How Different Renewable Energy Support Policies Address Technology Development

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Abstract

Real options studies have shown that the expectation of renewable energy (RE) technological development and a consequent cost reduction creates an incentive to postpone investments. Such an effect might reduce effectiveness of an RE policy in terms of technology diffusion and its cost-efficiency. However, this effect has been studied only under a simplistic tariff type of RE support. This paper aims to offer a systematic view of how the technology development effect materializes under different RE support mechanisms applying a real options framework to get insight into investors' behavior.

1 Extended abstract

Renewable energy (RE) is a core element in the global energy transformation (Gielen et al., 2019). Support policies are a key driver to RE deployment (REN21, 2019) and innovativeness (Rogge & Schleich, 2018). While one of the goals of such a policy is to support technological development and eventually drive the costs down to make the technology competitive in a free market (Batlle & Rodilla, 2010), the very same policy could create a negative feedback loop. Expectation of cheaper technology in the future could make delaying investment an attractive option (Murto, 2007), therefore inhibiting technology development or make the policy cost-inefficient.

It is important that a RE support scheme addresses technology development and the expected consequent drop in costs. Since the technology learning occurs continuously, if not addressed, it creates (i) an incentive to postpone investments that is not necessary desirable from a policymaker's point of view, and (ii) risk of oversubsidizing later (and cheaper) investments leading to windfall profits and a drain on public funds, as well as to a possible necessity of retroactive changes that undermine investors' trust and adversely affect the investment environment.

All real options studies that incorporate technological learning into their models unanimously arrive at a conclusion that the anticipation of the future cost reduction creates an incentive to postpone investments, see e.g. (Fuss & Szolgayová, 2010; Kumbaroğlu, Madlener, & Demirel, 2008; Torani, Rausser, & Zilberman, 2016; Welling, 2016). These studies involve none or a single straightforward RE support scheme, like direct subsidy or a feed-in tariff. The effects of technological learning on investment prospects under other schemes remain under-investigated. Volatile market-driven prices of RE certificates can be expected to generate different incentives with respect to technology development than offering a fixed guaranteed price over the project lifespan.

In this paper we analyze the effect of the technology development process on the prospects of RE investments under different support schemes, in particular, feed-in tariffs and premiums, auctions, certificate trading schemes and the rate-of-return mechanism, for the latter see e.g. (Kozlova, Fleten, & Hagspiel, 2019) . We model a stylized investment project with electricity production $Q(x)$, where *x* denotes installed capacity, and $I(A(t); x)$ upfront cost, where $A(t)$ represents technology cost that is assumed to evolve stochastically over time.

We arrive at the conclusion that the effects of technological learning can enter the investment strategy and produce policymaking implications in the following ways.

(i) Before the investment has been made, the expectation of technological learning could create an incentive to delay investment to benefit from cheaper and more profitable projects later. This happens if the support design does not account for falling technology costs (feed-in tariffs).

(ii) After the investment has been made.

   a. Subsidy rates that remains the same for projects constructed at different times will provide windfall profits to later and cheaper projects (feed-in tariffs).

   b. A flexible subsidy rate that does not remain the same neither across projects nor across years of the same project, although in a perfect market should flexibly adjust to falling technology costs and eliminate over-subsidization, in practice could be perceived as risky for investors, since the price level is not guaranteed throughout the project and might not necessarily match expectations (certificate trading).

   c. Flexible over years but fixed for a single investment subsidy rate can provide both certainty to investors with respect to their future revenues and proper adjustment to the falling technology costs that avoids over subsidization (auctions and rate-of-return).

Our analysis becomes especially relevant in the context of ongoing adjustments to RE policy schemes all over the world (REN21, 2019).

Acknowledgments

The authors would like to acknowledge the funding received from the Finnish Strategic Research Council, grant no. 313396/MFG40 – Manufacturing 4.0 and the grants no. 190196 and no. 190197 received from The Foundation for Economic Education.

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