



## CITIES – Centre for IT-Intelligent Energy Systems for Cities

**Heller, Alfred**

*Publication date:*  
2015

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*  
Heller, A. (Author). (2015). CITIES – Centre for IT-Intelligent Energy Systems for Cities. Sound/Visual production (digital)

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# CITIES – Centre for IT-Intelligent Energy Systems for Cities

Det Intelligente Energisystem

26. marts 2015

(AI)Fred Heller  
Lektor på DTU Byg  
alfh@byg.dtu.dk



DTU Byg  
Institut for Byggeri og Anlæg

---





Ea Energy Analyses



FREDERIKSSUND  
KOMMUNE



# Danish Partners



LEAN ENERGY  
CLUSTER



KØBENHAVNS KOMMUNE

EMT NORDIC  
ENERGY MANAGEMENT TECHNOLOGIES

EMD International A/S



Horsens Varmeværk



SYD ENERGI



EURISCO  
RESEARCH & DEVELOPMENT

Fjernvarme Fyn



AARHUS  
KOMMUNE

DTU Compute  
Department of Applied Ma



nce



TEKNOLOGISK  
INSTITUT



# International Partners





CITIES

ITAL

71 mio kr. (øges løbende)

44 mio kr. i tilskud DSF

40 partner (øges løbende)

2014-2019 (2020!!! Har vi nået det?)

Forskning, Udvikling, Demonstration og Innovation

11 PhD

5 PostDocs

# Globale tendenser

- Globalisering
- Urbanisering (stigende befolkningstal – det taler vi ikke om)
  - Større byer (80% forventes boende i byer i 2050)
  - Mere tætte byer
  - Højere byer
- Smart'ificering
  - Smart Cities
  - Smart Grids
  - Smart Buildings (Bygningsautomation)
  - Smart Sensors

=> Alle er smarte – Hvem er smartest? (bestemmer?)
- Bæredygtighed
  - Vedvarende energi
  - Cirkulære systemer
  - Konsekvenser af miljø'et



Det er bl.a. disse tendenser der danner rammen om CITIES

# Motivation for CITIES

## Samfundets udfordring / mål



## 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 electricity 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 renewable energy

### 2050

All energy supply - electricity, heat, industry and transport - is covered by renewable energy

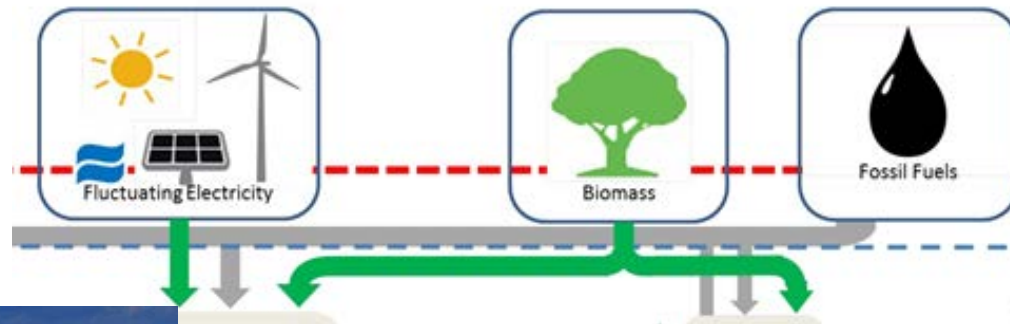
The initiatives up to 2020 will result in a greenhouse gas reduction by 35 pct. in relation to 1990.

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

**100% share of RE in the heating sector by 2035**

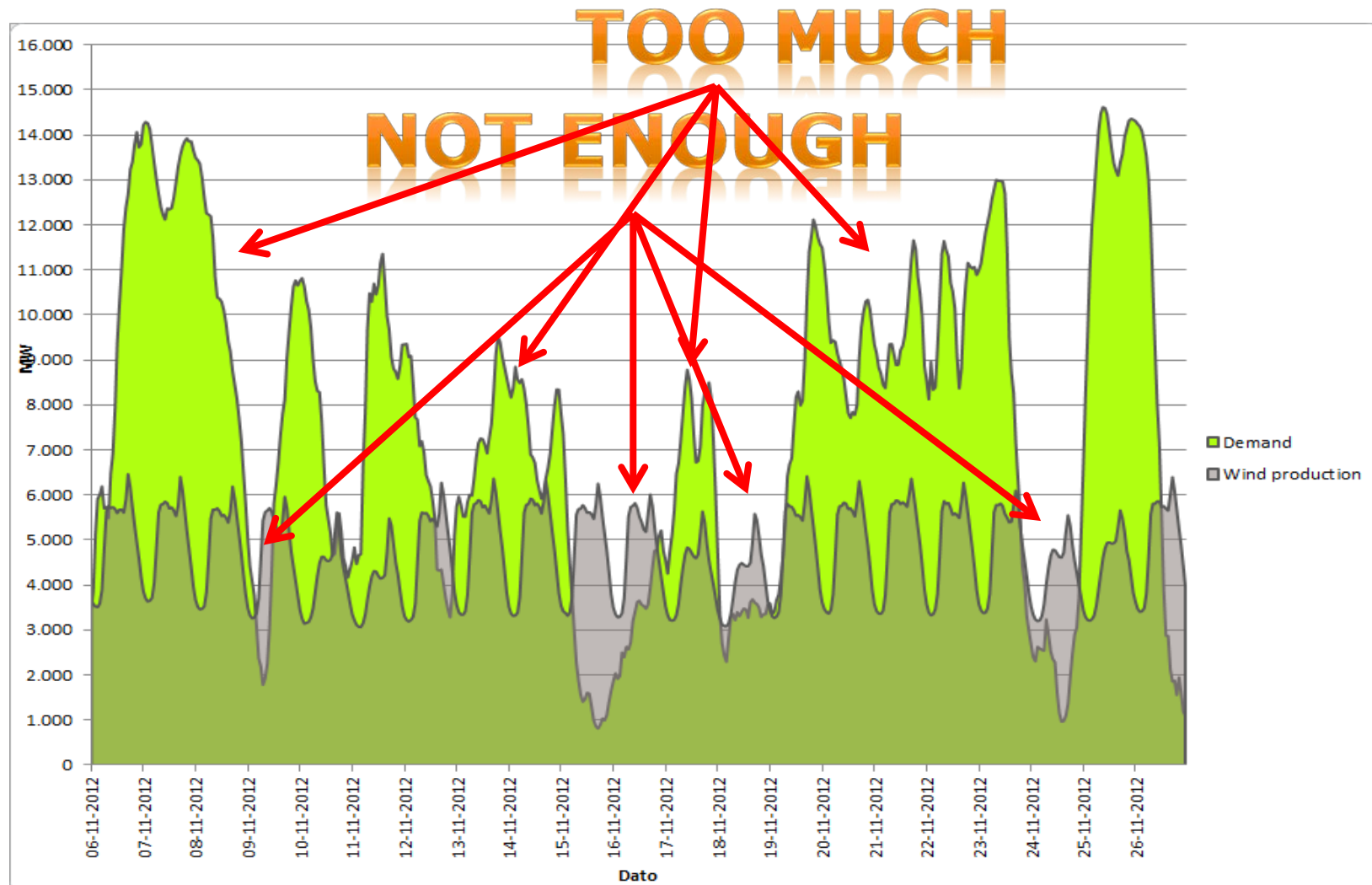
# Løsning – Vedvarende Energy

- Vindenergi
- Solenergi
- Biomasse
- Etc.



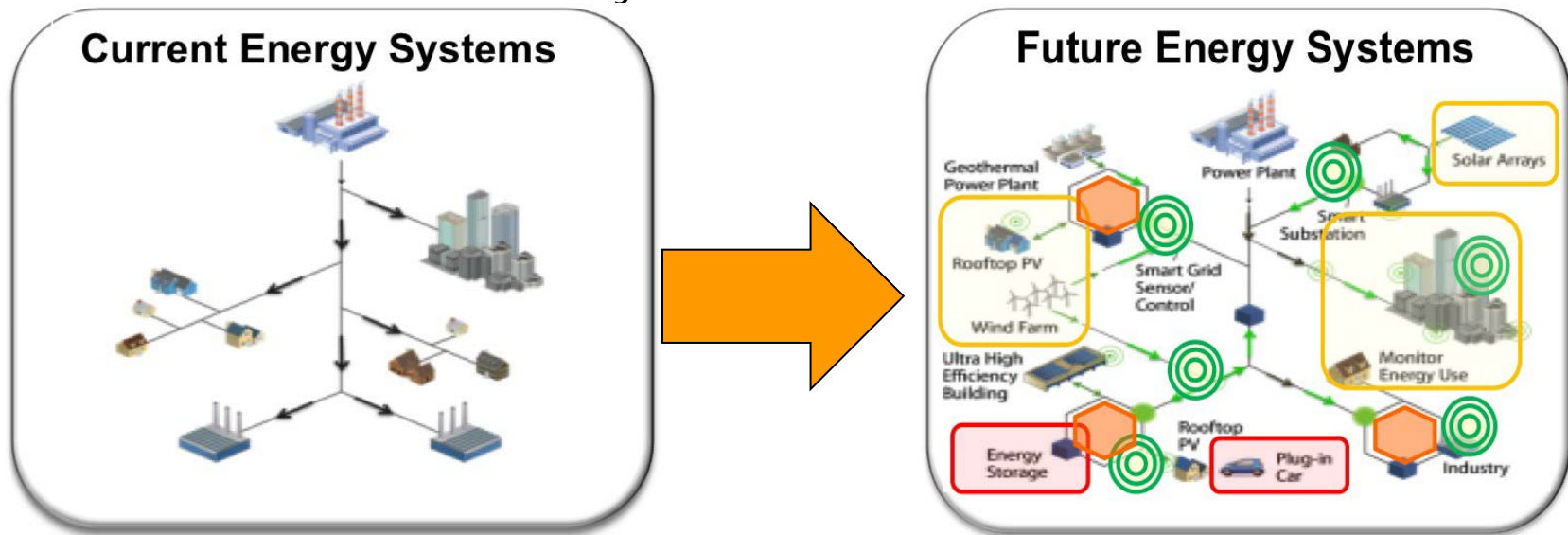


# Konsekvens – Balancering af systemet



# Første løsningsforslag – Smart Grid

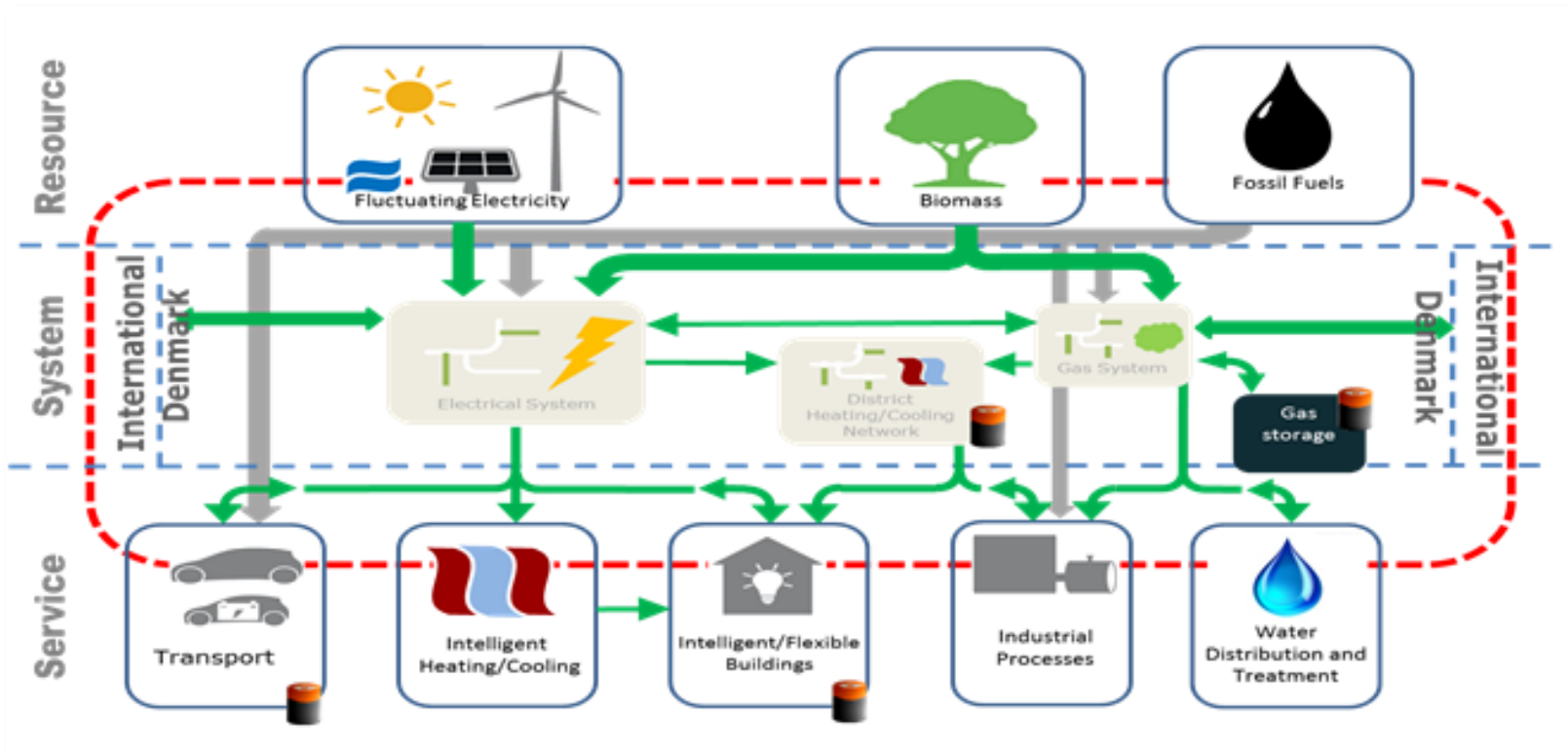
- Elektrificering
- Fra central til decentral el-system



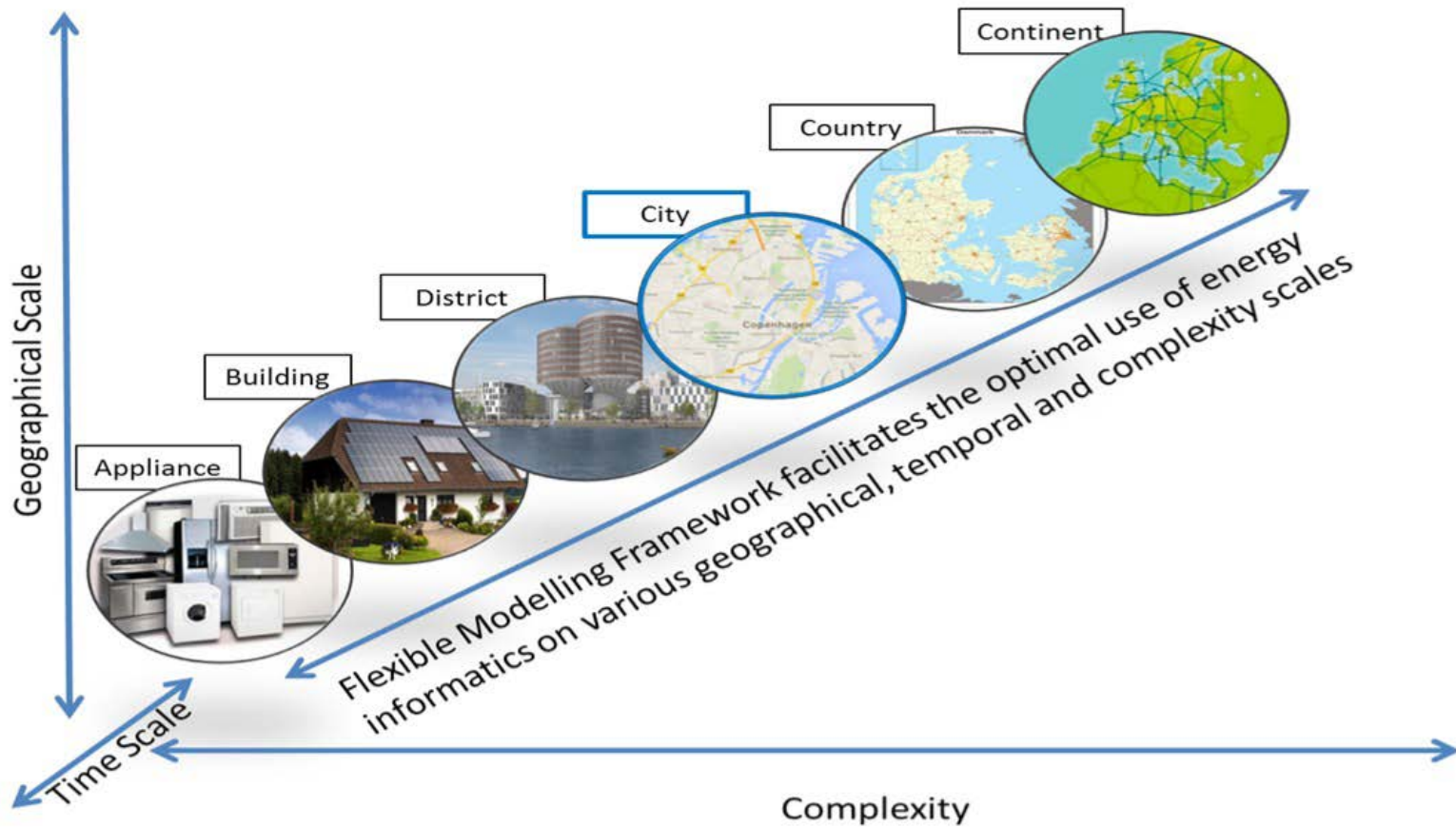
- Der er dog stadig behov for mere stabiliserende komponenter

Therefore the CITIES Research Centre

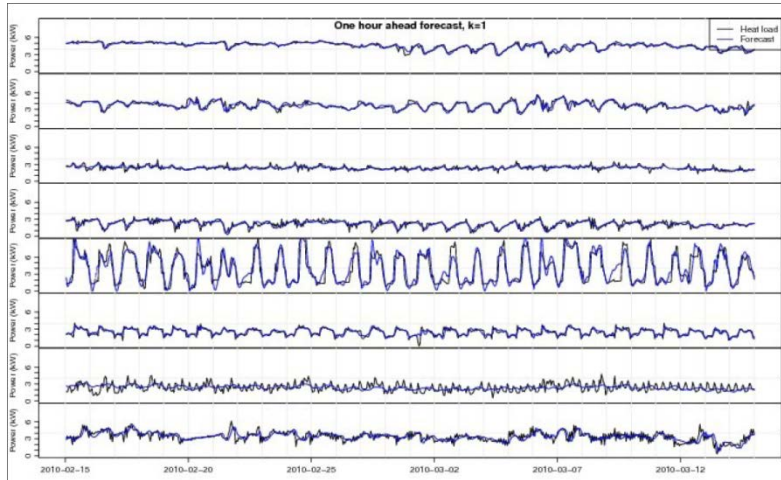
# Energisystemet Smart Energy



# Projektets dimensioner

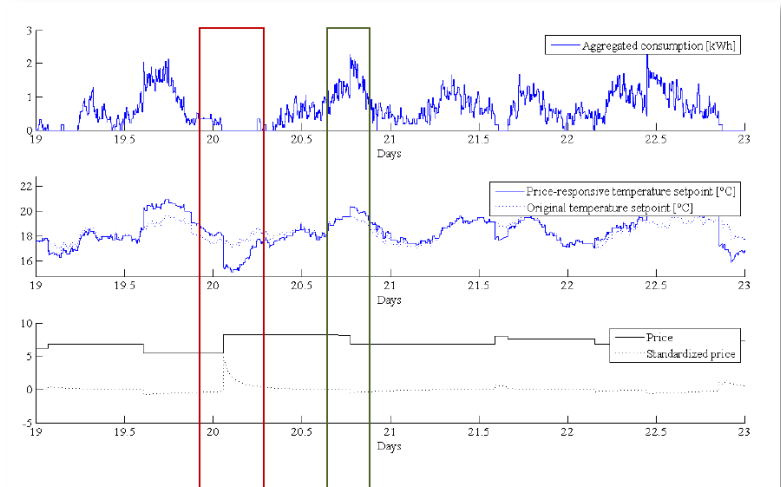


# Eksempel – Demand Side Management



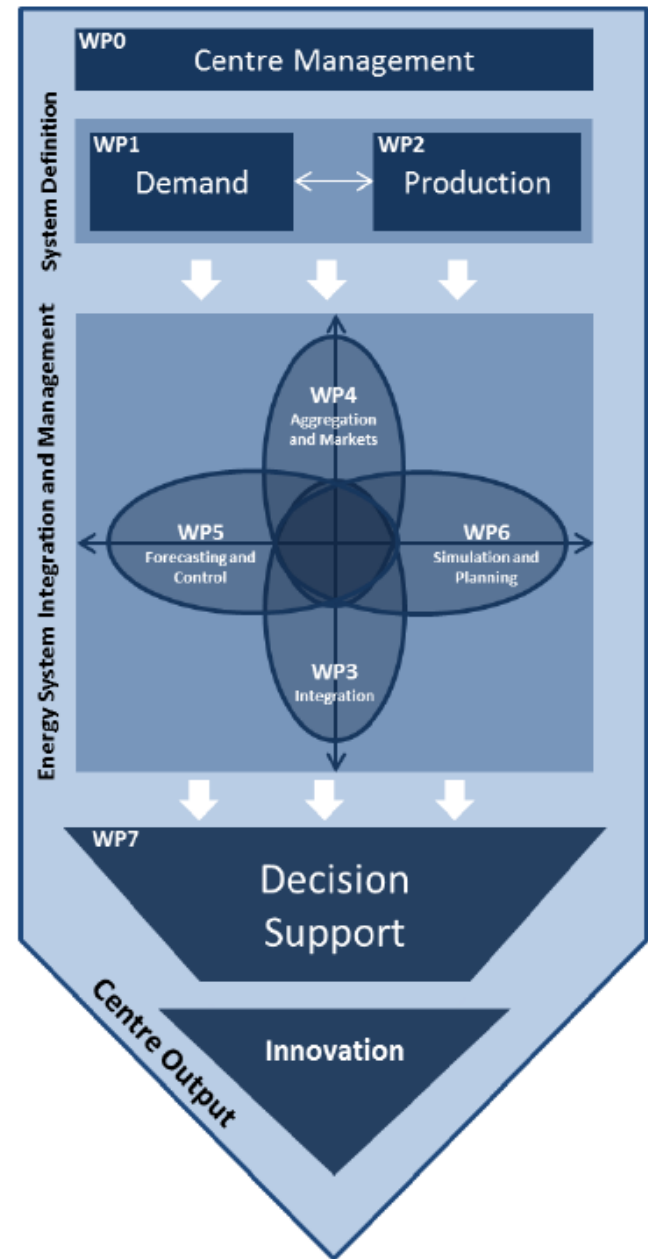
- Forecasting
- Predictive control
- ...
- Vi forsøger at forudse energiforbruget
- ... og styrer efter det
  - Vejrdata

– Energipriser / Markeder



# INTERDISCIPLINÆR SMART ENERGY

- Alle energiformer
  - El
  - Termisk
  - Gas
- Konvertering
- Markeder
- (Policy)



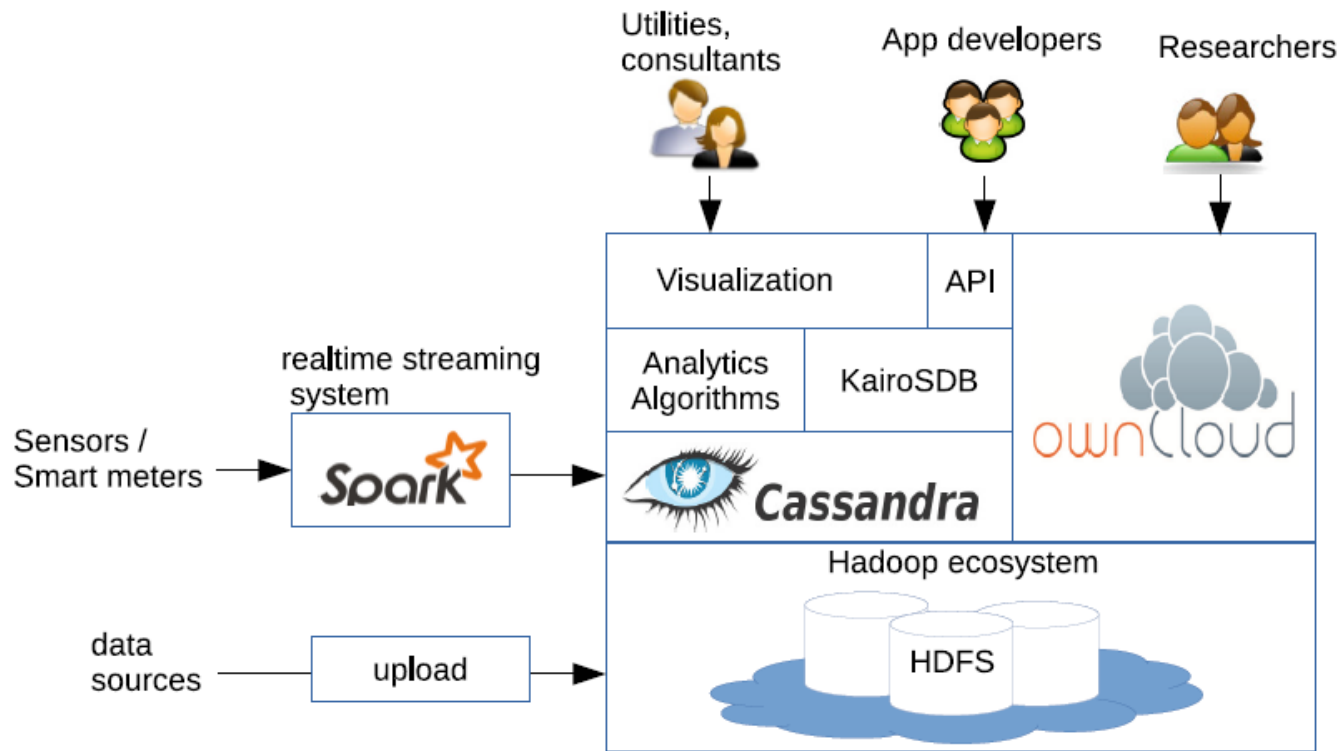
# Metoder

- Teoretisk forskning
- Workshops
- Fuldskala-labs
  - Industrielle labs: Grundfos, Danfoss – Denmark
  - Forskningslaboratorier: PowerLab.dk, Syslab Bornholm, DTU, Risø, Grønland
  - Internationale labs: Spanien, Irland, USA
- Living labs - Smart Cities projekter:
  - ProjectZero
  - Vinge
  - Odense
  - mange andre (undskyld)...
- Forskningssamarbejde (national og international)
- Innovation platform: CLEAN Inno-SE, "VE-net"



# METODE – (BIG) DATA

## Data Infrastruktur





# METODE – (BIG) DATA

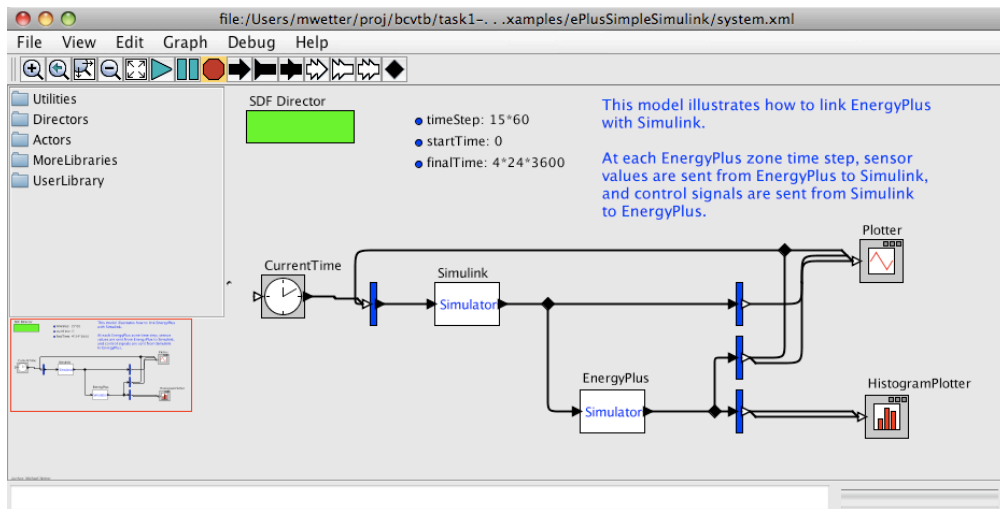


- Data fra energianlæg, bygninger osv. Søges
  - minutværdier til timeværdier
  - m/u aggregering

# METODE

# SIMULERINGSPLATFORM

- BCVTB
  - (PtolemyII)





# METODE - CASES

# Sønderborg

ProjectZero is an enabler for Sønderborg to become a **ZEROcarbon community by 2029,**



- Data Infrastruktur opbygges
  - Fjernvarme
  - El
  - Gas

Our ZEROcarbon masterplan outline directions and how to achieve 50% carbon reduction by 2020

## Energy Efficiency Improvement

- Energy retrofit of houses & buildings including PV cell-production
- Intelligent Heat pumps in rural areas
- Energy retrofit of companies, shops, offices
- Green transportation including electrical cars

## A New Green Energy Infrastructure

- Green District heating in the urban areas
- Wind turbines onshore & coastal near
- Biogas plants processing manure

## A Dynamic Energy system

**Changing the mindset and thinking**



# Vinge Frederikssund – Bygningen i el-systemet

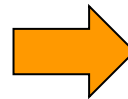
- Eksempel Vinge Frederikssund – Barmark-udviklingsprojekt
- Eneste energiform er elektricitet
  - Hvilke konsekvenser har dette valg?
  - Hvordan spiller Smart Grid her?
- For at kunne svare spørgsmålene er der behov for
  - Målinger
  - Sensorer
  - Data infrastruktur



Kilde: <http://www.frederikssund.dk/vinge>

## Nordhavn – Bygningen i det komplekse energisystem

- Eksempel EnergyLab Nordhavn (under planlægning)



- Vi forventer måling af
  - 129 mio kr.
  - Ca 50 huse
  - flere gader
  - alle energistrømme, vand m.m.
  - speciel målinger på krydstogtskibe for at dokumentere deres egenskaber
  - > 10.000 målepunkter pr. større bygning

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

# Vidensby Lyngby

## Smart Campus DTU

- Smart Campus DTU
  - opsamler alle datastrømme for energisystemet på Campus
  - gør dem offentlig tilgængelig
  - studenteropgaver
  - forskning og udvikling
  - innovation
  
- Living Lab Lyngby
  - Partner søges
  - At renovere bygninger til en smart city
  - Letbane-trassé
  - Det smarte Byggeportal
    - data om bygninger
    - kommunale data
    - byggeprocesser

UDBYGNINGSPLAN 2009 - 2020



# Bygninger som aktiv komponent i det intelligente energisystem

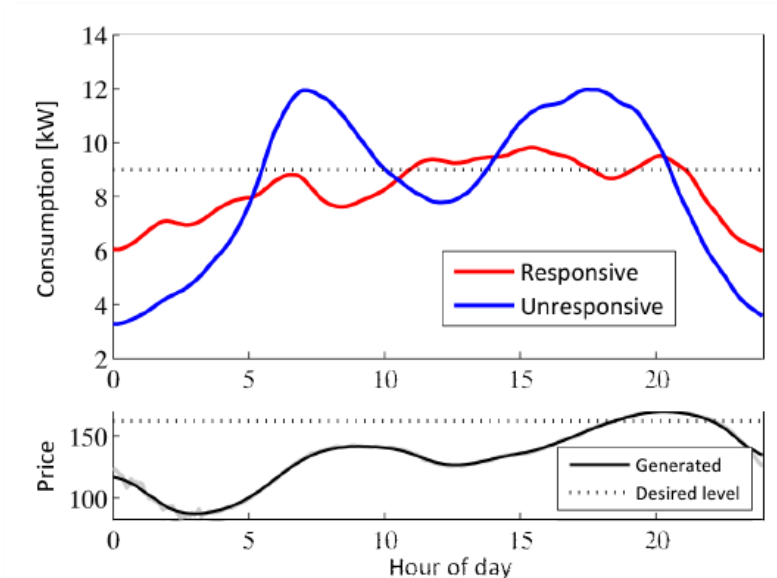
- Behov for sensorer
  - Avancerede kontorbygninger – 10.000 sensorer
    - Widex bygningen i Lyngø
    - Grundfos kollegiet i Århus
  - Lejligheder og små huse - >500 sensorer
  - De store systemer (målinger på det aggregerede niveau)
    - Bygninger
    - Logiske enheder/strenger
- En by får millioner af sensorer
  - som leverer aflæsninger hvert sekund/minut/time/dag
    - I kan selv regne på de store tal for data kommunikation og lagring



# Jagten på "fleksibilitet"

## Eksempel – Brug bygningens termiske masse

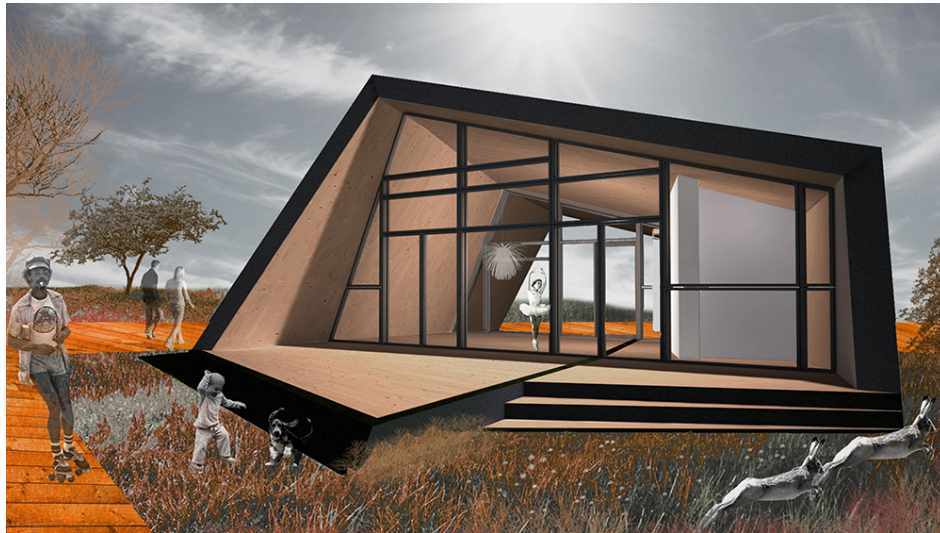
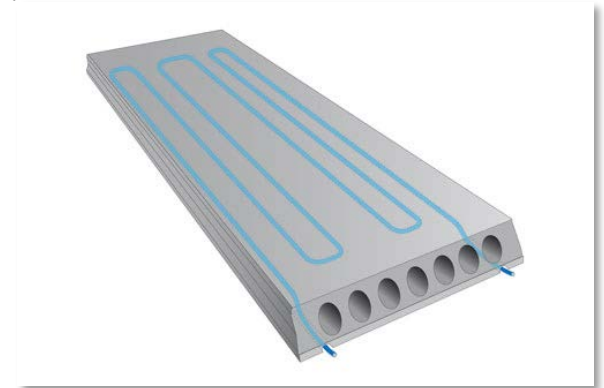
- Kan vi lagre varme/køling i væggene?
- .. og herigennem aflaste energinettet (økonomisk motivation)
  - Bygningens masse er "Gratis"
  - Stort potentiale - Hvor stort er potentialet?



- Bilers batterier
- Varmepumper
  - Central
  - Decentral
- Kølekapaciteter
- OSV.

# Aktivering af den termiske masse

- Den termiske masse skal komme i spil – Hvordan?
  - Gulvarme (eksisterende teknologi)
  - TABS og andre teknologier



- Kølende lofte (vægge)
- Solar Declathlon 2012 - FOLD