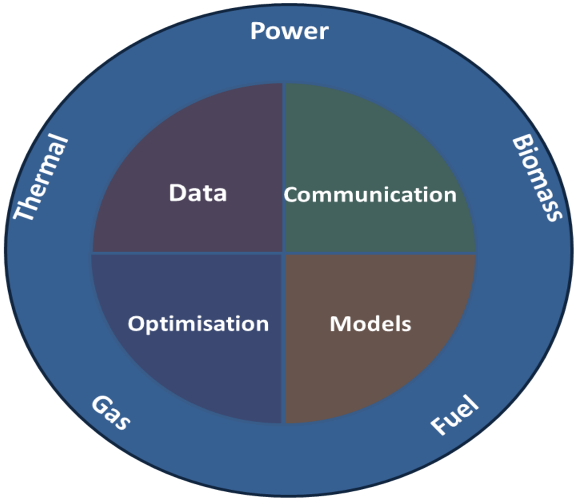
Smart Cities – NTNU-DTU Meeting



Henrik Madsen, DTU Compute

http://www.henrikmadsen.org

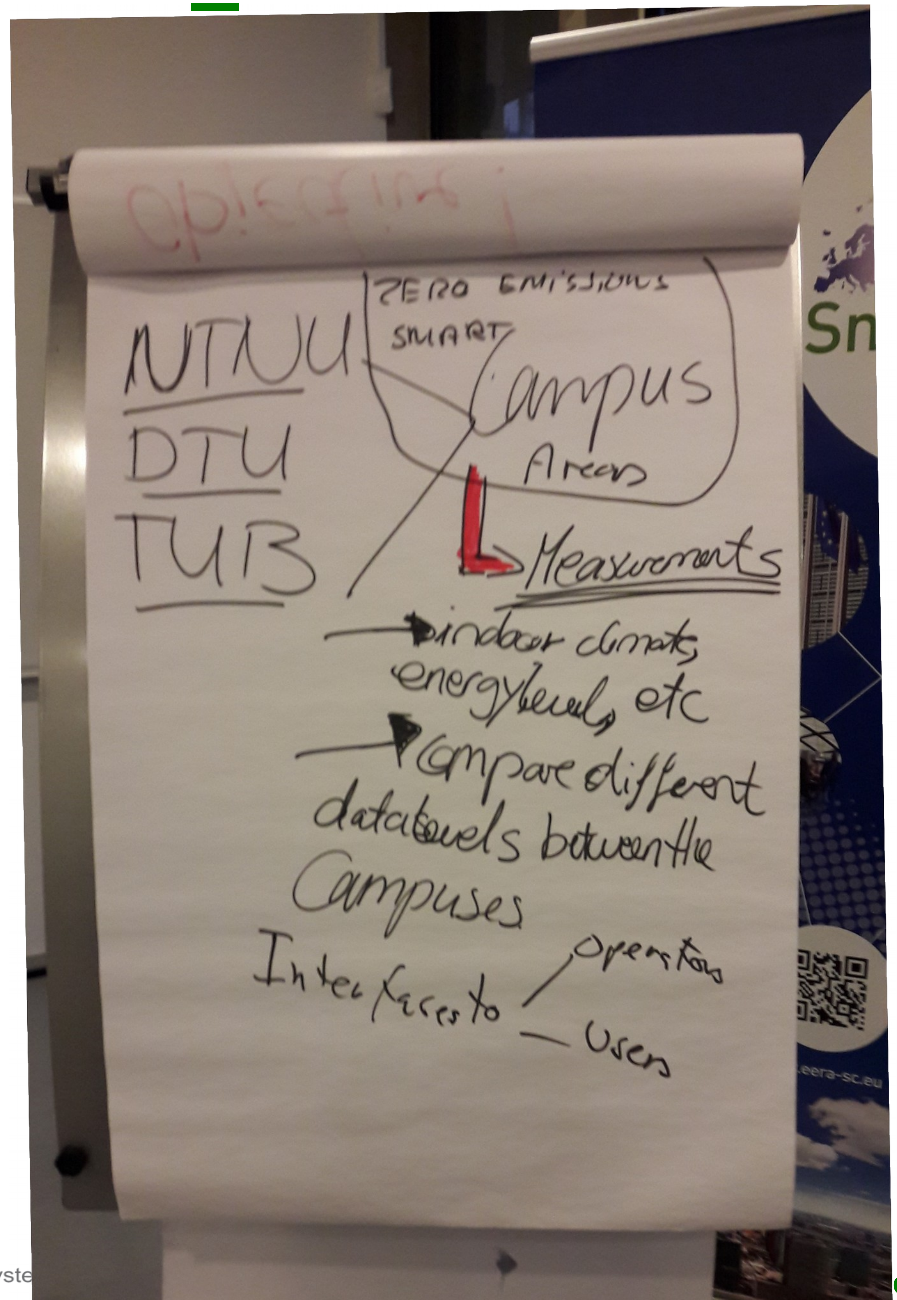
http://www.smart-cities-centre.org

CITIES
Centre for IT Intelligent Energy Systems

Agenda (draft)

- Joint H2020, N5T, … applications
- Demand Response in Cities and Districts
- Smart Campus initiative and collaboration (a follow up on the joint NTNU - TU-Berlin - DTU Workshop we had on DTU in February).
- Report from IEA Annex 67: Energy Flexible Buildings for the future smart energy systems
- Should we aim at having a joint (Big) Data Management Systems for Smart Cities (as a follow up on some joint initiatives)?
- ZEN and CITIES project - status and collaborations
- Project Smart Cities 2030

NTNU-TU_B-DTU Smart Campus



Zero Emission Smart Campus Areas

Demand Response

- We have demonstrated a large potential in Demand Response. Automatic solutions and end-user focus important)
- Controllers for building heat/comfort can focus on
  - Peak Shaving
  - Smart Grid demand (like ancillary services needs, ...)
  - Energy Efficiency
  - Cost Minimization
  - Emission Efficiency
- We see large problems with tax and tariff structures in many countries (eg. Denmark).

Annex 67: Flexibility Function

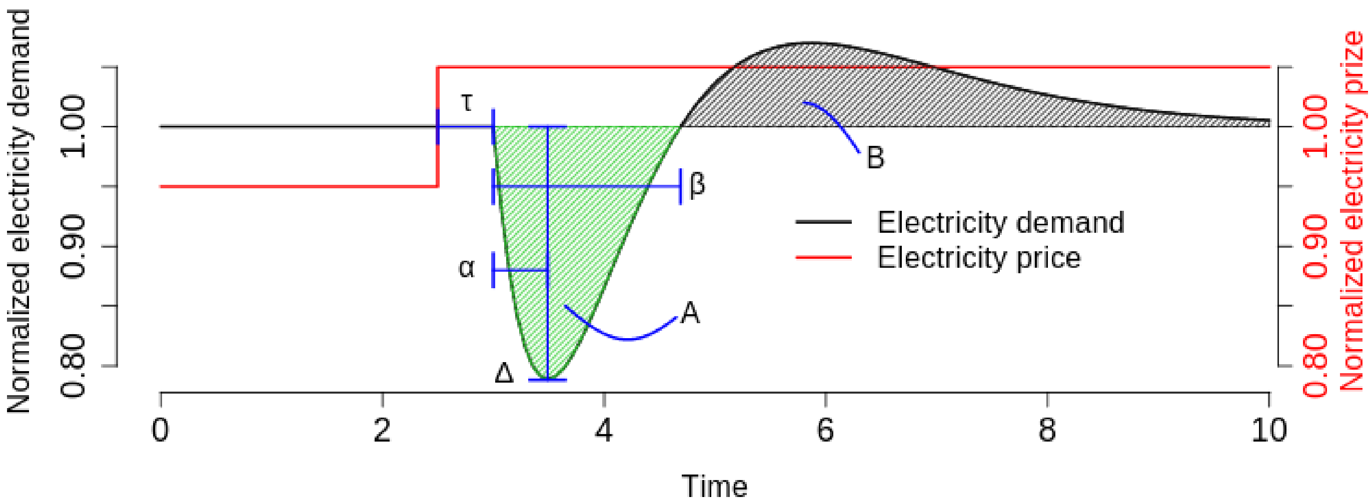


Figure 4: Six characteristics of the demand response to a step increase in electricity price. τ: The delay from adjusting the electricity prize and seeing an effect on the electricity demand, equal to approximately 0.5 here. Δ: The maximum change in demand following the price change, in this case close to 0.2. α: The time it takes from the change in demand starts until it reaches the lowest level, approximately equal to 0.5 here. β: The total time of decreased electricity demand, roughly equal to 2 here. A: The total amount of decreased energy demand, given by the green-shaded area. B: The total amount of increased energy demand, given by the grey-shaded area.

CITIES
Centre for IT Intelligent Energy Systems

Labelling proposal
for energy, price and emission based labelling

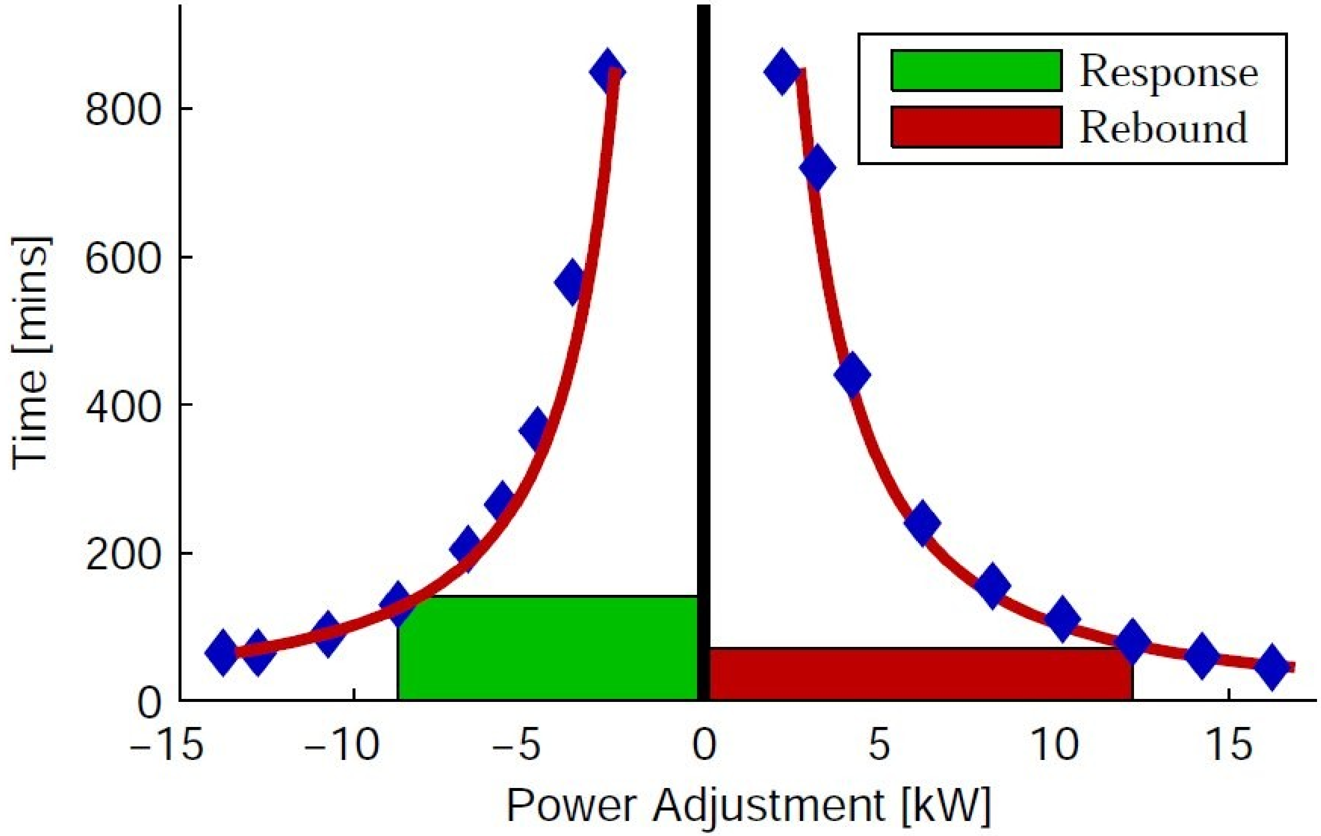
The test consists of the following steps:

1. Let λ_t be the price of electricity at time t.
2. Simulate the control of the building *without considering* the price, and let u_t^0 be the electricity consumption at time t.
3. Simulate the control of the building *considering* the price, and let u_t^1 be the electricity consumption at time t.
4. The total operation cost of the price-ignorant control is given by $C^0 = \sum_{t=0}^{N} \lambda_t u_t^0$.
5. Similarly the operation cost of the price-aware control is given by $C^1 = \sum_{t=0}^{N} \lambda_t u_t^1$.
6. $1 - \frac{C^1}{C^0}$ is the result of the test, giving us the fractional amount of saved money.

This test is inspired by minimizing total costs for varying electricity prices, but in general λ_t could just represent ones desire to reduce electricity demand at time t.

Flexibility Represented by Saturation Curves

(for market integration using block bids)



Smart CITIES Data Management System

Xiufeng Liu, Per Sieverts Nielsen, Alfred Heller, Alexander Turecz

Interreg
Öresund-Kattegat-Skagerrak
European Regional Development Fund
EUROPEAN UNION
CITIES
Centre for IT Intelligent Energy Systems

Smart City Data & Characteristics

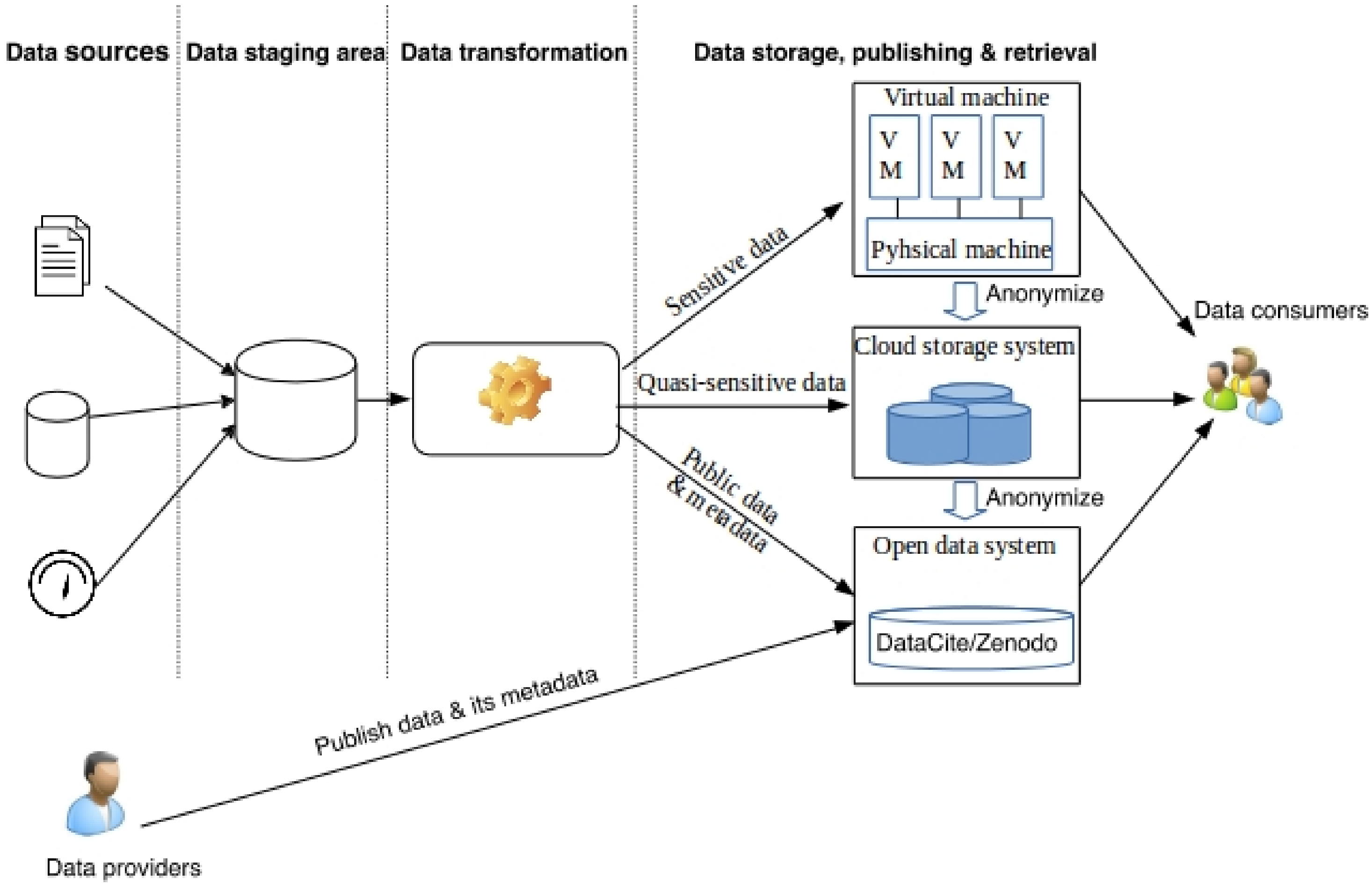
- Data Types:
  - City info., GPS, Traffic, Mobile, LBS, Environment and Climate data, Social activity, IoT, etc.
- Data Characteristics:
  - Heterogeneous data sources
  - Featured with big data:
    - Variety (varied/complex formats/types/meanings):
    - Volume: Very large data volumes
    - Velocity: Data arrives very fast (data streams)
  - Temporal-spatial data
  - Fine granularity
  - Multi-dimensions

CITIESData Platform

- Data security assurance
  - Data anonymization (e.g., for sensitivie data)
  - Secured data management (VM-based environment/private ownCloud)
- Quality assurance
  - Data cleansing/quality checking
- Data fusion
  - Open data platform
  - Linked data

Interreg
Öresund-Kattegat-Skagerrak
European Regional Development Fund
EUROPEAN UNION
CITIES
Centre for IT Intelligent Energy Systems

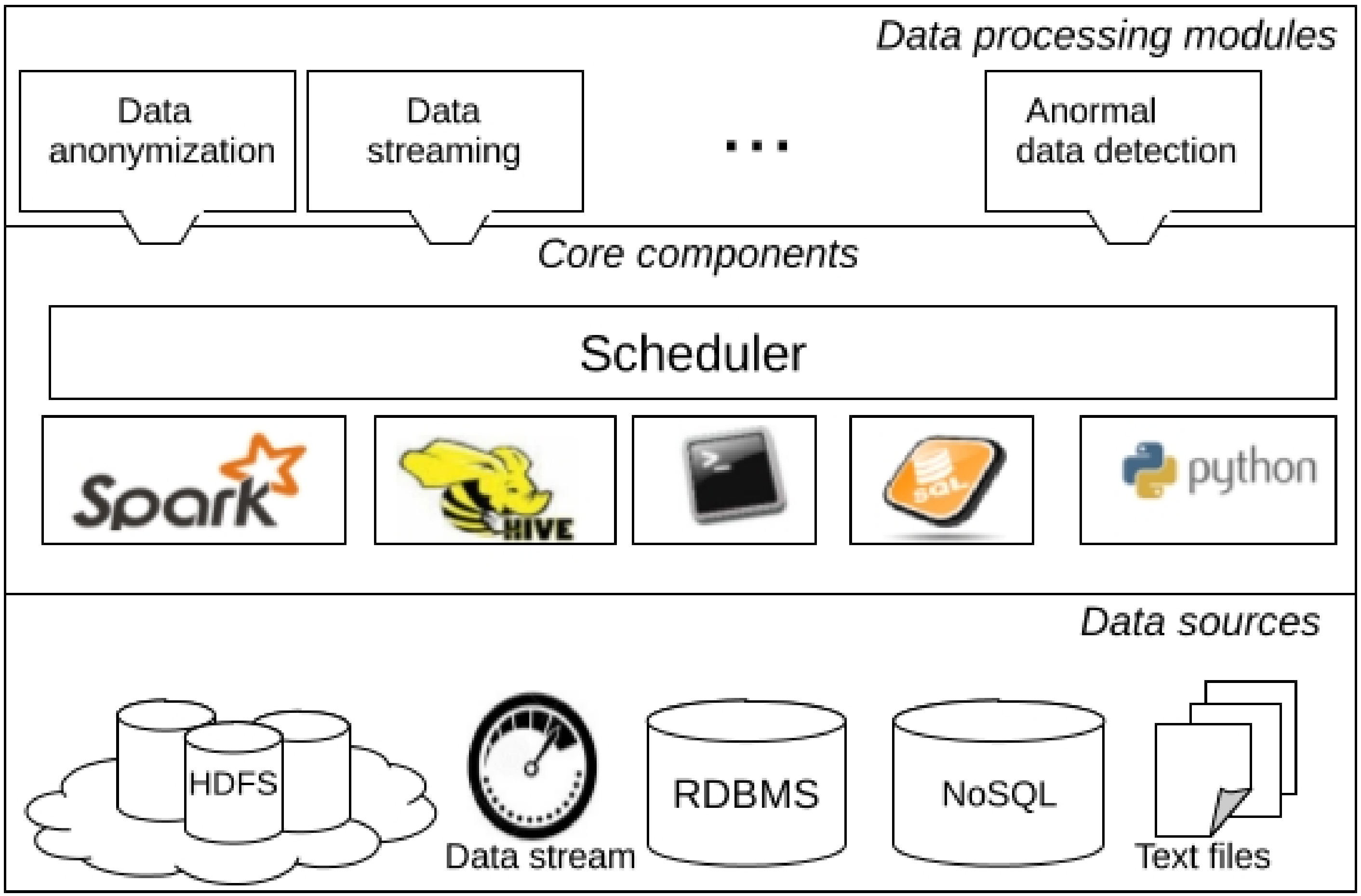
CITIESData Platform



Interreg Öresund-Kattegat-Skagerrak European Regional Development Fund
EUROPEAN UNION

CITIES Centre for IT Intelligent Energy Systems

Components of CITIESData Platform



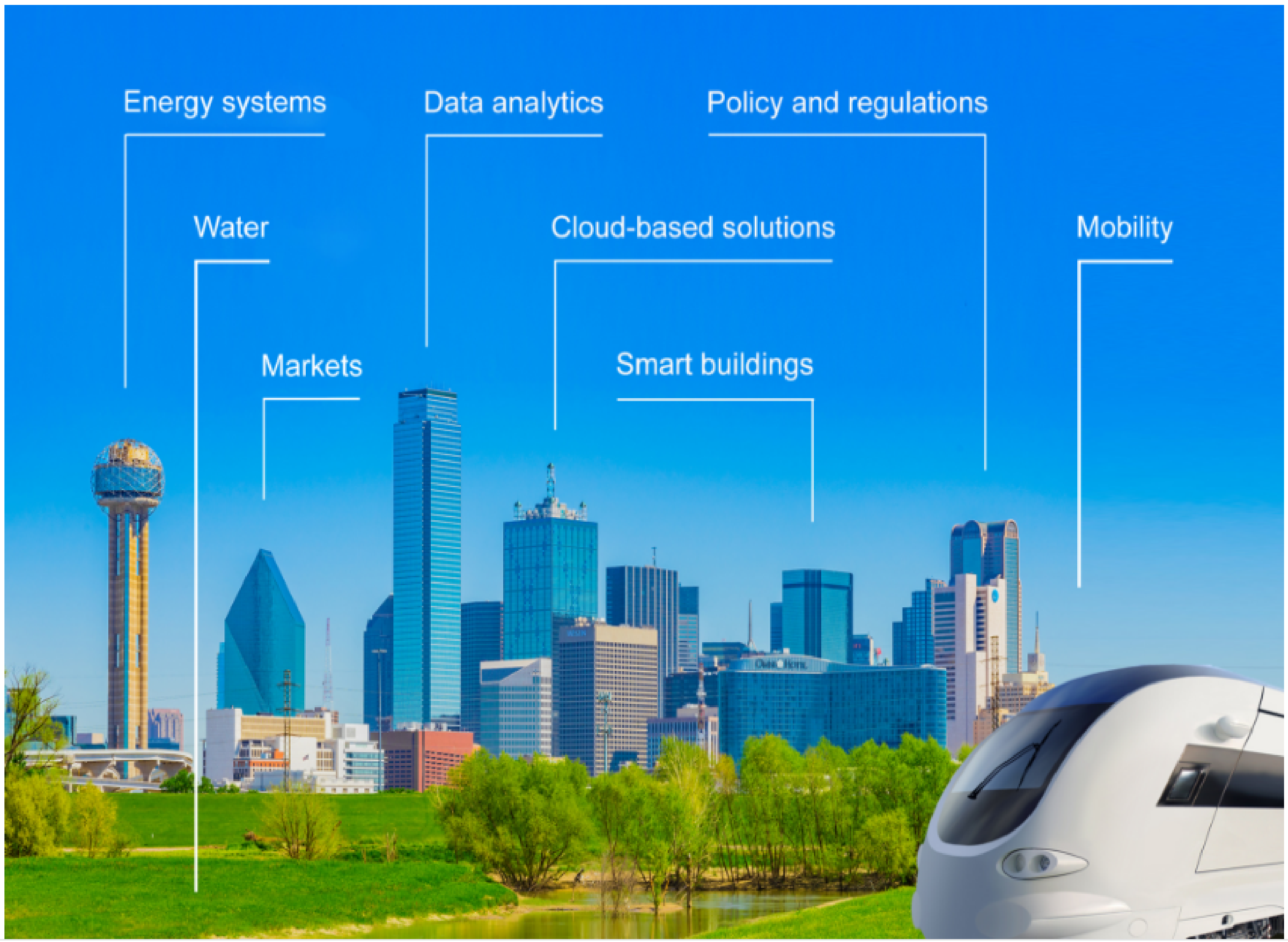
CITIES INNOVATION CENTER

Integrated energy systems powered by intelligent data

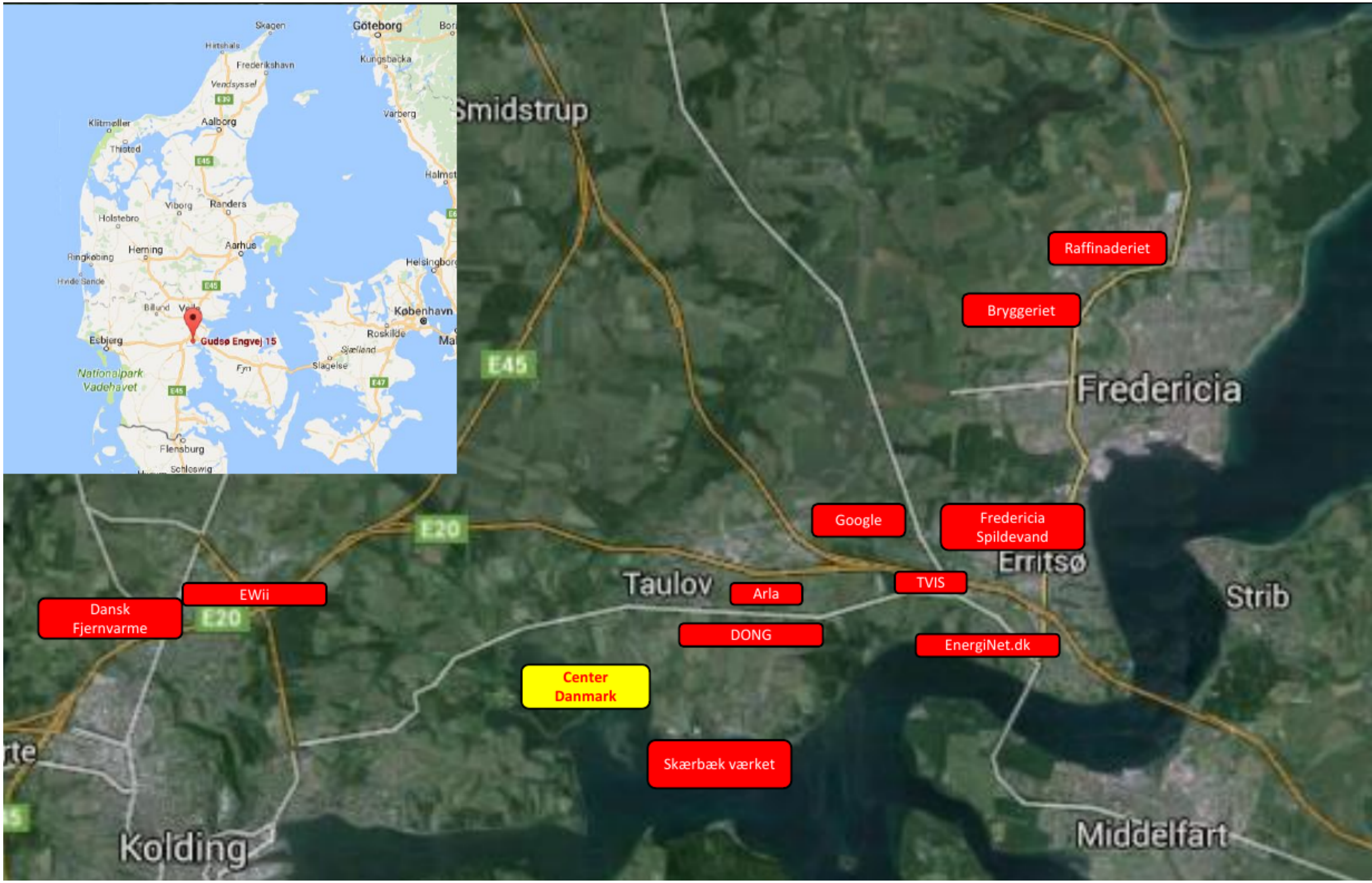
Search …

HOME | 100% BY 2050 | ABOUT US | TOPICS | PROJECTS | EVENTS | PARTNERS

Topics



Smart Cities 2030
Test Center for Intelligent and Integrated Energy Systems

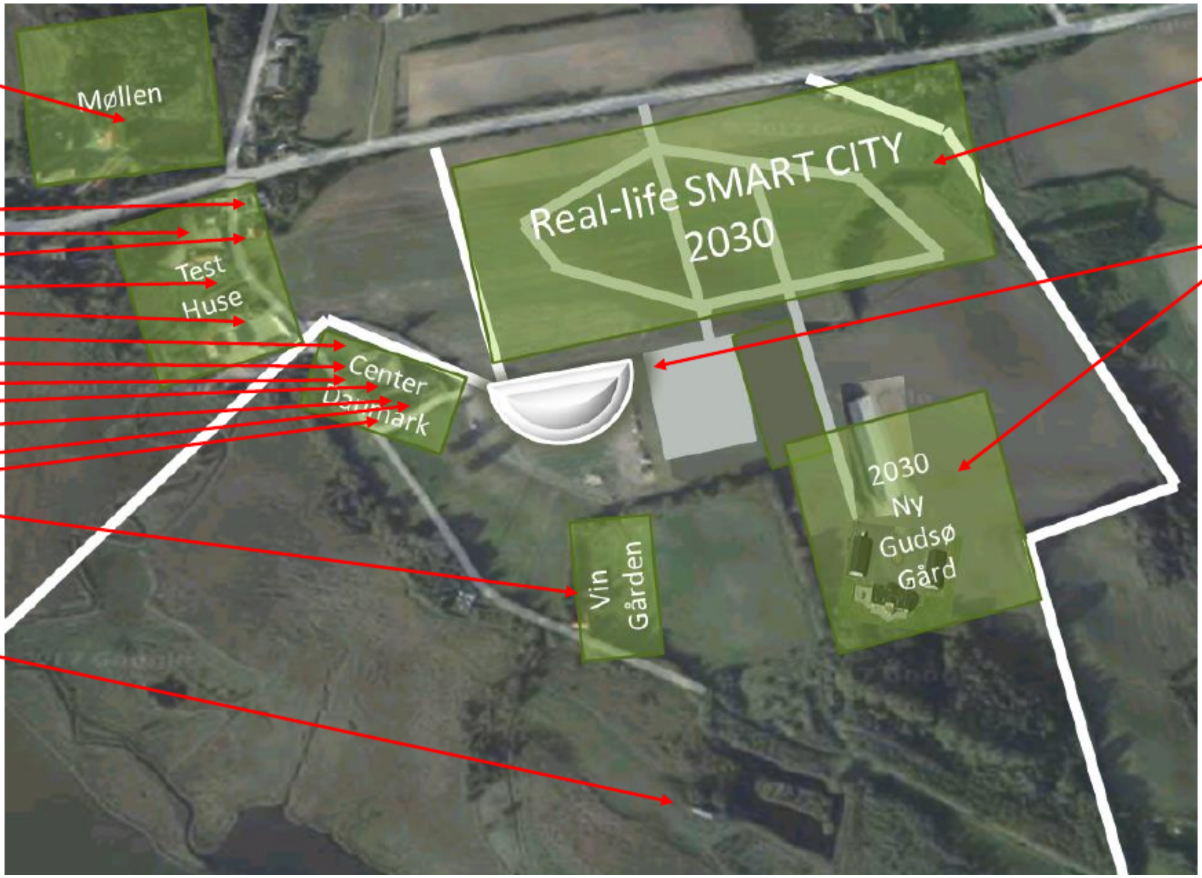


Test i et mini samfund beliggende på 40 Hektar naturgrund

- Test i et fungerende driftsmiljø bestående af mange forskellige typer bygninger

Ældre bygninger :

1. Møllen: Urban Farmning
    1. Bygning 228 m²
    2. Bygning 590 m²
    3. Bygning 290 m²
    4. Bygning 230 m²
    5. Bygning 155 m²
2. Privathus, 183 m².
3. Privathus, 153 m²
4. Privathus, 166 m²
5. Gård 140 m²
6. Gård 4-længet 231 m²
7. Rækkehus 140 m²
8. Rækkehus 130 m²
9. Depot 140 m²
10. Kontor 110 m²
11. Lager 450 m²
12. Erhverv produktion 450 m²
13. Privat hus 160 m²
14. Vingården 110 m²
    1. Erhverv 70 m²
    2. Produktion Vin 25 m²
    3. Kølerum 5 m²
    4. Klimarum kaffe 10 m²
15. Shelter 60 m²

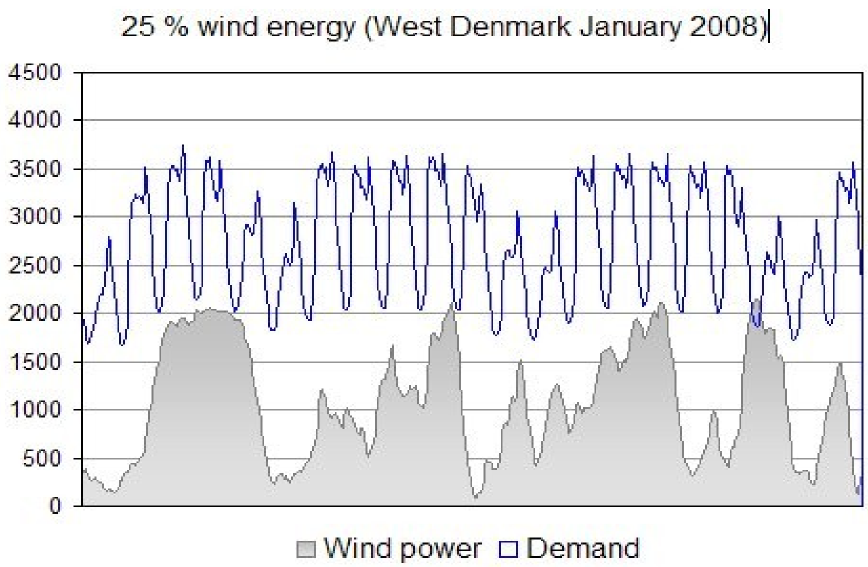


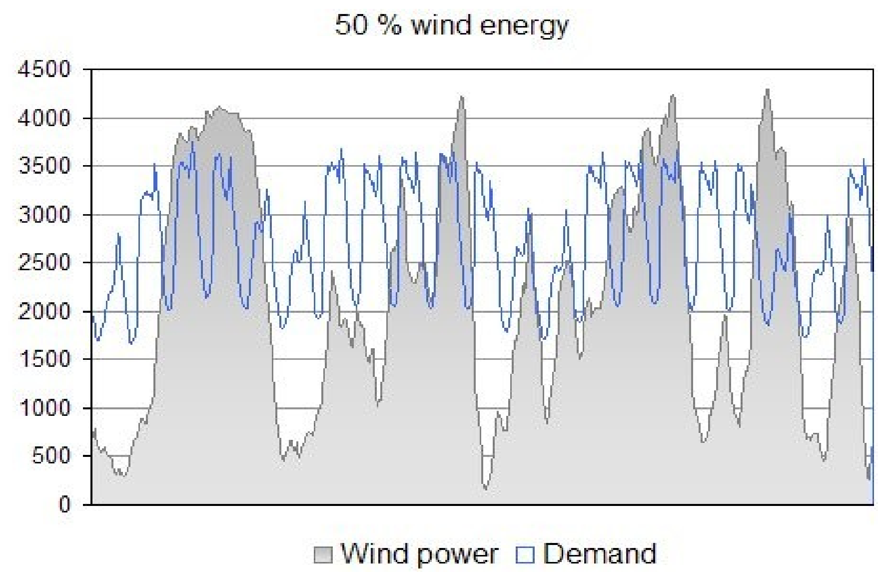
Nye bygninger :

1. Smart City 2030
    1. Urban Farmning
    2. Rækkehuse
    3. Parcel huse
    4. Kollegie værelser
    5. Undervisningsbygning
    6. Laboratorier
2. Center Danmark 4800 m²
3. Ny Gudsøgård 2600 m²
    1. Privat hus 280 m²
    2. Erhverv 280 m²
    3. Stald 280 m²
    4. Ridehal 1700 m²
    5. Produktion Gødning

The Danish Wind Power Case

.... balancing of the power system



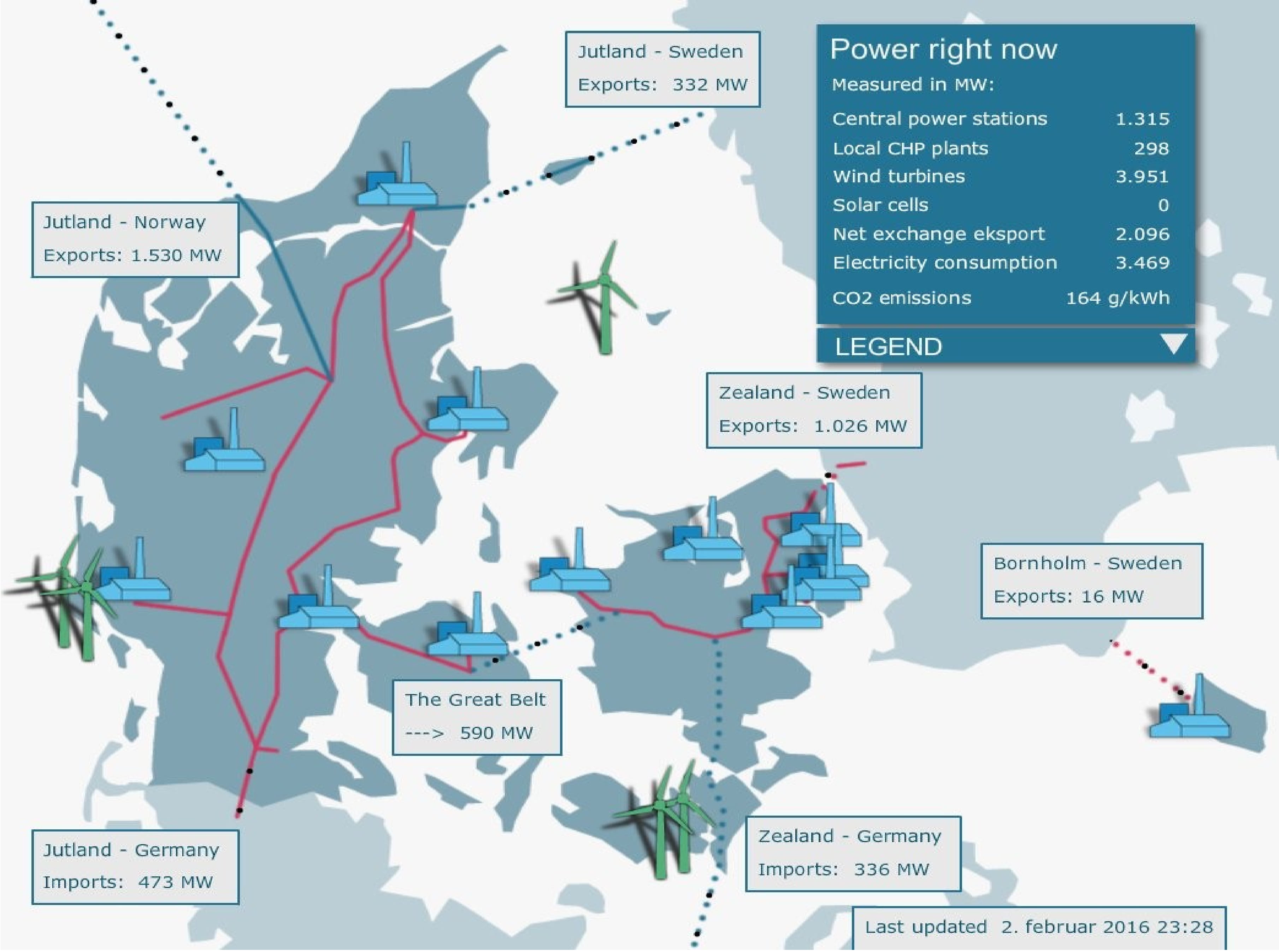


In 2008 wind power did cover the entire demand of electricity in 200 hours (West DK)

In 2015 more than 42 pct of electricity load was covered by wind power.

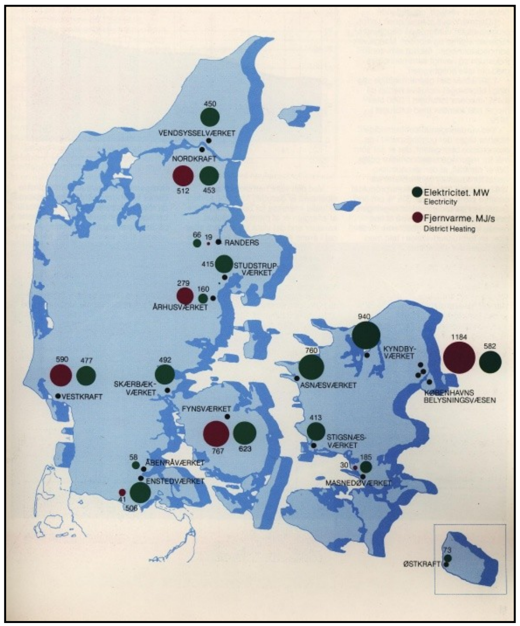
For several days the wind power production was more than 100 pct of the power load.

July 10th, 2015 more than 140 pct of the power load was covered by wind power


Jutland - Sweden
Exports: 332 MW
Power right now
Measured in MW:
Central power stations 1.315
Local CHP plants 298
Wind turbines 3.951
Solar cells 0
Net exchange eksport 2.096
Electricity consumption 3.469
CO2 emissions 164 g/kWh
LEGEND
Jutland - Norway
Exports: 1.530 MW
Zealand - Sweden
Exports: 1.026 MW
Bornholm - Sweden
Exports: 16 MW
The Great Belt
---> 590 MW
Jutland - Germany
Imports: 473 MW
Zealand - Germany
Imports: 336 MW
Last updated 2. februar 2016 23:28

From large central plants to Combined Heat and Power (CHP) production

1980



Today

From a few big power plants to many small ***combined heat and power*** *plants – however most of them based on coal*

DK has enough excess heat to cover most of the need for heating .... but ...

CITIES
Centre for IT Intelligent Energy Systems