Rethinking How to Support Intermittent Renewables.

By Patrick A. Narbel*

Most intermittent renewable energy technologies are not yet competitive at current market prices. Countries seeking their benefits have thus implemented various policy instruments in order to stimulate investment in intermittent renewable energy. Both effectiveness and efficiency of a policy instrument are traditionally measured in terms of the direct cost of energy, although some researchers are now suggesting a move towards instruments based on the realized value of energy instead. I look here at how efficient policy instruments are at deploying valuable intermittent renewable energy, highlighting the need for a new policy instrument.

Definition of a *Valuable* Renewable power Station

I define a valuable intermittent renewable power station based on a combination of two metrics: the spot price and the cost of intermittency.

Each intermittent renewable power station has a unique electricity production pattern. These production patterns will match differently the market needs (i.e. the spot price), making some renewable power stations more valuable than others.

The second metric pertains to the cost of intermittency. Given the inherent characteristics of intermittent renewable energy, the security of supply cannot be guaranteed by solely relying on intermittent power stations. Consequently, dispatchable capacity is needed to balance demand and supply of electricity at all times. Yet, the deployment of intermittent renewables negatively affects the economics of the extant generation mix, since in the presence of intermittent renewables, existing power plants spread their fixed cost over fewer units of electricity. Past a threshold, a number of plants may be decommissioned, threatening the security of supply. In such situation, policy makers may be forced to introduce capacity payments to ensure that dispatchable power plants remain online. Capacity payments thus reflect the intermittency cost induced by intermittent renewable energy sources.

Combining the intermittency cost to the ability to produce electricity when the market needs it, a valuable intermittent power station is a power station which produces electricity during high prices hours and which limits the need for mechanisms to guarantee the security of supply.

Without financial support, expectations on future spot prices should suffice to lead to the construction of valuable power projects. However, implementing policy instruments affect the prices perceived by the plant owner. The effectiveness of specific policy instruments at facilitating the deployment of valuable intermittent renewables is measured in the paper this article refers to via a deterministic numerical analysis based on historical data for West Denmark.

West Denmark is an interesting case because its geographical area is limited in size and wind power already contributes to about 30% of its electricity supply. In addition, Denmark is thermal based and does not have large-scale storage systems to mitigate the intermittency issue of its wind turbines. With a limited potential for hydro and increased biomass use, intermittent technologies such as solar- and especially wind power, are the most mature technologies available to increase the country's share of renewable electricity.

Results of the Numerical Analysis

In a numerical analysis, I assume that two power stations are available to increase West Denmark's share of renewable electricity: a wind farm and a solar power station. The cost of producing electricity from the solar power station exceeds this of the wind farm by 30%. Both power stations are unattractive financially in the absence of financial support.

A negative correlation exists between market prices and production of electricity from the extant intermittent electricity production in West Denmark. The production profile of the suggested wind farm would correlate with the extant intermittent production, whereas the production from the solar power station would not. Consequently, the latter would produce during hours with comparatively higher prices. Despite this advantage, the economics of the solar power station remains slightly less attractive than the economics of the wind farm.

Assuming that these power stations were deployed, the economics of the extant thermal generation mix would be negatively impacted. The solar power station has the characteristic that its deployment would allow for a reduction of the dispatchable capacity needed to balance the system, thus contributing to a limited need for capacity payments. This lower intermittency cost for the system compensates for the higher cost of the solar

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power station on a direct cost basis, effectively making the solar power station more valuable.

Nevertheless, the net present value of investing in either power station being negative in the absence of subsidy, some type of policy instrument will be needed if West Denmark wants to increase its share of electricity from renewable energy sources.

A first option is a feed-in tariff (FiT), which guarantees a price set in advance for each MWh fed into the grid for a fixed period of time. Since prices are guaranteed, the revenues of the plant owner are independent from the wholesale energy market prices and a power station owner has therefore no incentive to react to market signals. To be efficient, in the sense that a FiT delivers the most valuable energy first, a FiT requires to administratively define what the value of energy is. This process can prove to be challenging given the uncertainty underlying the cost of the technology, the future energy supply and the wind and solar conditions for instance. An inefficient FiT will facilitate the deployment of intermittent renewable energy as long as it is generous, although a fraction of it might be of little value to the system. Consequently, a FiT appears inappropriate to efficiently facilitate the deployment of valuable intermittent renewable energy.

A second option is the feed-in premium (FiP). A FiP rewards each unit of electricity fed into the grid with a constant premium on top of the wholesale electricity market price. Under the FiP, the station owner will curtail its production if the price perceived (spot price and premium) does not exceed the marginal cost of producing power. Hence, compared to a FiT system, the FiP creates an incentive to produce electricity when it is needed most because the plant owner total remuneration will rise with increasing electricity prices. Everything else being equal, investors will favor projects which deliver electricity when prices are high, hence facilitating the integration of intermittent renewable energy into the electricity system. However, this type of policy instrument does not reflect the intermittency cost and a FiP will, for that reason, not necessarily promote the most valuable intermittent power stations.

A third option is a quota system (QS). A QS is a quantity-based policy instrument where policy makers set how much renewable energy needs to be delivered. A plant owner will obtain revenues from the electricity markets and from the sale of green certificates, the price of which depends on how many certificates are available in the market. This type of policy instrument is deemed to be more efficient than price-based instruments (FiT and FiP), because the least costly technology will be built first and more efficient producers are favored. However, a quota system is not necessarily efficient if the full cost of energy is considered. The numerical analysis shows that a QS would facilitate the deployment of the wind farm when the solar power station has a higher value.

Of these three policy instruments, the quota system appears to be the most efficient. However, a quota system may still fail to deliver valuable power to the system. There is therefore a need for policy instruments which better reflect the value of energy.

A new policy instrument should pursue two goals. First, the revenues of a plant owner shall reflect the market needs. Second, the deployment of an intermittent power station should allow for a reduction in the capacity of dispatchable power needed to ensure the security of supply. A possible approach in achieving these goals simultaneously is to increase the variation in spot prices to force the deployment of power stations which deliver at times of high residual load and prices, thus increasing the chance that dispatchable capacity can be reduced. A premium multiplying the market prices by a fixed coefficient would be an option. Based on the numerical analysis, this multiplicative premium would deliver the most valuable intermittent energy source first.

Conclusion

A valuable intermittent renewable energy source is a source of energy which requires little financial support and which allows for an effective reduction of the quantity of dispatchable capacity needed to ensure the security of supply.

Given the comparatively higher cost of intermittent renewables, policy instruments have been implemented to facilitate their deployment. If the quota system seems to be the most efficient on a direct cost basis, it still ignores the cost of intermittency. A new policy instrument, a multiplicative premium, was suggested to reflect the perceived value of a power station. This policy instrument rewards power stations producing during high residual loads and high prices hours, forcing the deployment of intermittent power station during these hours. A multiplicative premium may therefore be more efficient at deploying valuable projects than current policy instruments.