

*Karoline S. Rogge and Paul Bödeker*

# **THE IMPACT OF THE POLICY MIX FOR RENEWABLE POWER GENERATION TECHNOLOGIES ON INVENTION: A PATENT ANALYSIS FOR GERMANY**

*[Special session „How the policy mix is affecting innovation in renewable power generation technologies - new insights from the GRETCHEN project”]*

Karoline S. Rogge<sup>1,2</sup>\*, Paul Bödeker<sup>1,3</sup>

\*Corresponding author: [karoline.rogge@isi.fraunhofer.de](mailto:karoline.rogge@isi.fraunhofer.de), +49-721-6809-126, +49-721-6809-272

<sup>1</sup> Fraunhofer Institute for System and Innovation Research, Breslauer Str. 48, 76189 Karlsruhe (Germany)

<sup>2</sup> University of Sussex, SPRU - Science and Technology Policy Research (UK)

<sup>3</sup> Karlsruhe Institute of Technology (Germany)

## **Overview**

Renewable power generation technologies received much political attention over recent decades, with Germany being a prime example. As a consequence, in Germany their contribution to electricity generation grew steadily from 18,932 GWh (3.4% of gross electricity production) in 1990 to 142,418 GWh (23.5%) in 2012 (BMU 2013). A key driver behind this diffusion were political support schemes (Zhao et al. 2013; Marques, Fuinhas 2012). In addition, different policy instruments were identified as an important driver for innovation (Peters et al. 2012). However, so far studies tend to focus on demand pull and technology push instruments only, neglecting other parts of the policy mix relevant for renewable power generation technologies as conceptualized by the more recent policy mix literature (Flanagan et al. 2011; Rogge, Reichardt 2013). Furthermore, the operationalization of the policy mix is still underdeveloped, and there is thus a shortage of corresponding empirical evidence on its impact on technological change. Therefore, in this paper we aim to develop a new approach for operationalizing the policy mix and its perception over time and apply it to analyze if and to what extent the policy mix affects patents as indicators of the output of inventive activities in renewable power generation technologies.

## **Methods**

This paper develops and applies a new approach to empirically represent the perception of the policy mix and how it changes over time, thereby explicitly addressing difficulties in capturing, quantifying and reconstructing this variable for past decades. We chose a content analysis approach which is built on the usage of industry journals to deduct indicators on perceptions of the policy mix, its characteristics and instrument design features. A major advantage of such a historical analysis based on journal articles is that industry journals are available over time, meaning that we are able to analyze and compare results without bias of retrospection. We apply this approach to the research case of PV and wind in Germany, and thus identified two monthly Renewable energy journals: “Photon – Das Solarstrom Magazin” for PV (1996-2012) and “Windpower Monthly” (1994 to 2012) for wind energy. We code all articles explicitly dealing with the policy mix according to several categories, the key ones being: (I) policy instruments (e.g. the Renewable Energy Law, EEG) and their rating (positive / negative / neutral / no rating), (II) the design feature “level of support”, (III) the policy mix characteristic “credibility” and (IV) the phase of the policy cycle (e.g. discussion/implementation). We also take into consideration different dimensions of the policy mix, such as governance level (e.g. national, EU).

We then econometrically link the variables extracted from the content analysis and “traditional” explanatory and control variables (e.g. sector-specific public R&D budgets, margins of LCOE to Feed-In tariff levels, GDP, oil price and sector-specific technology exports) with patent data retrieved from the PATSTAT database for PV and wind to perform bivariate econometric analysis.

## **Results**

Apart from designing and testing the new methodological approach of operationalizing the policy mix over time our results are two-fold. First, our content analysis approach allows for a descriptive analysis of the development of the policy mix over time as perceived in the industry. For example, we map the evolution of the perceived importance of key political instruments and policy mix characteristics. Second, our bivariate econometric variable assessment yields statements about possible autocorrelation of explanatory and control variables, the degree of their impact on patent counts in PV and wind, as well as appropriate time lag structures. We test for similar patterns of reporting on policy instruments and patent applications, expecting that a negative perception

of the policy mix and its credibility hampers invention in the studied renewable power generation technologies. As uncertainty in the perception of the policy mix may play a key role for inventive activities we also take a closer look on effects of frequent policy changes.

### **Conclusions**

Our findings highlight the added value of a more elaborated operationalization of the policy mix in order to make more precise statements about its impact on invention. We consider our analysis as a first archetype study, aiming at introducing a new methodological tool to innovation research that in our view has great potential to establish indicators capturing the trajectory of the policy mix over time. One avenue for future research in this direction would be to apply content analysis to larger panels (more years / industry sectors / countries) that allow for multivariate analyses (cf. Jenner et al. 2013) to study the impact of the policy mix on technological change.

### **References**

- BMU (2013): Erneuerbare Energien in Zahlen. Nationale und internationale Entwicklung. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, checked on 2/4/2014.
- Breitschopf, Barbara (2013): Does the policy mix matter? The case of the PV industry in Germany. [Special session „Renewable Energy Technologies, Innovation, and Policy Mix – first results from the GRETCHEN project”].
- Flanagan, Kieron; Uyarra, Elvira; Laranja, Manuel (2011): Reconceptualising the ‘policy mix’ for innovation. In *Research Policy* 40 (5), pp. 702–713. DOI: 10.1016/j.respol.2011.02.005.
- IEA (2013): World Energy Outlook 2013. International Energy Agency, checked on 3/14/2014.
- IEA (2014): Beyond 20/20 WDS. data services. Available online at <http://wds.iea.org>, checked on 3/14/2014.
- Jenner, Steffen; Groba, Felix; Indvik, Joe (2013): Assessing the strength and effectiveness of renewable electricity feed-in tariffs in European Union countries. In *Energy Policy* 52, pp. 385–401. DOI: 10.1016/j.enpol.2012.09.046.
- Johnstone, Nick; Hascic, Ivan; Popp, David (2010): Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts. In *Environmental & Resource Economics* 45 (1), pp. 133–155.
- Marques, António Cardoso; Fuinhas, José Alberto (2012): Are public policies towards renewables successful? Evidence from European countries. In *Renewable Energy* 44, pp. 109–118. DOI: 10.1016/j.renene.2012.01.007.
- Peters, Michael; Schneider, Malte; Griesshaber, Tobias; Hoffmann, Volker H. (2012): The impact of technology-push and demand-pull policies on technical change – Does the locus of policies matter? In *Research Policy* 41 (8), pp. 1296–1308. DOI: 10.1016/j.respol.2012.02.004.
- Rogge, Karoline; Reichardt, Kristin (2013): Towards a more comprehensive policy mix conceptualization for environmental technological change: a literature synthesis. policy mix concept. In *Working Paper Sustainability and Innovation* (No. S3/2013), checked on 11/4/2013.
- Zhao, Yong; Tang, Kam Ki; Wang, Li-li (2013): Do renewable electricity policies promote renewable electricity generation? Evidence from panel data. In *Energy Policy* 62, pp. 887–897. DOI: 10.1016/j.enpol.2013.07.072.