Universität Stuttgart
ZIRIUS – Center for Interdisciplinary
Risk and Innovation Studies






Social Sustainability in Models of Energy Transition Pathways: Concepts and Methodological Opportunities

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1. Sustainability assessment of energy transformation pathways (scenarios):
InNOSys: **Integrated sustainability assessment and optimisation of energy systems**

2. What does **social sustainability** mean in the context of energy transition pathways?

3. How can **social sustainability** be empirically studied and integrated in systems modelling of energy transition?

4. Methodological approach: Paired-conjoint analyses

1. Sustainability Assessment of Energy Transition Pathways (Scenarios)

- Energy scenarios & energy systems models usually analyse long-term dynamics, with the focus on
  - technical feasibility
  - energy-related CO_2-emissions
  - systems costs
- Life cycle assessments (LCA) offer insights into ecological impacts of individual technologies in a static manner, including
  - contributions to climate change, acidification, eutrophication
  - land use and resource use
  - impacts on human health

➢ Energy systems models and LCAs enable
  - ➢ Analysis of desired and undesired environmental and economic effects of long-term energy transformation processes
  - ➢ Comparison of environmental and economic effects across energy scenarios
  - ➢ Identification of sustainability trade-offs across energy scenarios

➢ **Current project InNOSys: How can aspects of social sustainability be integrated in the analysis of energy transition pathways?**

2. Social Sustainability in Analysis of Systems Modelling of Energy Transitions

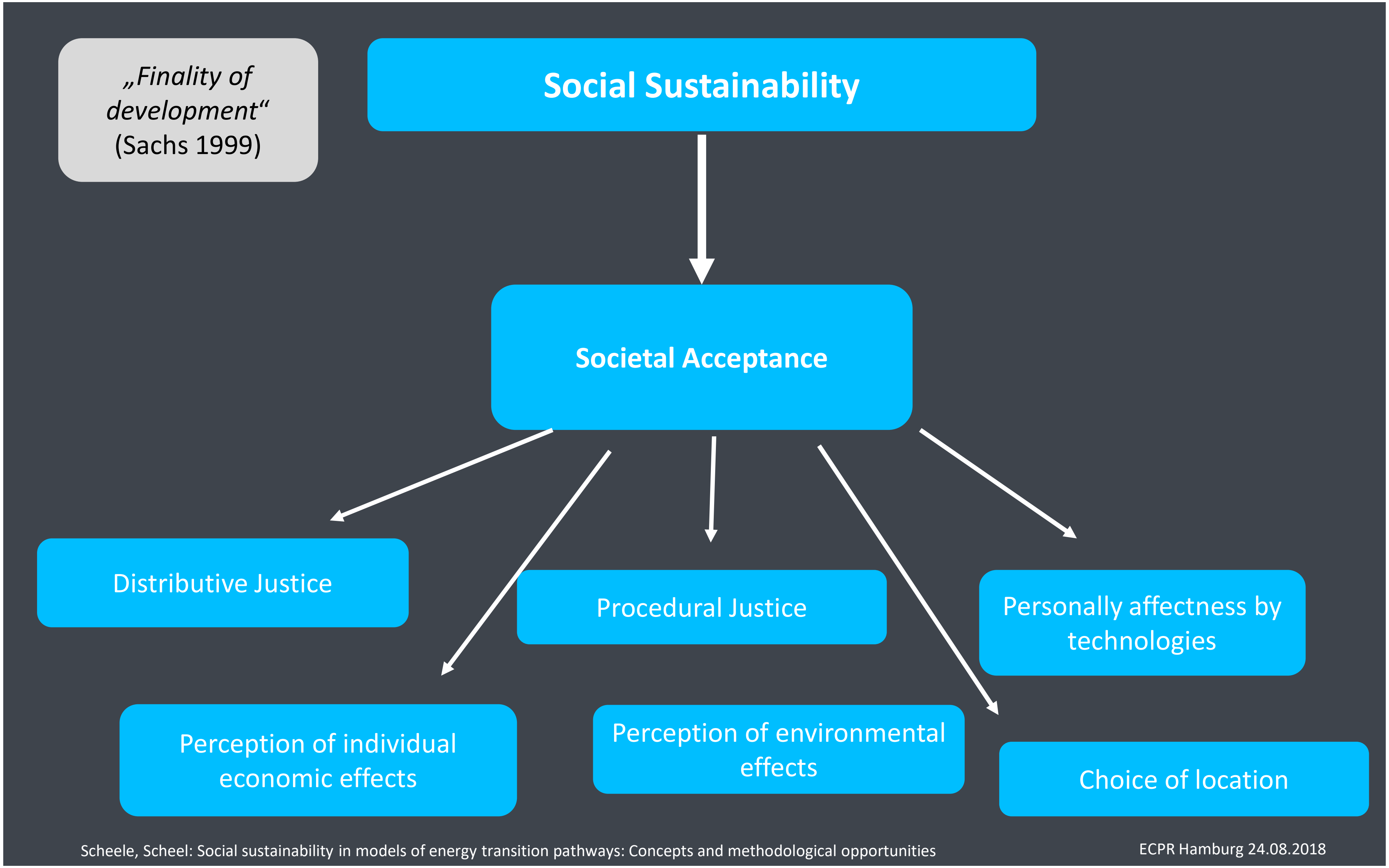
Extant inclusion of social sustainability in assessments of energy technologies and scenarios:

1. Social sustainability as technological acceptance (z.B. Wang et a. 2009, Santoyo-Castelazo et al. 2014)
2. Conception of measurable, environmental and economic indicators (e.g. job creation, land use, security of supply, CO2-emissions as social sustainability (Liu 2013)
3. Theory-based approach to social sustainability with limited indicators that are empirically observable

3. Social Sustainability of Energy Transition Pathways: Different Approaches

- Different conceptions of social sustainability (Parris & Kates 2003, Rösch et al. 2017)
  - Social sustainability of energy systems in relation to developing countries: Databases offer empirical indicators (e.g. corruption, access to energy)
  - Social sustainability in relation to modernized countries: Societal acceptance is often conceptualized as empirical indicator for social sustainability of individual energy technologies and scenarios (Alcorn 2003, Assefa & Öberg 2007)

➢ Societal acceptance also multi-dimensional concept:
  - As a societal process, in which different objectives of actors have to be developed in an integrative way (Renn et al. 2007)


„Finality of development“ (Sachs 1999)
Social Sustainability
Societal Acceptance
Distributive Justice
Procedural Justice
Personally affectness by technologies
Perception of individual economic effects
Perception of environmental effects
Choice of location
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3. Social Sustainability in Systems Modelling of Energy Transition

- Challenge for empirical sustainability studies:
  - One the one hand, the need for inevitable **normativity of sustainability**
    - Objectives and pathways towards sustainability need to be established in integrative negotiation processes
    - What interventions in nature and society are justified and legitimate?
    - Such a negotiation processes cannot be limited to the 3. pillar of sustainability (social), but extends to ecological and economic aspects too
  - On the other hand, the need for **functionality of the eco-social system**
    - Consideration of systemic relationships between objectives and their implications for different spheres of social and ecological life
    - Systems knowledge necessary to investigate trade-offs and synergies

➢ **Integration and dynamic relationship between normativity and functionality is vital for an analysis of social sustainability of energy transition pathways**

4. Methodological Approach: A normative-functional concept of sustainability (Renn et al. 2007)

- **Linking of both aspects into a normative-functional concept of sustainability for energy transition pathways:**
  - Systems knowledge is generated by modelling and energy systems partners to serve as basis for decision-making regarding how different energy-related measures and technologies perform economically and ecologically.
  - In turn, societal perceptions and normativities are taken into account in systems analysis (e.g. what economic and ecologic potentials are lost when wind power plants are built only outside of the range of local residents' visions)
  - Consideration of dimensions that lie across the traditional dimensions of environmental, economic and social sustainability that pertain to normative and functional concepts of sustainability:
    - **Systems integrity** (pertains social, ecologic and economic systems)
    - **Quality of life** (pertains social, but also ecologic aspects)
    - **Justice** (distributive justice and intergenerational justice)

Key question:

- *How can the normative-functional concept of sustainability, i.e. the consideration of actors' collective perceptions of what is sustainable AND systems knowledge about economic and ecologic systems be **empirically realized**?*

4. Methodological Approach: Operationalization with Paired Conjoint Analyses

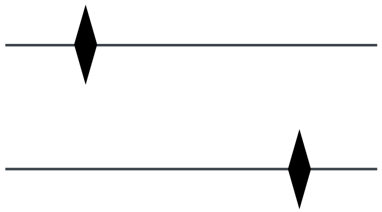
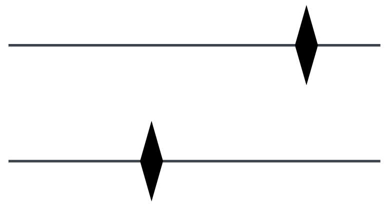
- Conjoint analyses are increasingly popular for technology acceptance studies:

Individual technologies	
Wind power plants	Álvarez-Farizo and Hanley 2002
Nuclear power and nuclear waste	Krütli et al. 2012
CCS	Wallquist et al 2012
Smart Meter	Kaufmann, Künzel und Loock 2013
Mobility/ Alternatives to fossil fuel	Beggs et al. 1981, Brownstone et al. 2000, Bunch et al. 1993, Dagsvik et al. 2002, Ewing and Sarigöllü 2000
Urban traffic	Saelensminde 1999
Specific attributes/ effects of technologies	
Environmental, health and job creation effects of different energy strategies	Johnson and Desvousges 1997
Energy prices	Steg et al. 2006
Attributes of electricity production	Burkhalter, Kaenzig and Wüstenhagen 2009
Social costs of landfills	Sasao 2004

4. Methodological Approach: Operationalization with Paired Conjoint Analyses

- Conjoint analysis allow to measure the relevance individuals place on certain sustainability aspects when asked to judge technologies of energy transition pathways
- For the analysis, seven energy technologies are chosen for the conjoint-analysis: *Wind power (onshore); PV (roof-top and free area); heat pump; battery storage; geothermal heat; gas power plants, power-to-Gas*
- Previous to the conjoint-analysis, the technologies are discussed with participants within focus groups
- For each of the tested technologies in the conjoint-analysis, ecological and economic sustainability scales are developed and serve as basis for sustainability assessment (→Input from systems knowledge, i.e. functional aspects of sustainability)
- Normative-functional aspects involving social sustainability are not displayed descriptively (e.g. In scales), but are assessed by the participants themselves (→ the conjoint itself reveals insights into the concept of social sustainability of energy technologies)

Design of the paired Conjoint -Analysis

Ecologic & economic sustainability scales	Technology A		Technology B	Ecologic & economic sustainability scales
				
1 – 2 – 3 – 4 – 5 – 6 – 7 1 – 2 – 3 – 4 – 5 – 6 – 7 1 – 2 – 3 – 4 – 5 – 6 – 7	**Assessment of sustainability** Quality of life Distributive Justice Intergenerational Justics			1 – 2 – 3 – 4 – 5 – 6 – 7 1 – 2 – 3 – 4 – 5 – 6 – 7 1 – 2 – 3 – 4 – 5 – 6 – 7

Ranking and Choice	
How sustainable do you think Technology A is overall?	1 – 2 – 3 – 4 – 5 – 6 – 7 Not sustainable very sustainable
How sustainable do you think Technology B is overall?	1 – 2 – 3 – 4 – 5 – 6 – 7 Not sustainable very sustainable
Which of the two technologies do you think is more sustainable overall?	Technology ____

Thank you for your attention!

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References

[endnote]