Renewable energy transitions – lessons learned from rural pilot regions and communities in southwestern Germany

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Abstract
The paper explores the implications of renewable energy and bio-economy strategies for rural communities and farmers' roles. Focusing on two administrative districts in southwestern Germany, we discuss the related developments in a low-carbon economy transition perspective.

The regional initiatives related to renewable energy are cross-sectoral in scope, and rely on effective multi-actor partnerships and (co-)learning networks, governance thus playing a central role. Farmers feature as pioneers in innovations such as the cultivation of alternative energy crops, the advancement of technology, and as providers and keepers of resources such as land, biomass, and knowledge.

Cross-sectoral and cross-scale integration requires learning and facilitation, e.g. in the form of network management. The Federal Ministry of Agriculture funded management and coordination in 25 German bio-energy pilot regions over the period of 2009-2015. Support included knowledge exchange among actors interested, e.g., in setting up a local heating system based on renewable energy sources and the establishment of so-called 'bio-energy villages'. These function as small 'innovation cells' providing models far beyond the local level. The transitions associated are located at the interface between agricultural and wider economic and community-level development. Contributing to improved agriculture-society relations and rural areas' enhanced attractiveness as places to live and work (not least for younger people), the bio-energy villages potentially to some extent help to counteract rural demographic change.

Findings also support the view that a stronger integration of different sectoral policies and funding mechanisms contributes to a harmonisation between renewable energy and bio-economy strategies and broader rural development goals.

1. Introduction and background

1.1 Research questions and methodology

New and innovative agriculture-oriented activities based on renewable resources adopted by farmers and other rural actors require learning processes to acquire (e.g. technical) knowledge as well as adequate governance structures (necessitating organisational expertise). In the case study building the basis of this paper, such activities are being picked up as a response to shifting framework conditions going along with agricultural and rural structural change as well as volatile policies (Peter et al., 2015). Among such policies, the implications of German national renewable energy and bio-economy strategies for rural communities and farmers' roles are explored. We focus on

two administrative districts in southwestern Germany, discussing the related developments in a low-carbon economy transition perspective.

At this, the emphasis is on bio-energy, specifically on-farm biogas production, although there are additional relevant sources of renewable energy in the study region. The biogas technology is central in community-related developments such as 'bio-energy villages'. Historically, the initial association of biogas production with animal husbandry through the primary objective of manure processing makes the two administrative districts – where animal husbandry is an important agricultural sub-sector – especially relevant as case study region. Moreover, biogas is well suited as an example of a long-standing evolution in terms of technology, actors and institutions.

The paper is based on a case study carried out in the EU FP7 project 'Rethinking the links between farm modernization, rural development and resilience in a world of increasing demands and finite resources' (RETHINK, 2013-2016). The German case study carried out between 2014 and 2015 entailed expert interviews and in-depth desktop analysis. In the paper, findings on agriculture-oriented activities rooted in renewable resources are related to wider current debates on the transition towards a low-carbon economy and sustainability in the bio-economy (see section 3.).

1.2 Overarching EU- and national-level strategies relevant to bio-energy

As stated in the European Commission's strategy 'Innovating for Sustainable Growth: A Bioeconomy for Europe', the 'Europe 2020 Strategy calls for a bioeconomy as a key element for smart and green growth in Europe' (EC, 2012:2; EC, 2010). Here, the bio-economy approach is defined as encompassing 'the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy' (EC, 2012:3).

Bio-economy – and bio-energy, as one of its 'key sectors' (Global Bioeconomy Summit, 2015:4) – are named as innovative fields to potentially contribute to an overall 'transition to sustainable agriculture and forestry' by the European Economic and Social Committee (EESC, 2014:4). The widely present bio-economy concept is increasingly being critically discussed, albeit lacking an unanimously shared definition and being subject to various competing interests. It is connected to a range of policy spheres – including industry and energy, agriculture and fisheries, climate and environment, research and development – as well as strategies. ~~Fin~~ Likewise, ~~the~~ access to biomass – be it timber, green waste, manure, or energy crops – is linked with the interests of various actors and subject to regulations at the interface of several sectors (Peter et al., 2015).

In Germany, strategies on bio-economy policy and bio-economy research are pursued by the Federal Ministry of Food and Agriculture and the Federal Ministry of Education and Research, building on the national sustainability strategy (BMEL, 2014; BMBF, 2010).

The 'Road Map for a Low-Carbon Economy by 2050', aiming at a reduction of EU domestic emissions by 80% by the year 2050 as compared to the baseline year of 1990, is an associated strategy of relevance (EC, 2011). Among its milestones throughout this transition process, it refers to agriculture as a sector 'potentially at some risk of carbon leakage' (EC, 2011:10). Furthermore, the aim of 'raising land use productivity sustainably' is to entail, amongst others, 'bio-gasification of organic manure' (EC, 2011:9). The 'shift towards a low carbon and climate resilient economy' is also present in the Rural Development Regulation (EU) No 1305/2013 (Publications Office of the European Union, 2013).

1.3 Evolution of strategic and legal framework relevant to renewable energy in Germany

The German renewable energy sector is highly policy-dependent. In the year 2000, the Renewable Energy Law (*Erneuerbare-Energien-Gesetz* – EEG) was introduced, establishing 20-year feed-in tariffs for energy from renewable sources. Its forerunner, the Electricity Feed-in Law (*Stromeinspeisungsgesetz* – StromEinspG) of 1991 ~~had~~ introduced a minimum compensation for electricity from renewable sources fed into the grid, making ~~the~~ biogas technology relevant for energy production while previously it had been mainly used for processing manure into fertiliser. The years following the EEG's introduction saw the launch of the national 'Energy Turnaround' policy framework. An expansion of the feed-in compensation by a so-called 'Nawaro' bonus for renewable materials including manure within the scope of the EEG's first amendment in 2004 led to rapid growth in energy crop cultivation (Bruns et al. 2009). 2009's second amendment again led to a clear increase in biogas digesters as the feed-in allowance for power from biogas was raised, the *'Nawaro'* bonus being extended to also apply to a parallel use of various substrates (Umweltbundesamt, 2010). A resultant acceleration of development in the biogas sector also took place in the case study region characterised by animal husbandry. With the stalling of the 20-year feed-in guarantee approaching, operators need to consider their perspective. However, there are also more short-term market changes and policy volatility. The capacity for responding to change necessitates access to information among the actors concerned and is central within the concept of resilience at the core of the RETHINK project (Peter et al., 2015).

Within the 'Energy Turnaround' framework, in 2010 the 'Energy Concept 2050' (*Energiekonzept 2050*) was enacted by the German state government with the overall objective of achieving an energy supply mostly from renewable sources by 2050. In 2011, an acceleration of the change process was agreed on as a consequence of the Fukushima nuclear catastrophe. The EEG's third amendment in 2012 led, amongst others, to a facilitation of operating 'mini' biogas plants with up to 75 kW, encouraging the setting-up of farmer-operated plants for the purpose of using on-farm biomass. However, meanwhile a point of uncertainty has been reached, with farmers facing the decision whether to risk additional investments into renewable energy activities or not (Peter et al., 2015).

Sutherland et al. (2015/2015a) trace back energy transitions across several decades, from the 'pioneering phase' as early as the 1950s to a 'contestation phase' marked by the 2007 global food crisis. They also include a detailed account of the development of biogas in Germany in terms of technology, actors involved and institutional frameworks.

2. Regional renewable energy transitions – the example of two administrative districts in southwestern Germany

2.1 Key characteristics of the regional agriculture

Located in southwestern Germany, the adjacent administrative districts of Hohenlohekreis and Schwäbisch Hall (SHA) are involved in a range of activities related to renewable energy. Hohenlohekreis was part of the 'Hohenlohe-Odenwald-Tauber Bio-energy Region' (H-O-T) in the national 'Bio-energy Regions' programme (BR) initiated by the Federal Ministry for Consumer Protection, Food and Agriculture (2009-2015). Support was provided for the establishment of regional networks in the field of bio-energy in 25 model regions throughout Germany. These networks could partly build on structures created during the 'Regional Action – Shaping Rural Futures' programme (2002-2007) for which so-called 'regional partnerships' had provided the organisational basis. Both districts had been part of the latter programme, which – amongst other thematic fields – had covered renewable energy as an important market regarding an environment-friendly and sustainable use of natural resources and regarding wider sustainable rural development. In 2006, the SHA district

government had committed to the objective of reaching a share of 100% electricity and heat supply from regional renewable sources within the context of a '100% Renewable Energy Regions' project. Although the district it did not participate in the BR programme, involvement in renewable energy activities is high (Peter et al., 2015).

The case study region is classified as rural area with some trends towards densification (BBSR, 2014a), and in 2012 on average had a population density of 132.2 inhabitants per sqkm, below the federal-state average (Statist. Ämter d. Bundes und der Länder, 2015).

Since the 1970s, the region experienced fast economic development. Outside the farming sector, the regional economy is characterised by a traditional craft sector, and small- and medium-sized enterprises mainly in the fields of engineering, food and wood industr~~y,~~ies and automotive suppliers, amongst others (Peter et al., 2015).

In 2012, in both districts, the share of employment in the primary and secondary sectors was above the average of the federal state, while the shares of the tertiary sector were below-average (see table 1).

Table 1: Selected figures on the case study region's economy (2011/12)

Region	2012					2011
	Primary sector's share of employment (%)	**Secondary sector's …**	**Tertiary sector's …**	**Knowledge-intensive, business-oriented services' …**	**Unemployment rate**	**GVA farming / forestry / fisheries (%)**
Hohenlohekreis admin. distr.	0.9%	48.4%	50.8%	4.6%	2.8%	1.6%
SHA admin. distr.	0.6%	44.7%	54.7%	10.2%	3.3%	1.7%
Federal state Ø (Ba.-Württ.)	0.4%	37.8%	61.8%	11.1%	4.1%	0.5%
National Ø	0.8%	30.2%	69.0%	10.5%	7.1%	0.8%

(Source: BBSR, 2014b; Statist. Ämter d. Bundes und der Länder, 2015; authors' compilation)

In both districts the share of utilised agricultural area (UAA) related to the total surface area in 2011 was above 55% (see table 2). This is above-average as compared to the federal-state (45.7%) and national levels (52.3%) (Statist. Ämter d. Bundes und der Länder, 2015). In 2010, the average farm size in the region was 35.5 ha UAA. Animal husbandry is relevant especially in SHA (26.5%, as compared to 13.7% in Hohenlohekreis). A share of 22.9% of farms in Hohenlohekreis and of 16.2% in SHA pursue a combination of mixed farming and animal husbandry (Statistisches Landesamt Baden-Württemberg, 2014). The manure available from this type of farming plays an important role as substrate for biogas production.

Table 2: Selected figures on the case study region's agricultural sector (2010/11)

		Hohenlo-hekreis admin. distr.	SHA admin. distr.
% share of UAA related to total surface area (2011)		57.2%	55.3%
Total number of farms		1,229	2,031
% share of full-time farms		39.5%	46.0%
Farm size structures:	Average total size (ha UAA)	33.5 ha	37.6 ha
	% share of farms < 20 ha UAA	52.9%	40.0%
	% share of farms 20 to < 50 ha UAA	24.2%	32.3%
	% share of farms 50+ ha UAA	22.7%	27.7%
	% share of farms 100+ ha UAA	0%	0%
% share of production types:	Arable farming	15.7%	10.5%
	Horticulture	1.3%	0.9%
	Permanent cultures	25.7%	0.4%
	Forage growing	20.6%	45.4%
	Animal husbandry	13.7%	26.5%
	Mixed farming and animal husbandry	22.9%	16.2%

(Source: Statist. Ämter d. Bundes und der Länder, 2015; Statistisches Landesamt Baden-Württemberg, 2014; authors' compilation)

2.2 Key renewable energy activities under support

Strengthened rural communities and improved agriculture-society relations – the example of 'bio-energy villages'

In the study region, non-energetic biomass use plays a subordinate role. The use of timber as a construction material, for example, is an exception from this rule (see aspect of cascading biomass use in section 3.). The most relevant bio-energy value-added chains include, first of all, biogas, and – additionally – energy wood pellets or chips, and short rotation plantations. In addition, 'energy tourism' has expanded. However, there is also concern voiced by regional stakeholders regarding renewable energy facilities (e.g. wind turbines) affecting the characteristic (cultural) landscape, not being convinced of a positive reframing of the visual impact of such infrastructures through thematic tourist routes. It is argued that renewable energy tourism is only a niche so far, but the majority of tourists still looking for 'classic' leisure activities (Peter et al., 2015).

So-called 'bio-energy villages' following the objective of a 100% renewable energy supply are central projects of the Bio-energy Region. Their activities had become independent from support already during the programme phase. Initially, H-O-T had facilitated knowledge exchange, e.g. during meetings for actors interested in setting up a local heating system. The villages follow the principle of community-based energy production using local resources for covering local demand. While farmers are involved, they are not necessarily the initiators of activities (see figure 1). Cross-sectoral linkages are exemplified by 'energy tourism' offers such as bicycle tracks from one bio-energy village to another and guided tours on 'transparent' bio-energy production.

From regional stakeholders' point of view, bio-energy villages have considerably contributed to mobilising enormous community spirit, improved agriculture-society relations, and contributed to the attractiveness of villages as places to live and work. To carry the villages have proven vital as

experimenting and innovation cells with an impact as models beyond the local level, and – at a larger scale – contribute to the transition towards a low-carbon economy.

[FIGURE 1 → *to be added from separate file*]

Fig. 1: *Key features of bio-energy villages*

(Source: based on Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016d; modified and translated by authors)

The bio-energy village of Untermaßholderbach (Hohenlohekreis) exemplifies such a development process: ~~The~~ the pioneering farmer operating a biogas plant on the outskirts as an additional pillar of farm income had initially been considered an 'outsider' by the population who were suspicious regarding his initiative to establish a local heating network. Assuming he was acting exclusively for his own profit, the potential benefit for the village as a whole was not realised at first. When facilitators from the Bio-energy Region's office started moderating the process with an open citizens' council as the first step, views changed and a joint village-wide project was initiated. The process started in 2010 and has been sustained by a core team of eight citizens who also form the managing team of a civil law association founded in 2011 and carrying the local heating system. Almost all of the village's citizens are participating as shareholders. Meanwhile almost the whole village sources its heat from the local network based on residual heat from biogas production, a cooperative plant for wood chip production was built in order to cover peaks in demand during winter, and the village has developed into a zero-emission municipality. Renewable electricity is sourced from the local biogas plant and from photovoltaic devices. The village that has completed the 'Energy Turnaround' envisaged by the national government at the local level and was awarded 'bio-energy village of the year' in 2014 serves as a model far beyond the local level, with professional visitors, students and tourists from the region, neighbouring urban centres and even delegations from abroad. With a population of only 110 and lacking e.g. educational infrastructure, the small municipality has nonetheless become an example of sustainability, future orientation, and environmental awareness. Because of the high demand for guided tours, people from the village are being trained as 'bio-energy guides'. According to regional stakeholders, this development process would not have been feasible without the Bio-energy Region's supportive structure (Peter et al., 2015; Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016c).

2.3 Multi-actor partnerships and (co-)learning processes

Combination of different knowledge sources

In order to achieve the objectives of the initiatives and funding schemes introduced above (see section 2.1), learning and related governance processes are central.

As a general finding, the integration of various knowledge types and sources as well as forms of learning is vital. This includes farmers' practical knowledge, vocational schools and universities, research institutions as well as farmers' associations and machinery rings, agricultural administration, and the federal-state level Ministry of Rural Areas (MLR) with its capacities for disseminating information. Forms of learning encompass both unilateral science-to-practice 'knowledge transfer' as well as mutual learning within multi-actor networks, driven by moderating bodies. From stakeholders' view it is crucial to have research and education institutions within the region as this creates *'a competitive advantage as compared to other regions that need to permanently buy that knowledge from external sources'* (Peter et al., 2015:38).

Farmers' experiential knowledge is likely to be exchanged among themselves as they prefer on-demand practical information which is e.g. gained by a visit to a neighbouring farmer running a biogas plant. At this, the benefit of mutual learning is valued higher than the potential risk of losing a competitive advantage. Businesses manufacturing renewable energy facilities also serve as exchange agents among farmers.

~~On the schedules of regional agricultural vocational schools, renewable energies have gained in importance in recent years.~~ In recent years renewable energy has increased in importance on the schedules on regional agricultural vocational schools.

Farmers' associations are important as consultants regarding detailed questions on technology or business management. Together with machinery rings, they are the central source of expert information on issues related to on-farm renewable energy, e.g. with regard to setting up a biogas digester or a wind turbine.

The Bio-energy Region's management to some extent plays a moderating or 'bridging' role in knowledge exchange in the field of material flow management and bio-energy. It facilitates farmers' access to knowledge by bundling and regularly spreading information (e.g. providing advice for farmers on concepts for the use of residual heat from biogas plants).

There are also some relevant federal-state-level scientific institutions to be named, such as a research body in a neighbouring administrative district, a 'Bio-energy Research Platform' engaged in multi-disciplinary cooperation and 'technology and knowledge transfer' on (energetic) biomass use (Peter et al., 2015), as well as the 'Bioeconomy Research Baden Württemberg' programme covering 'sustainable and flexible value chains of biogas production' (Bahrs & Angenendt, 2015).

The role of farmers in the regional multi-actor network

The multi-actor (learning) network studied encompasses farmers, but also actors from forestry, craft, education and research, as well as tourism, amongst others. Farmers play a part as protagonists of new agricultural activities, pioneers in innovations, as well as providers and keepers of various (in)tangible resources. In interaction with the other rural actors, farmers thus vitally contribute to opening up a future perspective for their rural region (Peter et al., 2015). Two success stories from the study region are to illustrate how 'energy farmers' innovate in the biogas sector based on a sustainable use of place-based resources such as land, biomass, and knowledge, by cultivating alternative energy crops and developing new approaches to processing of residuals from biogas plants. These examples correspond with the regional practice-oriented and hands-on mentality and openness for cooperation (Peter et al., 2015).

In the bio-energy village of Siebeneich (Hohenlohekreis) with a population of 200, a diversified farmer who also runs a butcher's shop and gastronomy services pioneered in the cultivation of Chinese reed (*Miscanthus giganteus*) on two hectares of arable land. Chips of the reed can be used in woodchip heating systems. As important drivers behind the story, a high willingness to innovate combined with a motivation to induce change are named. The conversion from heating oil to Miscanthus considerably helps reducing heating costs: the amount needed based on heating oil for one month suffices for a whole year based on the alternative energy crop. What has turned into a 'success story' is the result of an intense learning process lasting about three years. This was based on practical testing and experience as 'there was no one there to ask how it is done', starting from sourcing the plants to questions of planting and raising them in the field. Meanwhile, the

farmer's success is a model for others to follow in Miscanthus cultivation (Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016a).

Another pioneering farmer from the municipality of Kupferzell (Hohenlohekreis) even invested ca. ten years' time in experimenting before having worked out a method of producing fertiliser pellets from the digestate of his biogas plant. The idea is not to cultivate energy crops, but to use residual materials as substrate, such as fruit waste from juice producers, vegetable waste from wholesale trading centres, on-farm residuals from his own arable land, in addition to manure from pig fattening. In line with the idea of a circular economy (see section 3.), the point according to the farmer is: 'This is how the circle closes – from nature for nature.' The product has been certified organic according to EU regulations and is being marketed via regional horticultural centres and flower shops. The motivation behind the development had been to diversify in order to become less dependent on animal husbandry, in the face of pressures from the global agri-markets. The enterprise also has a community dimension as the on-farm biogas plant also supplies waste heat to a business company and 20 households via the local grid. 'The local people really like this', as the farmer states (Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016b).

Such pioneering initiatives correspond to history, with small-scale agricultural holdings in the Federal States of Bavaria and Baden-Württemberg being the 'cradle' of on-farm biogas plants during the pioneer phase at the national level in the 1970s to 1990s (Umweltbundesamt, 2010).

2.4 Renewable energy contributing to diversification at farm level and of the regional economy as a whole

In the regional energy mix, on-farm biogas, wind and photovoltaic energy generation play a central role. The related initiatives are cross-sectoral in scope (albeit limited in the range of sectors involved), and rely on effective multi-actor partnerships and (co-)learning networks. Governance thus plays a central role. The transitions associated are located at the interface between agricultural and wider economic and community-level development. This is exemplified for instance by value-added chains integrating energy production with 'energy tourism' as in the bio-energy villages (see section 2.2).

A certain level of diversity can be considered a key feature of resilient agricultural systems. This applies to various levels, including on-farm, the agricultural sector as a whole, as well as the overall regional economy. Several pillars of income help to expand the repertoire of responding to changing framework conditions (see examples in section 2.3) (Peter et al., 2015).

On the one hand, ~~the~~ activities related to renewable ~~energies~~ energy in the case study region can be stated to unfold relevance for wider economic and community-level development. 'Interface activities' such as 'energy tourism' are an example of cross-sectorality, and ownership and decision-making patterns related to the bio-energy villages contribute to empowerment and inclusiveness. The prospects for younger people's job opportunities created by the rise of the wider related developments help to enhance rural areas' attractiveness, thus potentially benefitting demographic structures. On the other hand, however, a focus of funding schemes on the topic of renewable ~~energie-s~~energy, and bio-energy in particular, can be argued to constitute a limitation regarding the rural development process as a whole (Peter et al., 2015).

Looking at the policy landscape, the case study suggests the need for a better integration of various funding schemes. For instance, the limitations of the Bio-energy Regions' non-investive support might be compensated given the opportunity of a combination with other, investment, funding sources. Agricultural-sector funding (e.g. a programme on renewable material flows) and for rural

areas as a whole (e.g. LEADER) are not integrated, due to 'departmental' separation and the prohibition of parallel funding from various sources (Peter et al., 2015).

3. Contextualising case study findings in wider debates on the transition towards a low-carbon economy and a sustainable bio-economy

The findings from the German case study region presented in the previous sections can be contextualised in current broader debates on the transition towards a low-carbon economy and a sustainable bio-economy. It can be concluded that the activities studied widely correspond to features discussed as requirements for a 'sustainable bio-economy'. In spite of a thematic focus as opposed to a thematically more differentiated rural development approach, the bio-energy activities studied mostly provide an example of an 'eco-economy' as discussed by Marsden (2012), e.g. with regard to on-farm energy production, community-owned biogas digesters and bio-energy villages using local CHP from nearby plants, and the sustainable use of regional biomass (Peter et al., 2015).

On the one hand, bio-economy and sustainable development are being associated in strategic documents. At the level of the case study, this is view exemplified by a status report entitled 'Bioeconomy – Baden-Württemberg's path towards a sustainable future' (Biopro Baden-Württemberg GmbH, 2013). On the other hand, resource efficiency and a low-carbon and circular economy are concepts discussed as necessary preconditions to a sustainable bio-economy yet to be established.

Although it is being stated that 'the bio-economy' well links to the realisation of a range of UN Sustainable Development Goals (SDGs) (United Nations, 2016; German Bioeconomy Council, 2015), it is conceded that a 'sustainable bio-economy' carried by society at large yet needs to be defined, alongside with ecological and social sustainability criteria enabling its assessment (Global Bioeconomy Summit, 2015; German Bioeconomy Council, 2015). This would help 'render bioeconomy a venture based on a widely shared vision of a sustainable future' (Global Bioeconomy Summit, 2015:3). From this point of view, it is agreed that 'bioeconomy as such is not inherently sustainable' (Global Bioeconomy Summit, 2015:4), and sustainability aspects remain to be incorporated in bio-economy-related policies (German Bioeconomy Council, 2015). Nonetheless, a 'communiqué' resulting from the first Global Bioeconomy Summit hosted by the German government's Bioeconomy Council in November 2015 in Berlin cites as a generally accepted definition of bio-economy 'the knowledge-based production and utilisation of biological resources, innovative biological processes and principles to *sustainably* provide goods and services across all economic sectors' (Global Bioeconomy Summit, 2015:4; authors' italics). The document contains recommendations developed by an International Advisory Committee on how the bio-economy could be designed in order to 'work for sustainable development', including the formulation of basic principles and measures. An integrated approach to a bio-economy policy is advocated, being in line with the recommendation derived from the German Baden-Württemberg case study for a stronger integration of various policy fields instead of a sectoral focus and thematic fragmentation among various funding schemes (Peter et al., 2015). The Standing Committee of Agricultural Research (SCAR) in its 2014-15 foresight exercise addresses the 'transition to a sustainable European bioeconomy', the development of a 'paradigm of a competitive bioeconomy fundamentally framed by the need for sustainability' (Kovacs [ed.], 2015:7).

With regard to the bio-economy's knowledge basis, the Commission in its related strategy refers to the relevance of 'local and tacit knowledge' alongside a variety of scientific disciplines associated with the range of sectors involved. This variety is named as precondition to the sectors' 'strong innovation potential' (EC, 2012:3). Also in the case study region, a combination of knowledge sources was found favourable, ranging from farmers' practical knowledge to scientific knowledge produced in research institutions (Peter et al., 2015; see section 2.3).

According to the EESC, the 'development of sustainably produced biomass should take place within a clearly defined policy framework, respecting limits on production and use, social aspects and biodiversity [...] to ensure the further evolution of the bioeconomy in a way that can bring social, economic and environmental benefits' (EESC 2014:8). In relation to resource efficiency, sustainable use and generation of value added and also with a view to the competing interests linked to biomass, the concept of a cascading use is of relevance. Being an element of a circular economy, cascading use 'in itself does not avoid waste, but it is among the principles of the circular economy that there is "no waste"' (Kovacs [ed.], 2015). The success story of the fertiliser pellets produced by the Hohenlohekreis biogas farmer is an example of this (Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016b). In the case study region in general, a more sophisticated, cascade, use of biomass beyond energetic use is subject to ongoing research. For instance, regional timber is being used as energy wood for combustion on the one hand, while there are other interests underlining the high value of timber as a construction material (Peter et al., 2015). In addition to the pointed 'no waste' claim, the circularity principles include avoiding negative impacts of consumable goods on the biosphere and enhanced reusability of durable goods, as well as the use of renewable energy (Kovacs [ed.], 2015).

A related strategic EU document was issued in 2015 – 'Closing the loop – An EU action plan for the Circular Economy' – after a 2014 forerunner had been withdrawn. It contains reference to the energetic use of 'biological resources' and states the bio-economy's potential to contribute to the circular economy by providing 'alternatives to fossil-based products and energy'. It also picks up the issue of interest conflicts, underlining that 'using biological resources requires attention to their lifecycle environmental impacts and sustainable sourcing. The multiple possibilities for their use can also generate competition for them and create pressure on land-use'. And further: 'In a circular economy, a cascading use of renewable resources, with several reuse and recycling cycles, should be encouraged where appropriate.' The Commission is announced to 'promote synergies with the circular economy when examining the sustainability of bioenergy under the Energy Union'. The role of farmers and rural areas is not explicitly mentioned in the document (EC, 2015:17). The issue of interest conflicts is also broached by SCAR, who state a critical clash of food and biomass demands, as well as a decline in biodiversity and ecosystem services (Kovacs [ed.], 2015).

In line with the idea of the interrelation of the concepts, the term of a 'circular bio-economy' is being coined and used, for instance, in the context of the European Innovation Partnership on Agricultural Sustainability and Productivity (EIP-AGRI, 2016). In a recent publication, the EIP quotes the Institute for European Environmental Policy (IEEP), stating that 'ensuring that farmers and foresters benefit from circular activities is critical to their engagement and to the long-term sustainability of circular bio-economy in practice'. Moreover, on the role of agriculture and forestry: 'The "circular bio-economy" is one where farmers and foresters take a leading role in developing the bio-economy and making it more sustainable by integrating circular activities and natural cycles into existing and new practices' (EIP-AGRI, 2016:1).

'Carbon-neutrality', its potential to 'considerably contribute to decarbonisation', are named among the beneficial features of the bio-economy, while the blurred definition of the concept shaped by diverse interests is not neglected (Global Bioeconomy Summit, 2015:2; German Bioeconomy Council, 2015:7). However, this potential is yet to be realised by moving 'toward a resource efficient and low-carbon economy' (German Bioeconomy Council, 2015:7).

The above-named 'communiqué's' intention to contribute to a 'global agenda' is also relevant for the case study region, reflecting a 'neo-endogenous' approach to rural development acknowledging the interplay of the local to global levels as 'key determinants' of a wider rural development in which

a ‘competitive farming sector is not a prerequisite for viable rural areas’ (Hubbard & Gorton, 2009:94). In this perspective, in order to pursue sustainable development, global approaches are required in complementation to bio-economy strategies’ adaptation to national- or regional-level conditions (German Bioeconomy Council, 2015). In line with this, regarding the role of farmers, the bio-economy development is expected to make rural areas less dependent on agriculture, but help establish ‘new bioeconomy value webs’ (Global Bioeconomy Summit, 2015:4). In the case study region, criticism of a rural development approach focused too narrowly on farming instead of a more integrated line was voiced by stakeholders; from this point of view, multifunctional and diversified farming should go along with a more cross-sectoral approach (Peter et al., 2015). At the level of production systems, the importance of diversity is also echoed by SCAR’s bio-economy understanding, stating that these ‘should be diverse, using context-specific practices at different scales and producing a diversity of outputs. As diversity is key to resilience, innovations in the bioeconomy should be developed to foster diversity rather than limit it.’ (Kovacs [ed.], 2015:16)

4. Conclusions

While the longer-term success of the German ‘Energy Turnaround’ and of EU-level strategies remains to be seen and concepts such as the ‘bio-economy’ face contestation, the bio-energy activities in the case study region can be stated to have successfully contributed to the transition towards a low-carbon economy at the local and regional levels.

A limitation to this positive resume is constituted by the fact that a more integrated rural development might be overshadowed by a narrow thematic focus. Advocating a more integrated rural development approach also has implications for the role of farmers and the agricultural sector, making them part of multi-actor networks and cross-sectoral value chains. Looking at the governance processes identified in the case study, on the ‘strong’ side, broad integrated rural development processes as implemented in the Bio-energy Region’s forerunner scheme, Regional Action, appear favourable in terms of including various thematic fields and actors’ aspirations in a cross-sectoral perspective. On the ‘weak’ side, the stronger thematic focus of the Bio-energy Region – in spite of its cross-sectoral implications – limits the range of actors getting together (including non-farmers, actors not involved in bio-energy) and sharing their knowledge within a network (Peter et al., 2015).

Case study findings also support the view that a stronger integration of different sectoral policies and support schemes would contribute to a harmonisation between renewable energy and bio-economy strategies, and broader rural development goals.

Given the policy dependence of the renewable energy sector, the long-term sustainability of the initiatives that were started within the policy frameworks introduced in the case study region remains to be seen. Especially network management has proven a vital component of such schemes, and its long-term funding can be regarded favourable in order to ensure the lasting of the processes and structures established within the framework of pilot programmes. While rural funding schemes can be considered vital in promoting innovative concepts (exemplified in the paper by a connection of renewable energy and tourism, or the cultivation of alternative energy crops), their ‘mainstreaming’ beyond the beneficiary regions remains an important open question.

Returning to the RETHINK project’s core questions, ‘rethinking’ the modernisation of farms and rural areas in the case study refers to valorising renewable resources sustainably and adapted to local and regional conditions. New forms of governance play a vital role in this development process, notably expressed in new actor network constellations. The activities studied exemplify responses to agricultural and rural structural change – i.e. being innovative (e.g. by entering new fields such as ‘energy farming’) and flexible (e.g. by relying on more than one pillar of farm income).

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