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Bringing breakthrough technologies to market: solar power and feed-in tariffs

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Executive summary

Incomplete markets and uncorrected environmental externalities result in the under-provision of low-carbon technologies. In this paper, Sugandha Srivastav examines whether the United Kingdom's renewable energy feed-in-tariff (FiT), which is a risk-reduction and price instrument, helped bring utility-scale solar energy to market.

This Policy Brief is based on the by Sugandha Srivastav entitled "Bringing Breakthrough Technologies to Market Evidence from Renewable Energy Projects." **The paper has received an Honorable Mention at the 2023 E-Axes Research Prize.**

Policy Brief

The world needs to invest in and scale-up innovative clean technologies to reach net zero by 2050. However, bringing these novel technologies to market involves risks, and commercialization takes time, which is problematic given the time-sensitive nature of the climate crisis. While the presence of risk is not a market failure, the absence of fully formed credit markets to support clean technologies alongside their unaccounted positive externalities is. Srivastav (2023) empirically documents the key role of long-term contracts in bringing early-stage clean technologies to market.

Before 2010, a firm looking to build a utility-scale solar farm in the United Kingdom (UK) would have struggled to find finance or insurance. Solar farms were price-takers in the power market and selling on the spot market would have involved exposure to significant revenue volatility. This made the cost of capital prohibitively high for project developers and finding a willing off-taker who would commit to buying solar power at fixed prices for long periods of time was both costly and risky.

Hedging through the futures market for electricity was also not possible given the under-developed nature of such markets at that time. Consequently, even though there was a

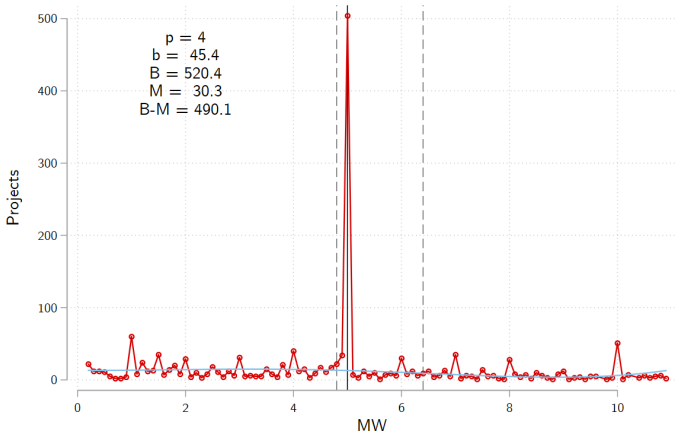
renewable energy certificate market since 2002, which offered variable subsidies, there was no investment in utility-scale solar until 2010, when the feed-in tariff (FiT) was introduced.

The FiT filled a gap by offering a 25-year contract with a fixed, inflation-indexed price for each unit of power generated by an eligible solar firm, thereby significantly reducing revenue volatility. Eligibility for the scheme required that the solar farm was at or below 5 MW of installed capacity. The scheme's guarantor was the UK government. If a solar farm was larger, it could opt for the variable subsidy scheme and forgo the FiT.

From 2010 to 2015, Srivastav (2023) observes huge bunching at precisely 5.0 MW and a smaller bunch at 4.9 MW (some firms misunderstood the eligibility criterion). Solar firms were choosing to be at or just below 5 MW, because going any higher would mean exposure to non-zero price volatility and a different price.

Using a bunching estimator, the paper finds that there is at least 40 times more solar capacity thanks to the FiT relative to a no-policy counterfactual. The vast majority of bunching is driven by new entries rather than inframarginal firms who would have entered anyway but strategically downsize. Overall, in a period of just five years, the FiT induces at least 2.3 GW of *additional* solar investment. This estimate is likely to be a lower bound due to the local nature of the identification strategy.

Figure 1



Notes: The red lines shows the observed data while the blue line is the estimated no-policy counterfactual. The bin width is 0.1 MW. If the histogram is plotted at 1 MW bins, one can see significant amounts of entry at the lower sizes. The narrow bins show how precise the bunching is.

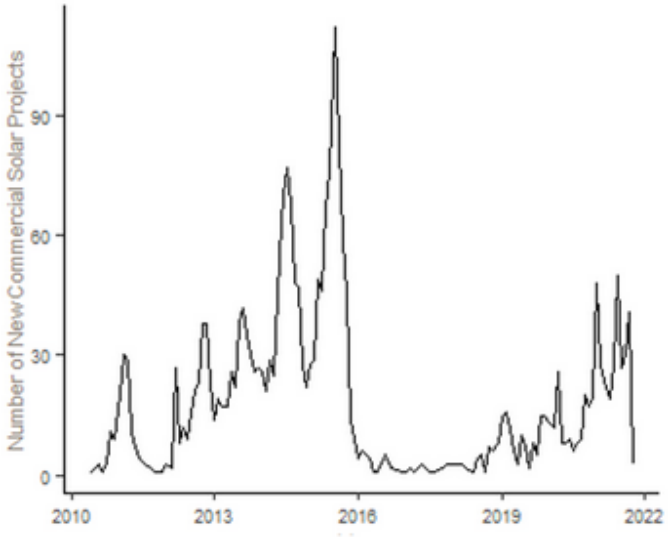
The government, realizing that it had created a very large discontinuity in financial incentives at 5 MW, decided to equalize revenues across this threshold by adjusting the renewable energy certificate scheme. However, while the government could promise to equalize revenues across the 5 MW threshold, it could not equalize the risk properties of the two instruments. One was a tradable certificate scheme, while the other was a 25-year fixed price contract. The paper finds that, even in the period where revenues are promised to be equalized (shown by the shaded region below), there is still enormous selection and bunching at the FiT threshold, illustrating the value of the long-term risk hedge for early-stage technologies.

Figure 2

Notes: Purple line shows the price floor of the tradable certificate scheme, solid red line is the FiT tariff and dashed line is the monthly average electricity price. The shaded area represents the region where the government committed to keeping revenues equal across the 5 MW threshold.

Subsequently, in 2016, the FiT was heavily diluted and investment in utility-scale solar fell. Bunching disappears, giving further confidence that the earlier bunching was indeed driven by the policy. In later years, a renewable energy marketplace emerged where private buyers and sellers could meet to negotiate long-term offtake agreements for solar power. It is possible that the demonstration effect of solar farms supported under the FiT regime helped create a critical mass of investment that justified the creation of ancillary credit market products to support the newly emerged UK solar industry.

Figure 3



The results underscore the importance of incomplete credit markets and the role of (temporary) industrial policy in kickstarting investment and entry into a market that is

nascent, and which carries potentially immense positive externalities. A key result is that even when subsidies are offered, the policy instrument that reduces volatility is highly preferred for early-stage technologies. A conservative value for money calculation shows that for most acceptable values of the social cost of carbon, the FiT for utility-scale solar provides a net benefit to society.

References

Srivastav, S. (2023). Bringing breakthrough technologies to market: Solar power and feed-in tariffs. *Working Paper*. https://www.tse-fr.eu/publications/bringing-breakthrough-technologies-market-evidence-renewable-energy-projects

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