



Institutional dynamics and technology legitimacy – A framework and a case study on biogas technology

Jochen Markard^{a,*}, Steffen Wirth^b, Bernhard Truffer^{c,d}

^a Swiss Federal Institute of Technology Zurich, Department of Management, Technology and Economics, Chair of Sustainability and Technology, Weinbergstrasse 56/58, 8092 Zurich, Switzerland

^b IFZ – Inter-University Research Centre for Technology, Work and Culture, Schloegelgasse 2, 8010 Graz, Austria

^c Eawag – Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstrasse 133, 8600 Duebendorf, Switzerland

^d Chair of Geography of Transitions in Urban Infrastructures, Faculty of Geosciences, University of Utrecht, Heidelberglaan 2, NL-3584 CS Utrecht, Netherlands

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ABSTRACT

Legitimacy is central for both novel and established technologies to mobilize the resources necessary for growth and survival. A loss of legitimacy, in turn, can have detrimental effects for an industry. In this paper, we study the rise and fall of technology legitimacy of agricultural biogas in Germany over a period of more than 20 years (1990–2012). The field witnessed impressive growth and professionalization for many years and has become one of the key technologies in Germany's energy transition. In recent years, however, it has been confronted with major criticism, which finally resulted in a substantial cut-back of public and political support. The aim of our study is twofold. In empirical terms, we will explain the technology's loss of legitimacy despite its compliance with original policy objectives: growth and maturation. In theoretical terms, we work toward a more general framework to understand technology legitimacy and to explain the institutional dynamics of technological innovation systems.

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1. Introduction

Whether a technology thrives and flourishes depends, among others, on how well it is aligned with the norms, values and beliefs in its wider context. A technology that is well understood, compatible with established practices, socially accepted and perhaps even endorsed by regulation, possesses a high degree of legitimacy, which is essential for resource mobilization and successful development (Bergek et al., 2008a, 2008b; Hekkert et al., 2007; Rao, 2002). Conversely, if there are conflicts and institutional misalignment, technology development may be hampered (Breukers and Wolsink, 2007; Geels and Verhees, 2011; Wirth et al., 2013).

In this paper we study the development of a novel technology with a focus on institutional structures. We analyze which technology-specific institutional structures emerge, how they interact with context structures and how both, technology-specific and contextual institutions change over time. Our focus is on the alignment (or misalignment) of the focal technology with elements in its wider context, which we refer to as *technology legitimacy*.

Analyzing institutional alignment and misalignment will help us to explain technology dynamics, including exponential growth and major drawbacks.

Legitimacy is of critical importance for the development and prospering of firms, technologies and industries (Aldrich and Fiol, 1994; Bergek et al., 2008b; Zimmerman and Zeitz, 2002). Legitimacy has been conceptualized as the perceived consonance of an entity with its institutional environment, i.e. a socially constructed set of norms, values, beliefs and practices in its context (Scott, 2008; Suchman, 1995). The concept has been widely used in organizational institutionalism explaining, among others, that organizations conform to their institutional environment so that they can mobilize critical resources (DiMaggio and Powell, 1983; Meyer and Rowan, 1977). While legitimacy of organizations has received much attention in the literature (Deephhouse and Suchman, 2008), comparably few scholars have looked into legitimacy at the level of an industry or technological field (Aldrich and Fiol, 1994; Bergek et al., 2008b; Geels and Verhees, 2011; Rao, 2002).

Legitimacy is important for both novel and established technologies as it is a prerequisite to mobilize financial, human and material resources as well as regulatory support (Bergek et al., 2008a; Hekkert et al., 2007). Legitimacy is created in a collective,

* Corresponding author.

E-mail address: jmarkard@ethz.ch (J. Markard).

social process involving organizations such as technology developers, experts, associations or interest groups (Bergek et al., 2008b; Johnson et al., 2006; Rao, 2004). Creation of legitimacy is particularly vital for novel technologies, especially if they are radically different from existing ones (Aldrich and Fiol, 1994; Bergek et al., 2008b; Harris-Lovett et al., 2015). As a consequence, it is implicitly assumed that once a new technology is well known and supported by a critical mass of actors (e.g. Bergek et al., 2008b), once its liability of newness is overcome, legitimacy is less of an issue.

However, also established technologies may go through phases of low legitimacy and crisis. In the case of nuclear power, for example, legitimacy has seen ups and downs as a result of changing societal values and framing struggles between technology proponents and anti-nuclear activists (Garud et al., 2010; Geels and Verhees, 2011). Such legitimacy dynamics, i.e. changes in the alignment of a focal technology and its wider institutional context, is what we are interested in. Especially the loss of legitimacy is an issue that deserves further attention because of its potentially detrimental effects for an entire technological field or industry (Jonsson et al., 2009; Lawrence et al., 1997; Ruef and Markard, 2010).

In our empirical analysis, we will show that a novel technology that has grown successfully and left its infant years behind might still run into legitimacy troubles. Interestingly, the loss of legitimacy might even be a consequence of strong growth, e.g. due to an increased competition for customers or resources, or because the expansion reveals institutional misalignments in the context. In theoretical terms, we draw on the technological innovation systems concept (e.g. Bergek et al., 2008a, 2015; Markard and Truffer, 2008) and insights from institutional theory (e.g. Deephouse and Suchman, 2008; Scott, 2008). Analytically, we focus on (alignment and misalignment of) institutional structures of the focal technology and the context.

As an empirical case, we have chosen agricultural biogas, a novel technology that has emerged at the interface of two different sectors, agriculture and energy supply. Biogas depends on resources from both sectors, which means that it is confronted with different ‘institutional demands’. Biogas can be used for the generation of electricity and heat, as vehicle fuel or as a substitute for natural gas. It is an alternative to fossil and nuclear energy sources, which is why the technology has received widespread public policy support over the past decades. Our study concentrates on the developments in Germany, which is a frontrunner in the promotion of renewable energies. As of 2013, Germany was the world’s leading country in agricultural biogas with around 7,700 plants generating 25 TWh of electricity (equal to 4.7% of the country’s electricity consumption). In Germany, biogas has grown rapidly but became recently confronted with increasing criticism. The technology has been criticized for competing with food production, causing corn monocultures, rising lease prices for arable land and odor and traffic nuisance at the local scale. Moreover, subsidies for renewable energy have received negative press because of the high costs involved. As a consequence, the German government has meanwhile cut back formerly favorable regulatory support for biogas, thus causing a severe breakdown in the market for biogas plants and leaving the technology with rather uncertain prospects.

Biogas in Germany can be viewed an example of a novel technological field that saw technological improvement, professionalization and strong growth, followed by a loss of legitimacy it still has to recover from. But how did this happen? Why did the former hope for crisis-ridden agriculture eventually create new problems in the very same sector? And what are the underlying institutional processes in the ups and downs of technology legitimacy?

To answer these questions, the paper proceeds as follows. In Section 2, we briefly review the literature on legitimacy and develop a framework to study legitimacy dynamics in technological

innovation systems. Section 3 describes our methods and data sources. Section 4 presents the results. In Section 5 we discuss our findings in the light of our framework. Section 6 concludes.

2. Theoretical framework

In the literature, legitimacy has been ascribed to different entities and different processes associated with the creation of legitimacy have been highlighted. This is what we discuss next before introducing our framework.

Legitimacy is a central concept in institutional theory, which highlights that it is important to conform with established institutional structures (Deephouse and Suchman, 2008; DiMaggio and Powell, 1983; Scott, 2008). Legitimacy has been conceptualized as the perceived consonance of an entity with a socially constructed set of norms, values, beliefs and practices in its context (Scott, 2008; Suchman, 1995). Legitimacy can be ascribed to different kinds of entities, including individuals, organizations, business models, industries, technologies etc. (Aldrich and Fiol, 1994). Legitimacy can be a key factor for the success of organizations (or other entities) because it is a precondition for gaining access to critical resources (Aldrich and Fiol, 1994; Deephouse and Suchman, 2008; Zimmerman and Zeitz, 2002).

Legitimacy is often studied in relation to novelties, i.e. new ventures, technologies or industries as they face a particular need to mobilize resources or regulatory support, for legitimacy is key (Aldrich and Fiol, 1994; Zimmerman and Zeitz, 2002). However, also established entities depend on resources and continuous support by their environment, for which they require legitimacy (Pfeffer and Salancik, 1978). For established entities, legitimacy is often only a salient issue, if it is dwindling and they are confronted with criticism. Our case will show the detrimental consequences of a loss of legitimacy.

Scholars have distinguished different types of legitimacy, including cognitive, normative and regulatory legitimacy (Aldrich and Fiol, 1994; Scott, 2008; Suchman, 1995). Cognitive legitimacy refers to the degree to which an entity is known, understood and taken for granted. Normative legitimacy is about conformity with societal values and widely shared beliefs, while regulatory (or sociopolitical) legitimacy is associated with the compliance to formal rules, laws and regulations.

Legitimacy is neither given nor purely emergent. Instead, it is created in a collective, social process that remains subject to contingencies (Johnson et al., 2006). In his study on the early American car industry, Rao (2002) shows how various public and private actors, including social movements, have contributed to the formation of industry legitimacy. Johnson et al. (2006) distinguish four stages in the legitimation of new social objects: innovation, i.e. creation of the new object; local validation, i.e. local actors construe the new object as consonant with an existing cultural framework of beliefs; diffusion, i.e. the new object is applied to new contexts and general validation, the object becomes part of society’s shared culture.

Many studies have concentrated on the role of actors and strategic action in the creation of legitimacy at the industry¹ or technology level, highlighting processes such as lobbying, coalition building, negotiation, compromise seeking, framing or categorization (Aldrich and Fiol, 1994; Garud et al., 2010; Geels and Verhees, 2011; Harris-Lovett et al., 2015; Rao, 2004). At the same time, scholars also point to more abstract processes, e.g. as (industry) convergence around a dominant design, or creating linkages with established educational curricula (Aldrich and Fiol, 1994),

¹ Here we also refer to studies on industry legitimacy to mobilize the respective insights. Industry and technology legitimacy are on a similar level of aggregation and we expect similar characteristics, e.g. in terms of legitimacy dynamics.

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