### Centre for IT-Intelligent Energy Systems in Cities CI IS Fourth General Consortum Meeting 30<sup>th</sup> 31<sup>st</sup> May 2017 a Daten Technological Institute Kongsvang allé 29 Aarhus Perifi





### Smart Energy Systems of Cities - going towards 100% Renewable Energy

Henrik Lund Professor in Energy Planning Aalborg University





### **Renewable Energy Systems**

A Smart Energy Systems Approach to the Choice and Modeling of 100% Renewable Solutions



### Smart Energy Systems The key to cost-efficient 100% Renewable Energy

- A sole focus on renewable electricity (smart grid) production leads to electricity storage and flexible demand solutions!
- Looking at renewable electricity as a part **smart energy systems** including heating, industry, gas and transportation opens for cheaper and better solutions...







#### Power-to-Gas Power-to-Transport





## Smart Energy Systems





#### Pump Hydro Storage 175 **∉**kWh

(Source: Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits. Electric Power Research Institute, 2010)

## Energy Storage

Thermal Storage 1-4 €kWh (Source: Danish Technology Catalogue, 2012)



#### **Energy storage: Price and Efficiency**





Natural Gas Underground Storage 0.05 ∉kWh (Source: Current State Of and Issues Concerning Underground Natural Gas Storage. Federal Energy Regulatory Commission, 2004)





# Smart Energy Systems



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Renewable En

## Energi System Analyse Model



#### Members Map

This is a map of the people who have registered with the EnergyPLAN website. Select a country to identify all users from that country, and then select their name on the right hand side if you would like to contact them. We hope that this map will connect users that have a common interest with one another.





DENMARK







- **Replicable by other researchers**. (Freeware, Userfriendly, normal PC, No solvers or similar. Data-sharing)
- **Credibility.** Documentation, many users, 5000 downloads, used in 100+ scientific paper.
- Smart Energy Systems: Sectors (Buildings, Industry, Transportation etc.) and relevant grid and storage options (Electricity, District Heating and Cooling, Hydrogen, Green gas, solid biomass and synthetic green liquid fuels).
- High time resolution and chronological calculations of storage and grid infrastructures. (In all relevant sectors)



## **Cities and Context**







CONTEXTUAL ASPECTS OF SMART CITY ENERGY SYSTEMS ANALYSIS METHODOLOGY AND TOOLS BY JAKOB ZACK THELLIFSON

ISSERTATION SUBMITTED 201

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Cities and Context









Welcome

Smart City c Energy Systems

Jakob Zinck Thellufsen PhD Thesis defense

- 14 June at 13:00
- Aalborg University



