Editorial

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Energy provision, distribution and consumption with its effects on social welfare, environment, climate change and resource exploitation is certainly a crucial field for a transition of our economies towards sustainability. Much of the discussion about energy systems is focussing on 'technical' issues such as the availability of alternative resources and technologies.

However, it is both the technological basis and the institutional framework of energy systems which are presently in a state of flux. While energy markets are increasingly liberalised and, at the same time, new and often decentral energy technologies are introduced, the role of various actors involved, such as users or service providers, is in a process of change, too. With new energy service concepts, the provision of energy can be customised to the specific needs and wants of users instead of just supplying a standardised product (including possible adverse effects of a social differentiation of service). Similarly, the implementation of decentral energy generation technologies changes the way energy systems are managed and may lead to an entrance of a range of new actors into the system.

What we observe thus is not only the improvement of a technical system of energy provision but a whole socio-technical configuration in a process of transformation. Many of these new technical and organisational changes also imply innovations at system level. The ensuing requirements of system adaptation are not possible without comprehensive social learning processes.

The transformation of socio-technical systems, such as the energy system, hence is a complex process taking place at different levels (new technologies, new social practices at a micro-level of niches; new regulations, norms and actor-configurations at the level of socio-technical systems or regimes), and involves a broad range of actors with their specific interests and expectations. Implementing policies to direct this transformation towards more sustainable configurations of technologies, social practices and institutional regulations cannot take place in a purely top-down manner, but has to involve a broad basis of social groups and stakeholders and has to be organised in a reflexive way that is flexible enough to adapt to changing contexts and societal goals.

This special issue explores the potential of interdisciplinary socio-technical analysis to better understand the transformation of energy systems as a co-evolution of changes at the level of technologies, institutions, social practices and actor constellations, and to inform governance strategies to shape the transformation of socio-technical systems

towards sustainability. The contributions of this issue are dealing with various key aspects of the transformation of energy systems such as:

- system innovations in the transformation of energy systems
- governance of transition processes towards sustainability
- the changing role of energy consumers
- socio-technical analysis of the introduction of new energy technologies
- assessing institutional innovations and new regulatory instruments in the energy sector
- improving social learning processes in the system of energy provision and consumption.

The paper by Rohracher gives an introduction to some of the key issues and concepts covered by a social science–based analysis of energy system transformation – the analysis of socio-technical arrangements and their dynamics of change, the importance of the projective dimension of expectations, visions and scenarios, and the contributions such a socio-technical analysis can make to the design and support of a long-term oriented, adaptive and reflexive energy and technology policy.

Most of the papers of this special issue focus on a specific sub-sector of the energy system or the development and diffusion of specific energy technologies. However, the empirical analysis is never restricted to these technologies, but emphasises their social embeddedness, the importance of institutional frameworks, broader socio-cultural developments and changing actor constellations. An example is Bunting's analysis of the specific characteristics of the diffusion of wind power in Australia – a development path that is influenced by the interrelations of technological characteristics with the institutional structure of the electricity sector and the interpretations and socio-political visions of influential stakeholders. Other technologies with a potential to transform the energy system such as the capture and storage of carbon dioxide (CCS), as analysed by Fischer and Praetorius, or the combined generation of heat and electricity at household level (micro-CHP), as investigated by Sauter, are at an earlier stage of development than the use of wind energy. Both papers are a good example of how socio-technical analysis can improve our understanding of the current state and the challenges faced by emerging fields of technology. These challenges often lie in the diverging strategies and interests of actor groups, mismatches with the existing institutional framework and the way policies and regulations try to deal with these emerging technologies.

An important issue covered by several papers in this issue is the role of users for the market introduction of new energy technologies. Crosbie and Guy investigate consumption practices of compact fluorescent lamps and link the formation of these practices to the social habits and practices of household lighting and the way they are portrayed in the media. Fischer, in turn, looks at the pioneer users of fuel cell–based combined heat and power generation, the characteristics of this social group and the way they might be more effectively involved in the further development of this technology. Both papers show how users and use practices – even if they play an active role in technology development – are themselves 'configured' and guided by broader social contexts. This is also what Chappells works out convincingly in her paper demonstrating the complex socio-technical interdependencies of energy supply and demand. The close

coupling of structures of provision and consumption calls for new approaches to a more systematic management of demand.

The remaining two papers of this issue analyse the systems of innovation around specific energy technologies. Kamp compares the introduction of wind power in the Netherlands and Denmark, and explains the differing success of these technologies in the two countries by the different fulfilment of various innovation system functions such as market formation or entrepreneurial activities. Loorbach, van der Brugge and Taanman widen the innovation system perspective to the whole energy system and evaluate the Dutch policy to support the transition of the energy system towards sustainability against the backdrop of an operational framework for complexity-based governance, which they develop based on socio-technical concepts.

Summing up, the special issue covers a broad range of socio-technical approaches to better understand the current transformation of energy systems and to feed back this understanding into improved strategies of policymaking. The contributions hopefully draw more attention to the relevance of social science research (social studies of technology in particular) for developing strategies to make energy systems more sustainable and to face the challenges of climate change.