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The stuttering energy transition in Germany: Wind energy policy and feed-in tariff lock-in

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HIGHLIGHTS

- Feed-in tariff favours specific wind innovation, rather than energy transition.
- Wind energy incorporated into a slightly modified socio-technical regime.
- The outdated grid infrastructure is a bottleneck for the wind energy sector.

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ABSTRACT

This article aims to examine whether the formulation of specific low carbon policy such as the feed-in tariff for wind energy in Germany can partly be a barrier to a comprehensive energy transition (Energiewende). Despite their short and medium-term success, these policies could create a long-term lock-in if they are formulated in a way that leads to a stagnation of systems innovation. The research finds that while the share of wind energy has increased rapidly over time, the feed-in-tariff and other low carbon policies and incentives have not been sufficient to achieve a socio-technical regime transition in Germany yet. We suggest that the German feed-in-tariff has incorporated wind energy (a niche-innovation) and wind energy actors (pathway newcomers) into a slightly modified socio-technical regime that is rather similar to the earlier 'fossil fuel dominant' socio-technical regime.

1. Introduction

This article aims to examine whether the formulation of specific low carbon policy such as the feed-in tariff for wind energy in Germany can partly be a barrier to a comprehensive energy transition (Energiewende). Despite their short and medium-term success, these policies could create a long-term lock-in if they are formulated in a way that leads to a stagnation of systems innovation. Lock-ins and path dependencies have often been used to describe barriers for transitions to sustainable and low carbon energy technologies.

Wind energy is considered an important technology in Germany to spearhead the Energiewende to sustainable and low carbon energy resources. However in Germany the policies and financial incentives that aim to support the development, production and use of wind energy are widely debated.

Germany is a global forerunner in innovation in renewable energy, particularly in wind energy. Germany is currently Europe's largest wind energy market and the world's third largest wind energy market, after China and the United States (US) (GWEC, 2014). Germany had an installed capacity of more than 34 GW by the end of 2013. This accounted for about 30% of the European installed wind capacity in 2013 (GWEC, 2014; IEA, 2014). Germany's installed capacity and market has been growing continuously since the mid-1990s (BWE, 2012; IEA, 2014). Germany has both considerable onshore wind capacity and a rapidly growing offshore capacity. The German government has targets in place for a share of 35% renewable energy among the final electricity consumption by 2020, 50% by 2030 and 80% by 2050, of which wind plays an important role (BMU, 2012, 2011). The market shares of wind firms in Germany are as follows: about 60% Enercon, 20% Vestas, 10% REpower, 4% Nordex, 2% Bard, remaining 4%: others, including e.n.o., Vensys, Siemens GE Electric and AREVA (Lema et al., 2014).

Despite its leading role in global wind energy, Germany's wind energy industry remains understudied from an academic perspective. Earlier studies cover important ground, however they are mostly limited in terms of their geographic scope (e.g. focusing on

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one specific region in Germany) or they adopt a narrow perspective (e.g. public perception of wind energy or costing of wind energy). For example, Jobert et al. (2007) and Musall and Kuik (2011) discuss the local acceptance of wind energy in Germany. Portman et al. (2009) examine offshore wind energy by comparing Germany with the US. Drechsler et al. (2012) focus on the feed-in tariffs in Lower Saxony in Northern Germany, while McKenna et al. (2013) discusses the determination of cost–potential-curves for wind energy in the federal state of Baden-Wurttemberg. Nicolosi (2010) discusses the wind power integration and power system flexibility in extreme weather events in Germany.

This paper is based on empirical research for the research project ‘Technological Trajectories for Climate Change Mitigation in Europe, China and India’. This study builds on fieldwork entailing in-depth qualitative interviews with 18 key actors from (wind) energy firms, business associations, research organisations and government authorities. The interviews were conducted by the authors in 2012 and 2013 at various sites in Germany. Taking wind energy as an example, this article aims to elaborate the potential path dependency and lock-in that could hinder the Energiewende. The paper examines the role German wind energy policy has played in creating a long-term transition to a new socio-technical system of renewable energy. The unique aspect of the paper is to look closer at the German wind energy sector using the framework of socio-technical systems and to elaborate whether a lock-in has occurred caused by the way wind energy policies are designed.

The argument of the paper is as follows: Existing wind energy policies have led to an upscaling of wind energy capacities and a recent emphasis on expensive and risky off-shore projects. Current German wind energy policy has creates two financial dilemmas: First, it has pushed up energy costs for consumers through the feed-in-tariff which is funded by increases in consumer electricity prices, second it has lowered energy costs for energy-intensive industries through feed-in-tariff exemptions. This has created an unequal burden for consumers. Moreover, we find there has been a lack of policy interest to remove existing barriers for wind energy such as an outdated and under-funded grid system, the overall limited policy framework for electricity distribution from North to South and a lack of regulation to create a fairer division of costs between the state, industry and the consumers. We suggest that the German feed-in-tariff has incorporated wind energy (a niche-innovation) and wind energy actors (pathway newcomers) into a slightly modified socio-technical regime that is rather similar to the earlier ‘fossil fuel dominant’ socio-technical regime.

We conclude further that there is a feed-in-tariff lock-in that has created an overt focus on increasing wind energy capacity (increasing output) rather than promoting innovation in renewing the grid systems and increasing the balance of wind energy supply and demand between the North and the South or creating a balanced funding system that also includes contributions from the industry and the state. The funding has been withheld from priority areas, such as grid systems that are now the financial, political and technical barrier to a large-scale successful energy transition.

Section 2 elaborates the conceptual framework and the methodology. Section 3 presents a literature review of the German wind energy case, Section 4 discusses the results from our empirical research and concludes the paper.

2. Methods

2.1. Introduction to key concepts

Innovation can be broadly defined as creating something new, developing a new product, service or idea. We here refer to innovation more narrowly as new products, services and ideas that have successfully reached the market (Rogers, 2003). *Wind energy innovation systems* relate to wind power generation (e.g. core technology and components for wind turbines), transmission and distribution (e.g. grid systems), as well as systems that relate to the deployment of wind energy (e.g. offshore/onshore). Innovation systems also include broader issues beyond the hardware, such as skills, expertise and knowledge (Urban et al., 2012).

Energy transitions are shifts from a country's economic activities based on one energy source to an economy based (partially) on another energy source. Several energy transitions have occurred in history, mainly in developed countries: The energy transition from manpower and animal power to traditional biomass (such as fuel wood, crop residues, dung), from traditional biomass to coal (ca. 1860), from coal to oil (ca. 1880), from oil to natural gas (ca. 1900), from natural gas to electricity and heat (ca. 1900–1910), the large-scale commercial introduction of nuclear (ca. 1965), the large-scale commercial introduction of renewable energy and large hydro power (ca.1995) (Bashmakov, 2007). Energy transitions are characterised by changing patterns of energy use (e.g. from solid to liquid to electricity), changing energy quantities (from scarcity to abundance or the other way around) and changing energy qualities (e.g. from fuel wood to electricity) (Bashmakov, 2007).

Energiewende refers to the German government-led energy transition that aims to reduce dependency on fossil fuels, particularly coal, and at the same time phase out nuclear power by 2021. It is heavily based on renewable energy, most importantly wind energy. A successful energy transition in Germany involves the following government targets: a share of 35% renewable energy among the final electricity consumption by 2020, 50% by 2030 and 80% by 2050 (BMU, 2012, 2011). An incomplete, partial energy transition would not achieve these goals, but would still have a share of renewable energy among the final electricity consumption.

The *feed-in-tariff* is a financial instrument to increase the share of renewable energy among the total energy mix. For onshore wind energy the tariff is currently 8.93 EUR ct/kWh for the first 5 years+0.48 EUR ct/kWh bonus=9.41 EUR ct/kWh for first 5 years, then 4.87 ct/kWh. For offshore wind energy the tariff is 15 ct/kWh for the first 12 years, then 3.5 ct/kWh or alternatively 19 ct/kWh for the first 8 years (in late 2014) (Lema et al., 2014).

2.2. Socio-technical regimes and lock-In

Berkhout et al. (2010) present the concept of *socio-technical regimes* which describe “stable and ordered configurations of technologies, actors and rules that represent the basis for social and economic practices” and includes “a complex web of technologies, producer companies, consumers and markets, regulations, infrastructures and cultural values” (Berkhout et al., 2010: 263). This is very much linked to the different development pathways that countries can take and that are constituted by a set of interlocking and interacting socio-technical regimes (Berkhout et al., 2010). From this perspective, energy systems could be described as “socio-technical configurations where technologies, institutional arrangements (for example, regulation, norms), social practices and actor constellations (such as user–producer relations and interactions, intermediary organisations, public authorities, etc.) mutually depend on and co-evolve with each other” (Rohracher and Späth, 2014: 1417)

Geels finds that socio-technical regimes consist of three different but interlinked dimensions that include (a) network of actors and social groups, (b) regulative, normative and cognitive rules and (c) material and technical elements (Geels, 2002).