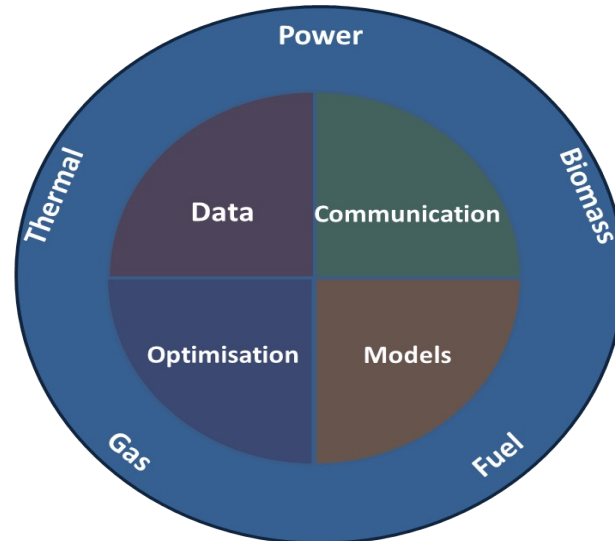




# Energy Projects in Cooperation between UCD and DTU

Visit by Minister Alex White TD, Ireland  
Minister for Communications, Energy and Natural Resources



**Henrik Madsen, DTU Compute**  
<http://www.henrikmadsen.org>

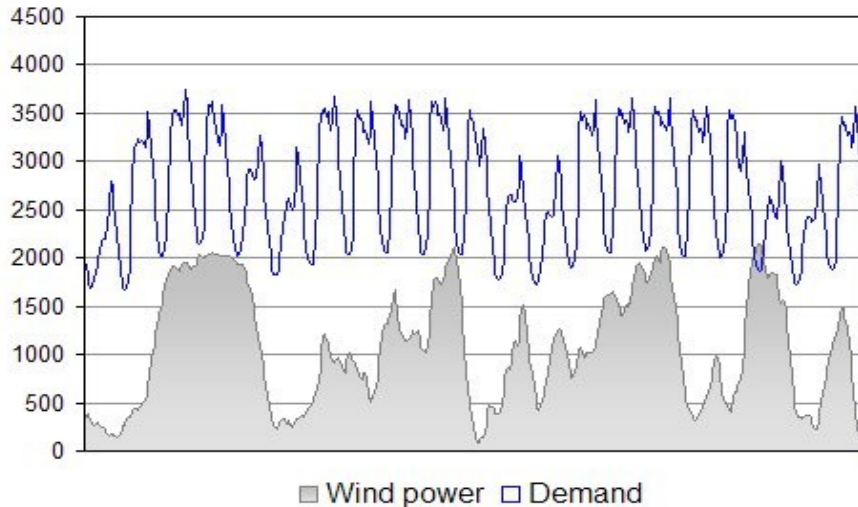


# The Danish Wind Power Case



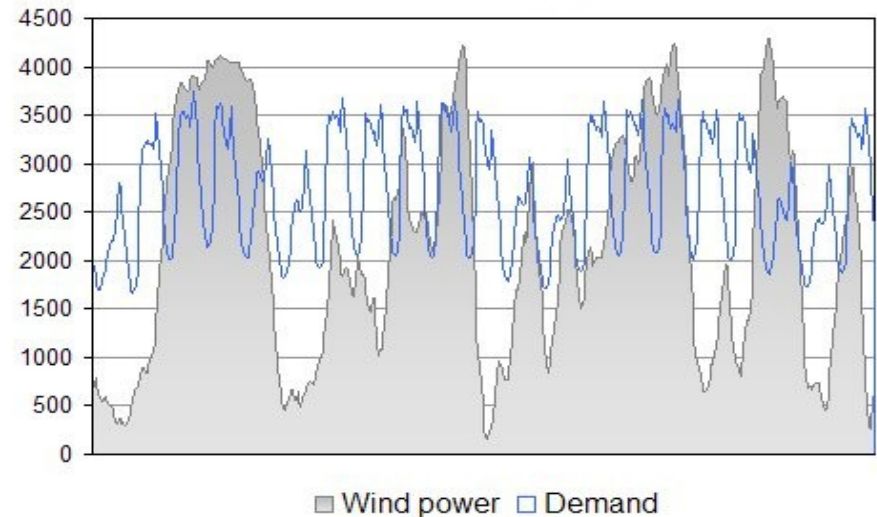
.... *balancing of the power system*

25 % wind energy (West Denmark January 2008)



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

50 % wind energy



**In the first half of 2015 about 43 pct of electricity load was covered by wind power.**

For longer periods the wind power production can be more than 120 pct of the power load.

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

# From large central plants to Combined Heat and Power production

1980



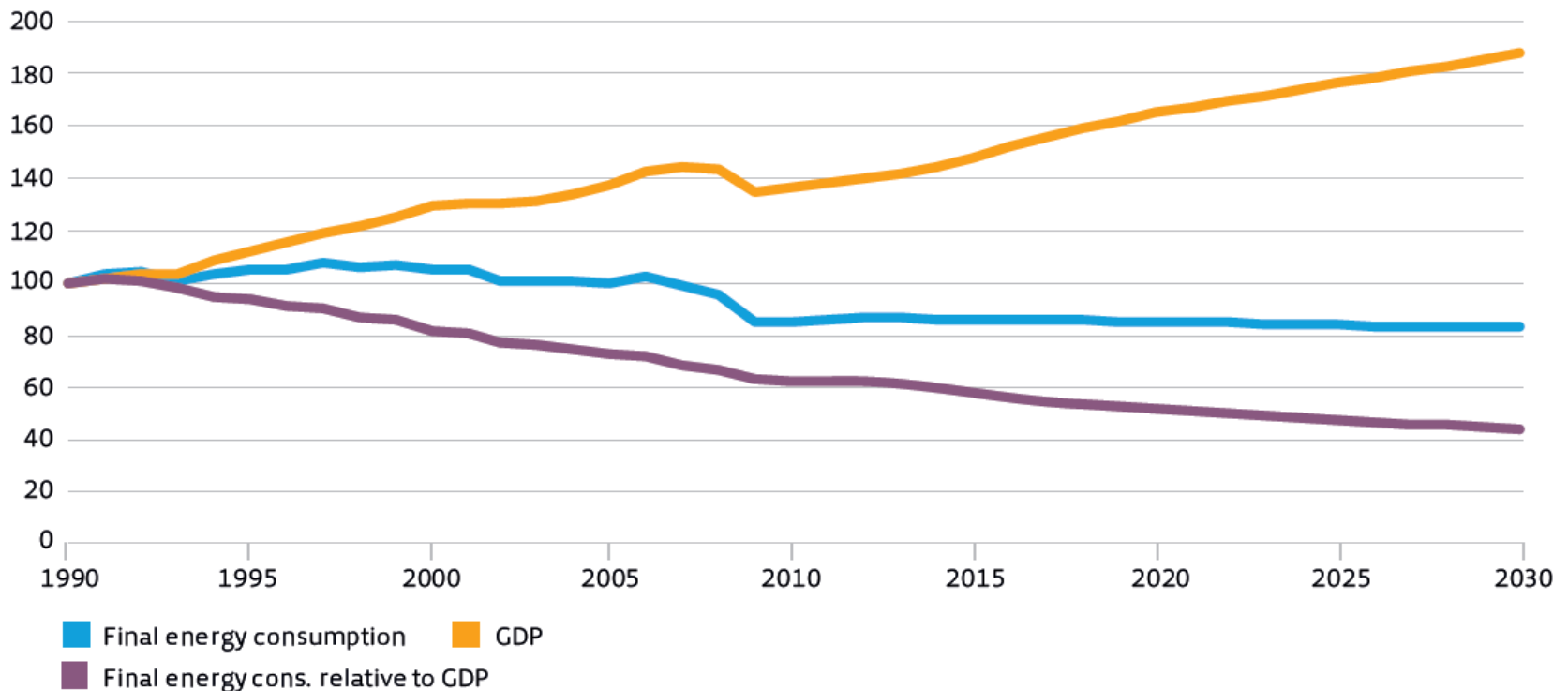
Today



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



# What has since been achieved: De-coupling of consumption and GDP growth



Source: Energy Policy in Denmark. Danish Energy Agency. December 2012

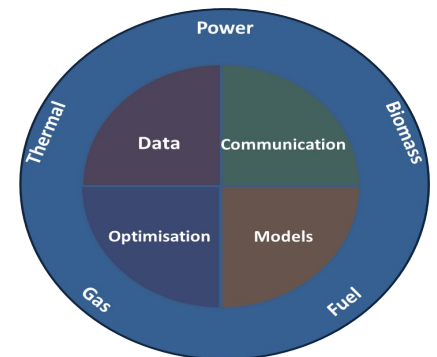


# Energy Systems Integration Hypothesis

The **central hypothesis of ESI** is that by **intelligently integrating** currently distinct **energy flows** (heat, power, gas and biomass) we can enable very large shares of renewables, and consequently obtain substantial reductions in CO2 emissions. *Smart Grid solutions alone are not effective and not sufficient.*

**Intelligent integration** will (for instance) enable lossless ‘virtual’ storage on a number of different time scales

*This is recognized by both UCD and DTU, and I consider this as the main driver behind the good and fruitful collaboration between UCD and DTU*



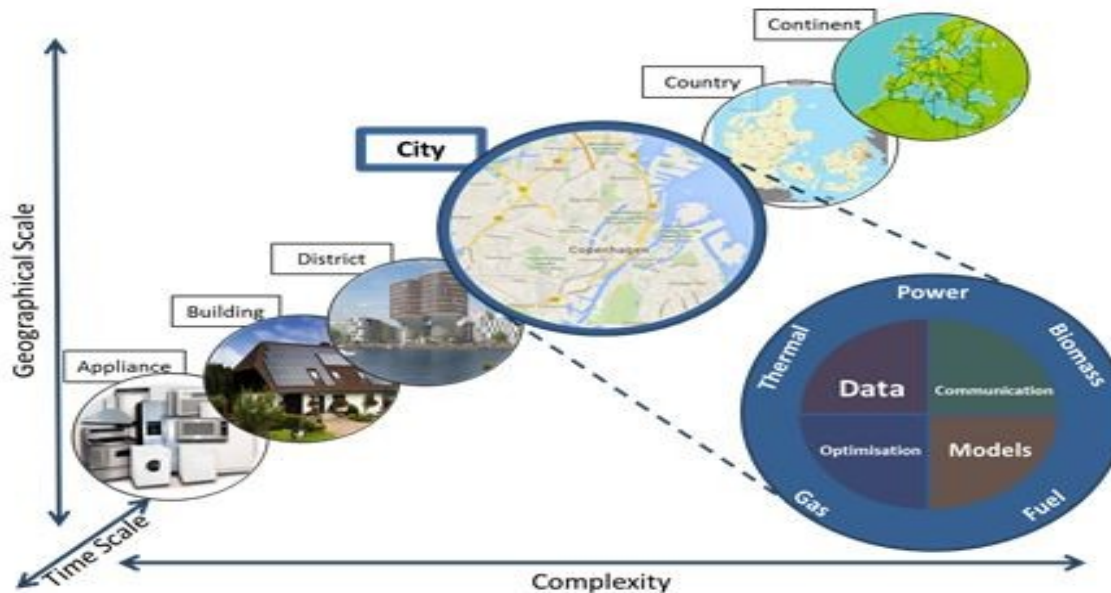


# ESI national projects in Ireland and Denmark

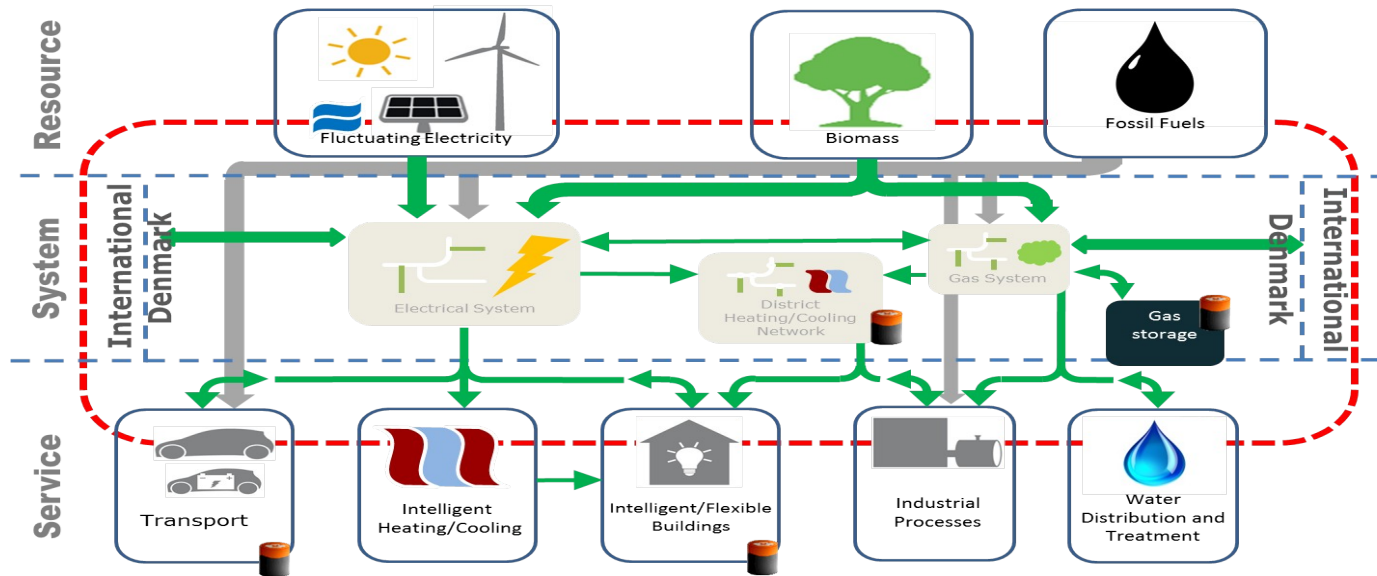


The **Center for IT-Intelligent Energy Systems in Cities (CITIES)** is aiming at establishing methodologies and solutions for design and operation of integrated electrical, thermal, fuel pathways at all scales.

This **Center is the largest Smart Cities and ESI research project in Denmark** – see <http://www.smart-cities-centre.org> (Led by Henrik Madsen). *Here UCD/ERC plays an important role. The focus of UCD is on power/gas.*



# Example: Storage by Energy Systems Integration



● **Denmark (2015) : 48 pct of power load by renewables (>100 pct for some days)**

● **(Virtual) storage principles and characteristics:**

- Buildings can provide storage up to, say, 5-12 hours ahead
- District heating/cooling systems can provide storage up to 1-3 days ahead
- Gas systems can provide seasonal storage

# ESIPP Energy Systems Integration Partnership Programme

Pending (not yet funded) €11M (half from industry)

Funding Agency  
Science Foundation Ireland



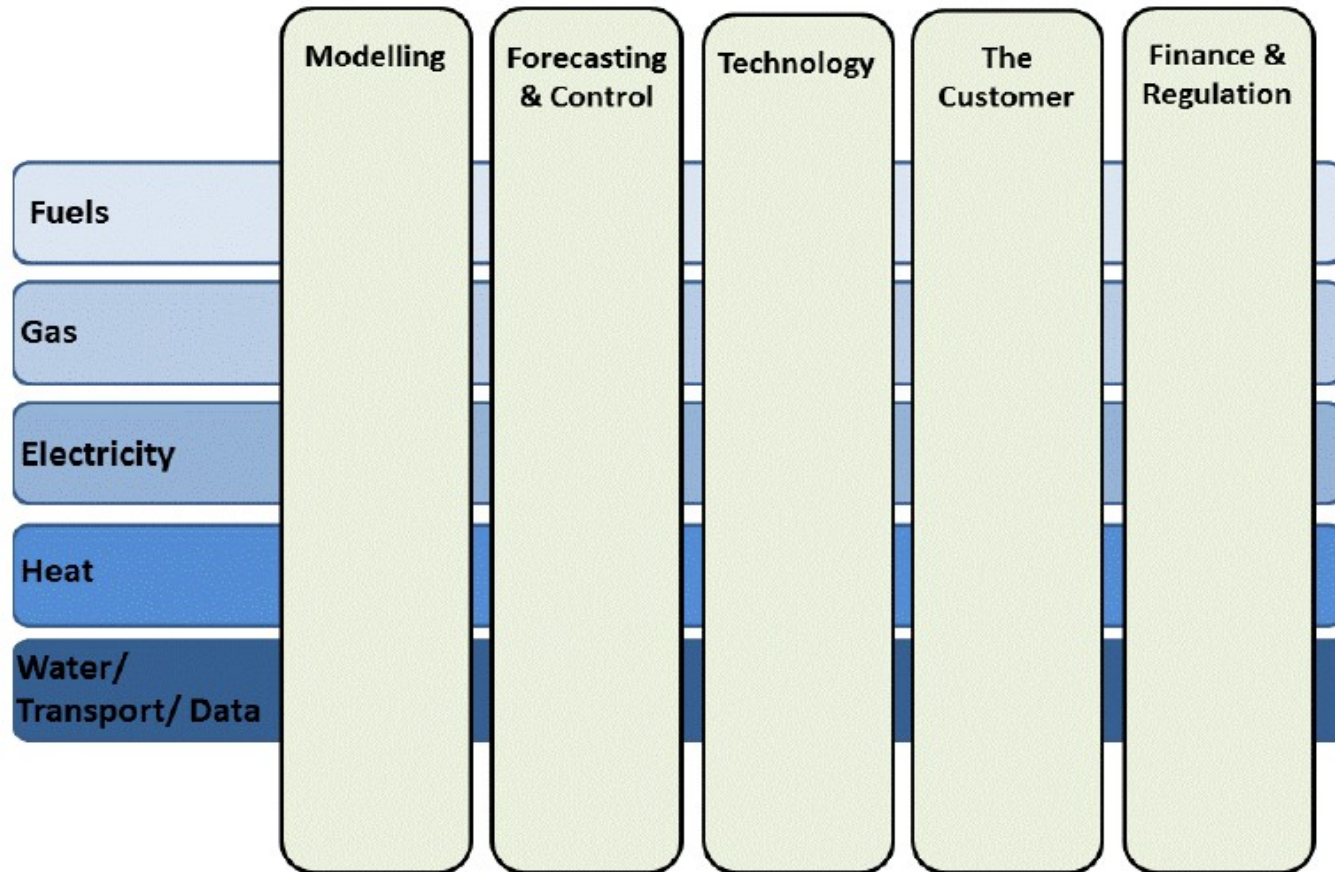
Led by Prof. Mark O'Malley







Proposal (UCD, DTU, KU Leuven):  
**ESI Joint Program as a part of  
European Research (EERA)**  
Main driver is Prof. Mark O'Malley, UCD





International Institute<sup>TM</sup>  
for Energy Systems  
Integration

## Addressing energy challenges through global collaboration



**Vision:** A global community of scholars and practitioners from leading institutes engaged in efforts to enable highly integrated, flexible, clean, and efficient energy systems

**Objectives:** Share ESI knowledge and Experience:  
Coordination of R&D activities:  
Education and Training  
Resources

### Activities 2014

- Feb 18-19 Workshop (Washington)
- May 28-29 Workshop (Copenhagen)
- July 21 - 25, ESI 101 (Denver)
- Nov 17th Workshop (Kyoto)

### Activities 2015

- Dublin, Denver, Brussels, Seoul





# Conclusions



- **Ireland and Denmark have both recognized that Energy Systems Integration using ICT is the key to large scale integration of renewables**
- **We at DTU acknowledge the good collaboration with the leading Electrical Engineering Research Center in the world (ERC lead by Prof. Mark O'Malley)**
- **Successful exchange of PhD students and researchers**
- **Decoupling of GDP growth and energy consumption**
- **Energy Systems Integration can provide virtual and lossless storage solutions**
- **District heating (or cooling) provides virtual storage on the essential time scale (up to a few days)**
- **Today almost 50 pct renewables (mostly wind) in the Danish power system**
- **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)**