



Original research article

Bioenergy as a socio-technical system: The nexus of rules, social capital and cooperation in the development of bioenergy villages in Germany



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ABSTRACT

Social resources are assumed to play an important role in the implementation of community renewable energy as a socio-technical system in Germany. The impact of social resources on the dynamics of community renewable energy has not been well understood until now. Given the importance of adapting to current and upcoming changes in the regulatory framework for renewable energy production, there is a need for a better understanding of the role of social resources in the process of sustaining community renewable energy production. Based on two case studies of bioenergy villages in the German Federal State of Brandenburg, we elucidate the nexus and impact of social capital, rules and cooperation in the development of community renewable energy. Promoting social capital that results in a balance between leadership and collective action, trust among all actors based on transparency, almost complete access to relevant information, involvement in social activities, and a consistent network of bonding and bridging ties, may contribute to the sustained development of community renewable energy.

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1. Introduction

The substantial change in energy policy in Germany in 2010 was part of a political and social process that began in the year 2000 with the implementation of Renewable Energy Act (EEG). The act aims to foster the replacement of non-renewable and fossil-based energy sources with renewables. The “energy transition” (*Energiewende*) has facilitated the development of innovative business models: e.g. decentralised biomass-based energy systems in the countryside. Different terms like “energy self-sufficient village” or “bioenergy villages” have become popular labels. Bioenergy villages in Germany are a model for international initiatives [1]. In

this study, we focus on biomass-based bioenergy as one branch of renewable energy and its particular form of bioenergy villages in Germany. By definition, a bioenergy-village can satisfy all of its electricity demand and at least half of its heating demand with locally produced biomass [2]. Furthermore, at least 50% of the production facilities should be owned by the farmers supplying the biomass and the household consumers connected to the heating grid [2].

Renewable energy based on decentralised energy supply is generally acknowledged to create new employment opportunities, increase the capacity for and acceptance of further economic and social activities [3], generate added value [4] and thereby have a significant influence on rural economies [5]. Due to the possibility of creating added value for rural areas [4,6,7], the local supply and consumption of renewable energy is of great interest to local authorities. On the other hand, problems may arise, such as rural residents’ acceptance of externalities (e.g. odour and noise emissions, etc.); uncertainty caused by frequent changes in the

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legal framework, particularly with regard to changing subsidies; unequal profit sharing; the transformation of landscapes [5]; and other socially, politically, economically and institutionally critical factors [8].

There has been a strong impetus for the development of community energy in Germany, which is reflected in the growing number of bioenergy villages registered for governmental support [9–11]. Empirical evidence shows that community energy initiatives may develop differently in terms of the achievement of objectives as well as cooperation and cost- and benefit-sharing between the numerous public and private actors involved. Previous assessments of bioenergy villages have focused mainly on techno-economic efficiencies or institutional aspects [12–15]. But although current governmental publications underline the importance of network structures and social capital [9,10], the impact of social resources on the dynamics of bioenergy villages is not yet well understood. We consider even small bioenergy villages to be deeply enmeshed in larger socio-technical systems [16]. In light of the decrease in support for biomass-based energy production announced by the current German federal government [17] and the consequential necessity of adapting to a new institutional framework, there is growing need for a better understanding and management of social resources in the process of sustaining bioenergy villages.

This empirical study of two cases in Brandenburg (Germany) aims to contribute to a better understanding of why, in certain cases, bioenergy village initiatives do or do not succeed. The results can support scientists and practitioners in the assessment of whether a social environment is favourable for the implementation of bioenergy village related projects, be it e.g. a biogas plant or a local heating grid. Furthermore we seek to contribute to the understanding of social processes by contrasting the analysis of singular elements of social systems such as social capital, institutions and cooperation with the analysis of nexuses of these elements.

As [18] previously stated, the governance of the commons is of great importance. To enhance social capital and trust among involved actors, institutions need to be adjusted to the characteristics of resources and actor groups [18]. We assume that the construction of a sustainable local heating grid is the most critical factor for the success of a bioenergy village. We further assume that because it usually involves a large number of households and economic stakeholders, a heating grid can be considered a collective resource. It can provide all stakeholders with added value when a collective solution is reached. As social capital is generally known to support the likelihood of cooperation [19,20], we explore the impact of social capital for sets of rules [21] that coordinate the decision-making process or interactions of several actors. In addition, we concentrate on the social dimension of technology, and thereby aim to contribute to a more comprehensive socio-economic assessment [22]. We examine the hypothesis that social capital drives the techno-economic development of bioenergy villages through shared rules and cooperation. The findings lead us to assert that there are no “panaceas” for the institutional settings [23] of bioenergy villages, but that priority should be given to the mobilisation and accumulation of social capital as a common resource.

We wish to contribute to the understanding of the development of bioenergy villages and the implications thereof, which differ despite being subject to the same legal framework, and ask how institutional mechanisms matter in regard to particular social interactions. In this context, we assess whether sketches or concepts of energy-autonomous communities are meaningful for the development of decentralised energy supplies. Therefore our research focuses on the following more specific questions: (1)

which actors, positions and roles are of importance; (2) which formal and informal rules are involved; (3) how social relations are coordinated; (4) what the dynamics of mutual interaction are and what their origins are; and (5) what social and institutional drivers and obstacles there are in establishing a sustainable bioenergy village.

First, we will present the theoretical concept of social capital. Then we briefly describe the case studies and the methodology before we begin the analysis and discussion of the results.

2. Nexus of rules, social capital and cooperation

There are relatively few studies that scrutinise how rules and social relations influence the performance of technical systems (see e.g. [7,24–27]). Although some authors [28] refer to institutional capacity and the need for cooperation, they do not reveal the influence of social capital, e.g. trust and cooperation, on formal and informal rules. Whereas other authors [7] clearly indicate that social capital can have both negative and positive effects on the decision making-process, they do not provide any indication about which form of social capital contributes to which effect. Some authors [29] emphasise how to overcome the energy efficiency gap that arises in a target-performance comparison by recognizing non-technical and non-economic factors. Moreover, they argue that social science should address these problems. This corresponds with previous studies that recommend implementing social science methodologies in studies on energy use [22], since the social sciences’ aim is to understand human action, and present frameworks for how to do so [30]. Some studies analyse the role of social acceptance of decentralised smart grids, which can be seen as a common good, but neglect the specific attributes of rural or urban communities or the specificities of biomass-based energy [28,31]. A noteworthy analysis [5] answers the question of how social organisation has an impact on the sustainability of biogas production in rural areas, mainly with a focus on India and China. Another study focuses on institutions in Great Britain and the need for energy subsidies [32]. A further study [33] highlights the importance of trust in developing “community energy” in the UK. But as literature reviews reveal [22], only a minority of energy research projects applies socio-economic approaches. This paper identifies fourteen promising avenues of research on energy systems, including institutions and energy governance as well as human-centred research methods [22]. To underline the urgent need for such research, the paper presents a large number of calls arguing that “(...) energy research has downplayed the role of choice and the human dimensions of energy use and environmental change”. The cited scholars go so far as to say that because of this “(...) much of what energy researchers produce is irrelevant to what actual energy policymakers and businesspersons consider important”. Consequently, the present paper follows a call for methodological contributions to “(...) more human-centred research methods, interdisciplinary collaborations, and comparative analysis” [22].

Our theoretical approach is guided by the concept of new institutional economics, which emphasizes the transactions and actors in added value chains and the coordination of formal and informal rules. North defines institutions as rules of the game and distinguishes between formal rules (law, prescription, etc.) and informal rules (oral agreements, mental models, etc.) [34,35]. A narrower definition of rules is: prescriptions of actions as either needed prohibited or permitted, and penalties if these prescriptions are not followed [23]. Moreover, rules contribute to the predictability of social outcomes. In this regard, informal rules or self-governing systems deliver incentives to solve collective

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