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Institutional context and cluster emergence:

The biogas industry in Southern Sweden

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Introduction

Recently, with the 'evolutionary turn' in economic geography (Boschma and Frenken 2006, Boschma and Martin 2007, Boschma and Martin 2010) there has been an increasing interest in the spatial emergence of economic phenomena, such as the origin of new industries. Having its roots in evolutionary economics, evolutionary economic geography (EEG) explains the uneven spatial distribution of economic activities and industrial structures based on the micro-level search and selection behaviour of firms understood as organizational routines. Emanating concepts such as related variety and regional branching have added considerably to the economic geography literature as they supplement the weakness of established systemic approaches to innovation by emphasizing the influence of historical preconditions and path-dependencies in regional economic development (Boschma and Frenken 2006, Uyarra 2010).

With the development of the research field, however, some scholars have criticized the strong emphasis ascribed to firm-level routines at the expense of institutions and other actors, for example the state (MacKinnon et al., 2009; Morgan 2012). Due to this bias, evolutionary economic geography has until now only rendered limited explanatory power to factors such as policy interventions and institutions in actively favouring certain development paths (Asheim et al., 2013), in spite of some notable exceptions (Martin and Sunley, 2006). According to pioneering proponents of EEG, the role of (territory-specific) institutions is considered small for explaining where new industry emerges and grows (Boschma and Frenken 2009a). At the same time, others have argued that there is a need in economic geography to better understand institutional evolution over time with regard to regional economic change (Gertler 2010) as there is still a rather limited understanding on the role of public policy for the diversification of regions into new growth paths over time (Asheim et al. 2011).

The objective of this paper is to make a contribution to our understanding of industry emergence and development from a co-evolutionary perspective involving technology, industry dynamics and institutions. To do so, the paper studies the evolution of the biogas industry in the region of Scania in southern Sweden. Triggered by policy programmes targeting local initiatives to reduce greenhouse gas emissions as well as experiences and existing infrastructures related to the extraction and distribution of natural gas in the region, biogas activities started to emerge in the late 1990s and early 2000s. During the past decade and simultaneous to technological advances in the biogas area, regional policies have induced further growth of this industry, for example through creating demand for locally produced biogas by setting up environmental goals that stimulate its use in the regional public transport system. The biogas industry constitutes today a visible and emergent industry in the region, involving a network of both public and private actors on the supply as well as demand side of biogas. More precisely, today various utilities, farmers, food and energy companies as well as universities, research centres and support organisations are part of this emerging industry, attracting more actors to enter.

From an EEG perspective, the biogas industry in the region of Scania constitutes an interesting and relevant case to study cluster emergence considering the co-evolution of institutions, firm-level routines and industry dynamics as well as technologies. In particular, it aims at investigating how territorial institutions, in combination with firm-level routines and technology development, can steer regional economic development and evolution along certain development paths. The paper takes a combined institutional-evolutionary perspective by drawing on literature from EEG and socio-technical transitions and seeks to unpack the evolutionary process that led to the emergence of this industry. In particular, the paper aims at addressing the following research questions:

How do specific territorial institutions matter for the emergence of biogas industry in Scania (specific/empirical RQ)?

How can policy interventions work actively in favour of new regional economic development paths (more general/theoretical RQ)?

The pronounced analytical focus on the role of public authorities and policies calls for taking a combined evolutionary-institutional perspective on cluster emergence and regional industrial development. The theoretical framework of the paper departs from a discussion on industry emergence in (evolutionary) economic geography introducing concepts such as path-dependence, related variety and regional branching. In order to account for an institutional perspective, the paper draws on insights from science, technology and innovation studies targeting the functions of technological innovation systems regarding transformative technological change.

//Paragraph on conclusions to be added here//

The paper is organised as follows. The next section presents the theoretical framework of the study, drawing on literature on spatial industry emergence as well as on socio-technical transitions. The subsequent section introduces the empirical case study and analysis, also including an outline of the research design and methods applied in the study. The paper ends with a discussion and conclusion section.

Theoretical framework

Towards a combined evolutionary and institutional perspective on cluster emergence

The objective of this paper is to make a contribution to the understanding of cluster emergence and development from a co-evolutionary perspective involving technology, industry dynamics and institutions. The theoretical framework of the paper departs from a discussion on an evolutionary understanding of spatial industry emergence introducing and discussing concepts such as path-dependence, related variety and regional branching. It also includes a discussion on the role of institutions in this stream of literature. In the further course of the theoretical section and in order to account for an institutional perspective, the paper uses insights from science and technology studies, particularly drawing on the technological innovation systems (TIS) approach concerning how technological change and industrial development can be actively supported.

Spatial industry emergence and evolution

Traditionally, the major part of the literature on economic geography and in particular the subfield of geography of innovation has been focusing on localised learning and agglomeration externalities for innovation processes. The emphasis on the evolutionary nature of innovation processes in EEG responds to an important critique raised against this literature in that they provide snapshots of successful regions detached from their time-space context (MacKinnon et al., 2002). According to Uyarra (2010) the majority of regional innovation system studies can be characterized as “inventory-like descriptions of regional systems, with a tendency to focus on a static landscape of actors and institutions” (p. 129). Having its roots in evolutionary economics, the notion of path dependence is central to EEG, denoting the importance of history and the dependence of past decisions for future events to occur. As a consequence, it is a widely shared understanding in the field of EEG that regional economic

development is path dependent. As Martin (2010) frames it, it is "the combination of historical contingency and the emergence of self-reinforcing effects" stemming from critical mass and spillovers that is considered key in steering the "technology, industry or regional economy along one 'path' rather than another" (Martin 2010:3).

Initial attempts in economic geography to understand industry emergence by paying attention to path-dependencies in regional economic development followed the 'window of locational opportunity' (WLO) line of thought (Scott and Storper 1987, Storper and Walker 1989). This literature argues that new industries experience a rather high degree of locational freedom as they put relatively novel demands on their locational conditions in terms of access to knowledge, labour skills and machines. As these requirements are still uncertain and not in place yet when a new industry starts to form, all regions have a similar potential to become host of a new industry (Boschma 1997). Once a critical amount of firms carrying out a new type of industrial activity has established itself in the region, the WLO narrows down because the industry becomes tied to its location. In this manner, an industry becomes locked-in in a specific place (Storper and Walker 1989). With regard to industry emergence, the WLO model assumes that new industries form and shape regional economic spaces (rather than the other way around) and ascribes much explanatory power to the role of chance and accidental events (Nygaard Tanner 2012), thus resonating with the traditional model of technological path dependence as laid out by David (1985) and its emphasis on "historical accidents", "chance events" or "random" action for new technological pathways.

With the evolutionary turn, however, voices have recently been raised for a re-interpretation of path-dependencies, implying a stronger consideration of local (knowledge) resources in shaping regional industrial development paths over time. The literature on EEG gives evidence to path-dependent regional development, stating that firms are expected to diversify into activities that are technologically related to their existing competences. Consequently, regions are assumed to slowly diversify and branch out into technologically related fields, implying that industrial structures are rather persistent in a region (Boschma and Frenken 2009b, Boschma and Martin 2010). This industrial development and evolution is from an EEG perspective explained by knowledge spillovers between firms, assuming that for effective learning to take place a certain degree of cognitive proximity between firms is needed that firms can interpret, absorb and implement new knowledge (Cohen and Levinthal 1990); however, also a certain degree of cognitive distance (or technological relatedness) between actors is needed to stimulate novelty (Nooteboom 2000). To address the question of optimal cognitive distance in a context of knowledge spillovers at the regional level the concept of 'related variety' has been introduced (Frenken et al. 2007), stating the positive impact of a variety of different yet technologically related regional industries on regional growth.

Due to its roots in evolutionary economics, the EEG framework has a pronounced perspective on and interest in firms and their routines. More precisely, the pioneering work on EEG (Boschma and Frenken 2006) makes an explicit distinction between evolutionary and institutional approaches to economic geography, arguing that the role of (territory-specific) institutions is small for explaining where a new industry emerges due to the fact that firms

develop routines in a path-dependent and idiosyncratic manner (Boschma and Frenken 2009a). This work does not neglect the impact that (territorial) institutions can have on the behaviour of firms, but institutions are treated as conditioning rather than determining the behaviour of firms and regional development as a whole (Boschma and Frenken 2011). Moreover, it is argued that institutions come into existence or become aligned to support a specific industrial activity once it has started to develop (Boschma and Frenken 2009a). As such, EEG follows the general line of arguments laid out in the WLO model in assuming that institutions are responsive to rather than responsible for new development paths.

The mentioned work on EEG has led to a general understanding in the discipline of economic geography that regional economic development is not random but that it relies on historical prerequisites in terms of firms' knowledge bases and routines as well as knowledge spillovers that lead to new industry emergence over time. However, the fact that the pioneering work in EEG puts much emphasis on path-dependencies in regional economic development has been taken up by in the literature, arguing for an incorporation of institutions in approaches to explain path-dependence as well as a stronger consideration of change processes in evolutionary thinking (Martin 2010) or emphasising the importance of processes of collective agency in creating and steering certain development paths (Simmie 2012). Other scholars have mentioned their concern about a 'theoretical relegation' of institutions and social agency (MacKinnon et al. 2009), while others such as Essletzbichler (2009) and Grabher (2009) regard a stronger consideration and inclusion of institutions in EEG as highly relevant for the further development of the research field (Asheim et al. 2013). As such, there is still a limited empirical and theoretical understanding on the role of institutions and public policy concerning the diversification of regions into new growth paths over time (Asheim et al. 2011), as well as a lack of scientific work taking a more holistic perspective regarding the co-evolution of institutions and technology (Strambach 2010).

Institutional context and industry formation

In contrast to the literature on EEG, the literature on socio-technical transitions allows taking a co-evolutionary perspective on technology and industry dynamics and their institutional embedding. A core tenet of this literature is that technology and institutional dimensions should not be analyzed separately when trying to understand innovation. Rather, both aspects are understood in their co-determination over time. The analysis is therefore not restricted to 'technologies' but rather addresses 'socio-technical systems'. The formation of socio-technical systems is conceived as a process of constructing 'configurations that work' (Rip and Kemp 1998) among technological artifacts and their organizational, institutional, infrastructural, use related aspects. During early formation phases largely all major components of a sociotechnical configuration are still in flux: technologies need to improve in performance and cost characteristics, use patterns and user preference have not yet been fully established and institutions to regulate the impacts of the technology are not yet fully spelled out (Callon 1998, Dosi 1982). On the other hand side, established and mature socio-technical configurations, may exhibit strong path dependencies that go beyond lock-in effects based on

increasing economies of scale (Arthur 1994), but may be generated by the initial establishment of use patterns (David 1985), standards, infrastructures or institutional structures (Granovetter and MacGuire 1998).

The technological innovation systems approach (TIS), introduced by Carlsson and Stankiewicz (1991) and further developed by amongst others Hekkert et al. (2007), Bergek et al. (2008) and Markard and Truffer (2008), has gained considerable attention in developing a process view on early industry formation. The framework takes a systemic perspective on innovation and considers different actors such as governmental and non-governmental organizations, research institutes and firms as well as different forms of institutions and their interplay as important elements for innovation to take place. Following Markard and Truffer (2008), a TIS can be defined as "a set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilization of variants of a new technology and/or a new product" (Markard and Truffer 2008:611). As a framework for analysis the TIS approach has a rather strong focus on mapping the functionality of the innovation system. In order to assess the performance of the innovation system, Johnson and Jacobsson (2001) and Bergek et al. (2008) have identified seven functions that have to exist around a new, emerging technology (i.e. they have to be carried out by actors and institutions) in order for a technology to diffuse and to lead to new industry emergence: 1) *Knowledge development and diffusion* (generation, diffusion and combination of knowledge in the innovation system), 2) *influence of the direction of search* (incentives for organizations to enter the TIS), 3) *entrepreneurial experimentation* (reducing uncertainty through probing and bringing a technology into practice), 4) *market formation* (development of markets for emerging technologies), 5) *resource mobilization* (mobilization of financial and human capital), 6) *legitimation* (exert influence on the public opinion with regard to a new technology), and 7) *development of positive externalities* (achievement of clustering effects in the emerging industry) (Bergek et al. 2008)[1].

The strong focus on functions in the TIS framework has brought about important insights with regard to key activities in innovation systems as well as understanding processes of technological change and innovation (Hekkert et al. 2007). This allows making statements concerning an active construction and the set-up of a supportive institutional context in emerging clean-tech industries. Furthermore, the TIS framework makes it possible to take a dynamic systems perspective on innovation which allows making statements concerning how specific functions have come in place. The TIS functions target various networks, actors and institutions of the system and makes obvious that for new technologies to penetrate markets, multiple dimensions play important roles. The core strength of the framework on mapping the functionality of innovation systems as well as its underlying strength concerning policy implications to support new technologies is yet accompanied by its weakness in explaining regional differences in technology evolution and development (Bergek et al. 2011, Coenen et al. 2012)

[1] However and according to the authors' view, the last named function could likewise be considered as a result of the six other functions being in place.

Analysis

Drawing on the previously mentioned insights from evolutionary economic geography and socio-technical transitions, this paper will use the biogas industry in the region of Scania as a demonstrative case of industry emergence, considering the co-evolution of institutions, technologies and industry dynamics (i.e. firm-level routines). The biogas industry is today an emergent industry in the region of Scania, a region that traditionally has been characterized by its agriculture and food industries (producers of organic waste). The region hosts a broad network of public and private actors on the supply as well as demand side of biogas, covering the entire value chain; that is feedstock production, (farmers, municipal water treatment, food industry, households and service sector), pre-treatment, upgrading of biogas and distribution (municipal waste and water treatment companies, energy companies), retail (municipal waste management companies, energy companies, oil companies) and end-use (farmers, public transport companies, food industry, private gas vehicle owners). Furthermore, universities, research centres and support organisations are part of this emerging industry, having the aim to develop the region into a nationally and internationally leading Centre of Excellence for biogas in 2020. Today, Scania is the county with the highest count of biogas plants in Sweden, producing 0,35 TWh of energy (in 2011) and aiming for an increase to 3TWh until 2020 which equals 10% of the county's energy demand.

The following sections will shed light on the formation process of this industry from a co-evolutionary perspective, whereby the analysis is based on a combination of qualitative research methods[2]. Personal in-depth interviews with key stakeholders are the main data source, complemented by document studies on publicly available data sources such as websites, strategy documents and annual reports. In total, the paper draws on a number of 17 semi-structured interviews with representatives of the industry were conducted, involving public sector and industry, as well as a major university in the region. Eleven interviews were conducted between September 2012 and April 2013, explicitly addressing the research questions studied in the paper. Additional six interviews, conducted in May 2013 within the framework of another research project, were used as reference and for cross-checking purposes.

Emergence of the biogas industry: unpacking the evolutionary process

Setting the scene: early activities in the region

Activities related to the production of biogas in the region of Scania had their first origin in the beginning of the 1980s and were a reaction to national regulations targeting the reduction of sludge emanating from water treatment at purification plants. Looking back, these early activities can be seen as one important element for the formation of the industry at later stages; at these times, however, these activities occurred also in other parts of the country and moreover, they were not exclusively targeting the production of energy (i.e. first and foremost

[2] As clean-tech activities do to date not underly any industry classification code, it is hardly possible to identify the industry in databases and to make statements on its regional economic impact in qualitative terms.

the reduction of sludge). However, the biogas produced at the pants at these times was partly used for energy purposes such as for heating the plant facilities. Also going back to the early 1980s, simultaneous activities of a large energy company in the region concerning the supply of southern Sweden with natural gas and the construction of a natural gas grid along the region's west coast can be seen as crucial component for the later formation of the biogas industry. These activities can be seen as a strategy targeting secured energy supply in the southern part of the country as reaction to a national nuclear power referendum in 1980 to decide on the close-down of a nuclear power plant in the region. The experiences with natural gas as a new source of energy in southern Sweden as well as progress in technology development led to the political decision in the mid-1990s to run public city traffic (i.e. the city busses) in the region's capital Malmö on natural gas in order to reduce emissions, improve urban air quality and reduce traffic noise. In other parts of the region, mostly driven by environmental concerns, early attempts were made by some municipalities to collect organic waste from households and to use it as a renewable energy source. Simultaneously in the late 1990s, the previously mentioned energy company became involved in a municipal project targeting pilot experiments concerning the feed-in of biogas into the natural gas grid. Due to this demonstration project, the energy company became an international forerunner in upgrading technologies, targeting the upgrade of biogas to natural gas quality in order to distribute it through the existing grid and making biogas available. At that time (i.e. between 1998 and 2002), the regional capital set up local environmental goals to reduce greenhouse gas emissions and biogas was increasingly considered as a future ambition in public transport.

Industry emergence

The emergence of the biogas industry in Scania gained momentum in 2002, when the Environmental Protection Agency of Sweden (i.e. the national governmental agency responsible for proposing and implementing environmental policies) announced the Climate Investment Programme (KLIMP). This programme targeted local initiatives focusing on the reduction of greenhouse gas emissions and increasing energy efficiency in Sweden. The programme denoted a call for public (local and regional) authorities in Sweden within which also several municipalities in Scania (partly in cooperation with each other) sent in their application. KLIMP constituted a seven-year grant for the period 2002-2008 whereby projects related to biogas where seen as highly important due to the fact that these showed the greatest climate effects. Altogether, biogas projects in 17 out of Sweden's 21 regions received a grant. However, the region of Scania was standing out and received together almost half of the overall grant (of a total of 622 million Swedish krona). As such, the activities and built up of infrastructures in the region of Scania prior to KLIMP during the 1980s and 1990s can be seen as a critical factor for success with regard to the KLIMP applications.

The KLIMP programme can be seen as an institutional setting providing legitimacy for technological change targeting increased energy efficiency and a reduction of greenhouse gas emissions by exerting influence on the general and public opinion of new technologies. The programme can be considered as an instrument to communicate that technological change was

desirable by relevant actors. By implication, as legitimacy influences expectations, KLIMP can likewise be seen as means of guiding the direction of search of actors and creating incentives to enter the TIS (Bergek et al. 2008). Hence, KLIMP provided stability and was a crucial element for steering the development along a new development path (or a technological trajectory). However, at that time only comparatively little industrial activities targeting biogas were existent in Scania. Rather, the previously mentioned simultaneous (and largely independent) activities and pre-requisites in the region such as suitable infrastructure and experiences with natural gas, a demonstration project targeting biogas upgrading technologies as well as early activities to collect organic waste from households can be seen as factors constituting an anchor for KLIMP to build on. The development in Scania was further strengthened in December 2002 when the County Administrative Board of Scania published an environmental action plan containing specific milestones concerning the reduction of greenhouse gases in the region. This action plan was worked out by a large number of municipalities, organizations and increasingly also companies in the region.

The network of actors involved in biogas activities in Scania gained increasing foothold in year 2005/2006 when a regional association for biogas stakeholders (Biogas Syd) was founded, driven by various public and private biogas actors in the region, involving waste management and energy companies, universities, research centres and municipalities. The association can be seen as bottom-up initiative resulting from a growing need for operational and strategic interaction in the biogas area and it is founded and funded by its members as well as by regional authorities providing basic funding. Thereby, the increasing need for interaction was resulting from the actors' increasing awareness that biogas has a high potential in Scania. First, the region is characterized by a high amount of raw material (biomass) through the region's traditional stronghold in agriculture and food industries. Second, there was an increasing interest among actors such as energy companies and utilities to develop a more environmentally friendly profile. Furthermore and also drawing on earlier experiences with natural gas, research regarding biogas technologies had made substantial progress in the region, leading amongst others to spin-offs from a technological university in the region. The establishment of the stakeholder association, being a support and network organization with the aim to increase the production and use of biogas in the region, can be seen as important towards strengthening the regional networks in the regional biogas field. From an institutional perspective, the foundation of the network organisation can be considered as supporting knowledge development and diffusion, a function considered as central for a TIS and innovation processes in general (Bergek et al. 2008). Network activities are considered crucial for knowledge exchange and interactive learning, and in the region of Scania these clearly profited from different, but related existing industrial activities existing in the region, such as agriculture and food industries. Likewise, the foundation of the network organisation can be seen as means of resource mobilization (both financial and human capital).

From industry emerge to growth

A decisive moment for the biogas industry in the region of Scania was in 2007 when the regional government's public transport committee set up a goal that all public transport in the region should be fossil free in 2020, with sub-goals targeting fossil free city traffic (city busses) in 2015, regional traffic in 2018 and remaining service trips in 2020. In reaction to the announcement of these goals, the company running the public transport in the region – being a publicly owned company and part of the regional authorities – thereupon took the decision to invest in biogas. Important for this decision was the fact that the energy needed for the public transport should be produced locally in order to obtain a direct environmental effect in the region. Biogas was regarded as the fuel with the highest regional potential; attributed also to the more and more developing regional specialization on biogas, as well as to the fact that Scania was considered to possess the greatest potential for biogas production within Sweden. From a raw material perspective, this potential can be ascribed to the previously mentioned stronghold in agriculture and resulting biomass residuals from related industries, the experiences and existing infrastructures for the production of biogas at sewage treatment plants since the 1980s as well as the interest of local waste management companies to collect organic waste from households. Furthermore, it was important for the transportation company, acting on behalf of the regional government, to decide only for one technology and not for several at the same time because of the high investments required; moreover, it was considered important to give a clear and secure signal to the market. The latter can be seen as clear example from the regional authorities to support entrepreneurial experimentation through reducing uncertainty and facilitating concrete actions targeting a specific technology (Hekkert et al. 2008). Moreover, the grant from KLIMP programme, still in place when the regional climate goals were set up, was used for the acquisition of biogas busses and public filling stations. The regional public transport system played thus a crucial role for promoting the development of the biogas industry in Scania as it created a local market for the biogas produced in the region. The decision taken for the regional public transport system led to activities of private companies (such as energy companies) to invest in the (commercial) production of biogas. Since then, various private actors have entered the industry and the number of biogas plants has increased rapidly.

The development of the industry was further supported in spring 2010 when the county administrative board of Scania set up a climate goal for the region, particularly to bring forward the regional production as well as consumption of biogas. The goal implies a total production of 3TW biogas in the region in 2020, which equals 10% of the energy demand of the county. Moreover, Scania shall develop into a nationally and internationally leading Centre of Excellence for biogas in the upcoming years. As a reaction to that, in December 2010, an action plan was worked out by the regional government together with municipalities, the county administrative board of Scania, universities and private companies in order to concretize specific actions to reach these goals and to form a basis for improved co-operation between actors in the industry. Although the action plan was worked out in collaboration with private companies and research organizations, the regional government played a major role in its development. As such, the action plan is in line with the decision on fossil free public

transport taken in 2007, and can be seen as further signal providing legitimacy concerning the future support or biogas related activities in the region in the future. The effect of the legitimacy and market creation on the industry becomes evident by the fact that increasingly also private actors enter the industry and that the industry is diversifying in terms of markets. Whereas in 2007 the public transport was almost the only – and still is the dominant – commercial demander of biogas, the industry is diversifying in terms of demand; for example, as bio fuel, biogas becomes increasingly accepted also among private vehicle drivers in the region.

Discussion

The above analysis aimed at unpacking the evolutionary process that has led to the emergence of the biogas industry in the region of Scania in southern Sweden. It intended to bring to light to what extent territory-specific institutions have mattered for its emergence – and in particular, to reveal how policy interventions can work actively in favour of new regional economic development paths.

As identified in the analysis, the emergence of the biogas industry in Scania gained momentum through the announcement of the national KLIMP programme. By targeting local initiatives for energy efficiency and a reduction of greenhouse gasses, it provided legitimacy for technological change, while at the same time influencing actor's expectations, guiding their direction of search and creating incentives for further actors to enter the TIS. The provision of legitimacy through policy interventions (i.e. KLIMP) led subsequently to an arising need for increased knowledge development and diffusion with regard to biogas technologies among actors, becoming apparent in the foundation of a network and support organisation for biogas (Biogas Syd). This need can be seen as a result of the preceding policy interventions, yet this time increasingly driven by private actors as a reaction to the legitimacy provided by the state towards (local) public authorities. Decisive for the further development of the emerging biogas industry in Scania were the subsequent political decisions taken in the region, i.e. by the county itself. By appointing biogas as a crucial fuel with future prospect in the regional public transport system, the regional authorities were tying up to the technological trajectory set by the preceding KLIMP programme and became active in supporting another TIS function, namely market formation. This can be seen as a crucial step for the commercialisation of a new technology and product as it provides further legitimacy, entrepreneurial experimentation and guidance of the search for the actors.

The fact that the TIS functions could be identified to have operated, as well as interacted with one another, during the early evolution of the biogas industry calls for a more detailed elaboration of the spatial levels at which the functions were supported. In order to allow for a

spatially differentiated analysis, figure 1 demonstrates the evolution of the biogas industry in Scania, yet in a simplified manner[3].

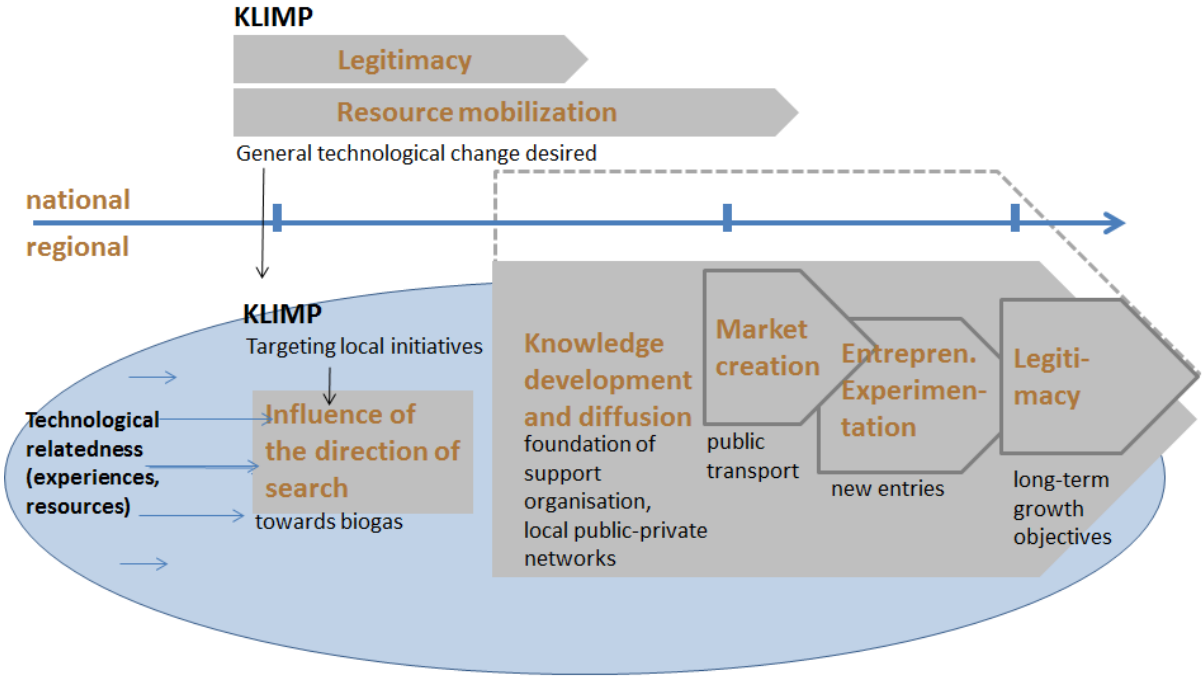

Figure 1: TIS functions: A spatial perspective on Scania. Source: own (unfinished) draft.

First and foremost, the figure illustrates that the majority of TIS functions is supported at the regional level (i.e. in Scania) whereas legitimacy and the mobilization of financial resources by the KLIMP programme are realized at the national level. As the KLIMP programme initially targeted initiatives in all Swedish municipalities, it could have led to similar effects all Swedish regions. However, the momentum in Scania was achieved due to the existence of specific local prerequisites that have been in place prior to KLIMP. These include particularly technological and infrastructural aspects regarding natural gas (existence of the grid, experience with buses, development of upgrading technologies) as well as a strong presence of agriculture and food industries in the region, possessing the potential to provide valuable resources (residuals) for the biogas production - in addition to organic waste stemming from households. In addition, the existence of related but different technological competences in the region was an important factor for the industry to form. These regional prerequisites should be seen as decisive for the success of the KLIMP applications stemming from municipalities in Scania. However, it has to be noted that the KLIMP programme did not target industry emergence. Rather, industry emergence should be seen as an implication and consequence of the programme as it provided a common orientation to previously existent (largely independent) activities. KLIMP played thus an important role in aligning competences and activities of actors in the region towards another. In other words, it

[3] As the TIS framework has a weakness in explainig regional differences in technology development and evolution (Coenen et al. 2012), the paper contributes by this means also to the literature on socio-technical transitions. In the majority of studies, TIS are set national boundaries that neglect local/regional specificities of TIS characteristics (for an exception see e.g. Binz and Truffer 2012).

influenced actors' direction of search and steered the development towards a new technological path.

Based on this alignment of interests and activities through KLIMP, several other processes became operative at the regional level. These include a growing need for further knowledge development and exchange, resource mobilization, market creation, entrepreneurial experimentation and legitimacy. All these developments result either from decisions that were actively taken in the region and/or that profited substantially from the regional level. It has to be noted, however, that these processes (functions) do not follow any strict sequence as pictured in figure 1; they overlap with one another and are in some cases simultaneously active. Furthermore, not all processes taking place at the regional level should be understood as being exclusively regional in nature as they may be linked to developments at the national or international level. By way of example, Scania is very likely to be embedded in knowledge networks exceeding the regional boundaries and moreover, developments targeting biogas are likely to be influenced by a general (international) endeavour to reduce the use of non-renewable resources. Yet, in Scania the regional level is considered crucial with regard to industry development, mainly due to technological competences existing in the region in the broad sense, regional processes taking place in context with and as a response to the KLIMP programme, as well as subsequent political decisions taken on the innovation system.

//To be included here: Short reference to other biogas cases in Sweden//

Conclusions

The objective of this paper was to make a contribution to the understanding of cluster emergence and development from a co-evolutionary perspective involving technology, industry dynamics and institutions. To do so, the paper took a combined institutional-evolutionary perspective by on the one hand drawing on literature from EEG concerning path-dependence in regional economic development and the question where new industries form and why they form where they do. On the other hand and to account for an institutional perspective, the paper made use of the literature on socio-technical transitions, particularly the technological innovation systems approach, concerning an active construction and the set-up of a supportive institutional context in emerging (clean-tech) industries. Empirically, the paper sought to unpack the evolutionary process that has led to the emergence of the biogas industry in the region of Scania, southern Sweden.

Referring to the discussion on industry emergence in evolutionary economic geography, the illustrated case does neither support the WLO argument of industry emergence and location being a random phenomenon, nor can industry emergence be exclusively explained by firm-level routines. Rather, the analysis reveals that specific territorial institutions can (and do) matter for regional industry emergence. In Scania, a national policy programme (KLIMP) was crucial for aligning existing competences and activities to one another that were different but related with regard to biogas. In other words, a certain degree of 'related variety' regarding biogas was existing in the region (e.g. experiences with (related) infrastructure and

technologies; the existence of valuable industries), yet, its potential was not made use of before KLIMP was announced. Here, the policy programme was thus decisive for steering the region towards a new development path.

This alignment of interests and expectations, caused by the policy programme, led subsequently to increased cooperation and a need for further knowledge development among both public and private actors in the region. Hence, it is a striking example of how policy programmes can (and do) shape behaviours of actors. A strategic perspective for the industry was thereupon built up by active policy decisions on the innovation system in the region itself, i.e. by creating a market for the produced biogas and by setting up further strategic development goals. Thus, we argue that in the case of the biogas industry in Scania have initiated and strengthened functions in the innovation system over time. These were either directly created by policy programmes, respectively decisions - or they developed as a consequence of these. The functions started to interact with one another and created path-dependencies and stability at the regional level. As such, Scania can be seen as a region possessing a critical amount of TIS functions working in favour of the biogas industry.

By way of concluding, we argue that the co-evolution of technology, industry dynamics and institutions is important to consider when studying processes of (clean-tech) industry emergence and evolution. The presented case reveals that institutions should be considered as important when studying the 'why', 'when' and 'where' of industry formation. Due to its strong focus on firms and their routines as main protagonists, the literature on EEG has to date a relatively weak focus on context. Therefore, we argue for a change in the empirical analysis of EEG that goes beyond the study of the micro-level search and selection behaviour of firms. This paper gives consideration to this claim particularly by showing how (and that) policy interventions can shape behaviours of firms and thus, steer regional economic development paths. Yet, the complex interplay between firm-level routines ('related variety') and institutional settings underlying this development should not be neglected.

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