Executive Summary

Investments in renewable energy (RE) projects rely crucially on government support, however, the absence of a clear policy framework increases uncertainty in revenue streams. In turn, this poses a formidable challenge to firms that must typically determine both the optimal time of investment and the size of a project, in the form of installed capacity. For capital intensive projects, such as RE power plants, such decisions entail considerable risk. Indeed, a large capacity exposes a firm to downside risk, whereas a small capacity implies that revenues could be forgone if market conditions suddenly become favourable. Additionally, the inability to contract an investment project after its initial installation due to high cost makes the investment timing and capacity sizing decisions even more crucial. Despite the crucial impact of policy uncertainty on the evolution of RE projects, its implementation in analytical frameworks for stepwise investment and capacity sizing has been limited. Consequently, models for predicting the level of RE investment remain underdeveloped.

We develop a real options framework in order to determine how investment timing and capacity sizing decisions are affected by price and policy uncertainty. The latter takes the form of the random provision or retraction of a subsidy, which is implemented as a fixed premium on top of the electricity price. In addition, we assume that a project can be completed in either a single (lumpy investment) or multiple stages (stepwise investment). Thus, we analyse how price and policy uncertainty interact to impact not only the optimal investment and capacity sizing decisions of a private firm, but also the choice of investment strategy, in terms of lumpy versus stepwise investment. After analysing the benchmark case of investment without policy uncertainty, we allow for the sudden and permanent retraction or provision of a subsidy. Subsequently, we analyse the case of sudden provision of a retractable subsidy, and, finally, we allow for infinite provisions and retractions. We conclude by presenting numerical examples for each case and illustrating the interaction between price and policy uncertainty in order to enable more informed investment, capacity sizing, and policy decisions.

Results indicate that the effectiveness of policies for supporting green investments may be improved by taking into account the interaction between different types of uncertainties and managerial discretion, e.g., investment timing, capacity sizing, and the choice of investment strategy. For example, the attractiveness of announcing the permanent

retraction of a subsidy, in terms of accelerating investment, should be weighed against the implications of a smaller project. Similarly, the sudden provision of a permanent subsidy may result in a bigger project, yet this postpones investment by raising the required investment threshold. More importantly, under sequential policy interventions, the non–monotonic impact of policy uncertainty on the optimal investment threshold and the optimal capacity implies a flexibility from a policymaking perspective. This flexibility is reflected in the ability to balance incentives related to investment timing and capacity sizing decisions. For example, policymakers may adjust the rate at which a subsidy is provided or retracted in order to either promote bigger projects that take longer to be realised or accelerate investment in smaller projects. Additionally, although it may be feasible to promote lumpy over stepwise investment by increasing the size of the subsidy when a firm does not have discretion over project scale, this is not the case when the capacity of the RE project is scalable. Indeed, a ceteris paribus increase in the subsidy raises the relative value of the lumpy investment strategy, as it is relatively cheaper than stepwise investment. However, with discretion over capacity, the firm compensates for the extra cost associated with the flexibility to proceed in stages by increasing the amount of installed capacity.