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Overcoming Barriers to Climate Adaptation in the Energy Sector with the Resilience Approach

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KLIMZUG climate change in regions

- Metropolitan area Bremen-Oldenburg: **2.3 Mill. Habitants**
- **5 year** Project (2009-2014)
- **5 Steps:** Theory, Analysis of Risks and Chances, Implementation of innovative projects, Roadmap of Change
- Time Frame: about 40 years (2009 – 2050)
- **4 Sectors:** Logistics & port management, food industry, Governance and **energy**

Source: www.frischköpfe.de/

Outline

1. Barriers on adaptation to climate change
2. Perceptions of uncertainty
3. Resilience as guiding principle
4. Operationalizing resilience – Examples
5. Conclusion and open questions

Adaptation on what ?

- Vulnerability Assessment along the whole supply chain
- Direct effects on the system due to climatic change are less serious
  - A kind of adaptation took place already decades ago
    - Within the region 99% of the distribution grid is underground
  - A high reliability of the grid is realized due to a highly sophisticated & good engineered system
    - System average interruption duration index per customer (SAIDI): about 4 min

  - *> Still works very well ! <*

Barriers within the Energy Sector

- **Question: Can this energy system still last for the next 40 years?**
  - List of Barriers and Vulnerabilities:
    - Increasing numbers of switching operations in Transmission & Distribution grid (stabilizing supply frequency and voltage)
    - Handling local /regional conflicts (Justice Problem)
      - Especially land + resource use (Food vs. Biogas production)
      - Complex decision-making on net extension process between different interest groups
    - Large scale restructuring (e.g. transition to decentralized systems)
    - non-quantifiable uncertainties
    - Short-term view, path dependencies, highly interest driven processes by powerful stakeholders, allocation of resources, …
  - The Barriers & Vulnerabilities are more **structural** & **indirect**
- -> **Two Important points:**
  - high pressures on the system due to transformation, that possibly increases in future -> Climate change can than have an effect as trigger
  - Actual agenda within the energy sector is set on Transformation to renewables, not on Adaptation on climate change!

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Perceptions of uncertainty

- Chance to use the actual high interest & strong agenda of Energy system transformation
- A combined adaptation and mitigation approach is needed
  - Frame focus on uncertainty and how to deal with it,
- Important: Perception of uncertainty could be very different between stakeholders from science, local governments or utility companies
  - Parts of public opinion:
    - still seem to be very uncertain if climate change happens,
    - personal perception of weather vs. actual research results + seemingly contrasting statements from science
- Different perception shows complexity of the of mitigation and adaptation research

The Resilience Approach

- Our approach is based on the idea that ecosystem always are confronted with changing environments
  - Despite all differences between social-technical systems & social-ecological systems, some principles seem to be transferrable
- Following ecosystem theory, **Resilience** (Holling & Gundersson, 2006; Brand, 2006) could be a kind of guiding principle for this

Resilience describes the capability of systems to maintain their system services even under stress and in turbulent environments (despite massive external disturbances and internal losses)

System Services

- Resilience focuses on securing supply system service
- Brings together the system service approach from the energy sector with ecological system services
- System services are
  - Structures, products or services, which are
  - directly (!) enjoyed or utilised by “users”,
  - delivering a technical, economic or welfare related benefit, and which
  - can be characterised by quantitative (“what”, e.g. frequency) and qualitative (“how”, e.g. sustainability, social responsibility, etc.) criteria.

Operationalizing resilience

Implementing Resilience as **Guiding Principle** („Leitbilder“):

- Guiding the attempt to build more ‘resilient systems’
- Focus on affected systems, not on disturbing signals
- Bring together different stakeholder with:
  - Different priorities concerning climate adaptation & mitigation,
  - Different concepts of uncertainty,
  - Different perceptions + priorities about actual dynamics vs. long-term effects
- For that: Resilience has to operationalized e.g. depending on the “degree” of uncertainty, pursued goals within the process, or the speed of change (gradual/abrupt change)

Operationalizing of Resilience – Example 1

Task: Direct perception of resilience within a Stakeholder Process

- Example: vision development
- Uncertainty: high, very diverse goals
- Framing the process by different resilience abilities belonging to "uncertainty" and "changing time of challenges"

Challenges/	Known issues	Unknown issues
Slow/gradual change	Adaptivity	Innovation capacity
Fast/abrupt changes	Robustness/Resistance	Capacity to improvise

e.g. results for **capacity to improvise:**

- Need: systems ability to react spontaneous
- Need: give explicit responsibility and resources to a "response-team"
- Need: establish and training communication structures
- Need: Training of emergency events / find creative solutions

Operationalizing of Resilience – Example 2

Task: Systematically design a resilient system:

- Uncertainty: middle (given set of technologies) , diverse goals

Use of Design principles: e.g.

- Flexibility / Interoperability/ (”High Flux”):
  Ability to switch fast and easy between different energy forms, grids and sub-systems (gas, heat, fuels, electricity)
- Balanced proportion of centralization / cross linking and decentralization / autonomy
- Flat hierarchies, …

And Design components: e.g.

- Buffers (Short term storage: Batteries, etc. / Long term storage: e.g. caverns
- Adaptive Elements: Cross linking at different spatial levels (European, national, local), …

Further Design Principles & components: Gleich et al 2012. Wardekker et al. 2010

Operationalizing of Resilience – Example 3

Task: Assess different resilient system Designs

- Uncertainty: low , common goals (maintaining system services)

- Building Resilience indicators:
- E.g. depending on different type of extreme events, type resources, etc.
- Possible indicators are:
  - Diversity
  - biggest capacity that could fail
  - load factors
  - Dependence on imports / ability to export
  - Energy intensity
  - …

(For more Indicators see: Chaudry et al. 2011, Wiliamson et al. 2009)

Conclusion

Goal: Integrate Adaptation into the process of energy system transformation

- In climate adaptation as well in climate protection (especially in energy system transformation) different concepts of uncertainty exist that hinder the process
- Resilience set a frame of reference
  - Influences how decisions and knowledge is perceived
- Guiding principle **Resilience** is a way to deal with **uncertainty** in adaptation **and** energy system transformation
- By defining system services, a better understanding between stakeholders could be achieved
- Resilience as guiding principle gives the possibility to:
  - guide this process
  - find a mutual approach that integrate different views

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Open questions

- How to weight different system services / resilience (e.g. heat vs. electricity) against each other and against other political constraints?
- How to design the process of transformation from one stable state to another by securing system services?
  - Different concepts of Stability in engineering and ecology
  - Maintaining *efficiency of function* vs. *existence of function (Holling, 1996)*
- Partly unsolvable contradiction
  - Increase in Resilience needs a minimum of e.g. redundancy, buffer and decentralization -> decreases efficiency
- …

Thank you for your attention..

Transforming the energy system with resilience needs depth of knowledge of the system, time and a lot of resources
– but it could be worth spending it!

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