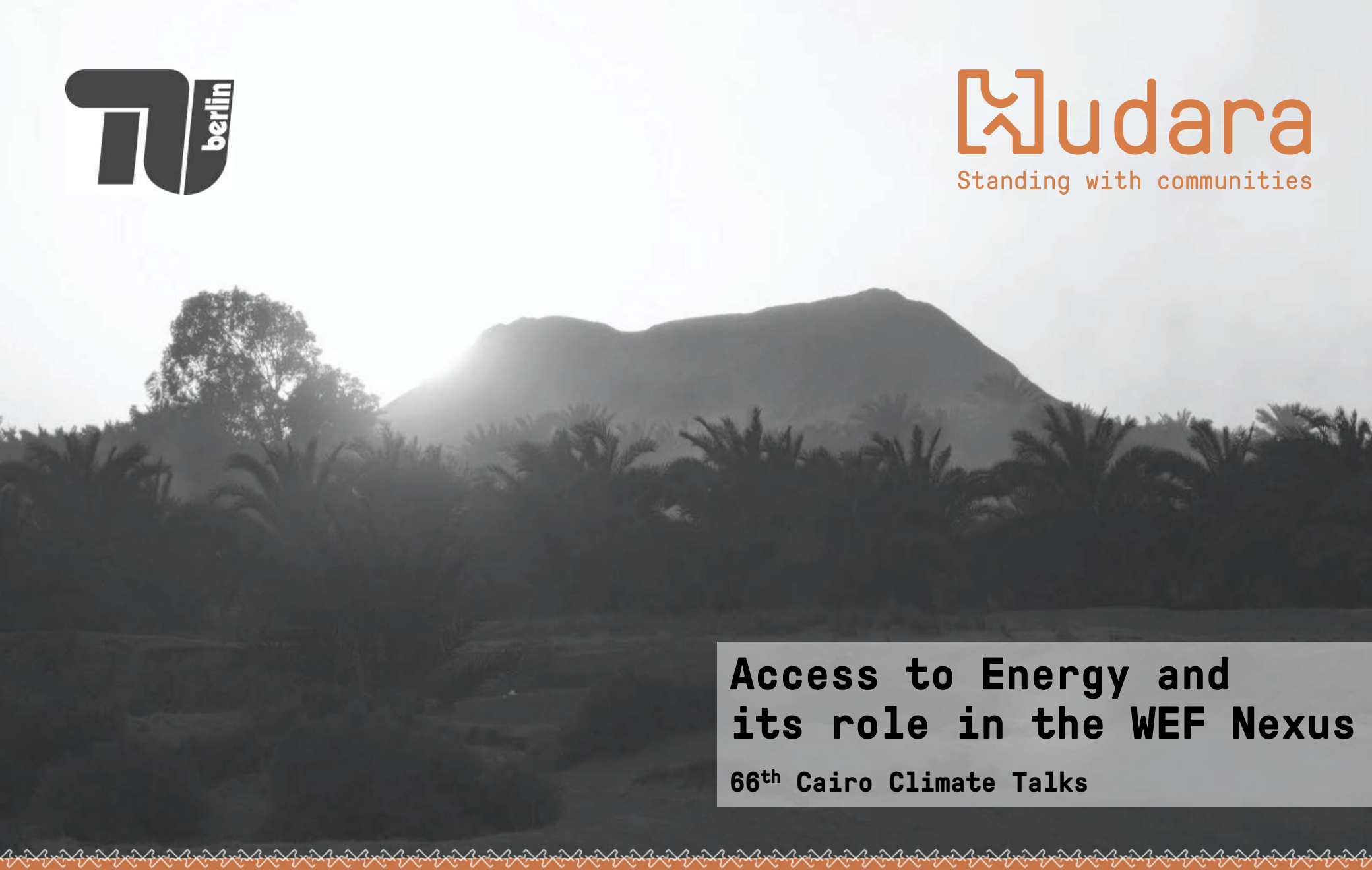

Access to Energy and its role in the WEF Nexus

66th Cairo Climate Talks

Prof. Dr. Boris Heinz · Dr. Lena Schmid

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Overview

Introduction

- Access to Energy
- Multi-tier framework of Energy Access

The Nexus and the role of Energy

Introduction

Access to Energy

&

Multi-tier framework

Access to energy – what does it encompass?

- **Proximity and availability** of modern energy sources, i.e. electricity, natural gas, liquid petroleum gas, biogas, ethanol

- **Availability of efficient end-user applications**, i.e. cooking units, lighting, water pumps, food processing, school & health facility appliances, energy-efficient housing/transport

- **Economy and security of supply**

Access includes affordable and stable supply of clean energy, reliability of supply and quality

Broadening the view on access to energy

Recent push to develop more comprehensive measures of energy access

- Capture the multidimensional and multi-tiered nature of Energy
  - (1) capacity
  - (2) duration and availability
  - (3) reliability
  - (4) quality
  - (5) affordability
  - (6) legality
  - (7) convenience
  - (8) health and safety

1. **Definition**: How to define affordable, reliable, and modern energy services
2. **Tracking**: How to measure the progress toward universal access

Multi-tier framework of Energy Access

Attributes of energy supply		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Household electricity	No electricity[a]	Very low power	Low power	Medium power	High power	
	Household cooking	Inadequate capacity of the primary cooking solution				Adequate capacity of the primary cooking solution	
Duration and availability	Household electricity	<4 hours	4–8 hours		8–16 hours	16–22 hours	>22 hours
	Household cooking	Inadequate availability of the primary cooking solution				Adequate availability of the primary cooking solution	
Reliability	Household electricity	Unreliable energy supply				Reliable energy supply	
Quality	Household electricity/cooking	Poor quality of energy supply			Good quality of energy supply		
Affordability	Household electricity	Unaffordable energy supply		Affordable energy supply			
	Household cooking	Unaffordable energy supply				Affordable energy supply	
Legality	Household electricity	Illegal energy supply			Legal energy supply		
Convenience	Household cooking	Time and effort spent sourcing energy cause inconvenience			Time and effort spent sourcing energy do not cause inconvenience		
Health and safety	Household electricity	Unhealthy and unsafe energy system				Healthy and safe energy system	
	Household cooking[b]	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5

Source: World Bank, Spalding-Fecher et. Al. 2015

The Nexus and the role of Energy

The Nexus

A concept put forward to call for an integrated management of the three sectors by cross-sector coordination in order to

- reduce (unexpected) sectoral trade-offs
- promote the sustainable development of each sectoe

--- Different from conventional decision-making practices in separate disciplines ---

Coupled systems as a circle comprised of several subsystems

- Internal relationship analysis
- External impact analysis
- evaluation of the coupled system

→ Resilience and Sustainability

The Nexus - interactions

- Nexus system

  → Interdependencies between energy and water, as they are coupled in their supply, processing, distribution and use

  → System boundary extended to water-energy-food system (WEF)

  → Nexus can be defined as the interlink between water, energy and food

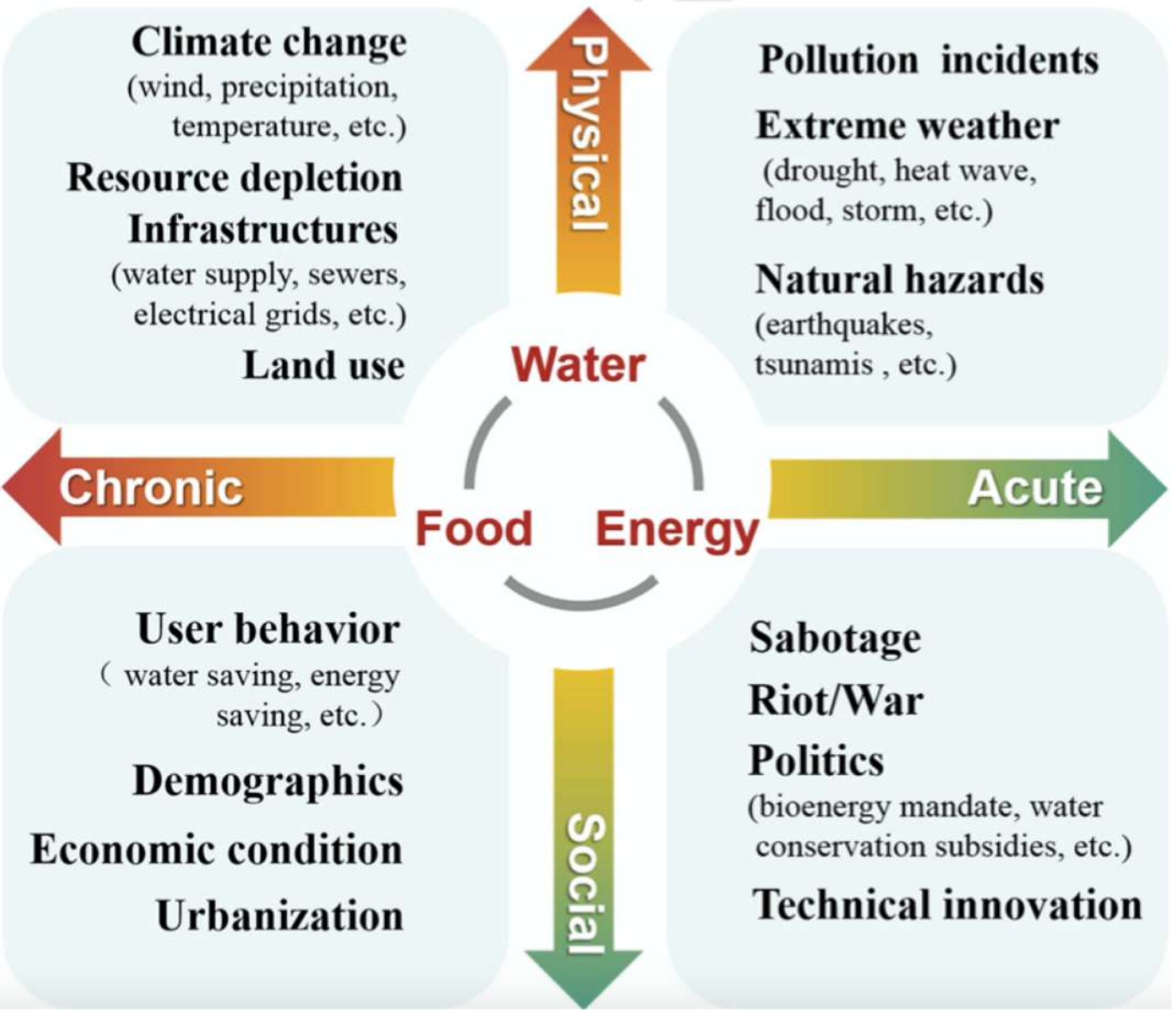
- Three perspectives to capture WEF interactions
  - The interconnected processes (e.g. physical and chemical)
  - The input-output relations during resource production
  - The interactions dominated by institutions, markets, and infrastructure

Security issues of these three sectors become more and more severe

→ *Term emphasizes that failures in one sector may exert pressures on the other two*

→ *Requires a holistic management among these sectors*

Classification of external factors



External Factors

- Population growth
- Climate change
- More extensive land use
- …

Source: Zhang C, Chen X, Li Y, Ding W, Fu G, Water-energy-food nexus: Concepts, questions and methodologies

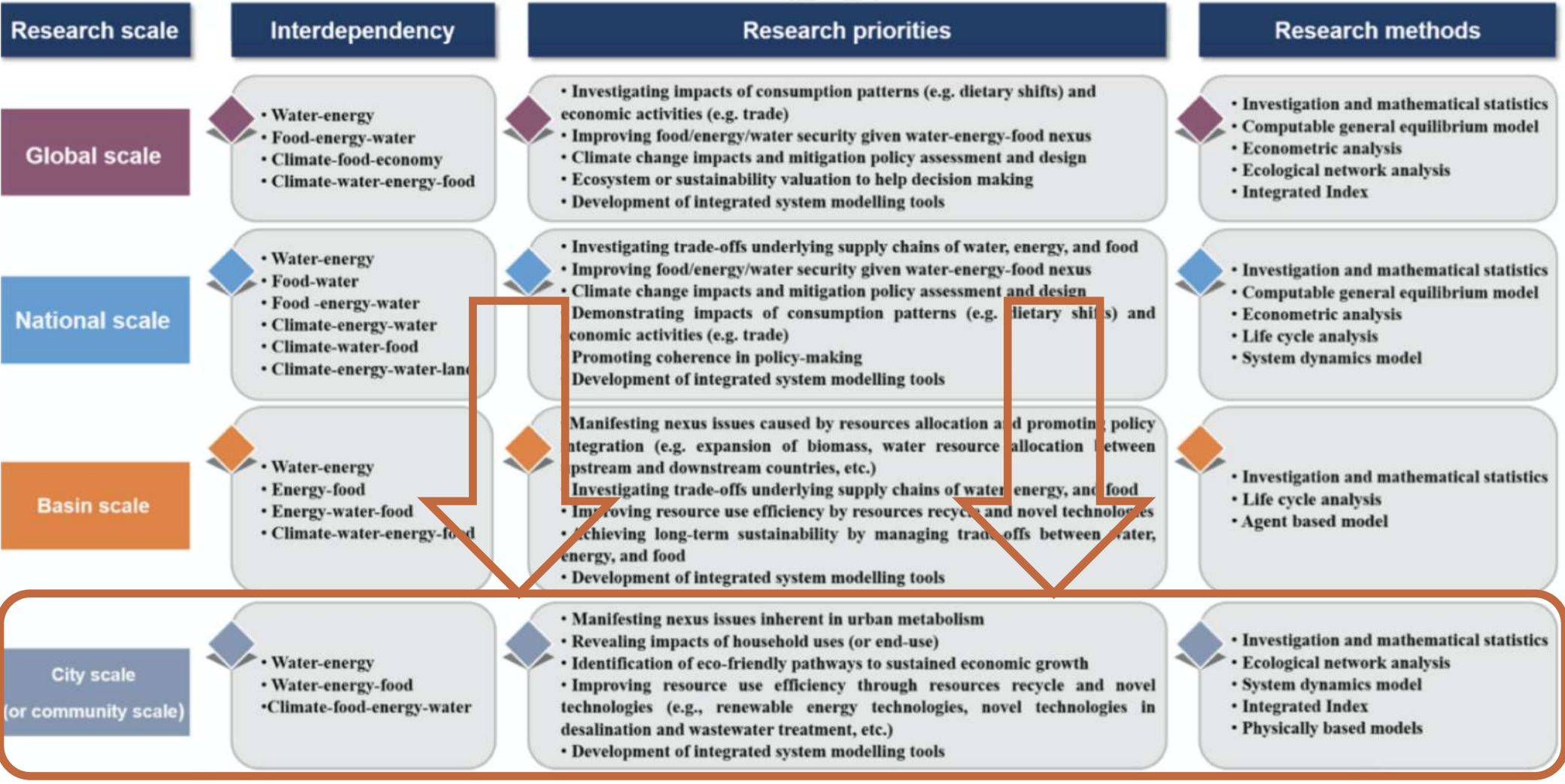
Evaluation of the couple system

Except for internal and external impact analyses, assessment of the whole system performance

- **Resilience**
- **Sustainability**

→ field of current research

Modelling approaches



Source: Zhang C, Chen X, Li Y, Ding W, Fu G, Water-energy-food nexus: Concepts, questions and methodologies

Modelling approach at community scale

- Social issues locally
- Contextual sensitivity possible to meet
- Community based approaches have the potential to be high in efficiency and high in impact given its tailored nature to the context (evidence from energy poverty)
- Allows to draw conclusions for higher levels, local policy to policy levels – from bottom-up approach to top levels
- Community-based approach builds capacities, leads to ownership, promises higher impact and sustainability

Modelling approach – ABM

Agent-based modelling

"bottom-up" approach where every agent is a discrete autonomous entity with distinct goals and actions within a particular social context "

- Modelling agents allows for the diversity that exists among agents/households in their attributes and behaviours at the bottom level
- System level can also be investigated through aggregation of all agents' behaviours
- ABM breaks through the limitations of single-level and individual-perspective
  - provides a more realistic and effective modelling framework
  - describing and investigating complex systems by offering a way to model social systems
  - systems composed of numerous agents which can interact with and influence each other, learn from experiences, and adapt their behaviours to be better suited to their environment

Agent-based modelling in practice

Decentralised energy supply

→ Flexibility to adjust production to consumption of energy (more dynamic)

→ Local production, closer to consumption, potential to use excess heat (higher efficiency, less losses in transport)

→ Mass market for energy systems and reduced costs

→ Higher number of energy systems lowers risk of outages (Resilience)

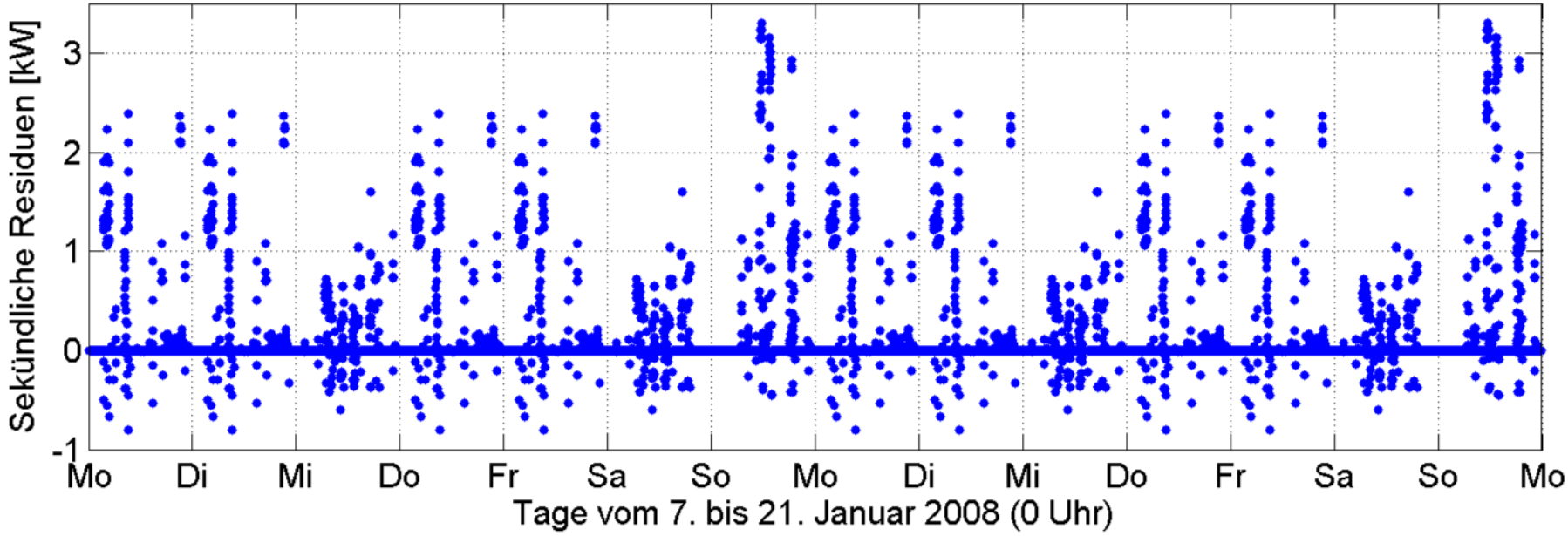
→ Renewable advances in decentralized energy technology (Sustainability)

Agent-based modelling in practice

What can a small energy production system in a household lead to?

→ Blue dot above the line – when there is too much energy produced for the household

→ Blue dot below the line – when there is too little energy produced for the household



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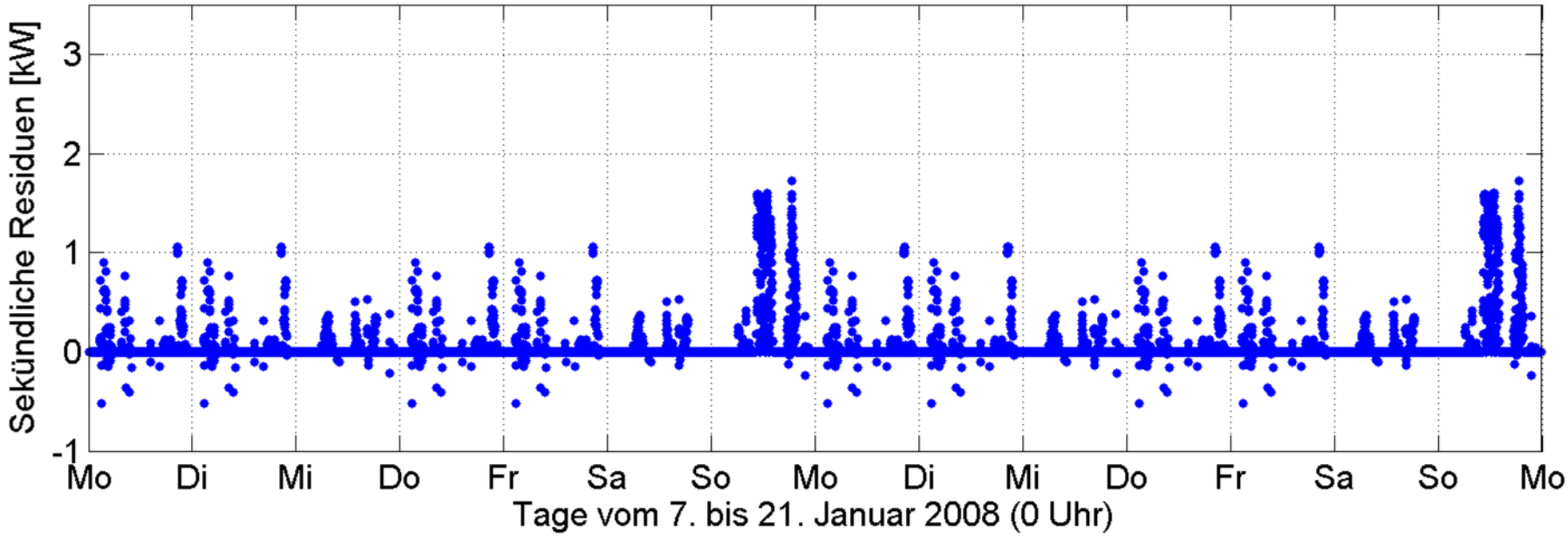

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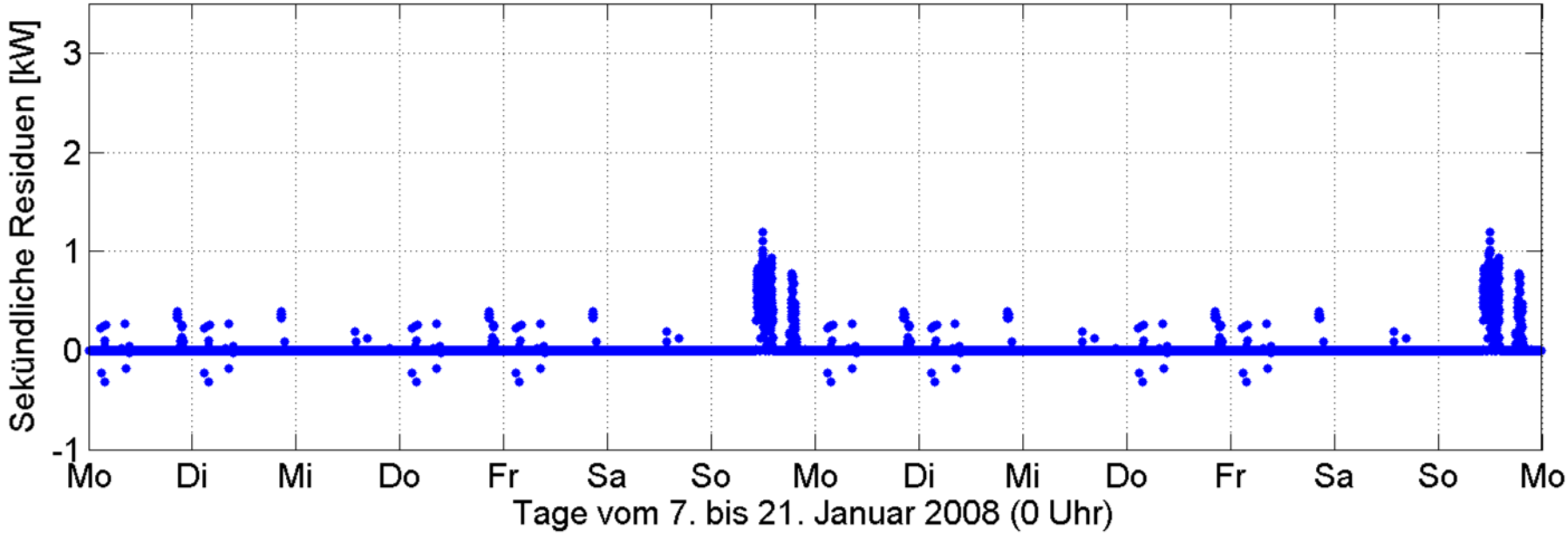

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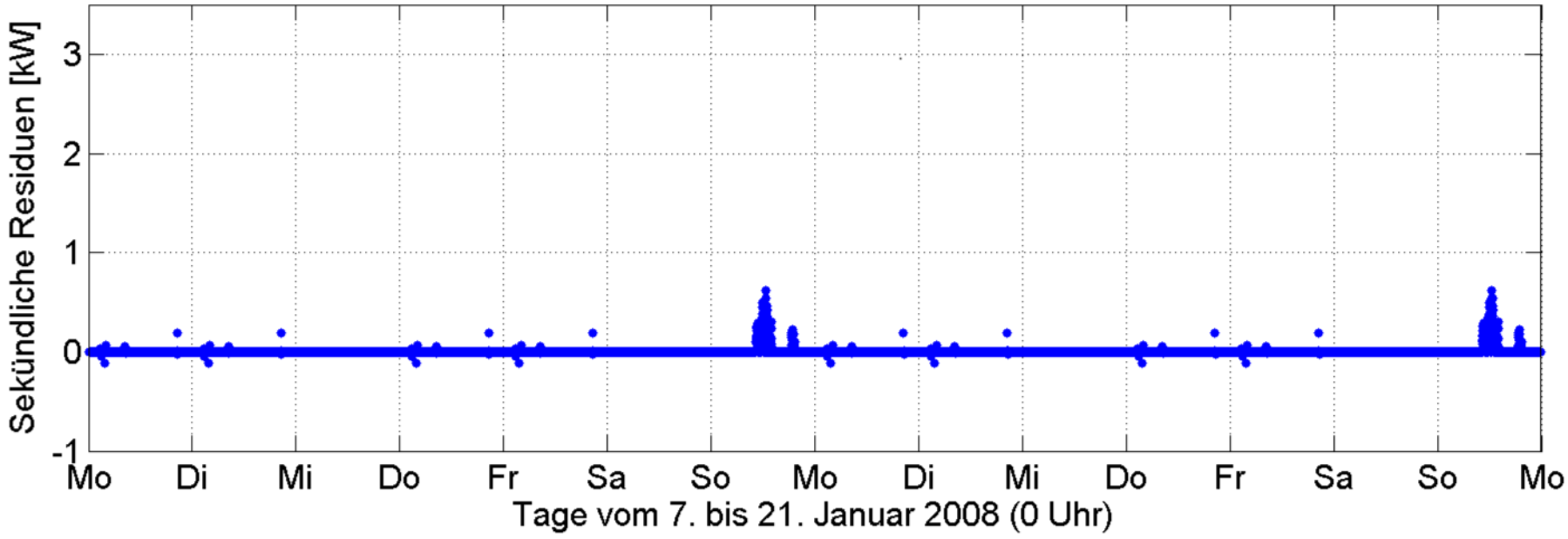

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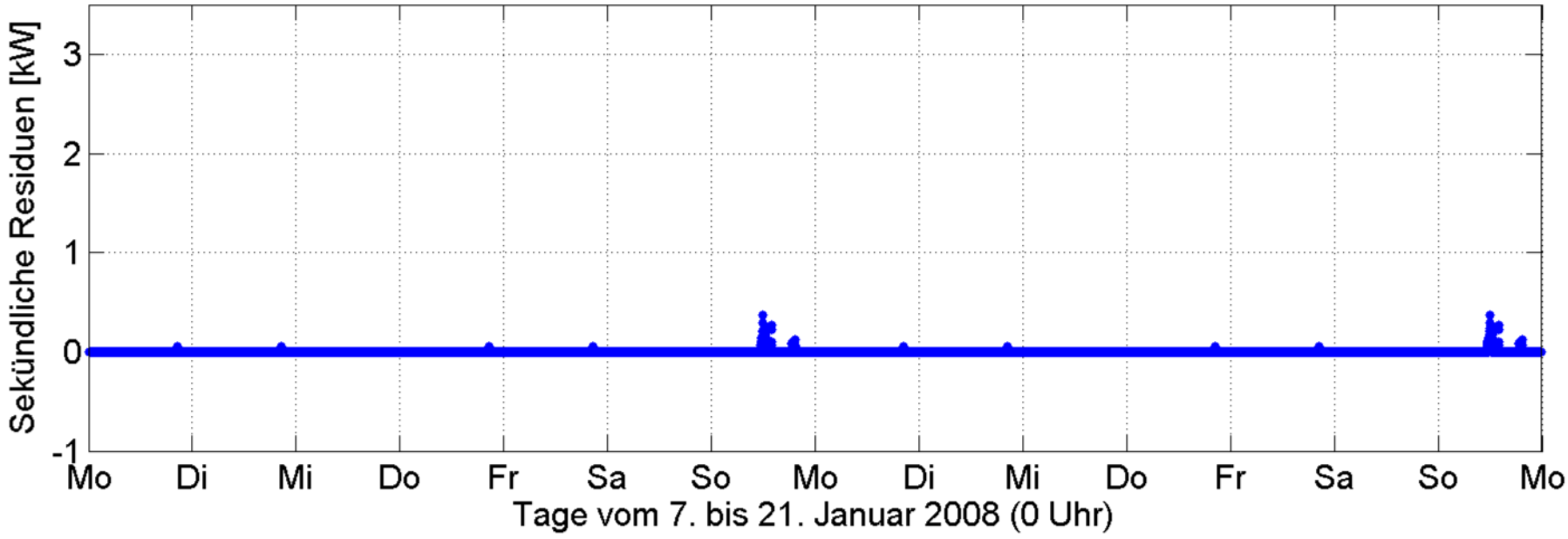

Challenges and chances

Existing studies and methods offer promising outlook for WFE nexus

- Assessing trade-offs
- Predicting potential (unintended) effects
- Providing a co-optimization base for different stakeholders who often have conflicting interests
- Visualizing the impacts for informed decision making

Limitations of current studies still exist

- Definition of the system boundary
- Data uncertainty and modelling (sensitivity analyses to the help?)
- Nexus mechanism (physical, chemical processes associated with resource flows as well as their supply chains, decision making mechanisms)
- System evaluation (evaluation of coupled nexus system, including assessment metrics and quantitative assessment approaches)

Conclusions and the way forward

Evaluation of the coupled nexus systems

- Urgent need to develop nexus-specific models to provide a better representation of nexus systems
  - Models need to go beyond partial description of feedback and interactions of nexus systems
- Nexus elements continue to expand
  - Given current data availability, such models are also required to have the ability to combine quantitative with qualitative data (insights locally into context, data requirements)
  - Integrated and flexible model for water-energy-food nexus, multiple stakeholders and decision makers should be engaged into modelling processes to incorporate valuable and timely information from different sectors
  - avoid ignorance of vital processes or interactions owing to the site-specific nature of nexus

→ **closer collaborations between sectors**

Thank you. Do you have any questions?

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