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Solar feed-in tariffs in a post-grid parity world: The role of risk, investor diversity and business models

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ABSTRACT

Over the past decade, feed-in tariffs have spurred significant deployment of solar photovoltaics in Germany and other countries. With recent cost trends, several countries are approaching retail grid parity. Some policymakers conclude that now is the time to remove feed-in tariffs, as grid parity creates a self-sustaining market, where economically rational investors will invest even in the absence of government incentives. Recent experience in key European solar markets, however, shows that with the advent of grid parity and the reduction of feed-in tariffs, investment in new solar capacity has decreased rather than increased, making it questionable whether low-carbon energy policy targets will be reached. We conduct a cross-case study analysis of three PV markets – Germany, Italy and Switzerland – to investigate the role of feed-in tariffs for the near- and post-grid parity stages of diffusion, accounting for investor diversity and distinguishing between implications for revenue-based and savings-based business models. We find that recent market trends are strongly driven by increased levels of risk, especially policy risk and exposure to revenue risk. We therefore suggest that relatively frugal but stable policy environments may be conducive to further growth of investment in photovoltaics and minimize cost to society.

1. Introduction

With costs of photovoltaic modules having declined by 75% between 2009 and 2014 (Taylor et al., 2015), the economics of solar versus conventional power generation have dramatically shifted in recent years. Retail grid parity has been reached in several countries, meaning that consumers can now generate their own electricity from rooftop solar PV at the same cost as purchasing electricity from the grid at retail rates (Fraunhofer, 2015a, 2015b; Pérez et al., 2014; Reichelstein and Yorston, 2013).

What are the policy implications of PV grid parity? Two opposing views can be identified in the energy policy debate: While one camp argues that solar can now “stand on its own two feet”[2] and the lower cost of solar indicates that it is time to remove feed-in tariffs, another camp points to negative investor reactions to previous policy cuts and therefore claims that eliminating incentives now will harm the PV market and negatively affect climate change mitigation targets. The objective of this article is to provide empirical and conceptual clarity to this debate by assessing the factors determining further PV diffusion in the near- and post-grid parity environment and hence investigating what the role of the most common PV policy, feed-in tariffs, may be for the next stages of diffusion, taking investor diversity and newly emerging business models into account.

The research questions addressed in this paper are the following:

1. What is the role of feed-in tariffs for the near- and post-grid parity stages of PV diffusion?
2. How does investor diversity moderate the need for feed-in tariffs after grid parity?
3. How do business models moderate the need for feed-in tariffs after grid parity?

In empirical terms, we review evidence from three interconnected European solar markets (Germany, Italy and Switzerland) to explore how the advent of grid parity changes the diffusion process of photovoltaics. Combining two countries with high pre-grid parity penetration levels of solar PV with a contrasting case, which has recently been outpacing them in terms of per-capita installations, will allow to get detailed insights into what happens near grid parity. A cross-country analysis of these three markets lends itself particularly well to answering our research questions

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[2] Andrea Leadsom, then Minister of State in the UK Department of Energy and Climate Change, on October 20, 2015. https://www.theguardian.com/environment/2015/oct/20/energy-minister-open-minded-about-uk-solar-subsidy-cuts.

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because they are characterized by a diverse investor landscape, the emergence of new business models and varying degrees of policy risk in recent years. This article is, to the best of our knowledge, the first systematic, longitudinal comparison of levelised costs of electricity (LCOE) in these three markets, including analysis of electricity prices, levels of feed-in tariffs, and installations per capita. We also compare the investor landscape in the three countries, calculate profitability for different business models, and quantify the policy risk affecting PV investors. Our aim is to understand how PV investments have changed in recent years in the context of cost reductions and policy changes. In conceptual terms, we build on existing literature and the empirical evidence to develop a framework that puts past experience into a bigger picture and allows for a more nuanced understanding of future scenarios for PV market development.

The remainder of this article is structured as follows. Section 2 provides a short literature review. Section 3 describes the methodology. Section 4 provides results of our country case studies for Germany, Italy and Switzerland. Section 5 presents the cross-case study analysis, and Section 6 concludes the paper with policy implications and an outlook on further research.

2. Literature review

2.1. The role of policy in renewable energy technology diffusion

The diffusion of technology innovation usually follows an S-shaped curve, where market adoption picks up as costs decline (Grubb, 2004; Rao and Kishore, 2010). In the early part of the diffusion curve, technologies tend to be expensive, hence reducing market adoption to innovative customer segments who are willing to pay more and are less risk averse than mainstream customers (Andersson and Jacobsson, 2000; Rogers, 1995; Wüstenhagen et al., 2003). Because it is difficult for innovating firms to capture the benefits of a new product in this early part of market development, there is a case for government intervention to help innovators survive the "technology valley of death" (Grubb, 2004; Murphy and Edwards, 2003). When it comes to environmental innovation, there is a double-externality problem (Rennings, 2000), because it does not only create positive spill-over effects in the market, but also in the non-market environment (e.g. lower emissions), hence creating a second rationale for government intervention.

The classical policy response to the first externality problem is to encourage publicly funded research and development (Margolis and Kammen, 1999; Wiesenthal, 2012). Applied to the case of solar power, this view would suggest that policy support is legitimate to help "buying down the learning curve",[3] but should cease to be in place once grid parity has been achieved (see Fig. 1).

How does the second externality problem influence the picture? Many economists would argue that the first-best solution to environmental externalities is a Pigouvian tax (Pigou, 1920). However, challenges to the political feasibility of sufficiently high energy and carbon taxes have led to the adoption of dedicated "market-pull policies" such as feed-in tariffs that internalize the external benefit of renewable energies (Bürer and Wüstenhagen, 2009; Gawel et al., 2014). From this perspective, the lack of full internalization of external cost of conventional energy sources provides a rationale for continuing policy support for PV diffusion after grid parity.

2.2. The future of feed-in tariffs

As pointed out in the introduction, there are currently two contrasting views on whether feed-in tariffs will (or should) have a future after grid parity has been reached.

[3] This expression is widely used in the literature on government policies to support technological innovation (Ogden et al., 2004; Vos, 2015).

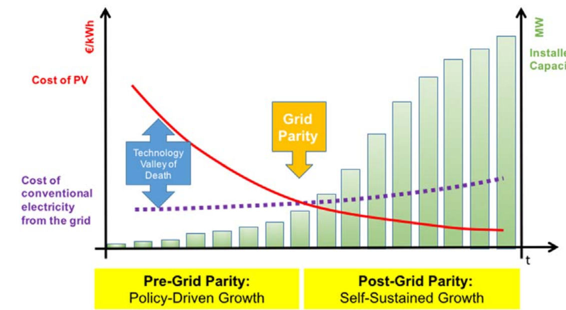

Fig. 1. PV diffusion model (Source: Own illustration adapted from EPIA (2011), Rogers (1995), Grubb (2004)).

FIT-skeptics express discomfort with policy cost and claim that it lacks incentives for investors to generate RE when it's needed the most. As for the first argument, the cost of refinancing feed-in tariffs is perceived to be a burden to electricity consumers (Frondel et al., 2008, 2010), which at some point may exceed consumers' willingness-to-pay (Andor et al., 2016) or the inherent value created by FIT-supported RE generation, e.g. through the merit order effect (Ciarreta et al., 2014). While it is difficult to quantify policy cost and benefit, concerns of overburdening consumers resonate with many policymakers, and in combination with critical design issues and an economic downturn can lead to the collapse of support systems, as evidenced in the Spanish case (Pyrgou et al., 2016). As for the second argument, classical FITs shield investors completely from revenue risk, which eliminates the incentive to generate electricity when it is most needed. While this feature has been helpful in kick-starting investment in capital-intensive low-carbon technologies (Dinica, 2006; Helms et al., 2015; Hirth and Steckel, 2016; Kitzing, 2014),[4] the resulting risk has to be borne by some counterparty in the market, such as conventional producers or the grid operator (Gross et al., 2010), which may become a problem when higher levels of RE penetration are reached (Avril et al., 2012). Solutions brought forward include capping or eliminating feed-in tariffs, or replacing them with quota or auction systems which show desirable characteristics in economic models (Andor et al., 2016), but may or may not deliver on capacity targets (Butler and Neuhoff, 2008; Jacobsson et al., 2009). An alternative solution to completely moving away from feed-in tariffs are more evolutionary changes in policy design, such as a combination of feed-in premiums with net metering (Ramírez et al., 2017). It has been pointed out that investor reactions to feed-in tariffs changes are moderated by (perceived) policy risk (Lüthi, 2010; Lüthi and Wüstenhagen, 2012). This can work both ways – good policies can help to de-risk investment (De Jager et al., 2008; Hamilton, 2009), but poor policies can increase the "price of policy risk" (Lüthi and Wüstenhagen, 2012) resulting in investors requiring a risk premium and consequently lowering investment levels.

FIT-proponents, in contrast, put forward three main arguments why FIT should remain even after grid parity is reached: External cost, dynamic efficiency and limitations to the concept of grid parity. As for the first argument, several authors point out that the external cost of conventional energy sources is still insufficiently internalized (Owen, 2006), as evidenced by low prices in emissions trading (Jenkins, 2014),fossil fuel subsidies (Merrill et al., 2015) or limited liability of nuclear operators (Zelenika-Zovko and Pearce, 2011). Supporting renewables even beyond grid parity would then be a second-best solution to internalizing the external cost of conventional energy sources, and may reap positive co-benefits (Papaefthimiou et al., 2016)). As for the second point, FIT-proponents disagree with FIT-skeptics on the policy cost argument, by suggesting that the relevant

[4] This argument is even more relevant for non-dispatchable renewables like solar and wind, whose output cannot be adjusted to fluctuations in market demand and who are therefore price takers on the electricity market (Lamont, 2008)