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Non-hierarchic Polycentric Regimes Facilitating Intelligent Distributed Energy Systems: The Common-Pool Resource Nature of Renewables

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Topics:

- Social acceptance of renewables' innovation;
- Renewables' deployment in Distributed Generation and Intelligent Grid developments;
- Energy policy, particularly with regards distributed generation with renewables, and infrastructure decision making;

Introduction

State-of-the art *social acceptance* (SA) *of energy innovation* research (Gaede, Rowlands 2018; Wolsink, 2018b) shows that the original definition of social acceptance (Wüstenhagen et al., 2007) must be tightened up. This contribution will do so, based on:

(1) The coverage of multiple levels, and institutional frameworks as the major factors of SA;

(2) Focusing on crucial characteristics of the renewables' innovations, e.g. *distributed energy systems* (DES), as the major elements of the object of SA.

Beside distributed generation (DG), DES also includes *distributed storage*, systems of *internal demand response* (DR), and adjacent *infrastructures connecting and regulating* the DES. This not simply implementing new hardware, the crux is that DES is based on entirely different organizational principles than the existing centralist and hierarchical system of electricity supply.

Distributed Energy Systems

The development of power supply based on renewables is heavily depending upon the rapid emergence of DES. At the same time all elements of DES, including the infrastructures for power generation based on renewables, are facing many problems: social acceptance (obstruction, resistance, lack of cooperation etc. among many actors), perceived low potential (limited cognition, paradigmatic and cultural lock-in), and perceived low economic attractiveness (based on paradigmatic and market-structure lock-in). All these factors are associated with high policy risk, as a result, for actors actually willing to invest social capital as well as economic resources.

On the other hand these factors themselves are risks created by existing policy frames, to a large extent. Low acceptability, low economic viability, and also perceived limited potential are often resulting from institutional conditions that must be considered the result from policy frames. In terms of innovation theory, the *social-technical system* (STS) is highly locked-in (Unruh, 2000). Although DES cannot be simply classified as decentralized but also based on entirely different organizational principles, most obstructions for deployment are associated with the currently dominant *centralized power supply system.* This is leading to impediments for initiatives to establish DES, as current decision-making frames create investor reluctance, inflexible and flawed spatial decision making, and the tend to reproduce hierarchic, uniform and inflexible policy frames (legislation, policies, culture, incumbent organizations, etc.).

Social Acceptance 2.0

The object of SA of renewables' innovation is complex and multidimensional. For that reason, in the original conceptualization of SA a distinction is made between three dimensions, community acceptance, market acceptance, and socio-political acceptance (Wüstenhagen et al., 2007). All three are characterized by different *processes*, with partly different *actors* – some operating in more than one dimension –, and also distinguished *objects*. The most important objects of socio-political acceptance are the *institutional changes* required for the transformation of the power supply system, e.g. the abandonment of the centralized, hierarchic system, and the establishment instead of a polycentric, hybrid, flexible, and adaptive system serving the deployment and development of DES. This requires the establishments of intelligent grids (IG) with strong variety and resilience. Scaling up to intelligent grids with a large amounts and huge variety of DES units requires new organisational principles and structural changes (Wolsink, 2012), for example, institutional changes in spatial planning.

SA is a bundle of complex, dynamic, and interdependent processes, and even the main object itself, innovation, is a process. The innovation literature highlights that innovation is neither invention nor diffusion of technology, but rather the development of new ideas materialized in products and services that become accepted in society, replacing other products and practices.

The process character of SA has been the purport of distinguishing between the three principal dimensions of acceptance: community, market, and socio-political, but in further elaboration of the concept of SA it has been recognized that the three dimensions are also a manifestation of multiple layers (fig.1)

- Environmental conflict and environmental justice in infrastructure decision making (energy, waste, water, green space);.

Latest papers (open access): *Social acceptance revisited: gaps, questionable trends, and an auspicious perspective*. https://doi.org/10.1016/j.erss.2018.07.034. *Co-production in distributed generation and landscape values.* http://www.tandfonline.com/doi/full/10.1080/01426397.2017.1358360

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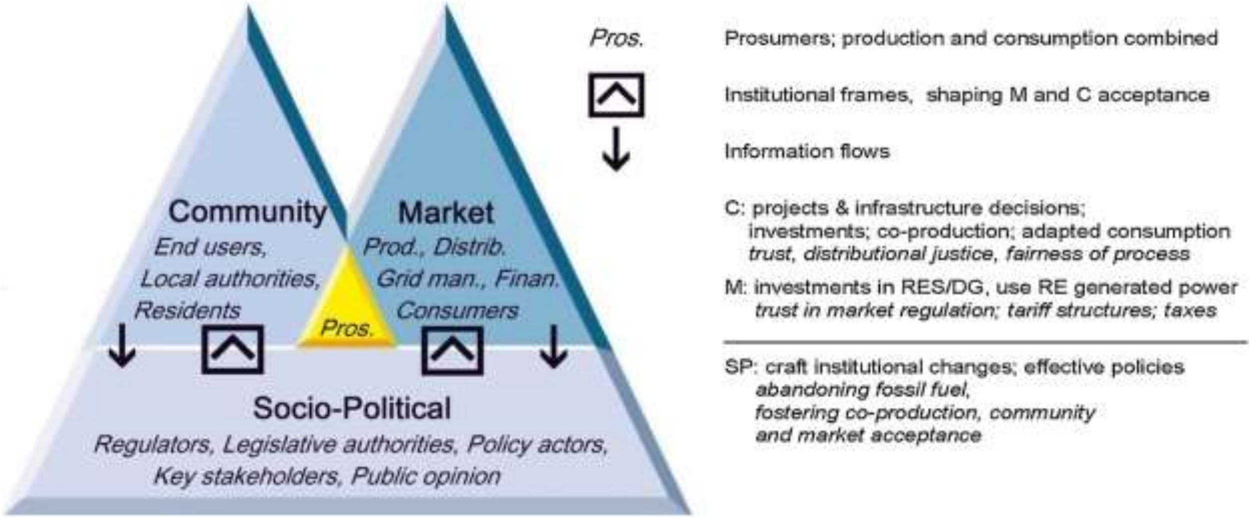


Figure 1: Three multi-layered dimensions of SA, with significant actor groups (Wolsink, 2018b).

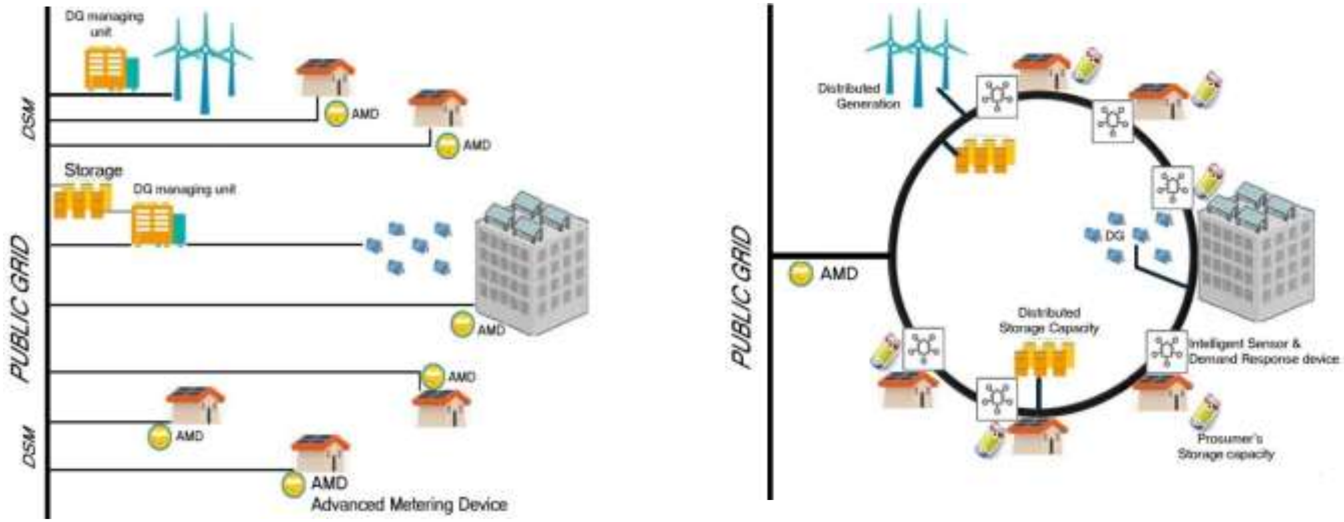
The multi-level configuration of SA processes emphasizes that conditions set within the socio-political layer (e.g. defining market conditions, or empowerment of local actors) are affecting acceptance processes in the two other layers. For example, the literature widely agrees about the notion that institutional frameworks generally should foster stakeholder and community engagement (participation, inclusiveness, co-production, empowerment) in projects. DES deployment asks for co-production in establishing the new STS infrastructure, which is co-production in investments and making space – the prime scarcity factor of renewables – and coproduction in generation and management of energy (Wolsink, 2018a).

Example: coproduction in DES microgrid

The imaginary implementation of renewables ‘replacing’ central power plant generation in the current public grid is schematically pictured in figure 2A. Advanced Metering Devices (AMDs) are measuring consumption and production of renewables’ generation units located decentral at consumers’ rooftops, ground based PV and wind farms, and Demand Side Management is possibly applied to balance the grid.

The alternative in terms of DES for the same spatial configuration is shown in fig.2B. Here the consumers manage their own generating capacity in large variations of micro-grids (Wolsink, 2012) based on community co-production (Koirala et al., 2018; Wolsink, 2018a). Moreover, they do so with control over their own generation units, storage capacity and they use demand response (DR) with monitoring and control systems (real 'smart' meters, expressly distinguish from the ADM (fig.2A) which is currently claimed to be 'smart') to balance their consumption optimally to the power generated, stored, and re-loaded in their own system. Peer-to-peer deliverance becomes essential, because of the utilization of jointly placed and jointly managed infrastructure, and balancing with the micro-grid (Wolsink, 2012; Mengelkamp et al. 2018; Tushar et al., 2018). This way DR and individual and communal storage are serving the feasibility of coproduction of DES, and simultaneously the exchange of power to the public grid is reduced, helping to solve the capacity issue there, by reducing peak demands from, also and peak feed-in to the public grid.

Figure 2. A: Renewables located decentral, in centrally configured and managed public grid;
B: Same community; DES controlled and microdrid-managed by co-producing prosumers.



Institutional theory: CPR

There should be full recognition of the essence of the acceptance object – which is anything related to innovation power supply STS. The most prominent implication is the acceptance of necessary conditions for stimulating innovation processes, of conditions needed for implementation, and of the consequences of such implementation. This implies acceptance of *institutional changes:* restructured markets, new taxing systems, education systems, spatial planning processes, energy governance frames, redefined properties in power supply, etc. It even concerns acceptance of 'creative destruction', like dismantling infrastructures, and disempowering dominant actors.

Whereas most applied theories in SA research only cover one layer/scale focusing upon static positions (one-shot case studies), highlighting one specified actor group (e.g. the "public"), this presentation will discuss the rapidly increasing recognition (Wolsink, 2012; Melville, 2017; Gollwitzer et al., 2018; Acosta, 2018; Wolsink, 2018a) of the relevance of common pool resources (CPR) theory (Ostrom, 2009). This institutional theory covers the management of social-ecological systems with regards to natural resources in natural as well as human-made – infrastructures – social-ecological systems (fig.3). It starts with fully characterizing any system in terms of variables defining four subsystems and their interactions. A social-technical system for sustainably harvesting and using renewable energy can be analyzed with this theoretical framework.

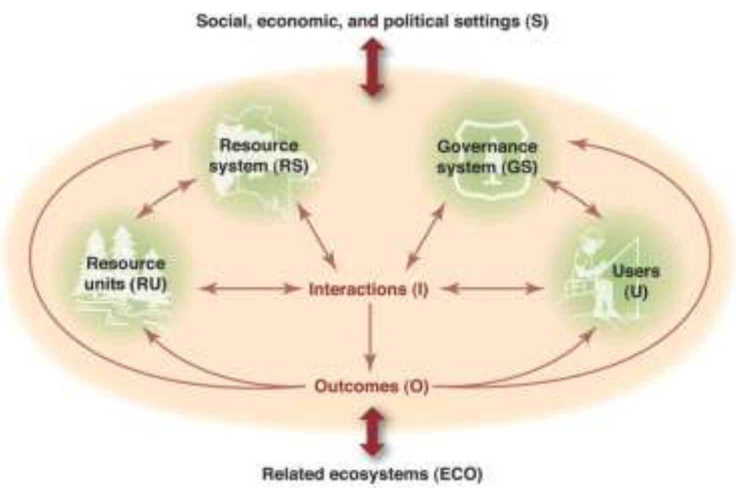


Figure 3. Social-ecological system for sustainable use of a natural resource (Ostrom, 2009, p420).

CPR theory provides a sound alternative rooted in empirical evidence from many other natural resources studies. It is, as requires for studying SA, multi-level. For this workshop we will focus upon socio-political acceptance. Socio-political acceptance mainly concerns such institutional changes rather than a conception that renewables' innovation would call for central direction from above. However, CPR studies have strongly falsified the assumption that organization itself of systems generating public value requires central direction (Ostrom, 1999). In power supply, as part of the lock-in, this idea still seems to be dominant. To avoid suggestions that the three layers (fig.1) imply any kind of hierarchy, socio-political acceptance should not be positioned on top, but it must be considered as a foundation at the bottom. Processes of institutional change are apparent in all three levels, but formally changing the rules of the game, like redefining the choice sets in markets or effectively empowering citizens for co-production of renewables, is mainly the object of socio-political acceptance. It concerns, for example, changing strong legislation favouring centralized power supply over newly emerging, but strongly obstructed initiatives of co-production by prosumers, which is in fact an overlap of market and community acceptance which is important for renewables (yellow, figure 1). In terms of socio-technical systems and transition, it is particularly about structurally change regimes, with high resistance among institutional power.

Policy relevance will be revealed concerning:
- the locked-in biases of most current social acceptance studies and policies alike;
- the multi-layer perspective of polycentric management of DES in intelligent grids;
- the significance of institutionalized regime changes fostering co-production.

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