WHO BENEFITS FROM RENEWABLES IN LIBERALIZED ELECTRICITY MARKETS?

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Overview

The growing share of renewable energy sources is rapidly reshaping the way the liberalized electricity markets operate. Reduction of wholesale electrcity prices induced by renewable energy has enabled consumers to save €840 million in Germany in 2010. In Australia, wholesale electricity price could have saved customers on average AU$ 900 million in the same year. Our analysis for Singapore has estimated the savings potential from a 600 MW PV capacity at roughly S$ 380 million. Countries with feed-in-tariffs in place may achieve savings that outweigh the total amount of money paid for feed-in-tariffs. However, there is still no uniform view who should be the beneficiary of these savings. Consumers may still pay the same amount for electricity as before. From a fossil fuel power generator's perspective, these "savings" mean shrinking market share and deferred revenue.
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This paper discussed implications of three PV penetration scenarios (600 MW, 1 GW, 2 GW) in the electricity market of Singapore in 2014. We discuss the magnitude of reduction of the wholesale electricity prices, total possible savings and the implications for the fossil fuel power generators and consumers. We also draw parallels to other markets with more diversified fuel mixes.

The paper is organised as follows: After the introduction of the Singapore's electricity market, the second section gives a brief overview about the methodology and data used for our analysis. The third section discusses results of our study and highlights some key observations in savings pattern. In the last section, we discuss implications for policy makers, energy producers and consumers.

Methods

Analysis of real-time bidding data
Simulation of PV output using measured weather data

Results

Total yearly savings for PV capacity scenarios of 600 MW, 1 GW, 2 GW were estiamted at S$ 380 million, S$ 463 million and S$ 680 million or between 5% and 10% of all energy payments in year 2014. The average price reduction due to PV could be 13.95 S$/MWh PV, 17.07 S$/MWh PV and 25.53 S$/MWh PV respectively. In the competitive electricity markets the benfits of price reduction are predetermined not only by the performance of renewable energy sources but also by the bidding behavior of fossil power generators. Bidding behavior, or more precisely speaking, the steepness of the supply curve in the wholesale electricity market is the key component behind the reallocation of the money that would have been otherwise paid to the fossil fuel generators.

	NEA			Meteonorm		
PV capacity scenario	**600 MW**	**1 GW**	**2 GW**	**600 MW**	**1 GW**	**2 GW**
Total yearly merit-order effect, S$	379,786,930	463,382,731	679,670,061	362,412,784	451,811,444	723,107,726
Merit order effect per kWh solar PV, Sct/kWh	51.0	37.3	27.4	48.8	36.5	29.2
Yearly merit order as % of all energy payments 2014[1]	5.95	7.37	10.8	5.77	7.19	11.5
Average new market clearing price,	120.34	117.23	108.77	120.99	117.64	107.03

[1] Based on monthly energy payment for last 12 months by EMC Singapore (6.28 Billion S$).

S$/MWh						
Average reduction of market clearing price, $/MWh [2]	13.95	17.07	25.53	13.32	16.66	27.27

An important discussion point is how realistic the results outlined here are when comparing them with an actual price reduction in the future. Besides the common uncertainties about future demand, fuel prices and market policies, we see two limitations. The first one is that our merit-order analysis was based on the historical bidding behaviour of power generation companies. Obviously, as more PV will be added to the grid, fossil power generators will adapt their bidding in order to secure dispatch.

The second limitation stems from a comparison of PV integration scenarios to a zero PV static system. Our results for the merit-order effect and electricity wholesale price reduction was based on this approach. Unlike that in reality, distributed PV is developed gradually and is added to a system where a certain PV capacity is already integrated. Therefore, it can be argued that the effects of every capacity increment would decrease with a growing total share of integrated PV.

Conclusion

The magnitude of cost savings by PV systems is highly sensitive to the bidding behaviour of CCGT generators. Solar PV is able to create savings due to potential market inefficiencies especially during peak demand hours.

In a market with high degree of competition and inexpensive baseload power, cost savings by variable renewable sources will gravitate towards operational costs of the displaced generators.

Choosing a system without renewables as a reference value to estimate savings has limitations because renewables are deployed gradually. The appropriate baseline for every new PV increment should be a system without this increment. In line with other literature sources, we foresee that every new MW of PV deployed will have a lower marginal value.

Solar PV is able to create a net benefit to the consumers in energy markets with expensive baseload fuel and high power prices during peak periods. This benefit represents the deferred revenue of the fossil power generators. The allocation of this benefit depends, however, on the energy market policy of the regulator.

References

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[2] Compared to a system with zero installed PV.