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The social organization of agricultural biogas production and use

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HIGHLIGHTS

- Through agricultural institutions and farmers′ practices, biogas is made available.
- Scale, supply and delivery network distinguish biogas infrastructural systems.
- Access and benefit distribution are key for a biogas system′s sustainability.

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ABSTRACT

While for wind, solar energy or hydropower, energy supply happens directly from the source to the wind wheels, hydropower turbines or solar panels, in the case of biogas, energy production cannot directly take from the energy source, organic matter, but depends on the institutional structures and farmers′ practices involved for making energy available. With the production of bioenergy in rural areas, practices within agriculture are transformed, requiring new ways of organizing production processes. Research has left the question largely unanswered of how agricultural biogas production and use are – and can best be – organized within rural society. Which kinds of social organization exist, how are these embedded in existing agricultural institutions and practices, and how do these systems function? Under which conditions may the different kinds of social organization of biogas production and use work sustainably? This introduction article to the Special Issue “The social organization of agricultural biogas production and use” presents a framework for analysing the different kinds of social organization of biogas production and use presented hereafter. Analysis parameters are the supply network, distribution network, distribution of benefits, social boundaries of the system (accessibility) and scale. Using these parameters, the Special Issue articles are outlined.

1. Renewable energies in rural areas

Renewable energies are known for a variety of socioeconomic benefits. If integrated in the productive structure of rural areas, they can diversify rural production systems and create new employment opportunities as an alternative to traditional agriculture (Bergmann et al., 2008; Del Rio and Burguillo, 2009). Among renewable energies, especially bioenergy has the potential to be integrated in the rural economy, since it uses endogenous resources like land and agricultural products. With the production of bioenergy in rural areas, the agricultural landscape, but also practices within agriculture are transformed, requiring new ways of organizing energy production processes.

Renewable energy not only has a significant influence on rural economy (Del Rio and Burguillo, 2009), it also diversifies the energy supply in rural areas, which is of particular importance in developing countries. Rural electrification here with about 60% still looms rather low[1], and especially remote rural areas often do not have access to large electricity grids. Due to low population densities and low demand for electricity, an extension of large grids often would not be cost effective. With renewable energy technologies being continuously improved and coming at lower costs, they are expected to considerably increase the rural electrification rate. The independence of these technologies from existing electricity grids, their cost-efficiency, especially in remote rural areas, and their high potential to adapt to natural and societal conditions, make them a viable alternative. Furthermore, renewable energy technologies can considerably improve energy

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[1] Figures for 2009, http://www.iea.org/weo/electricity.asp, viewed 25.08.2011.

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efficiency in rural areas of developing countries. Traditionally, rural households cover their energy demand from a variety of resources. For example, in northern China, the rural household energy consumption structure in 2005 consisted of 41.9% coal, 33.0% straw, 14.2% firewood, 6.5% electricity, 3.0% oil products and 1.4% others (Zhou et al., 2008). In rural India, 43.5% of the rural households cover lighting with electricity, the remainder uses kerosene; 64% of the households rely on firewood for cooking and 26% on crop residues or animal waste (Bhattacharyya, 2006). Sources for rural household energy consumption hence are rather diversified. Energy efficiency is hereby considerably low. If we take a look at the energy efficiency for cooking, which according to Zhang et al. (2007) makes 40–60% of total household energy use, the thermal efficiency of current stoves is about 30% for coal, 20% for straw and firewood, and 10% for straw and firewood if burned in traditional stoves (Chen, 2010, citing Wang et al., 2006). Energy consumption hence directly withdraws from local natural resources and is of low efficiency. With the introduction of renewable energy technologies, household energy use is expected to shift away from resource abstraction, and to increase in efficiency through the use of improved technology. With the introduction of, e.g. household level biogas digesters, farm households do not have to collect energy feedstock like firewood anymore, but reuse the manure of their livestock for energy generation. Together with the introduction of these technical systems, also practices within rural house holds hence need to be transformed.

Biogas is one of the renewable energy sources that is attracting more and more attention in both developing and developed countries in different parts of the world. Biogas is different from other renewable energy sources in that it is deeply embedded in rural institutional structures and social practices. This makes research on biogas production and use from a social sciences perspective, as presented in this Special Issue, particularly important. The articles in this Special Issue present a variety of modes of social organization around biogas production and use. In this introduction article, we will present these cases with the objective to initiate a discussion on the conditions under which different forms of social organization of biogas production and use work sustainably. We refer to “social organization” as the coordination of actors and material (such as organic matter) in the frame of certain rules and norms (generally referred to as “institutional structure”) to the end of producing and using energy from biogas. With “working sustainably”, we refer to the continued operation of a biogas infrastructural system. We are interested in this question of a sustained operation of biogas infrastructural systems since they are foremost small-scale and embedded in different kinds of social structures. This makes their continued operation particularly vulnerable to societal processes,—and research on the social organization of biogas production and use particularly necessary.

In the following, characteristics of agricultural biogas production and use in rural areas are presented. For a comparison of the different cases of this Special Issue, we will use a framework which builds on the literature of modernized mixtures (see e.g. Hegger, 2007; Spaargaren et al., 2006; van Vliet, 2006). After outlining this theoretical concept, we will devise the framework for comparison and then use it for the introduction of the cases presented in the Special Issue. In the synopsis article of this Special Issue, we will present a more detailed analysis of the articles.

2. Agricultural biogas production and use

Biogas is produced from digesting a variety of organic materials and wastes. In developing countries, organic waste is used such as animal manure and human excreta, kitchen waste, garden waste, and other waste from agriculture, slaughterhouses and food industries. In developed countries, apart from these organic wastes, commercialized biogas plants also use energy crops like maize, barley, sunflower, lucerne and sorghum, in order to keep biogas production stable (Bauer et al., 2010). In exploring the developments of biogas in different contexts, this Special Issue will concentrate on agricultural biogas production systems, and pays less attention to biogas production related to sanitary landfills, wastewater treatment systems and industrial effluents (three other more centralized systems of biogas production).

Agricultural biogas production systems largely depend on inputs (e.g. animal and human excreta, agricultural residues) which previously hardly served energy production, but rather were embedded in the agricultural system and related institutional structures within the agricultural sector. Whether a farm has enough feedstock for its biogas digester depends, for example, on the size of its land and its cropping pattern, as well as on wider incentives for livestock raising like meat prices, or livestock raising habits. Biogas therefore considerably differs from other renewable energies like wind, solar energy or hydro power where energy supply happens directly from the source to the wind wheels, hydropower turbines or solar panels. In the case of biogas, energy production cannot directly take from the energy source, i.e. organic matter, but depends on the institutional structures and farmers′ practices involved for making energy available.

The social organization of biogas production and use gets more complex if a farm has no livestock and/or the land affiliated to the digester is too small to supply a digester with enough feedstock. Additional feedstock needs to be collected or bought from markets, neighbouring farmers or members of a cooperative. Wider policy frameworks furthermore define the kinds of feedstock. While in Germany, supportive policies resulted in an agricultural surface of 5.4% under energy crops for biogas production, in China, cultivation of energy crops on arable land is prohibited. Biogas production hence is fundamentally embedded in these institutional structures and policy frameworks of the agricultural sector.

This embedding partly also is the reason why agricultural biogas production has evoked strong debates. Energy crops compete with food production for inputs such as water, land and nutrients. However, if feedstock is composed of manure and agricultural residues, biogas production entails foremost benefits which again can be integrated in the agricultural sector. Agricultural biogas production then can be said to have less trade-offs than other renewable energies. Especially in the case of wind energy, side effects have been highly debated, like visual impacts on the landscape, shadow cast from wind mills, or noise creation. These disadvantages can raise considerable scepticism against renewable energy systems (see e.g. Musall and Kuik, 2011). Hydropower systems, even if small scale, can substantially impact the ecosystem by increasing concentrations of pollutants in the water, changing habitat availability for fauna and flora, as well as through siltation within rivers and erosion (Abbasi and Abbasi, 2011). Such substantial impacts cannot be expected from current forms of small-scale biogas infrastructural systems.

Agricultural biogas production furthermore differs from other renewable energies in the multiple benefits that it can entail for local society. Especially in developing countries, the benefits of agricultural biogas production can be realized. In the absence of functional sanitation and waste collection infrastructures in rural areas, organic waste material and excreta are collected in the biogas digesters, preventing them to drain into and pollute the local environment. Processing in the digester destroys pathogens and therewith can reduce the spreading of diseases. Cooking with biogas eliminates smoke in the kitchen from the burning of e.g. firewood or straw, which improves indoor air quality and prevents