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Determinants of courses of action in bioenergy villages responding to changes in renewable heat utilization policy

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The *Energiewende* in Germany includes organizational innovations for the provision of renewable energy to rural communities, often referred to as "bioenergy villages". These villages have dealt with frequent regulatory and economic changes, but little is known about what determines their response to such changes. We investigate courses of action in five villages in the federal state of Brandenburg (Germany) in response to changes in the regulatory framework promoting better utilization of surplus heat from biogas facilities. Our comparative case study method draws on interviews with village stakeholders and complementary material to scrutinize action situations and focal transactions in bioenergy value chains. A framework combining institutional economics and value-chain approaches guides our analysis. The findings suggest that linkages between action situations in bioenergy villages can facilitate accommodation of conflicting expectations of village actors in their responses to future changes, as they create opportunities and enhance capabilities to balance interests of actors and promote cooperation and coordination across value chains. Village and higher-level policy aiming to future-proof villages' facilities against challenges of the *Energiewende* could capitalize on linkages of action situations across bioenergy value chains.

1. Introduction

The German Renewable Energy Act (REA) is seen as an important determinant for the engagement of entrepreneurs and communities in renewable energy production in Germany (see Editorial, this issue). The REA is part of a set of support instruments promoting the German *Energiewende*, which literally translated means "energy turn" and involves a substantial transformation of energy provision, as it aims at fostering the replacement of non-renewable energy sources. It started with priority grid access in 1991 for renewables and gained additional momentum with fixed feed-in tariffs in 2000 and the official commitment of the government in 2011 to phase out nuclear energy. The German *Energiewende* involves the deployment of renewable energy technology and organizational innovations, including decentralized utilities, to provide biomass-based energy from rural environments. Terms like "bioenergy villages", "community energy" or "energy self-sufficient villages" have become popular, when referring to such novel local utilities in rural environments. Although definitions remain ambiguous (Becker and Kunze, 2014) authorities, politicians and community leaders in Germany stick to the term "bioenergy villages". According to the German Federal Ministry of Food and Agriculture (BMEL), a bioenergy village satisfies at least 50 percent of its total energy demand (electricity and heat) with locally produced energy from biomass (BMEL, 2015). This understanding is close to scholarly definitions of "community energy" referring to energy projects, which generate collective benefits for communities of place or interest, who have extensive ownership and control of them (Walker and Devine-Wright, 2008; Seyfang et al., 2013; see also Avelino et al., 2014). To be officially recognized as bioenergy villages by the BMEL production facilities should be owned to some extent by the villagers producing the feedstock (e.g. farmers) and the village households consuming the energy, while the feedstock originates from close proximity of the village. There are 118 officially recognized bioenergy villages in Germany that have become models for international initiatives (Jenssen et al., 2014; Eltrop et al., 2014). An increasing number of rural municipalities in Germany are seeking to become bioenergy villages

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(Jenssen and König, 2010) and the BMEL (2015) expects a further 54 villages to become official bioenergy villages in Germany. The development of bioenergy production in rural settlements is supported through private initiatives and governmental support programs at regional, national and European level, as it is assumed to reduce dependency of rural settlements from finite fossil energy resources, reduce CO_2 emissions, support structural adjustment and promote quality of life, community vibrancy and local identity in rural environments (BMEL, 2015; Eltrop et al., 2014).

The core components of a bioenergy village energy system include raw materials production and feedstock supply from forest and farm waste and land, energy generation facilities typically consisting of combined heat and power plants, distribution grids and the consumers of the generated energy. However, the bioenergy sector made both good and bad experiences with frequent regulatory and economic changes. These dynamics reflect perceived costs and benefits of bioenergy production for society, leading to changes in policy, which in turn affect investment in bioenergy (Grundmann et al., 2012). The capacity of bioenergy villages to deal with such exogenous changes is still poorly understood. As Fig. 1 shows, the growth of the biogas sector declined prior to and after amendments of the REA in 2004, 2008 and 2012. In the past, the sector recovered from cuts of privileges for energy from renewables such as reduced feed-in tariffs and increased regulatory requirements. However, Fig. 1 indicates that after the amendment of the REA in 2012, the sector has not been able to regain previous growth rates. Moreover, recent discussions on further amendments of the REA suggest future changes of the economic and legal conditions for biomass-based energy production and use in rural settlements.

If bioenergy facilities in rural settlements are expected to make a contribution to the *Energiewende* in Germany, we need to understand what determines their capacities for action and how critical conditions for these determinants can be evaluated to enhance their responsiveness to future technological, economic and regulatory changes. Focusing on biomass-based energy generation and utilization facilities in rural settlements in Germany and recent heat utilization policy, we aim to address the following research questions:

1. What policy changes induced action at the level of bioenergy villages?
2. How are bioenergy villages responding to the changing policies?
3. What determines the capacity of bioenergy villages to respond to changing policies?
4. What conditions catalyze or inhibit the specific courses and outcomes of actions in bioenergy villages?

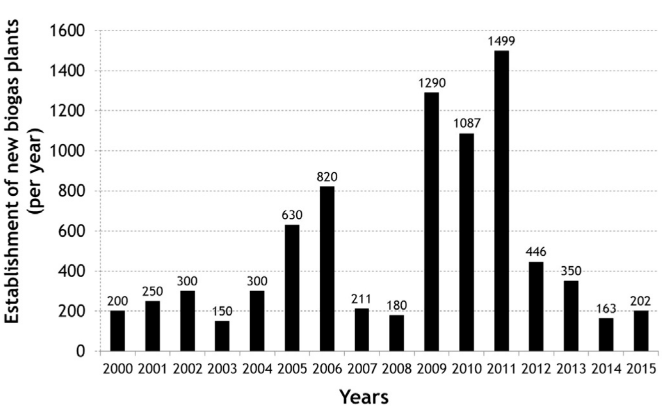

Fig. 1. Yearly increments of biogas plants in Germany, since the implementation of the Renewable Energy Act (Fachverband Biogas e.V., 2015).

We approach these questions with an analytical framework based on value chains and institutional theory, described in the next section. While the approach is exploratory and not based on preconceived theory, it develops and applies a novel analytical framework which integrates three formerly disjointed approaches. Subsequently, we present the empirical methods we use to comparatively analyze case study villages. In the results section the different response actions in the case study villages are being described and compared with the help of the analytical framework and evaluated against the outcomes of actions. We identify strategic pathways of the villages and discuss the conditions required to enhance the capability of bioenergy villages to respond to future economic, technical and regulatory changes, before concluding with implications for research, policy and practice.

2. Analytical framework

The analytical framework guides the research as a heuristic, providing for compatible assumptions, definitions and a common language between theories (Hagedorn, 2015). Our framework combines 1) the value chain approach (Brown, 2009; Kaplinsky and Morris, 2001; Raikes et al., 2000; Lenz, 1997; Kogut, 1985), 2) the Institutions of Sustainability framework (IoS) (Hagedorn et al., 2002), and 3) the Networks of Action Situations (NAS) approach (McGinnis, 2011). There are important theoretical underpinnings, which are not discussed in detail at this stage, but their significance will be uncovered, when unfolding our analytical framework empirically. In our particular study, the combination of analytical perspectives in a comprehensive framework facilitates an encompassing understanding of how the villages responded to specific changes. First, the value chain approach draws attention to the interfaces between first steps of production and final steps of consumption for each product. It also specifies the linkages of chain elements as part of a system of input–output relationships. However, it tells us little about effects of institutions on outcomes of action situations in value chains. Thus, we integrated the IoS and NAS in the value chain approach to better capture the institutional dimension of action situations in value chains and how they affect decisions and outcomes. This is particularly relevant for changes in natural resources based sectors, such as bioenergy production, which typically involve several action situations and value chains (Hagedorn, 2008). Transactions require gathering and sharing information as well as reaching and monitoring agreements. Their costs (or efforts more broadly) are contingent on the attributes and alignment of the transactions in the value chains with institutions (Williamson, 1985).

2.1. Value chain approach

A value chain includes the full range of activities which are required to bring a product or service from conception, through to the different phases of production, delivery to final consumers, and final disposal after use (Gereffi et al., 2005; Kaplinsky and Morris, 2001; Kogut, 1985). Kaplinsky and Morris (2001) emphasize that production is only one of a number of links in value chains, that there are a range of activities within each link and that these "intra-chain linkages" are mostly bi-directional. For instance, activities in a particular link in a value chain are affected by both the outputs of upstream activities and constraints in downstream links. Thus, in the value chain approach action situations and their influence on each other are not necessarily sequential. For example, the sizing of a heating grid in a bioenergy village is affected by the scale of the