





#### Henrik Madsen

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https://www.flexibleenergydenmark.dk/

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

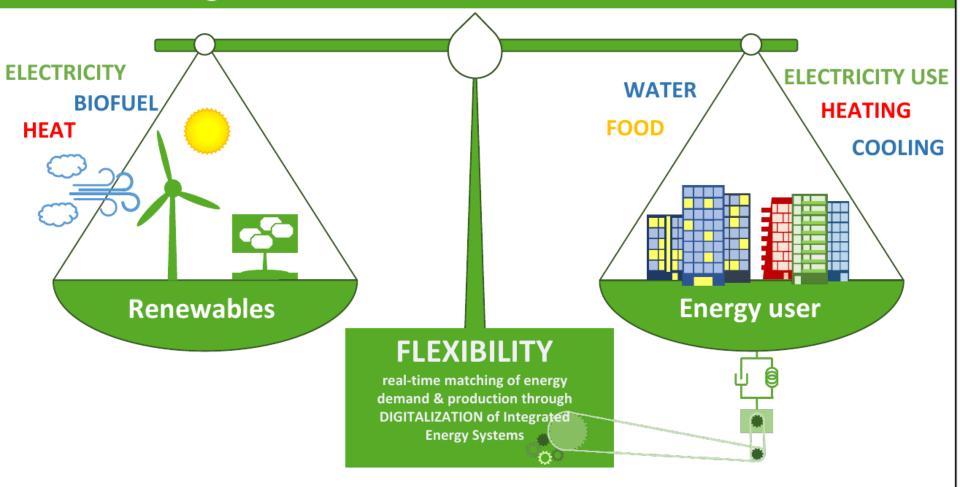
http://www.henrikmadsen.org







### The Challenge: Denmark Fossil Free 2050









### Data-Intelligent and Flexible Energy Systems



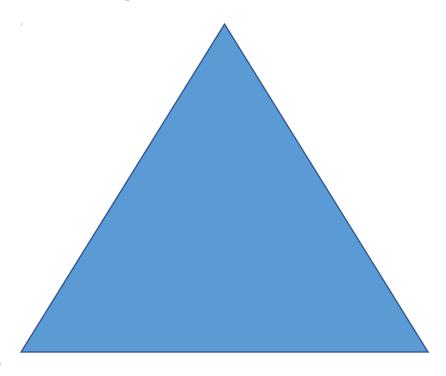




## **Space of Solutions**



Flexibility (enabled by AI, Energy Systems Integration and IoT)



(Super) Grids

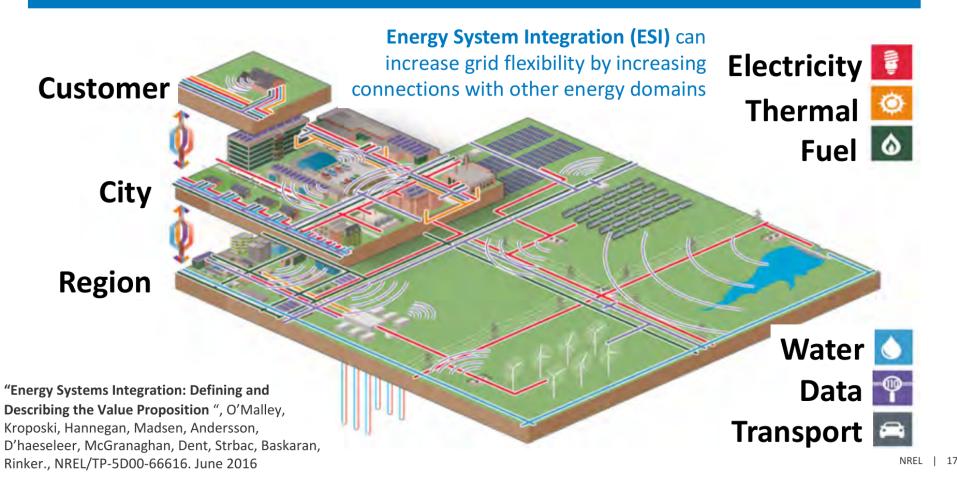
**Batteries** 







### **Energy Systems Integration**





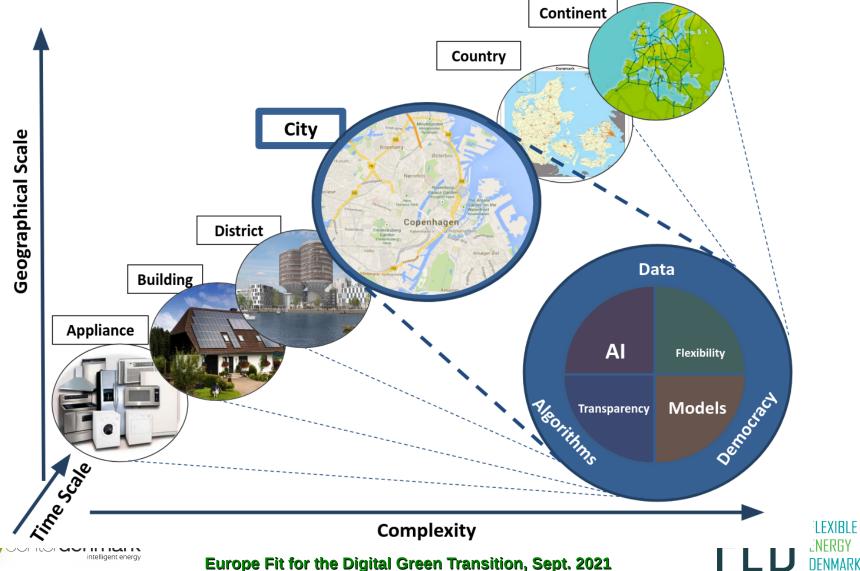


### **Temporal and Spatial Scales**



LEXIBLE

**INERGY** 





### **Center Denmark**

# Digitalization Hub for Accelerating the Green Transition











### **Trusted Data Sharing Platform**

Data Exchange Facilities Market provide neutral (infrastructure and rules) mechanisms in the background for controlled, trusted and secure data transactions.

Participants accepting the market rules benefit from the exchange mechanisms and shape together an open market for data.



This is how we work together





# Center Denmark - Control Room Spatial-Temporal thinking



## **Business Ecosystem**



#### **Solutions**

Products and tools combined into solutions for the provision of services for data visualization, forecasting, flexibility provision, virtual storage provision, aggregation & control and new market set-ups

Industrial partners + Center Denmark



#### uni-lab.dk

Union of the labs for energy research in Denmark. unilab.dk comprehends buildings (residential and non-residential, schools), supermarkets (and their refrigeration systems), water treatment plants, the energy infrastructure including production (through gas, wind, solar), storage (e.g. hot water storages for district heating networks), cooling, and distribution (gas, heat, power) and other facilities, unilab, dk is strictly related to the worldwide union of labs UNILAB.

Wind turbine test center, Green Labs DK, Water Center Syd, AU Foulum, Aarhus Harbour, Energy Cities, ...



Accelerating Green
Innovation through Data
Intelligence & IoT
Devices in Integrated
Energy Systems



#### **Products**

Products from consortium partners aiming at providing flexibility using data, IoT, AI, Cloud/fog/edge Computing, etc.

#### **Living Labs**

Three physical sites representing the building mass (residential, office, holiday, dormitory), selected industry, and further energy systems with embedded sensors and actuators

**Living Lab partners** 



#### **Data Lake**

Cleansing, integration, and analysis of data from all Living Labs for fast and effective evaluation. Data organisation into a unique Data Lake

**Center Denmark** 

#### **Tools**

A palette of tools for monitoring energy systems, data aggregation, prediction & forecasting. It includes also methods for cyber-physical modeling and for optimal set-up, operation & control of a flexible energy market

IT partners + Center Denmark

**Industrial partners** 

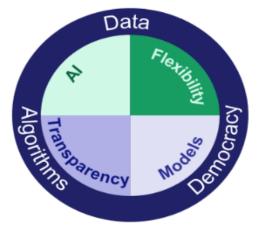
### **Summary**



- The future weather-driven energy system calls for disruptions. We need a deep digitalisation (AI, IoT, Cloud/Fog/Edge Computing, etc.)
- We need transparent, safe and democratic solutions
- We need data hubs for energy related streaming data (like Center Denmark)
- We need a Business Ecosystem with Living Labs
- We appreciate the regular joint meetings we have with DG CNECT and DG ENER

(Rolf Riemenschneider, ... +

Mark van Stiphout, ...)



# **Wind Power Forecasting** Operated by DTU spin-out (ENFOR a/s)



