
Tendency: Less than expected

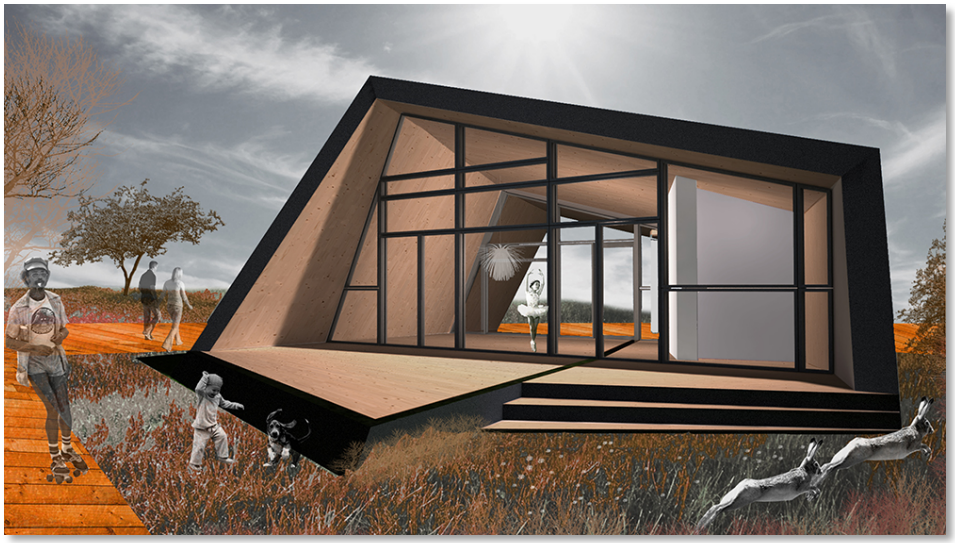
Design tendency – Activate the termal mass

- Known technologies: Floor heating

Next technologies (innovative potential)

– TABS and others

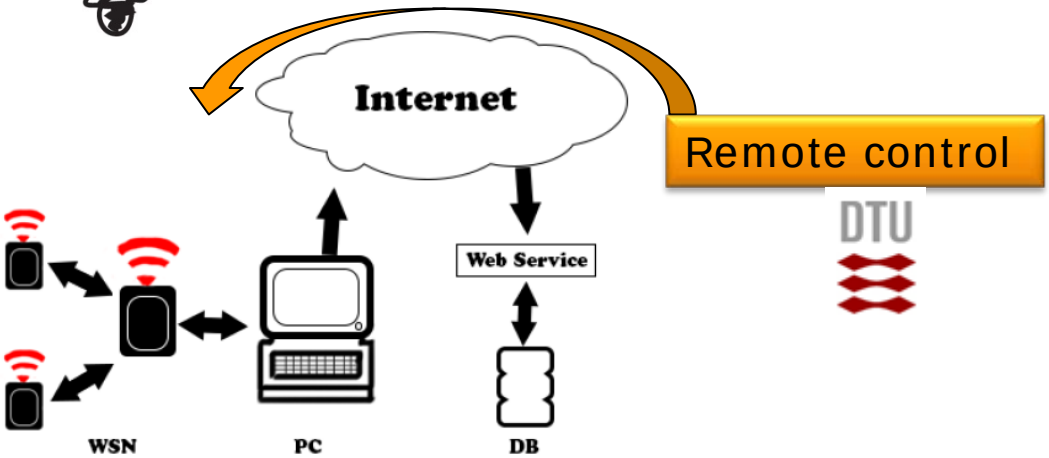




- Solar Declathlon 2012
  THE FOLD
- with cealing and floor “activated”

Flexible sensoring – Smart Buildings (automation)

Apisseq, Sisimiut -Grønland

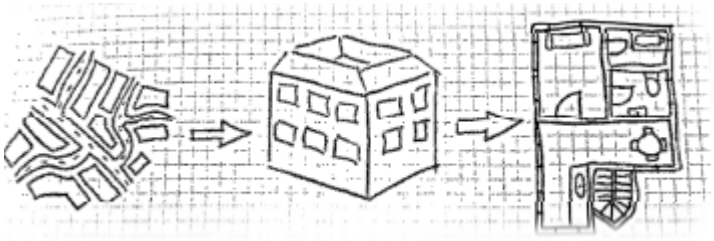


- “Communcative sensors”

Remote controllable

Internet of Things

Flexible sensoring – Smart Buildings (automation)



Brugervenlig visualisering

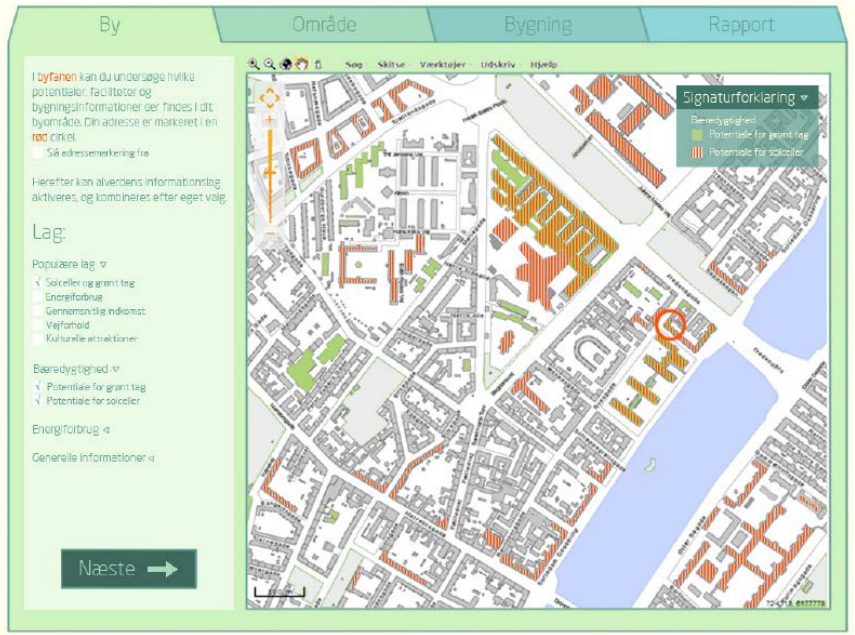
Af byplans- og bygningsspecifik data

DTU Mads Harding Møller s093341
Lærke Philipsen s093375

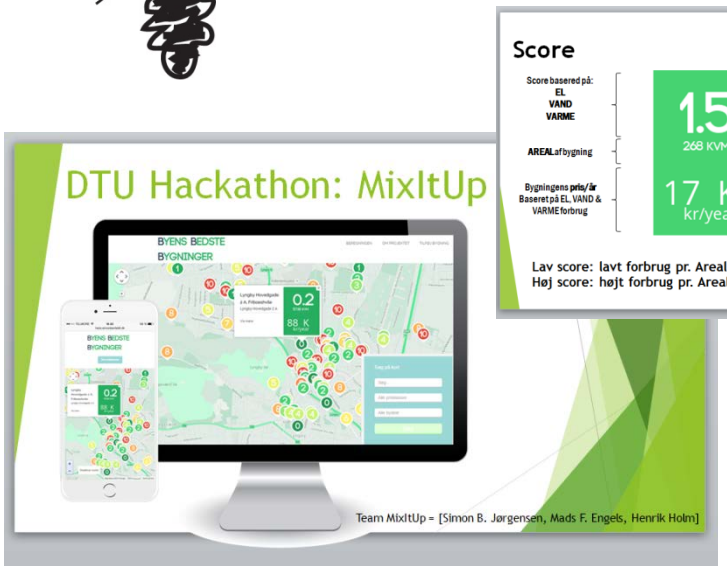
Visualization of Potentials

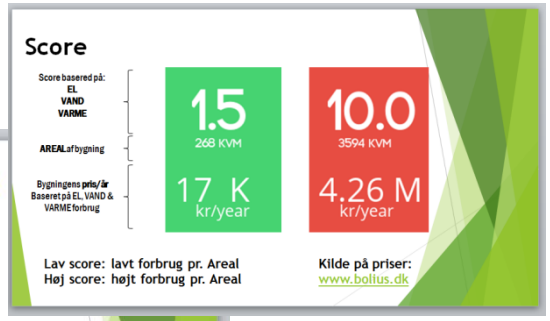
Communication Integration:

GIS>BIM>Plan>Component>…



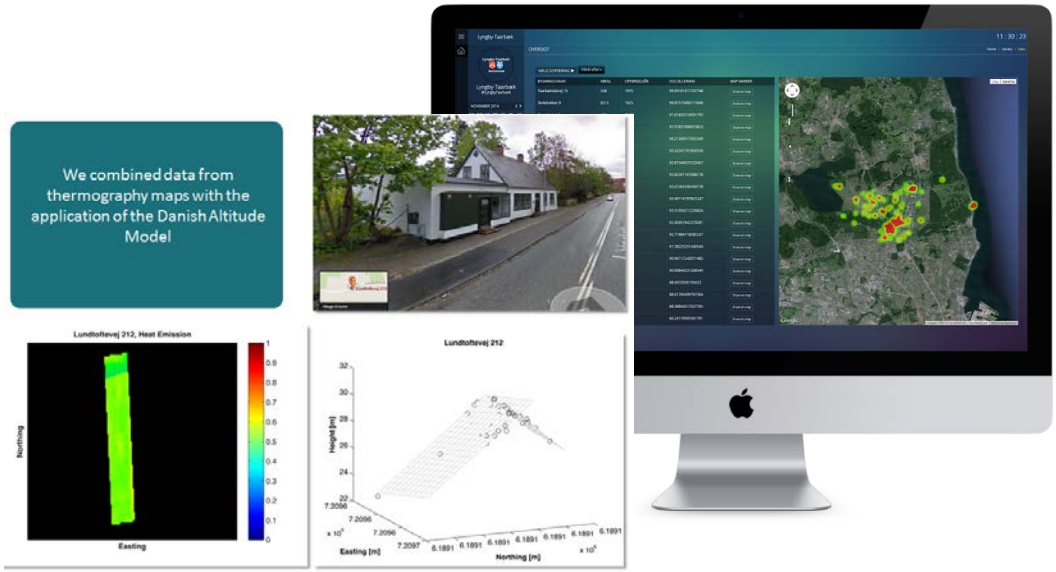
Flexible sensoring – Smart Buildings (automation)





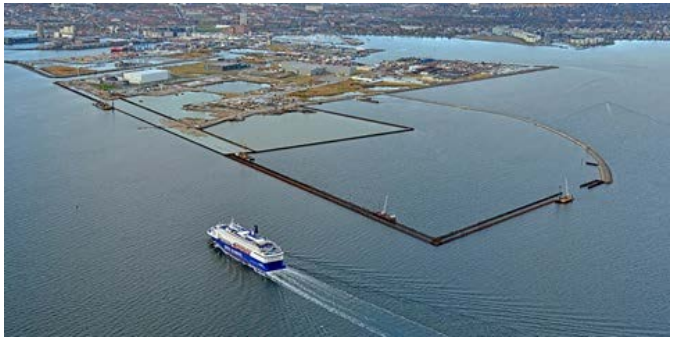
City level information (Big Data)

Building level information



Copenhagen - Energy Lab Nordhavn
The future energy system

EnergyLab Nordhavn (under planlægning)

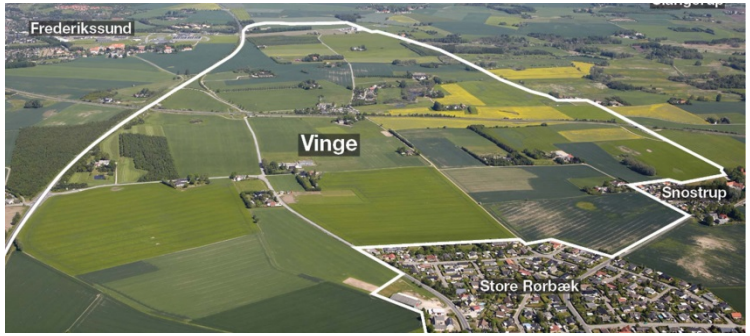


Kilde: http://www.byoghavn.dk/byudvikling/bydele/nordhavnen/landvindingsprojektet+i+nordhavnen.aspx

- Research project (26 mill. €)
  - Monitoring of buildings, energy systems (el, heat, cooling, gas …)
    - > 100.000 data points
  - Experiments
    - Low temperature district heating
    - Cross eneryg carrier experiments
  - Living Lab Experiments
    - User
    - Communities

Frederikssund - Vinge
The smart grid city

Electicity – sole energy source – How do we get this smart grid stable?



Source: da.henninglarsen.com

Smart City Lyngby

The university smart city

Big Data Campus Open Infrastructure ‘
(openness => intelligens & innovation)

- A train trassé defining the Hot Spots
and developments