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Motivation
The analysis of energy system transitions is mainly affected by a socio-technical system (STS) understanding, focusing on the co-evolution of societal and technical changes. However, energy systems are highly dependent on and characterised by ecological resources, which are not explicitly considered in the STS approaches.

Concept
Integration of the multi-level-perspective (MLP) (Geels 2002) as an analytical approach on STS and the socio-ecological systems framework (SESF) (Ostrom 2009). Conceptualisation of energy systems as integrated socio-ecological technical systems in transition towards sustainability - considering technical & ecological aspects.

The Multi-Level Perspective (MLP)
The MLP analyses the drivers of societal transitions (e.g. the energy transition) on three structuration levels:
- niches: low structuration level, high innovative potential (photovoltaic cells)
- regime: structured systemic patterns (used technology, e.g. nuclear power)
- landscape: high structuration level (societal values in energy use)

Regimes change through pressure from the landscape (e.g. changing societal norm on nuclear power) & open a window of opportunity through which niches enter the regime. The MLP is based on the concept of actor-rules-system interaction which constitute a socio-technical system.

The Socio-ecological Systems Framework (SESF)
The SESF analyse the human-environment interactions in SES, i.e. the governance structures which allow for a sustainable utilisation of ecological resources. The SESF considers four subsystems:
- the resource units (energy resources), the resource system (e.g. the grid)
- the governance system (e.g. resource property rights, policy) and the actors.

The four subsystems are linked through the focal action situation in which the actors use the resources, produce and sell energy etc.

The actor-rules-system interactions (in focal action situations) in STS and SES
Actor-rules-system (ARS) interaction constitute a STS: actors (e.g. energy companies) carry rules (e.g. policies) & influence them, actors & rules are influenced by artefacts (e.g. grids) etc.

Biophysical conditions
Action situations are influenced by biophysical conditions (system artefacts), rules & attributes of the community (actors). The output of action situations feedbacks on all input factors (interaction).

Outcomes
★ The STS & the SES perspective share a similar understanding on the constitution of a system through the interaction of system artefacts, rules & the actors (SRA).
★ The MLP contributes the technical system aspects, the dynamic transition perspective and has frequently been applied to energy systems in transition.
★ The SESF delivers the ecological system aspects, the preservation of system functionality and an indicator set for empirical analysis.
★ The integration of the MLP and the SESF provides the basis for the conceptualisation of energy systems as SETS based on the interaction of SRA.
★ The conceptualisation allows for the analysis of the role of actors for systemic transitions considering technical and ecological aspects.


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