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

Assoc. Prof. Alfred Heller
Technical University of Denmark

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% renewable energy by 2050, the government has set 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% in relation to 1990.


100% share of RE in the heating sector by 2035
The proposed solutions

- Energy efficiency and savings

& Renewables

www.roennebaeskoleskoleintra.dk
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

Current Energy Systems

Cross Energy Carrier

Data & Modelling

Energy Efficiency

Storage through ESI

Flexibility

Future Energy Systems

Electrification

Renewables
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*. 
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
Scientific Method – Data

Because we cannot do the modelling (yet)

- The data research cycle

**DATA**

- System identification
- Modelling
- Validation
- Simulation
- Dimensioning
- Optimizing
- Predicting
- Control
- Implementation
- Demand Side Management
- Monitoring
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 thermal mass

- Known technologies: Floor heating

Next technologies (innovative potential)
  - TABS and others

- Solar Declathlon 2012
  THE FOLD

- with ceiling and floor “activated”
Flexible sensoring – Smart Buildings (automation)

Apisseq, Sisimiut - Grønland

- “Communicative sensors”
- Remote controllable
- Internet of Things
Flexible sensing – Smart Buildings (automation)

Communication Integration:
GIS>BIM>Plan>Component>…

Visualization of Potentials
Flexible sensing – Smart Buildings (automation)

Building level information

City level information (Big Data)

We combined data from thermography maps with the application of the Danish Altitude Model.
Copenhagen - Energy Lab Nordhavn
The future energy system

EnergyLab Nordhavn (under planlægning)

- Research project (26 mill. €)
  - Monitoring of buildings, energy systems (el, heat, cooling, gas ...)
    - > 100,000 data points
  - Experiments
    - Low temperature district heating
    - Cross energy carrier experiments
  - Living Lab Experiments
    - User
    - Communities

Kilde: http://www.byoghavn.dk/byudvikling/bydele/nordhavnen/landvindingsprojektet+i+nordhavnen.aspx
Frederikssund - Vinge
The smart grid city

Electricity – 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