PROMOTION OF MARKET ACCESS FOR RENEWABLE ENERGY IN THE NORDIC POWER MARKETS

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Overview

A society wanting to increase the amount of electricity production based on renewable energy must increase the amount of such technologies which are currently not competitive under free market conditions. This means that if we want to see a considerable increase in electricity produced by renewable energy we must have a system which supports market access for renewable energy. The aim of the support system is on the one hand to promote the implementation of new technology based on renewable energy and on the other hand to promote these technologies to become more competitive.

The EU has adopted specific targets for both CO_2 reductions and electricity production from renewable sources, by the year 2020. This study investigates how the renewable target might be achieved at lowest possible costs. The instruments investigated are Feed-In Tariffs (two varieties) for wind power production, shadow-prices for CO_2 emissions (through Emission Trading Scheme (ETS)), increased penetration of Real-Time Pricing (RTP) into electricity markets and an increased price-elasticity of demand for electric power.

Feed-In Tariffs are a support system based on price and they are already in use in 21 countries in the European Union (EU). The guaranteed price can in the FIT mechanism differ between technologies and locations. The basic mechanism in FIT is such that government sets the level of tariffs and after that the market decides how much electricity is produced using technologies based on renewable primary energy (see e.g.Butler & Neuhoff (2008), Fouquet & Johansson (2008), Lipp (2007), Mitchell, Bauknecht & Connor (2006), Toke (2007), Toke & Lauber (2007)).

It has to be noted that even though there is increasing interest towards renewable energy and in the support mechanisms of renewable energy, research on promotion mechanisms' efficiencies in the least-cost sense is, however, quite rare. The main motivation for this paper is to find a cost efficient way to reach the goals set for renewable energy sources in the Nordic countries. We do this by analyzing different renewable energy support scenarios. In those scenarios different policy instruments (FITs and ETS) are combined with different assumptions on Real-Time Pricing and consumers' price-elasticity of demand for electric power. Using simulation techniques we study the impacts of these scenarios to the access of wind power to the market, to market prices, to equilibrium capacities, to CO_2 emissions and to costs of reduced CO_2 emissions.

Methods

In this paper we theoretically derive the cost efficient way to reach the goals set for renewable energy sources in the Nordic countries and then construct and utilize a long-run oriented Real-Time Price (RTP) based model (see Kopsakangas-Savolainen and Svento (2011) in order to analyse different renewable energy support scenarios. In those scenarios different policy instruments (FITs and ETS) are combined with different assumptions on Real-Time Pricing and consumers' price-elasticity of demand for electric power. Using simulation techniques we study the impacts of these scenarios to the access of wind power to the market, to market prices, to equilibrium capacities, to CO_2 emissions and to costs of reduced CO_2 emissions.

The theoretical background for constructing a simulation model is based on the fact pointed out for long by economists that in order to reach efficient electricity markets both the generation and retail of electricity should be based on the price determined hour by hour as a price that equates supply and demand. The simulation model that we construct reflects this and other features of the Nordic electricity market as closely as possible. This model has a firm theoretical background on which it is based and which is described in detail in Borenstein and Holland (2005). The model of course is based on the assumption of competition both in generation and in retail. In generation profit maximizing generators choose their hourly supply based on marginal cost of generation. The demand curve is a constant elasticity curve so that the utility maximizing consumers do not end up in corner solutions. A fixed share of customers has real-time price based agreements and the rest have a flat-rate agreement. The price elasticity is constant and exogenous. Competition in the retail sector forces the retailers into Bertrand competition so that the retail prices are set so that the retailers have zero-profits. Based on these behavioral assumptions the short run competitive equilibrium can be characterized so that, for a given capacity and given share of customers in real-time pricing, the short-run competitive equilibrium is characterized by real-time retail prices that are equal to wholesale (real-time) prices and the flat-rate price equals the demand-weighted average wholesale price. The wholesale prices are determined so that they equal marginal generation costs with the fixed capacities. Generation capacity will enter the wholesale market as long as short-run profits are positive. Investments then drive the long-run generation profits to zero and the long-run competitive equilibrium wholesale prices are characterized by the conditions of the short-run equilibrium plus the additional zero-profit condition where investment costs are taken into consideration. In the case, however, when some technologies are capacity constrained, these technologies may take positive profits. The conditions for long-run equilibrium wholesale prices still hold also in this case.

Results

Our main results are that even with strong assumptions concerning Real-Time Pricing combined with current emissions trading system (with the average price of 23€/tCO_2) no new wind power emerges in the Nordic power market without Feed-In Tariffs. The emissions are lowest according to the scenario when Feed-In Tariff is set at the level of 83,5€/MWh. Notable however is that we achieve almost as low emissions if the Feed-In Tariff is based on our economic tariff structure. Cost of reducing emissions by tCO_2 is clearly lowest if we use this economic tariff structure combined with the RTP mechanism. Emissions are expectedly highest when there is no ETS nor FIT system.

The consumer behaviour is very important since even without FIT we can have cost efficient reductions in emissions if consumers become more price sensitive. According to our results the emissions trading system does not have the required impact on promoting market access for wind power and we need a renewable energy support mechanism if we want to reach the target level investments. From the society's point of view it is important to achieve this target level at the most cost efficient way which according to our results is not the administratively set FIT but the opportunity costs of the implemented support scheme should be taken into account as we have done in our economic tariff design FIT.

Conclusions

Our simulations show that even with strong assumptions of Real-Time Pricing, two thirds of consumers using Real-Time Pricing with a price elasticity of -0.2, no wind power emerges on the market without Feed-In Tariffs. We show that the current administrate tariff level (83,5€/MWh) is able to reach the target level of wind power but with remarkable windfall profits (38,4€/MWh). We show that an economic opportunity cost based Feed-In Tariff is able to reach almost the same level of installed wind power (23660 MW) than the Nordic target (25600 MW) without any windfall profits.

We show that the current version of the emissions trading system alone combined with the real time pricing leads to total annual energy demand decrease of about 2% due to an increase of about 50% of the flat electricity price rate. At the same time the structure of production moves from midmerit capacities to peaker capacities. Combined current emissions trading system and the administrative Feed-In Tariff (83.5€/MWh) leads to a strong decrease of midmerit capacity and a maximum assumed capacity of wind power. When we look at the efficiency of various schemes in emissions reductions we show that the current emissions trading system as such is not enough to reach the set renewable energy target and consequently also the resulting reductions in national level emissions are not high enough to meet the European Commission set target level 2020. Costs per reduced ton of carbon dioxide turn out to be clearly lowest when the current emissions trading system is combined with the opportunity cost based wind power Feed-In Tariff. Interestingly consumers can reduce emissions quite effectively by becoming more price sensitive.

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