Editorial

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1 Introduction

The electric utilities for transmitting and distributing power are entering into a period of change. Competition has been introduced in power systems around the world based on the premise that it will increase the efficiency of electricity sector and reduce the cost of electrical energy to the users. Electrical energy is not, however, a simple commodity unlike other forms of energy, which cannot easily be stored in large quantities. Continuity of supply, thus, has been a value that can be much higher than the cost of energy consumed. Overview of the technology of power system competition provides a solid basis upon which workable and durable solutions can be developed for the problems created by the introduction of electricity markets (Lie, 2001).

Due to the increased penetration of wind power into the emerging electricity market, there are several challenges and key issues which must be resolved. One of the challenges facing state policy makers who are considering electric industry regulatory reform is how to preserve the options for renewable resources, like wind energy, to play a role in the future of the industry. Wind is an innovative, clean, modular and intermittent technology. Though wind power offers many possible benefits, it faces a number of potential barriers to full competitive participation in a restructured electric industry. The type and severity of these challenges will depend upon the final design and implementation details of public policies and regulatory reforms for the new electric industry model chosen.

2 Wind power in deregulated power system

In the pre-deregulation power systems, most of the energy sales were between adjacent utilities. The transaction would not go forward unless each utility agreed that it was their

best interests for both economy and security. Several emerging issues in competitive power market, namely, enhancement of security and available transfer capability of the system, transmission pricing, etc. have been restricting the free and fair trade of electricity. Changing environment influences the optimisation of the transmission network since load flows existing today will be altered considerably. The ancillary functions are required for the smooth operation of the networks, such as frequency control, load flow control, reactive power, voltage stability and network security.

Deregulated electricity markets can be a pool type and/or bilateral/multi-lateral contracts types. The energy prices can be determined either ex-ante or ex-post. The wind power resource and technology characteristics differ from those of the large fossil power stations that have traditionally been used in many countries. The most important differences are as follows (Outhred, 2002):

- Wind resources are time varying and non-storable in bulk amount, therefore, wind power output is non-dispatchable except at the cost of spilling wind resources.
- The generators used in modern large wind turbines often employ doubly fed induction generators with power electronic interface.
- A wind farm typically consists of many turbines of relatively small rating, making it less cost-effective to install expensive turbine control mechanism than on a single large machine.
- Wind turbines start and stop when the wind speed reaches cut-in and cut-out speed, respectively, with associated transients that depend on the technology and control algorithm employed.

The introduction of large amount of non-dispatchable generation (wind power) would require the ancillary services to control the frequency and voltage of the system. The wind power is often available in the remote areas from the existing generation and load centres, involving significant network extension and enhancement. Regulatory regime should facilitate the transmission network development. With the rapid growth of wind power, important factors need to be investigated include:

- ancillary service requirements due to varying amounts of wind generation
- market structure and imbalance energy pricing due to forecasting error
- varying generation portfolio and fuel cost mix
- wind penetration in new and existing grid code requirement
- transmission congestion management
- power quality and security issues
- system stability and reliability issues
- relay coordination and FACTS requirements.

Wind generators must have low-voltage ride-through capability without which the system may be exposed to the loss of excessively large amounts of generation due to the system disturbances. It is intolerable from a voltage and transient stability perspective as it places too much stress on the interconnection lines. From an operating perspective it may be

equally intolerable since it would markedly increase the required reserve margins. To be able to regulate voltage at the low voltage side of the substation transformer stepping up the voltage to the bulk transmission level, a wind farm must have the capability to be a net generator or absorber of reactive power. The wind farms have to provide a contribution to maintain grid voltage as per requirement of the grid code. If the reactive power capability of wind farms is limited, they must install SVC/STATCOM to maintain the reactive power requirements at the point of common coupling.

3 Wind power trading

To fit the non-conventional energy sources into liberalised electricity market, these generators are taken into the market differently than the dispatchable generators. Wind power is assumed as non-competitive as it has higher cost and uncertainty of availability of power. In some countries, wind generation is accommodated in day-ahead and hour-ahead energy markets without imbalance penalties. Imbalance (scheduled generation minus actual production) penalties are imposed to prevent gaming and to secure better system operation. In some electricity market, wind generators are not allowed to bid and they are taken into the system as and when these powers are available. Normally, wind generators are paid at the actual energy market price plus a fixed premium. Even at these prices, wind generators can only recover the cost if they get some subsidy from the governments. With the removal of subsidies from these generators, it would be very difficult for them to survive in the emerging electricity market (Singh and Erlich, 2006). In some countries, the wind energy is considered as the ancillary service but the intermittent nature of wind may severely hamper the market operation both technically and economically.

Because of unpredictability of a wind power generation, it is likely that there will be always be a discrepancy between the forecasted wind energy and the actual generation. The effect of non-availability of wind power is the same as the non-availability of conventional power plant which have less probability of the same and they are penalised with huge revenue. Since the wind power depends on the availability of wind, the forecasting error is higher and, therefore, its effect on the market price and system operation is to be minimised. With proper pricing mechanism, the efficiency of market can be improved.

There are two possibilities for integration of wind generators in the competitive electricity market. In option one, they will be allowed to bid into the market and take the Market Clearing Price (MCP) with some premium. Moreover, they must not be charged the output variability penalty as other dispatchable generators are charged for the same. The risk of getting dispatched in the pay-as bid market is more. Due to government's commitments for green energy this option is not suitable. Moreover, wind generators are not competitive without the government subsidy and in future government would like to remove the subsidies. Another option, which is more appealing, is that the outputs of wind generators can be taken into the system whenever and wherever, they are available. In this condition, MCP is to be determined without wind power. The wind generators, if output is available, will also be given the same MCP which may be higher than the MCP calculated with wind power output and the output of other supply bidders will be reduced as per their bidding rates. Wind power will recover cost and will be sustainable in the

market. In the case of non-availability of wind power, there is no loss in the market and supply bidders that must be ready to supply the complete load.

Wind power outputs can be used by Market Operators (MOs) for mitigating the market power exercised by the dispatchable generators. In normal cases, MOs are mitigating the market power abuse by using the dispatchable loads which is more expensive than the wind power because the cost of non-served energy is more than the cost of energy supplied. Since the wind power is intermittent and other generators do not know the exact amount of output from the wind power, their market power capability will be reduced. Wind power with pump storage hydro power plant can have much effect on the market price setting. To recover the cost, wind power may try to get associated with other types of generators and may create the market power. Any such type of merger/collusion should be avoided by allowing the wind power to generate power as and when available.

Ancillary services such as reactive power support, spinning reserve, Load Frequency Control, black start capability, energy imbalance etc. can be procured through auction-based competitive markets similar to energy market. These ancillary services are required for maintaining the quality and security/reliability of supply. Due to intermittent output of wind power coupled with uncertainty of wind, there is a possibility of higher cost of power due to greater imbalance of power, if wind generators are allowed to bid into the market. On the other hand, if wind power is with MOs, it can be used to provide the real power either in ancillary service or primary energy market to reduce the cost of electricity.

4 Summary and conclusion

A suitable market mechanism is required to accommodate the non-conventional energy sources in the new grid code due to several technical and non-technical reasons. Having intermittent nature of wind power availability, a proper trading option must be used for these sources to recover their costs in competitive power market. A proper use of these sources can also avoid the abuse of competitive power market by which the efficiency of the market can be increased. Wind power can play a vital role in mitigating the market power, but their costs must be recovered for successful promotion of wind power energy. The trading with wind power must be transparent for free and fair trade of electricity. A proper guide line could be developed by the policy makers and MOs to promote the wind power with system reliability and security.

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