

IoT Week, Dublin 2022

Data Spaces: Common data models for Energy, Home, Mobility

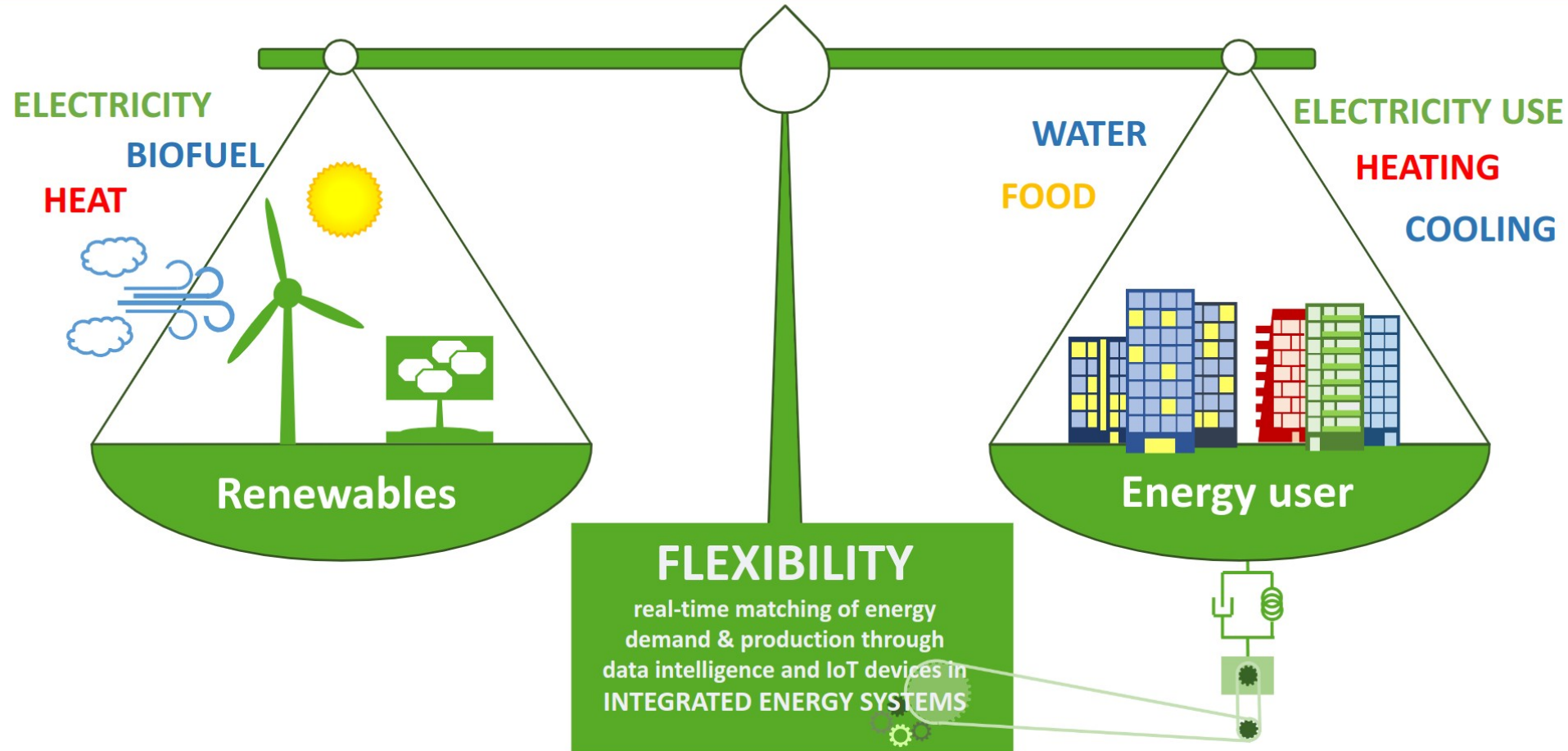
Data Integration - A Path for More Flexibility Management at the Edge

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(IFD projects: Flexible Energy Denmark + Cool Data)
(EU/BRIDGE projects: ELEXIA + ARV + ebalanceplus)



The Challenge: Europe Fossil Free



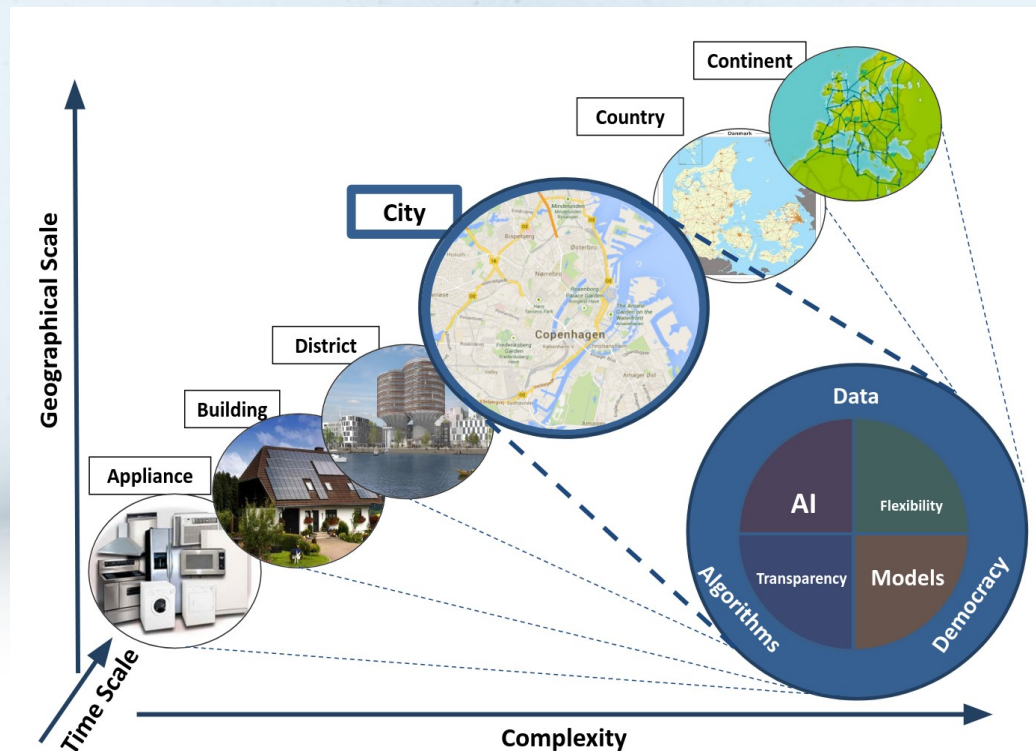
Local Flexibility Characteristics vs Classical Markets

- Static -> **Dynamic**
- Deterministic -> **Stochastic**
- Linear -> **Nonlinear**
- Many power related services (voltage, frequency, balancing, spinning reserve, congestion, ...) -> **Coordination + Hierarchy**
- Speed / problem size -> **Decomposition + Control Based Solutions**
- Characterization of flexibility (bids) -> **Flexibility Functions**
- Requirements on user installations -> **One-way communication**



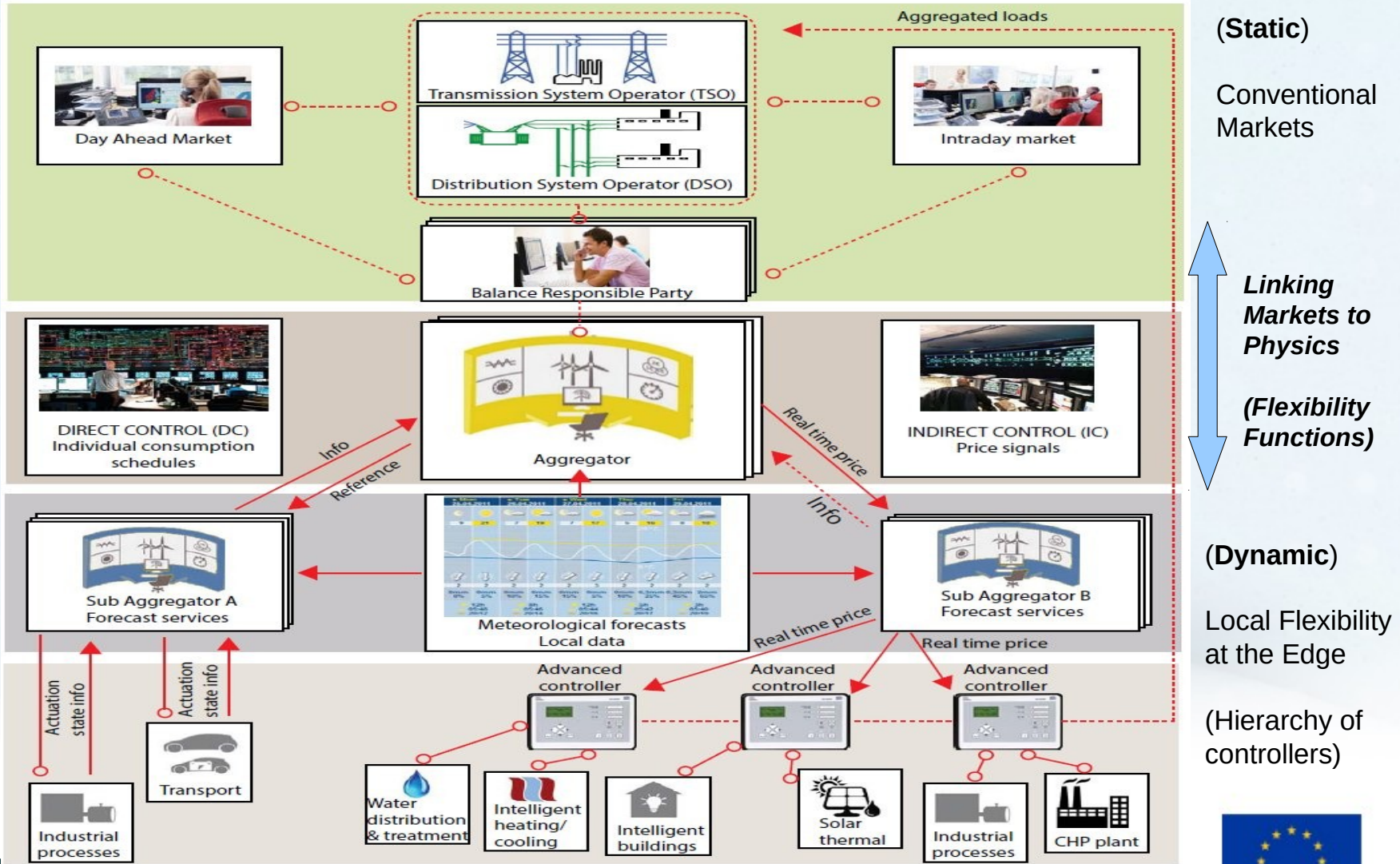
Temporal and Spatial Scales

A so-called **Smart-Energy Operating-System (SE-OS)** is suggested in order to develop, implement and test solutions (layers: data, models, optimization, control, communication) for **operating flexible electrical energy systems** at all scales including the Edge.



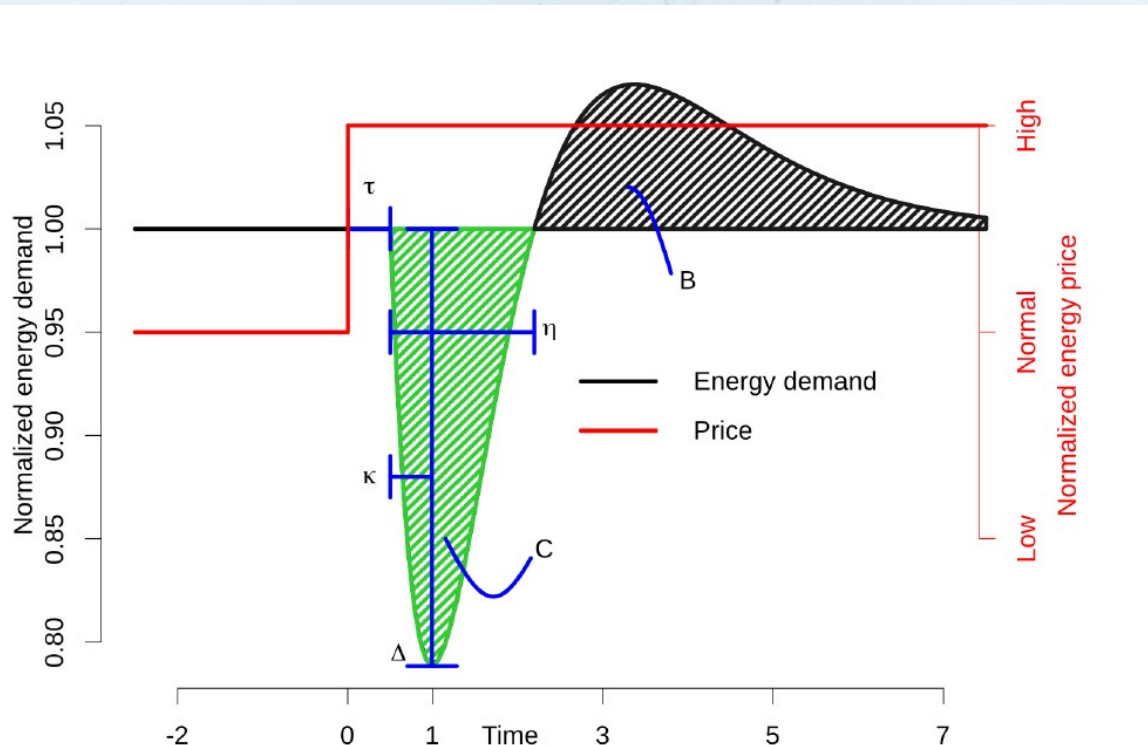
Smart-Energy OS

The Transformative Power of Digitalization



Flexibility Function

The **Flexibility Function (FF)** is a MIMs for energy systems used to characterizing flexibility and providing interface between local flexibility and high-level markets



Flexible Users and Penalty Signals

Penalty Generator for, e.g.:

Voltage Control,
Balancing,
Congestion Management
...

Reference

**Penalty Generator
(Controller)**

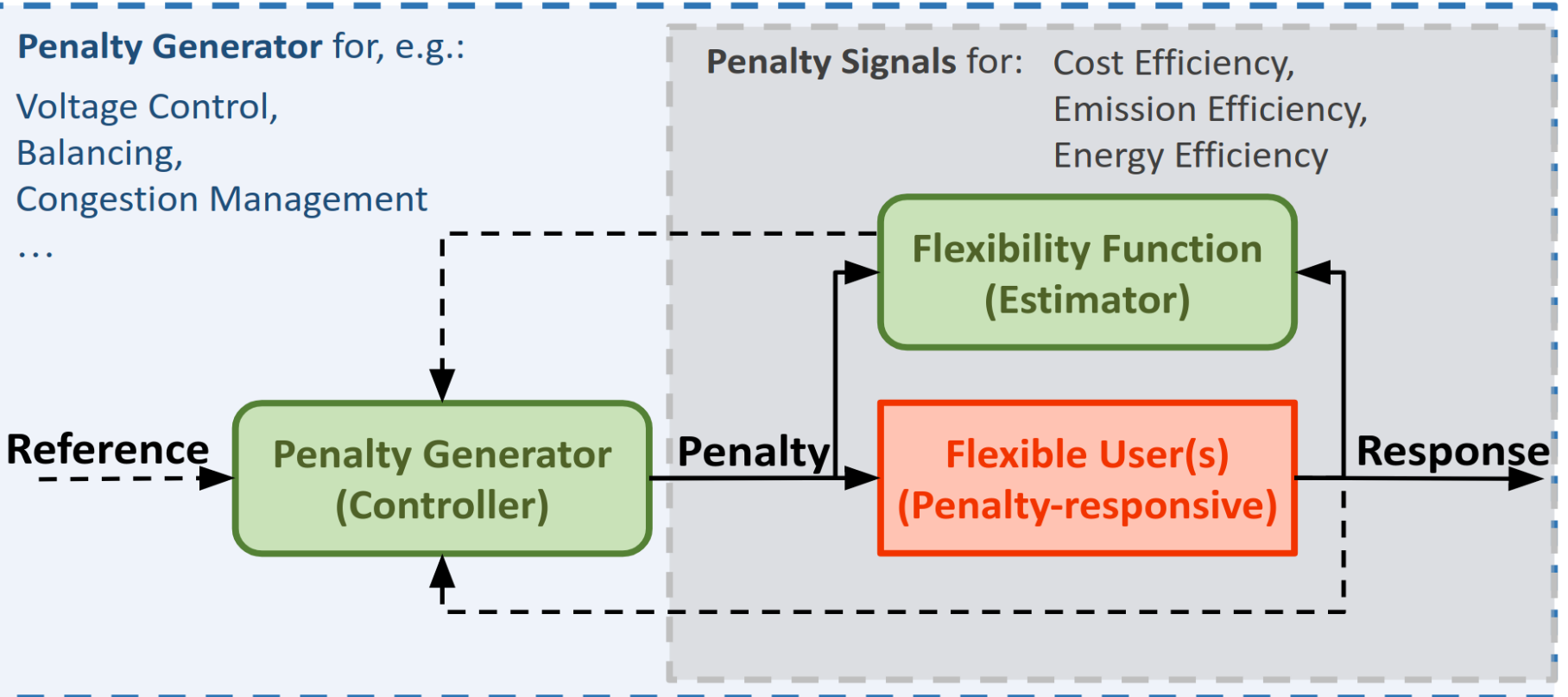
Penalty

**Flexibility Function
(Estimator)**

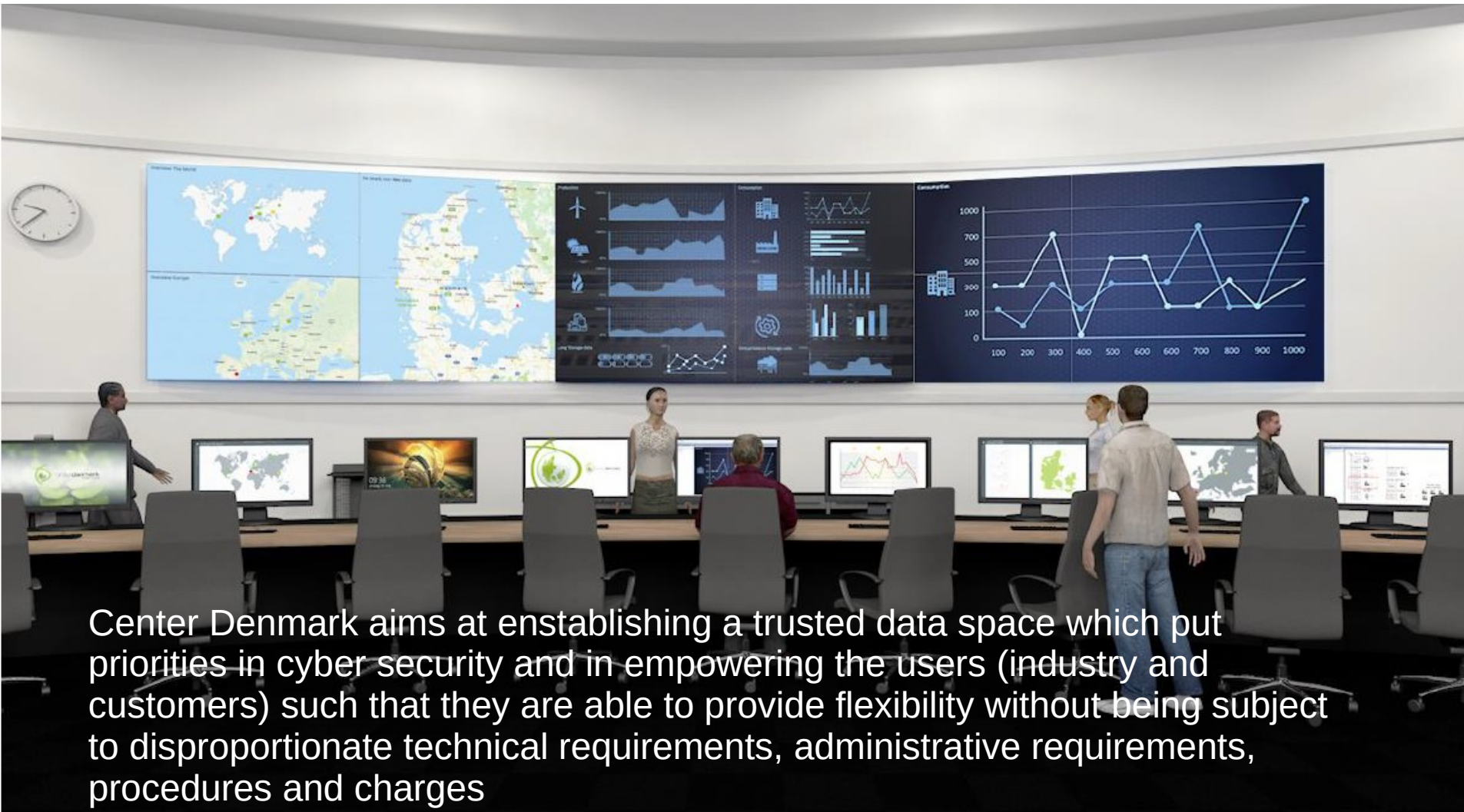
**Flexible User(s)
(Penalty-responsive)**

Response

Penalty Signals for: Cost Efficiency,
Emission Efficiency,
Energy Efficiency



Center Denmark Control Room and Data Space Spatial-Temporal thinking



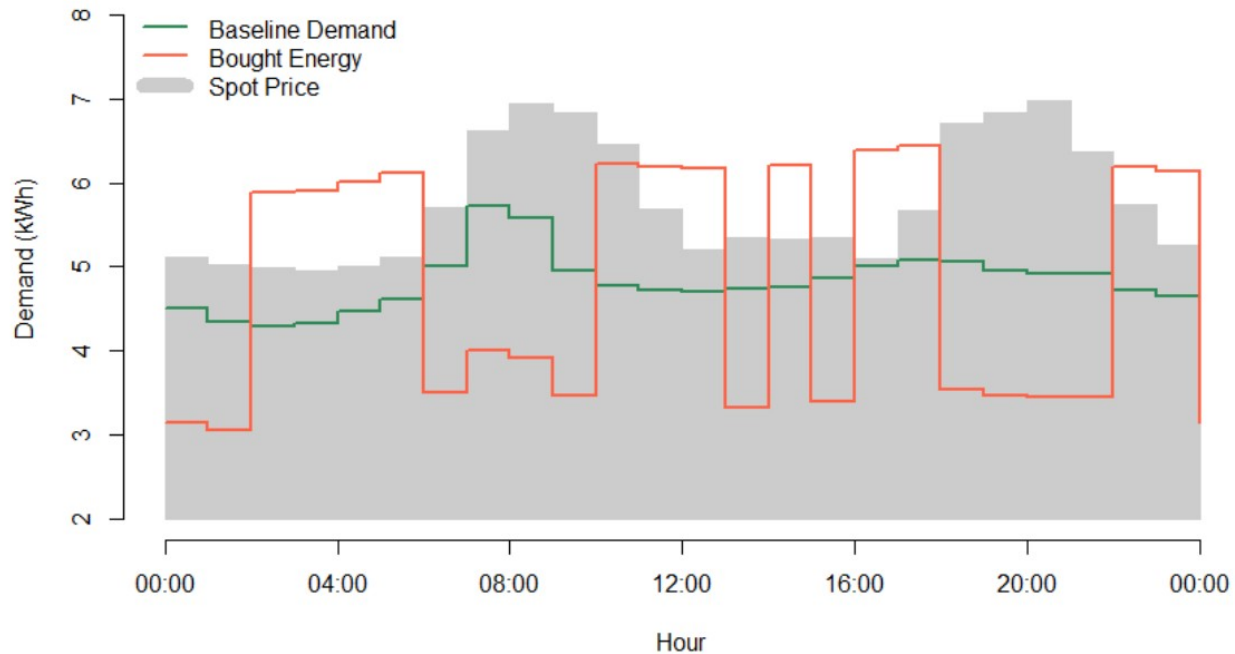
Case study

Summerhouses with a pool



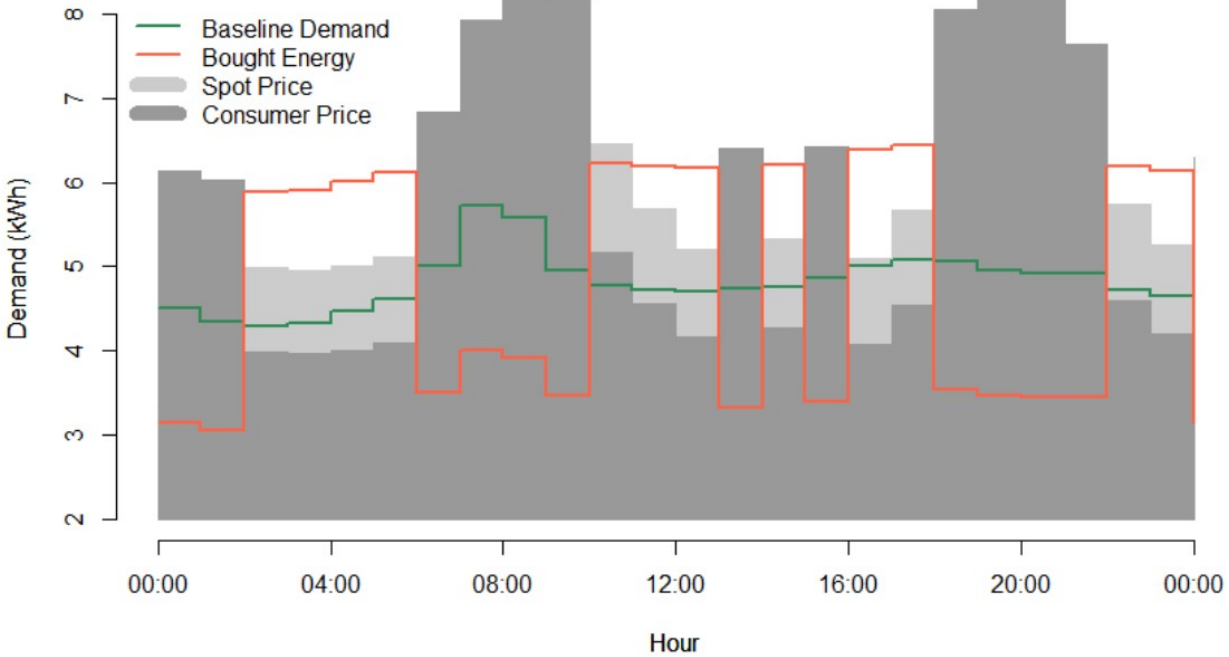
Bidding Flexibility into Markets

- 4 hours intervals consisting of 30% of consumption with durations of 2 hours:



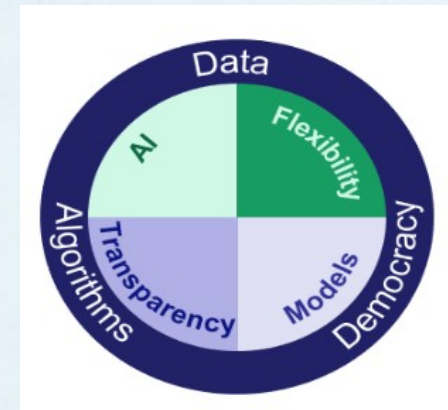
Bidding Flexibility into Markets

Solve $FF(\text{Price}) = \text{Bought Energy}$:



Summary

- An efficient implementation of the **future weather-driven** energy system calls for **data-driven Smart Energy Systems**
- **Flexibility Functions** are used to describe the **flexibility everywhere**
- **Flexibility Functions** are suggested as **MIMs for Energy**
(*MIMs = Minimal Interoperability Mechanisms*)
- **Flexibility Functions** are key to unlock and manage flexibility at the **Edge**
- We need **transparent, safe, fair** and **democratic** solutions
- We have proposed to use **methods based on Flexibility Functions for activating flexibility at all levels (via the Smart-Energy OS)**
- We have indicated how use the Flexibility Functions **for providing all type of grid services**
- Implemented at the **National Digitalization Hub, Center Denmark**
- **Savings** in summerhouses: 20 – 30 pct CO2/Cost



Thank you !

Connect – Share – Innovate

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