

Why we need Disruptions in Methods for Planning and Operation for the Future Weather-driven Energy System ?

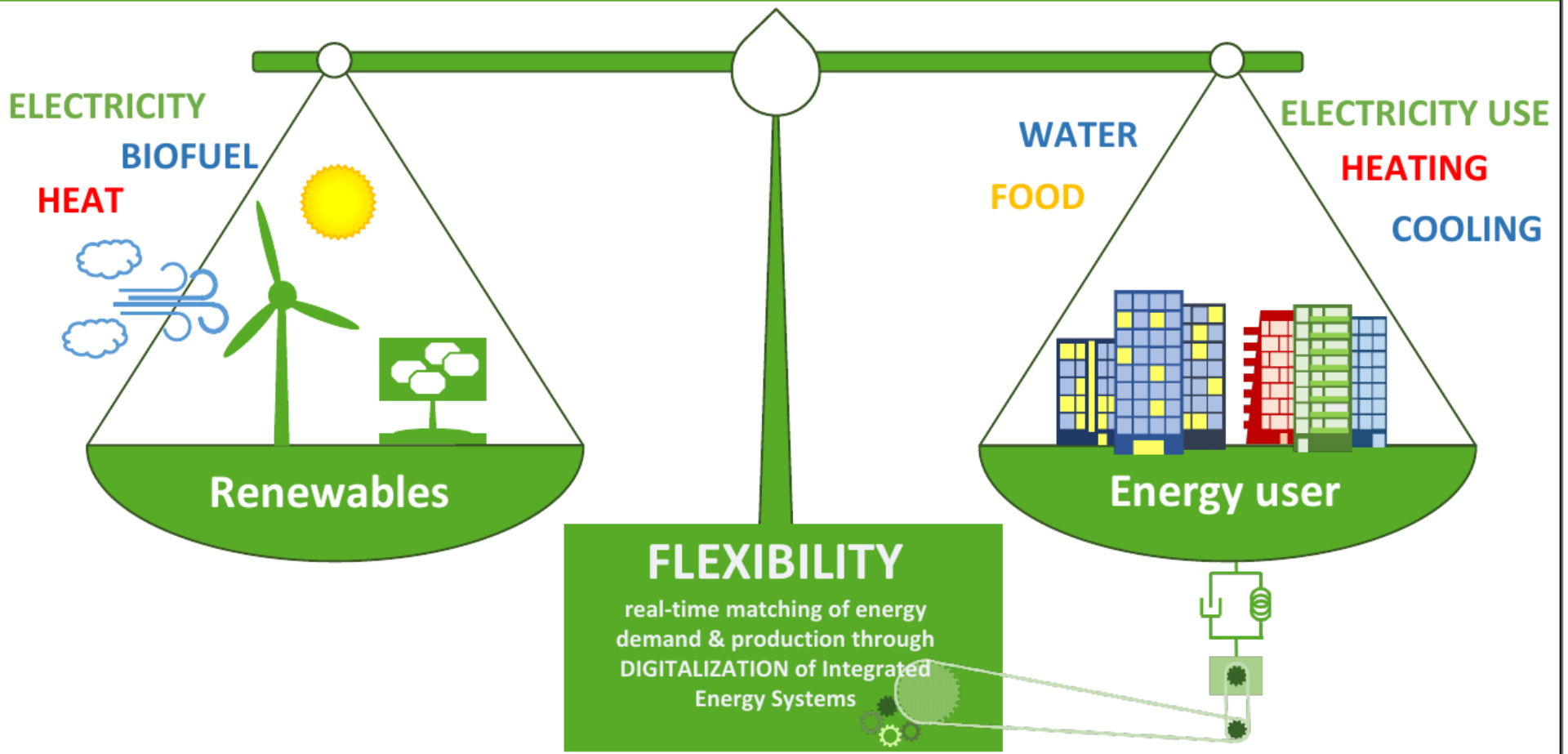


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The Challenge: Denmark Fossil Free 2050



Markets and Services

Challenges and possibilities

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

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.

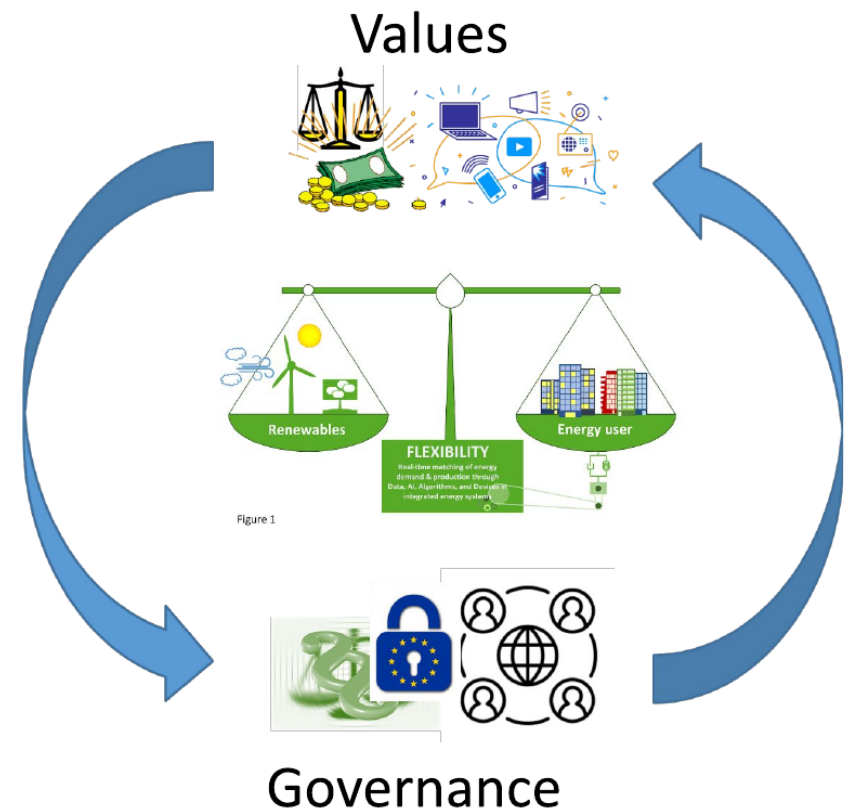


This is how we work together

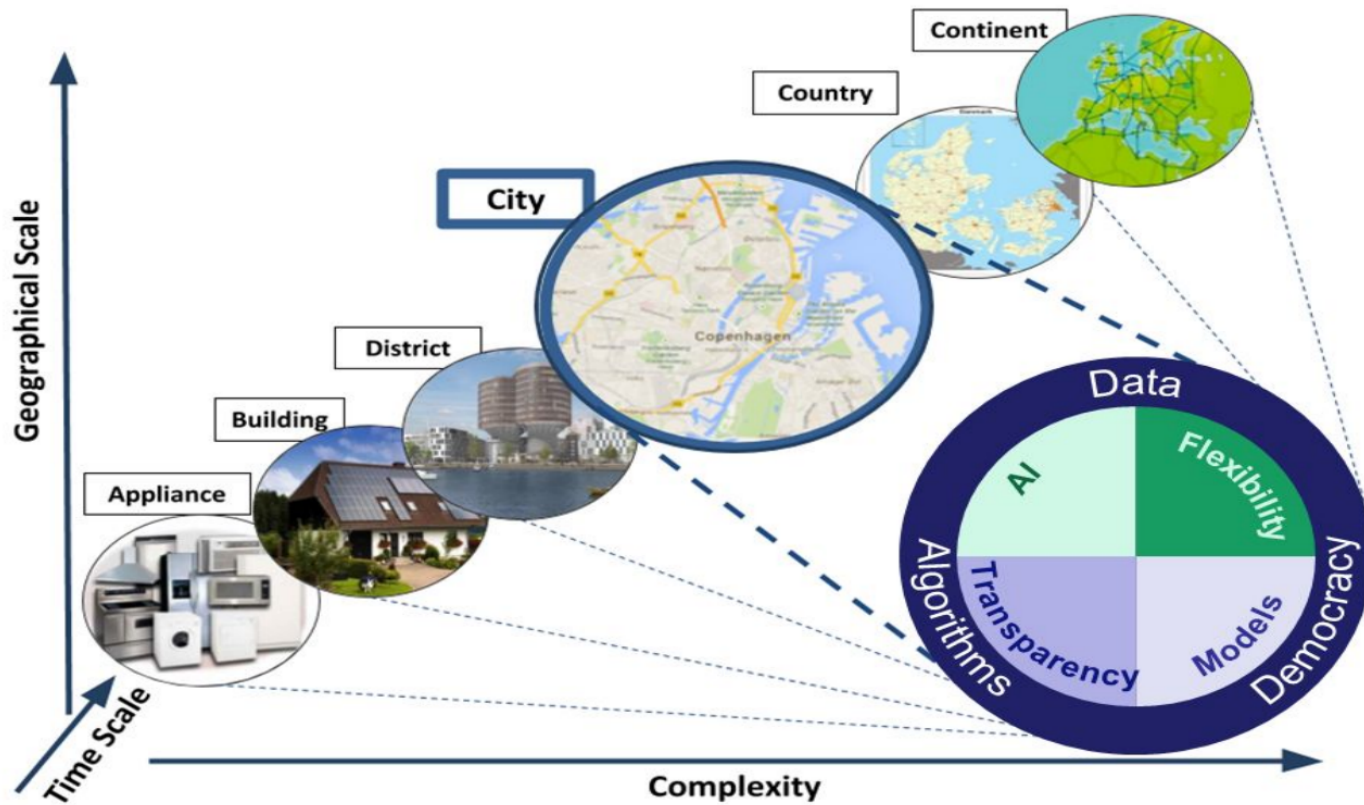
Privacy, democracy, transparency

Transition to flexible energy system poses challenges to democratic governance

- How to use **data** without compromising **privacy**?
- Whose energy needs to **prioritize**?
- How to redesign **market structures** aimed a liberalisation?
- What are our shared preferences on energy **justice**?
- Where to locate power to **control**?



Coherency across data, algorithms and democracy on all spatial and temporal scales





Center Denmark – Control Room (Spatio-Temporal thinking)



Challenges

- Existing market framework (how to link markets to physics)
- Many power related services (voltage, frequency, congestion, ramping, balancing, capacity, ..)
- Coherency in models, forecasts, optimization, etc. (eg. between Edge, Fog, Cloud levels)
- End-user engagement is important (ordinary people, wastewater treatment plants, industry, ...)
- How to describe - and use - flexibility?
- How to implement an integrated multi-vector energy system?
- Data (privacy, aggregation, trusted, transparent, democratic, ...)
- Energy systems planning models of today take load profile as input ... In the future the production profile is the primary input!
- Complicated contracts and requirements on user installations