Regulatory Design and Incentives for Renewable Energy

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August, 2011

Abstract

Increasing electric power production from renewable energy sources is now widely perceived as a sensible goal for energy policy. The intermittent nature of renewables, such as wind and solar, necessarily imposes complex trade-offs for regulatory objectives, such as resource adequacy, system reliability and GHG reductions. Regulatory interventions (e.g. feed-in tariffs, renewable portfolio standards) need to be designed to ensure that incentives for potential investors are properly aligned with the socially optimal trade-offs in regulatory objectives. In this paper, we develop a highly stylized model of investments in order to derive insights regarding regulatory incentives for increased renewable energy. Feed-in tariffs and renewable portfolio standards (RPS) are perhaps the most widely used regulatory designs aimed at increasing renewable output. In its simplest form, a feed-in tariff mechanism is one in which the wholesale electricity market is forced to buy all renewable electricity at a fixed, pre-established price. Under the RPS regime, utilities holding a mix of generation technologies must invest so that their renewable capacity is always greater than a given fraction of their conventional capacity. Interestingly, the need for regulatory incentives seems to be a generally accepted fact as most of the literature on regulatory designs for increased renewable energy compares the relative effectiveness of various alternatives. It seems only prudent to take a closer look at the extent to which incentives are needed. In this paper, we develop a model to analyze the need for incentives as well as the effectiveness of feed-in tariffs and renewable portfolio standards. Our analysis shows that incentives for increased investment in renewable technology may only be needed

if there are significant economies of scale which in this paper are modeled as "learning by doing". Interestingly, under-investment in renewable capacity may also be further exacerbated by regulatory policies aimed at ensuring a certain level of installed capacity in conventional fossil-fuel based generation capacity (e.g. capacity markets). This points to an inherent tension between regulatory designs for resource adequacy and optimal investment in renewables. We analyze two different regulatory schemes (feed-in tariffs and renewable portfolio standards) aimed at increasing investment in renewable capacity. We show that neither scheme is capable of inducing the socially optimal levels of investment. A single feed-in tariff fails to induce optimal investment as the most attractive sites are over-developed thus preempting investment in less attractive yet socially valuable sites. Thus, discriminatory feed-in tariffs may be better suited to promote the right kind of development. An RPS that promotes increased investment in renewable technology induces under-investment in the conventional technology since a lower capacity margin in the conventional technology induces higher spot prices that serve to recoup the losses associated with implementing socially optimal investment levels in renewable technology. These results illustrate the inherent difficulties in inducing optimal investment in renewables within the context of an electricity market because increased renewable capacity significantly affects the nature of competition. Therefore, equilibrium investment in conventional capacity and renewable capacity are closely coupled. A "clinical" regulatory design, that is, one that promotes the right amount of renewable capacity without affecting conventional capacity is a challenging proposition.

JEL Codes: L51, L94, Q42, Q58, D4.