

Distributed Renewable Energy Investment: The Effect of Time-of-Use Pricing

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A transition from flat rate (FR) to time-of-use (TOU) pricing is widely adopted by electric utilities, which may affect firm's distributed renewable energy (DRE) investment. TOU pricing scheme usually sets a higher electricity tariff in the peak period and a lower one in the off-peak period. Theoretically, in a TOU pricing scheme the setting of peak and off-peak time periods and the number of time periods will both affect the economics of renewable energy technology.

This paper contributes to investigate the effect of TOU pricing on firm's DRE investment, taking into account the intermittency of renewables as well as the firm's electricity demand. First, a cost minimization model is constructed to determine the optimal DRE investment level for a non-power generating firm. Second, we derive the conditions under which electricity pricing (either TOU or FR pricing) leads to a higher level of DRE investment. Meanwhile, the effects of TOU pricing (i.e., peak, off-peak prices and times, price signals) on firm's optimal DRE investment decision are assessed. Third, we generalize the model to handle the case of three-period TOU pricing.

The modeling results show that the TOU pricing in contrast with FR pricing can lead to a higher investment level when the DRE technology under TOU pricing is more desirable and the firm's average electricity consumption during peak period is high. Moreover, it is found that the firm's optimal investment strategy is not necessarily sensitive to the price signal of TOU pricing (i.e., the ratio of peak to off-peak price). Specifically, when the service-level difference in meeting firm's electricity consumption between peak and off-peak periods by adopting DRE technology is above a threshold, a strong price signal will not promote the firm's optimal DRE capacity investment. Conversely, the firm's optimal capacity investment will increase in the price signal. The above conditions are determined by electricity demand and availability during peak and off-peak periods, which are highly dependent on the details of peak and off-peak times. In addition, we find that implementing full retail prices compensation for firm's surplus renewable electricity is probably not good as it may lead to DRE over-investment.

Based on these findings, we suggest that firms should first pay attention to peak time when making DRE investment decisions under TOU pricing scheme. To encourage DRE investment, it is vital to ensure different prices occur at the right times, as this will stimulate the firms sourcing with DRE technology in reaction to the price signal. One interesting implication is that "getting the time right" may be more important than "getting the price right" in terms of encouraging DRE investment. For net metering compensation design, maintaining the ratio of buyback price to electricity retail price below the ratio of costs to benefits by investing DRE technology cannot only stimulate investing but also prevent over-investing.

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