Risk Implications of Energy Policy Instruments

In many countries in Europe and the rest of the world, electricity systems are on the verge of a new era: they are transforming from begin CO2-intensive and centralised towards becoming sustainable and more integrated. The role of policy makers in this transition is evident: ambitious targets of abandoning the use of fossil fuels and increasing the use of renewable energy sources (RES) need to become reality through respective investments in new technologies. Understanding the effects of energy policy and support instruments on investments, especially in terms of risks, is crucial for developing an adequate policy framework in energy systems with high shares of renewable energies. This dissertation contributes to the research area of RES policy support. With a special focus on risk implications of policy, the economic consequences of different RES support instruments are investigated, both from an investor's perspective and from a societal point of view.

This dissertation assesses energy policy and especially renewable support instruments with regard to their differences in investment incentives, effectiveness of deploying renewable technologies, cost-efficiency (in terms of required support levels) and welfare economic effects. Focus lies on policy incentives for electricity generation from renewable energies that have significant influence on the risk profile of investments (such as renewable quota systems and fixed feed-in tariffs). The consequences of different policy portfolios are evaluated. We show, both qualitatively and quantitatively, that policy makers cannot neglect risk implications when designing RES support instruments without compromising either on effectiveness or cost-efficiency of energy policy.

The central research questions are: how can risk implications of RES policy instruments be integrated into policy design, so that the policies provide adequate investment incentives? And can the consideration of such risk implications in policy design make overall energy policy more successful? These questions are answered in seven research papers (four journal papers, two conference papers and a working paper), based on a combination of micro-economic and policy analysis.

Financial theory is used for the quantitative analysis of investment problems under uncertainty, including mean-variance portfolio theory, real option analysis, Monte Carlo simulations and time series analysis of the underlying data. Modelling of stochastic price processes plays an important role in the analysis. Using concrete cases for offshore wind in Denmark and Germany, we show that feed-in premiums structurally require higher support levels than feed-in tariffs due to the higher risk exposure. We quantify this effect for several cases, and obtain differences of 4.3-10 EUR/MWh, corresponding to up to 40% of the support payments in particular cases. Lower risk exposure under feed-in tariffs also leads to faster deployment and in some situations smaller project sizes. The results for tradable green certificate schemes are more ambiguous, depending on the characteristics of the underlying stochastic processes. We also show that policies that reduce risk for investors can trigger more successful energy transitions, if certain conditions are fulfilled and policy safeguards are put in place for later phases of the development.

Overall, this dissertation contributes with model development in the area of support scheme analysis, using several innovative approaches for partial models that produce easily and quickly applicable results. Thus, tools are provided that help in the design of RES support policies, e.g. when deciding between support instruments and when determining adequate support levels.