

The influence of policy regime risks on investments in innovative energy technology

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This paper addresses the effects of policy regime risks in interaction with wholesale market dynamics on investments in innovative energy technology. It is motivated by two observations. First, there is an ongoing debate about power market design reforms in numerous countries, with potentially drastic implications for the economic attractiveness of different energy technologies. Second, there is a gap between required and actual investment levels with respect to innovative technologies and business models for low-carbon, smart energy infrastructure. We seek to contribute to a better understanding of this subject matter.

Strikingly, the ways in which policy regime risks interact with and influences innovative energy technology investments have not been dissected in much detail to date. We attempt to add to the existing literature by looking at policy regime risk from a micro-level perspective. We observe the strategy of a risk-neutral, rational investor under different conditions of policy regimes and related uncertainty. Our focus is on the implications of different policy conditions on his investment valuation and timing. In this context, the notion of policy regime risks is scrutinized beyond the existing literature, by explicitly distinguishing between content and process. Two individual investments are considered: a VPP platform and some wind power plant. The latter's value is directly retrieved from receiving some subsidized revenue in exchange for wind power generation. The VPP platform's value results from the additional value pools that become accessible when operating DER in a VPP; we consider balancing markets for dispatchable DER, such as biogas power plants, and netting effects for non-dispatchable DER, i.e. wind and solar PV power plants, as additional value pools.

As an instrument for investigation, we develop a valuation framework that extends from the traditional discrete time real options (RO) methodology. The framework formalizes the opportunity to build a VPP by first investing in a platform and, second, integrating DER assets. The opportunity to invest in some wind power plant capacities is investigated separately from that sequence; however, it is assumed that the wind power plant capacities can be integrated into the VPP once operational later on, in order to maximize expected revenues. Further, we incorporate market prices and subsidies as drivers of cash flows that are treated as correlated stochastic processes. Correlation is introduced with standard as well as alternative stochastic processes. Policy regime risks are introduced through market design alternatives and corresponding probabilities of design change; if change occurs, (stochastic) market parameters are being structurally overhauled. We construct several scenarios. In scenarios 1 to 3, a specific policy regime is fixed and sure to remain. The individual scenarios then represent a base case, a "free market world", and "a regulated world", respectively. In scenarios 4 and 5, the base case is the starting point, with uncertainty about a switch to either the free market world (scenario 4) or the regulated world (scenario 5). In scenario 6, the base case is again the starting point. However, this time the investor anticipates a regime switch without knowing whether the switch will introduce the free market world or the regulated world.

In our analytical and simulation-based research, we can observe both a policy content as well as a policy process effect. Both the anticipated content as well as the assumptions about the process of policy regime change influence rational investment decisions. The impacts could be separately quantified in our approach. More specifically, we indeed see that the value of investing in a VPP platform as a market-dependent technology is strongly affected by the contents of the given policy regime.

For instance, the high volatility and expected increases of underlying stochastic parameters in the free market world induce a particularly high NPV for the platform. Meanwhile, they also lead to investment postponement, since volatility is high and further upsides are anticipated. The implication is that investments in technologies whose value depends on market rather than subsidy developments might be postponed whenever the current or anticipated market design implies great volatility -- be it for reasons of a higher expected profit or due to the risk of unfavorable market developments. In other words, the often called-for free market design may not always be the energy technology investment catalyst it is believed to be. The more volatile market prices are expected to be, the more postponement can be expected regarding non-subsidized technologies. Maybe even more strikingly, our analysis shows that investment decisions regarding (partly) subsidized technologies are more likely to be postponed under regimes with stable subsidies than in regimes with declining subsidies (scenario 3 versus scenarios 1, 2). As a consequence for policymakers, regressing subsidy schemes might turn out to be more effective after all: they stimulate investment front-loading, which may speed up technological learning curves and thereby reduce future investment costs; eventually, less subsidies might be necessary to spur investment in the future. All in all, the treatment of (partly) subsidized innovative energy technologies requires caution.

Next to the policy content effect, we could identify the policy process effect as a further effect on rational investment decisions. Namely, the degree to which NPV and option value are affected by anticipated changes in market design is strongly influenced by expectations about timing. The assumptions that investors make about the speed of change affects their expected values significantly. Again, a differentiation is required regarding subsidized technologies; in case a lock-in effect is present and the expected NPV is positive (as for wind power plants in our analysis), anticipations about future regime changes do not matter. Obviously, this finding rests on the assumption that future regime changes do not reverse any lock-in effects.

A limitation of our exploratory work, particularly with respect to the policy process effect, is that we focused on a rational investor, which is a pre-condition of the real options methodology used. Further, especially the policy process effect depends heavily on assumptions about type and time of change. This points out the critical role of sound policymaking: the more transparency and the less ambiguity regarding regime changes policymakers ensure, the more informed the decisions of investors will be.

Finally, the analysis reveals some particularities referring to VPP platform investments. On the one hand, VPP platforms present an innovative energy technology with great exposure to markets and ultimately policy regime risks which (may) influence market parameters. This is in stark contrast to heavily subsidized innovative energy technologies, like wind power plants, which have fared much better regarding investment levels so far. The results of our numerical example confirm that, indeed, market exposure and policy regime risks may be a reason that potential investors have preferred to postpone VPP investments. On the other hand, VPP platform investments are not exposed to the commercial success of any individual business model. Rather, they can be understood as a claim on various DER and value pool options, implying a valuable diversification in the presence of policy regime risks.

In our example, we have only touched upon a fraction of the value pools a VPP platform could provide access to. For instance, demand response with flexible loads or storage, or negative balancing capacity offered by wind or PV power plants could be further value pools. As a consequence, it could well be that potential investors underestimate some of the (long-term) value potential of VPP platforms owing to the platform role of VPP technology with access to a number of value pools.