IMPACT OF RE POLICY ON TECHNOLOGY COSTS – PV SYSTEM COSTS IN GERMANY

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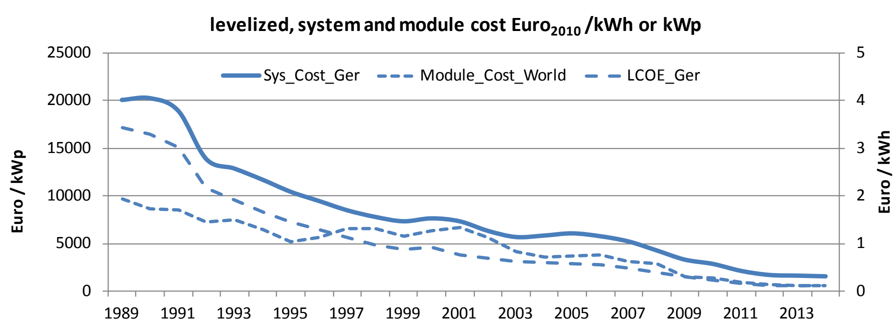
Overview

Since the adoption of its Renewable Energy (RE) act in 2000 Germany has intensified its effort for renewable energy technology (RET) deployment. The main instrument has been feed-in tariffs, which have faced several adjustments in magnitude and specific designs. Nevertheless, promoting RET use entails increasing costs and benefits. While burdens for consumers have increased considerably from 4.7 bill Euro in 2008 to almost 19 bill Euro in 2014 (Monitoring Report 2015), benefits for consumers are difficult to capture and quantify. In addition, benefits and costs occur at three levels – system, micro- and macro-economic – and cannot be arbitrarily summed up (Breitschopf, B., Held, A. 2014). Especially, benefits arising from RE policies serve special attention as they accrue across al levels. Among them, the contribution to innovation and technology cost development is considered as one major positive aspect of RE policy support. To enrich and support the discussion on RET support and deployment targets, this paper strives to assess the impact of the German RE policy on RET costs in the case of PV in Germany. To evaluate the contribution of RE policies to market and technology development, especially in wind power and PV, increased attention has been paid to the learning curve concept (Ek & Söderholm, 2009). This concept will be extended by taking into account interdependencies between technology, demand and supply.

Figure 1: Development of levelized costs (PV), system and module costs over time in Germany



Source: diverse sources, own compilation and calculation

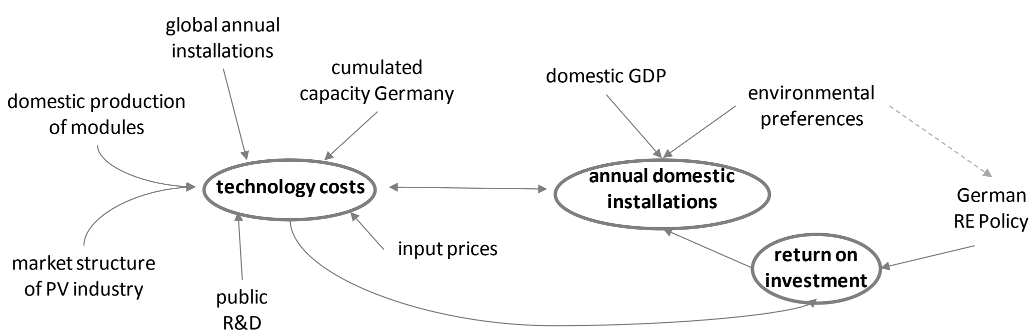
Technology costs, especially PV system costs have shown a tremendous decline over time (see Figure 1). The paper aims to identify and assess the impact of the German RE policy on PV technology costs. In a first step, the “learning curve concept” is briefly discussed. Based on this discussion an approach is derived how to assess the impact of renewable energy policies (RE policies) that addresses demand for RET. It is intended to explain factors affecting technology costs and sketch a potential approach to assess the impact of RE policy on technology costs. The paper concentrates on PV and the demand focused policy (demand pull) in Germany. It includes further R&D policy (public R&D spending) but ignores supplier focused policies, although they are part of the RE policy bundle (IEA-RETD 2014).

Methods

Learning curves are seen as an important tool to endogenize technological changes in models and inform on future costs of RET use (Nemet 2006). The basic idea of learning curve is to draw conclusions from the quantitative relationship between costs and accumulated production or capacity by econometric analysis of empirical data (Ibenholt, 2002). In the context of this paper, the focus is on the historical development of PV technology costs and the impact of demand-pull and R&D policies and other drivers. Learning curves are theoretically based on cost minimization. The respective costs are a function of input prices, the amount produced and the parameters (return to scale). This approach already has a flaw as the data used to depict “costs” of RET in learning curve are not costs but market prices determined by demand and supply. This calls for including a market pricing mechanism, which embeds implicitly utility or profit maximization at the demand side as well. And the market pricing mechanism is an interaction between demand and supply. In addition, the decision of suppliers to extend production (exploitation) or explore further technological potentials is a decision mechanism which depends on factors such as the maturity of the RET (Hoppmann 2013) or firm specific factors. Subsequently, apart from “original” learning effects, interactions and economies of scale or other market factors determine technology costs as well.

To achieve the objective of this paper, technology cost is modeled as a function of demand for PV (annual installations), input prices, PV market development (production and structure), R&D spending, learning (cumulated installations) and external factors. As there are interactions between demand and technology costs (prices), demand is depicted as a function of PV technology costs, returns on PV investments and preferences (environmental). Finally, returns depend on technology costs and revenues that are triggered by RE support, i.e. demand-pull policies. The relations are depicted in Figure 2. Returns are measured as the difference between the specific generation cost of a small scale PV system adjusted by RE supports (further subsidies) and the specific revenues (feed-in tariffs). The pull effect of demand policy is understood as the difference between average specific revenues of energy suppliers (retail) and the feed-in tariff. Simultaneous structural equation modeling is applied to assess the impact of demand and policies on levelized generation costs of PV power.

Figure 2: Structural model and dependent and explaining factors



Results

Results suggest that demand as well as input prices significantly increase technology costs. In contrast, learning effects that also occur at construction sites lead to significant cost declines. In addition, global growth of PV installations is also significant, suggesting that a certain share of technology cost decreases is pushed by external (non-policy or non-German policies) factors. Demand for PV systems is significantly driven by costs (prices) as well as by expected returns while environmental attitudes (preferences) seem to correlate negatively with demand for PV systems. Returns of PV investments clearly depend on system costs and less on demand-pull policies. Overall, the impact of the demand pull policy (Feed-in tariff) on technology costs seems to push costs slightly upwards while domestic cumulated capacity, reflecting learning, and global market development reduce them significantly.

Conclusions

The results are based on a structural equation approach and accounts for a limited set of interdependencies. The primary impact of demand pushing policies augments prices through increased demand but as demand immediately is reflected in growing cumulated installations (learning), which significantly reduce costs, policy has, in a second step, a declining effect on technology costs. Further refinement of the model and assessment is needed. This includes the design of the exogenous variable capturing demand pull policies, the interactions and the assessment method. One problem can only be addressed over time: the analysis is limited by the number of observations, which is very small (n = 30).

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