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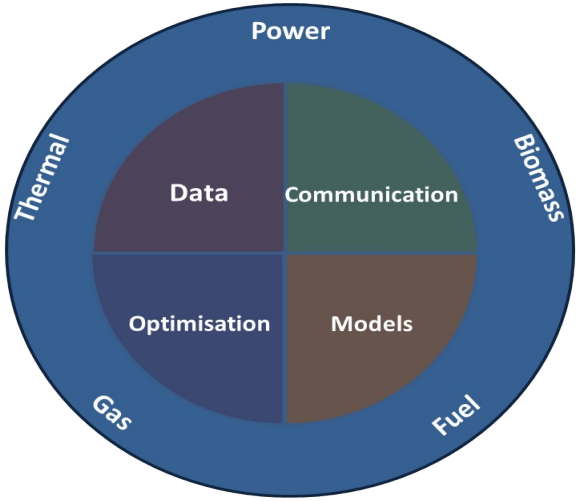
DSF – 1305-00027B



Center for IT-Intelligent Energy Systems in Cities

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

Henrik Madsen, DTU Compute

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Quote by B. Obama:
(U.N. Climate Change Summit,
New York, Sept. 2014)

*We are the **first generation***
affected by climate changes,

*and we are the **last generation***
able to do something about it!

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Potentials and Challenges for renewable energy

- **Scenario**: We want to cover the worlds entire need for power using wind power.
- How large an area should be covered by wind turbines?

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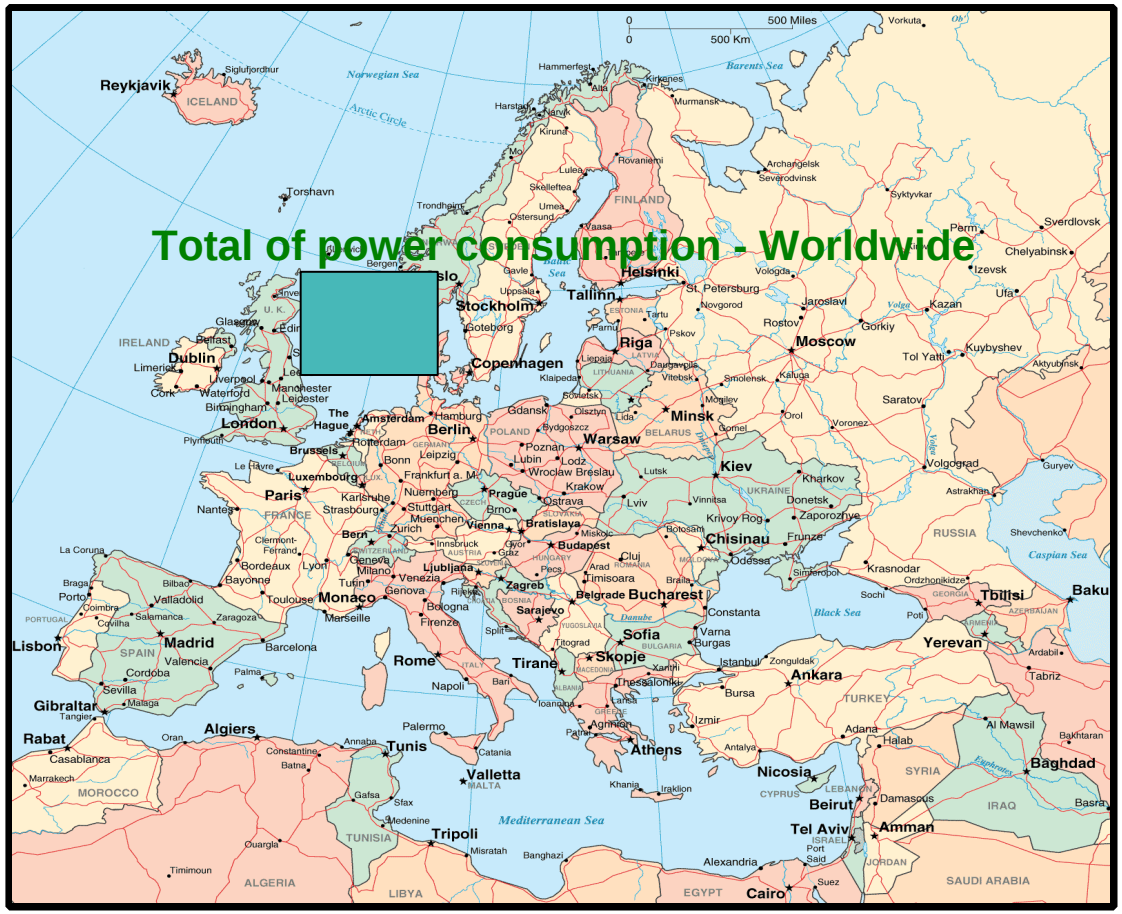
Potentials and Challenges for renewable energy

- **Scenario:** We want to cover the worlds entire need for power using wind power
- How large an area should be covered by wind turbines?
- **Conclusion**: Use intelligence ....
- Calls for **IT / Big Data / Smart Energy Solutions/ Smart/Green Cities**



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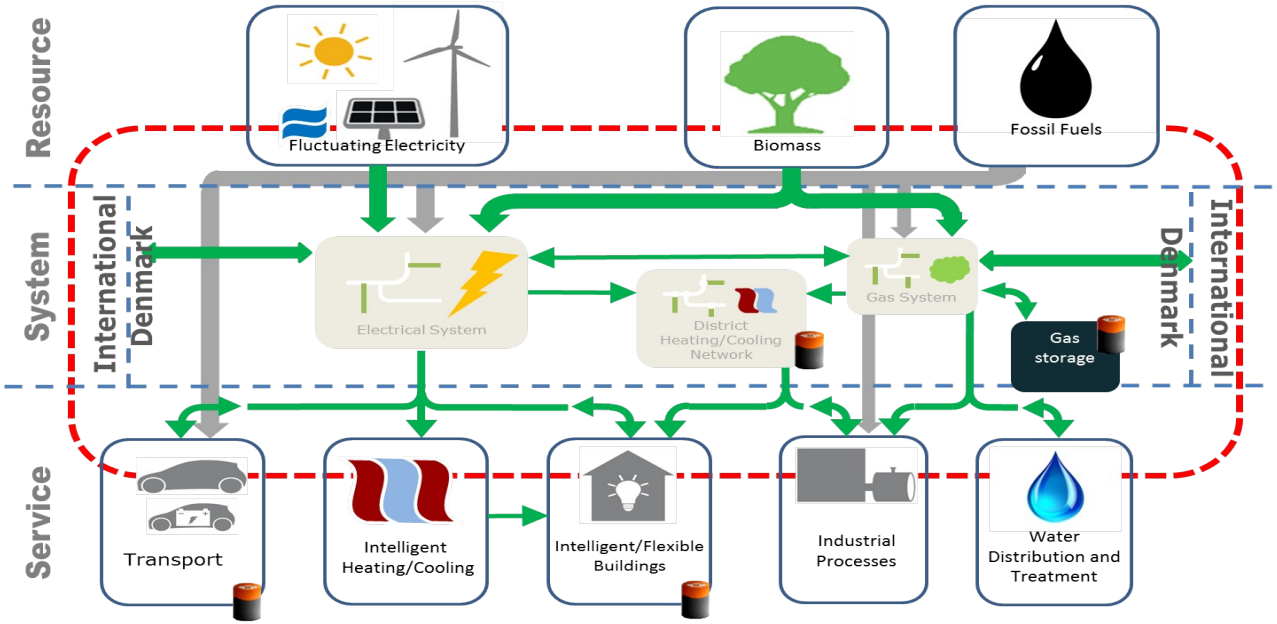
CITIES - Concepts

Energy Systems Integration based on **data and IT solutions** leading to models and methods for *planning and operation* of future energy systems and smart cities



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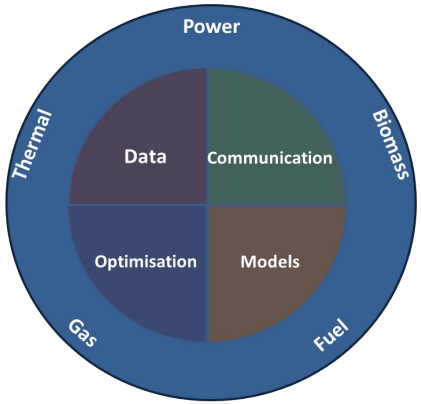
CITIES – Hypothesis

The **central hypothesis** of CITIES is that by **intelligently integrating** currently distinct energy flows (heat, power, gas and biomass) in urban environments we can enable very large shares of renewables, and consequently obtain substantial reductions in CO2 emissions.

Intelligent integration will enable lossless ‘virtual’ storage on a number of different time scales.



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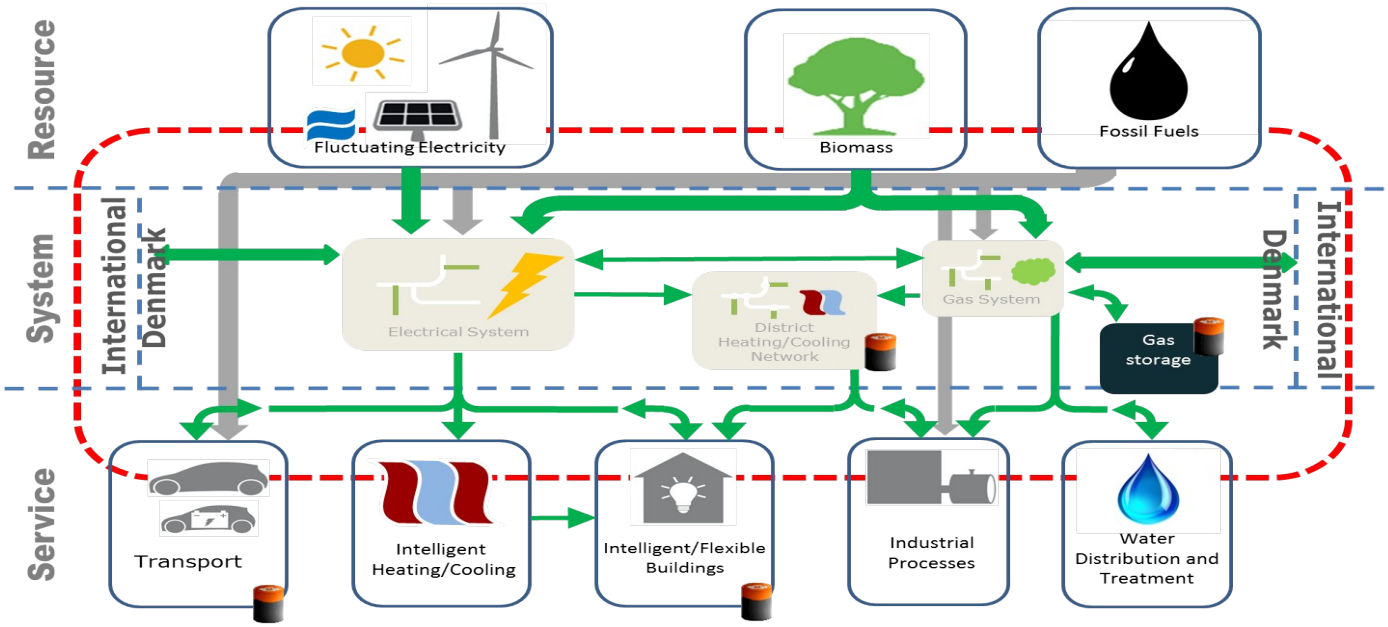
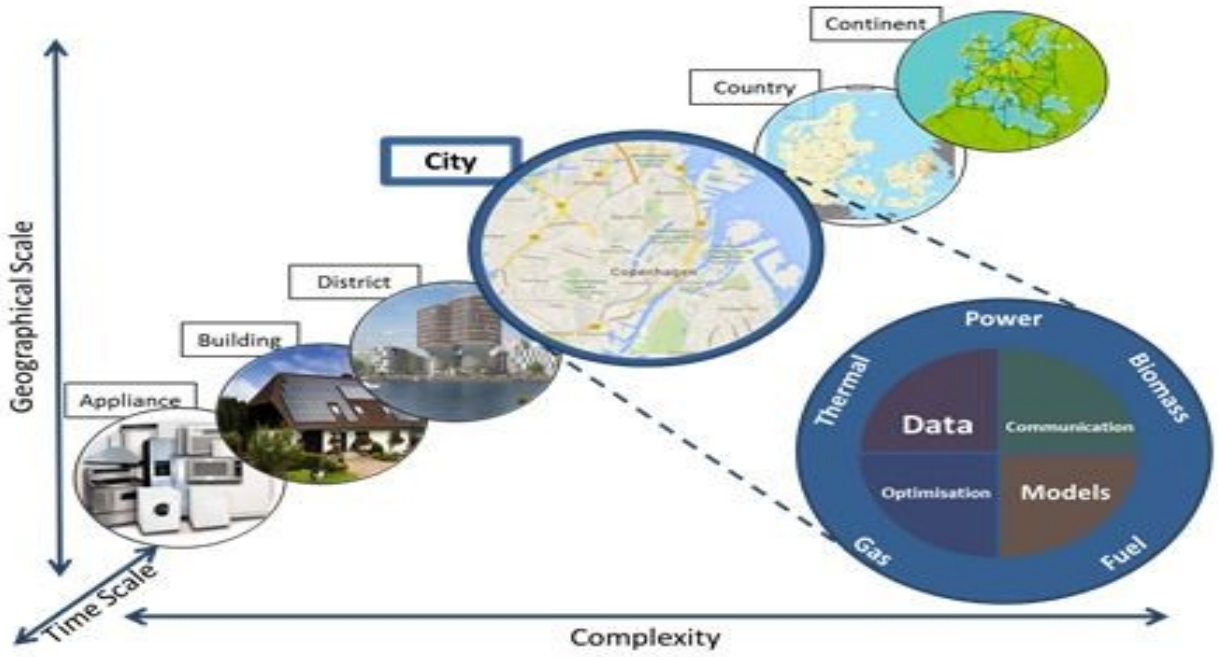
Example: Storage by Energy Systems Integration



- Operational (simplified) models for integration, optimization and control
- (Virtual) storage principles:
  - Buildings can provide storage up to, say, 5-12 hours ahead
  - District heating systems can provide storage up to 1-2 days ahead
  - Gas systems can provide seasonal storage

Scientific Objective

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



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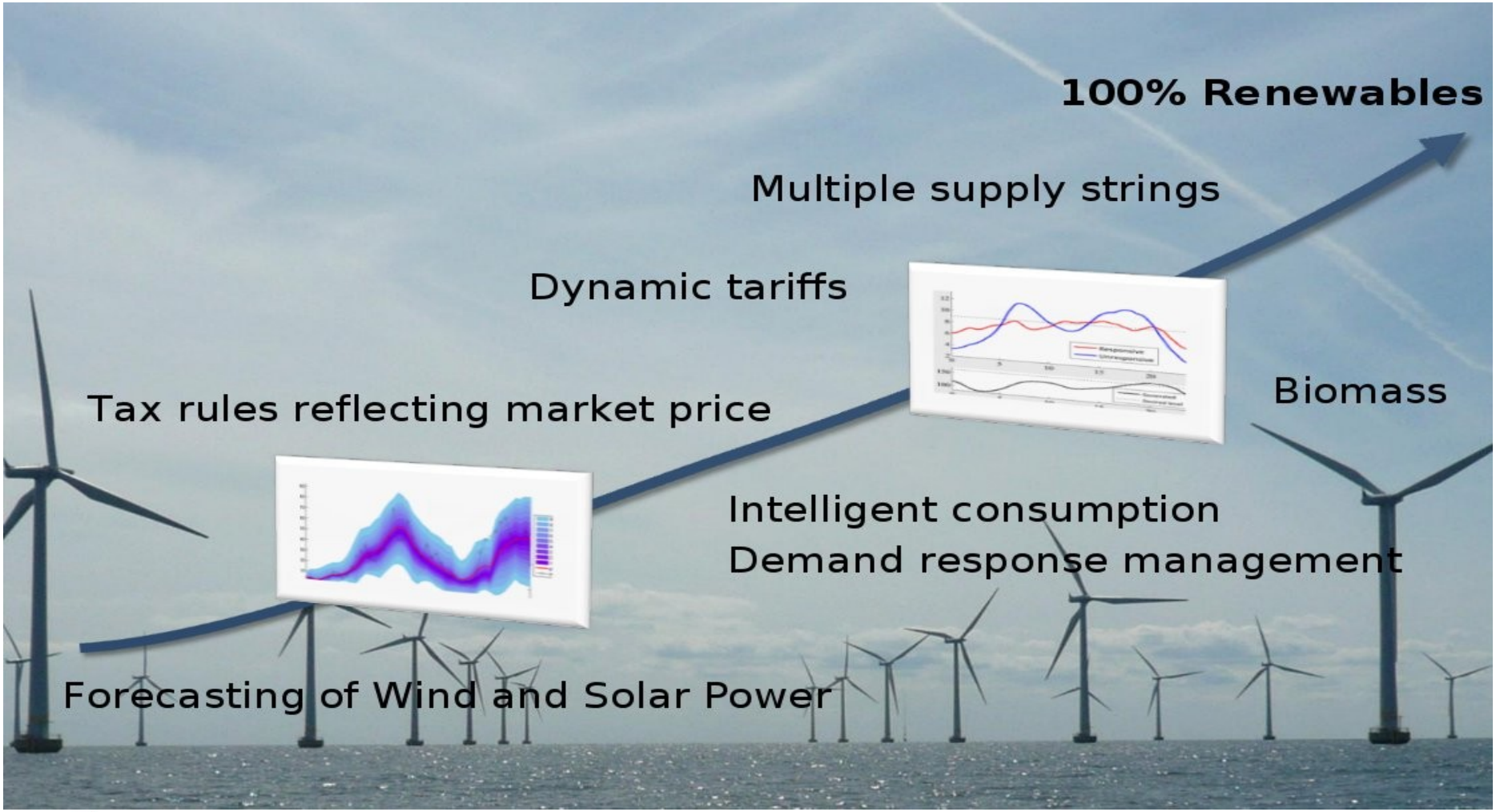
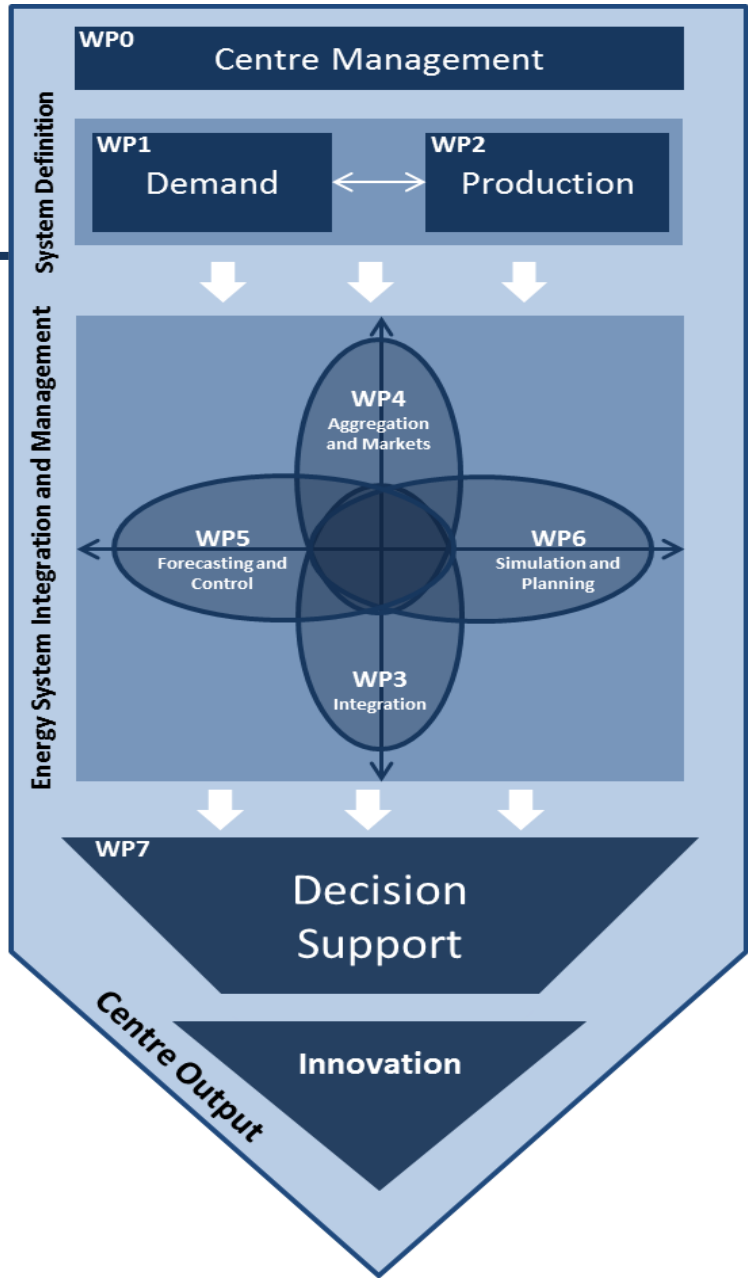
Challenges

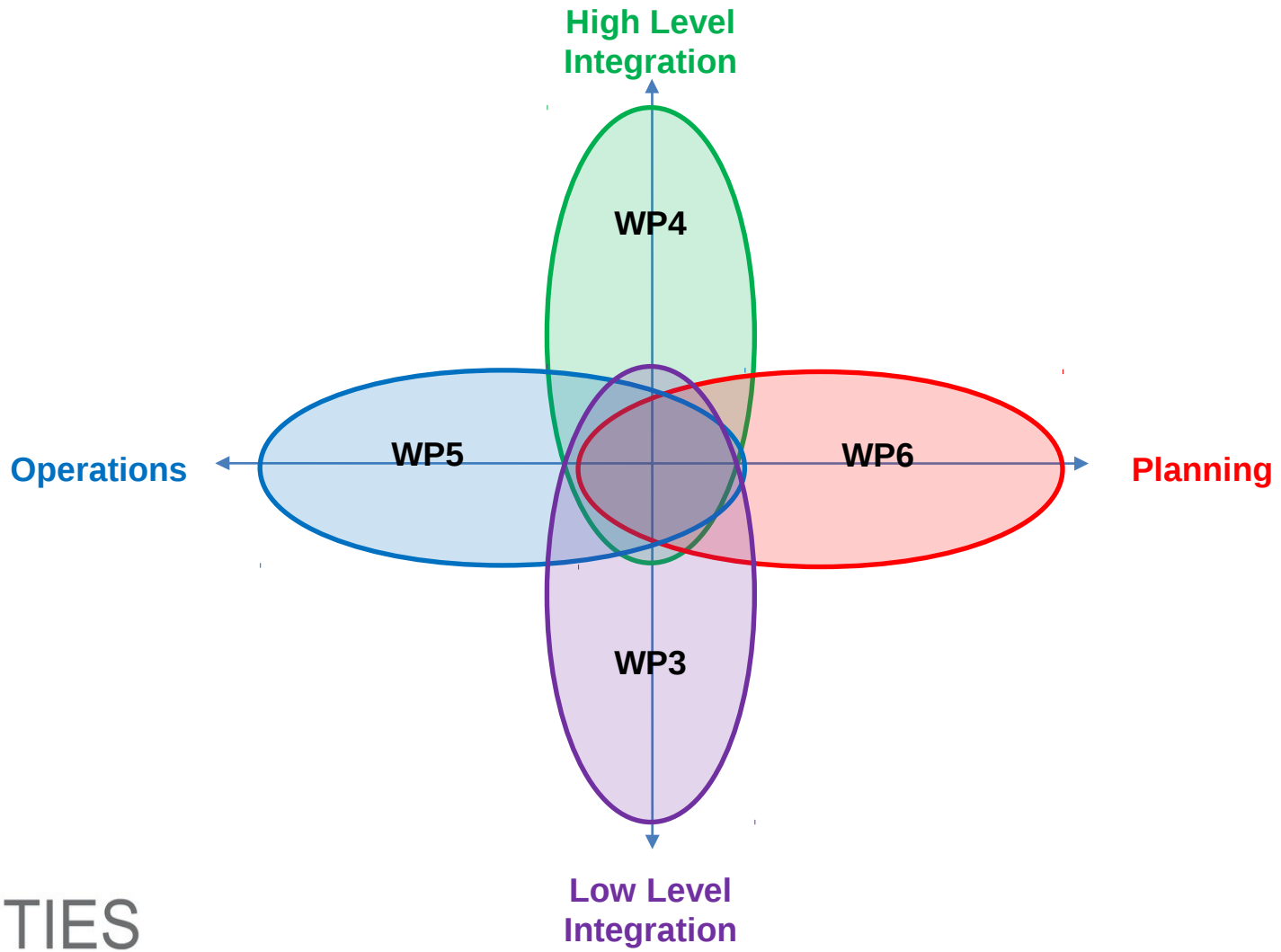

100% Renewables
Multiple supply strings
Dynamic tariffs
Tax rules reflecting market price
Biomass
Intelligent consumption
Demand response management
Forecasting of Wind and Solar Power

Methodology

Research and work flow arranged into **work packages**.



Energy Systems Integration and Management



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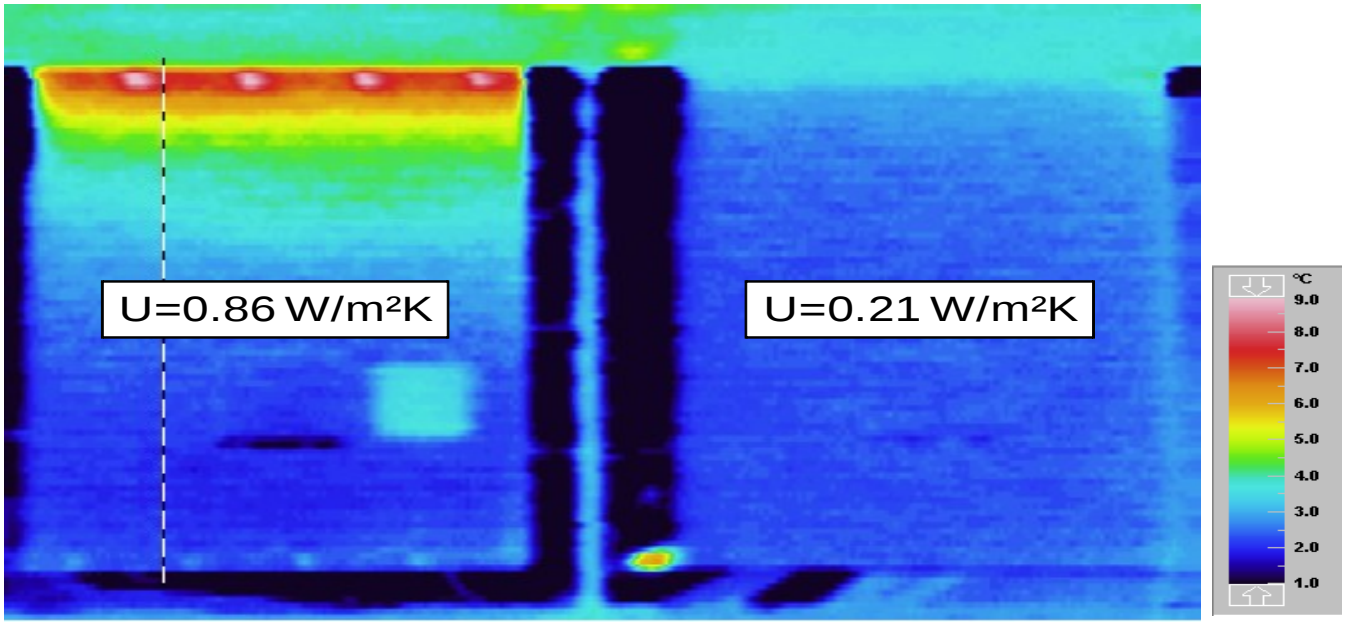
Case Study

Identification of Thermal Performance of Buildings using Smart Meter Data

Example



Consequence of good or bad workmanship (theoretical value is U=0.16W/m2K

Results using meter data

	UA W/°C	σ_{UA}	gA^{max} W	wA_E^{max} W/°C	wA_S^{max} W/°C	wA_W^{max} W/°C	T_i °C	σ_{T_i}
4218598	211.8	10.4	597.0	11.0	3.3	8.9	23.6	1.1
4381449	228.2	12.6	1012.3	29.8	42.8	39.7	19.4	1.0
4711160	155.4	6.3	518.8	14.5	4.4	9.1	22.5	0.9
4836681	155.3	8.1	591.0	39.5	28.0	21.4	23.5	1.1
4836722	236.0	17.7	1578.3	4.3	3.3	18.9	23.5	1.6
4986050	159.6	10.7	715.7	10.2	7.5	7.2	20.8	1.4
5069878	144.8	10.4	87.6	3.7	1.6	17.3	21.8	1.5
5069913	207.8	9.0	962.5	3.7	8.6	10.6	22.6	0.9
5107720	189.4	15.4	657.7	41.4	29.4	16.5	21.0	1.6
.	.	.	.	.	.	.	.	.

Perspectives for using data from Smart Meters

- Screening of existing buildings
- Reliable Energy Signature.
- Energy Labelling
- Time Constants (eg for night set-back)
- Proposals for Energy Savings:
  - Replace the windows?
  - Put more insulation on the roof?
  - Is the house too untight?
  - .....
- Optimized Control
- Integration of Solar and Wind Power using DSM

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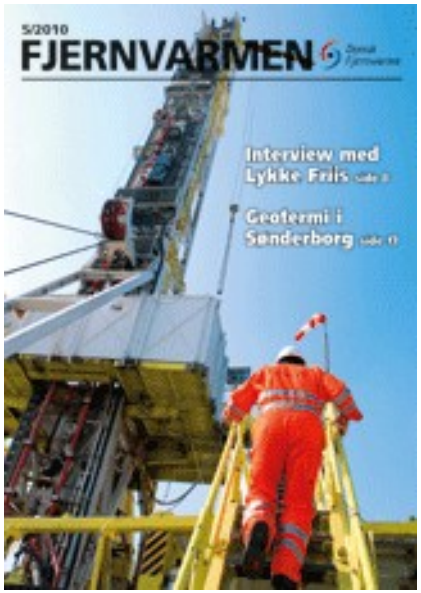
Control of Supply Temperature in DH networks using data



Our research shows that:

- Control of supply temperature **using simulation** in DH networks implies up to 10 pct savings in the heat loss.
- Control of the supply temperature **using forecasts based on data** implies up to 20 pct savings in the heat loss.

FJERNVARMEN | 5 2010

Styring af temperatur rummer kæmpe sparepotentiale

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Discussion and Possibilities for Collaboration

- Energy Systems Integration in Cities can provide virtual and lossless storage solutions (so maybe we should put less focus on physical storage solutions)
- Demonstration of CITIES' Solutions for Smart/Green Cities
- Focus on zero emission buildings – and less on zero energy buildings (the same holds supermarkets, wastewater treatment plants, etc.)
- District heating (or cooling) provide virtual storage on the essential time scale (up to a few days)
- We see a large potential in Demand Side Management. Automatic solutions and end-user focus are important
- We see a large potential in coupling cooling (eg. for comfort) and heating systems using DH networks
- We see large problems with the tax and tariff structures in many countries (eg Denmark). Coupling to prices for carbon capture could be advantageous.
- Markets and pricing principles need to be reconsidered; we see an advantage of having a physical link to the mechanism (eg. nodal pricing, capacity markets)

CITIES' Key Outcome

- Operational methods and scenarios for energy systems integration and management, paving scenarios towards a fossil free future
- *Component level, modular and aggregate models of energy supply, consumption, and transmission, suitable for simulation, control and optimisation frameworks*
- Market structures that support energy systems integration
- Modular forecasting and control models for a variety of energy system components, including their interactions
- Integration of short-term operational models in models for long-term planning.
- *Methods for controlling energy consumption and demand side management*.
- *CITIES is aiming at being a leading knowledge centre for Smart Cities development and related tools*.
- Synergies with existing and new smart cities development projects
- **A number of Demo Projects will demonstrate the solutions**

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Danish Partners

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Forecasting and Optimization for the Energy Sector

DANSK ENERGI

DTU

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