Evaluation of Locational Marginal Prices in Electricity Market

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Abstract: In electric power systems the constrained transmission leads to locally pricing for energy. This locally pricing is so called locational marginal prices (LMP) or nodal pricing. Locational marginal prices (LMP) are important pricing signals for the participants of competitive electricity markets, as the effects of transmission losses and binding constraints are embedded in LMPs. studying LMPs in electricity market is an important issue for independent system operator (ISO). ISO always analysis the system form different views for improving system nodal pricing. In this paper, LMPs are evaluated from different views and effects some factors on LMPs are tested.
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1. Introduction

Electricity industry restructuring during the last two decades has made drastic changes to the traditional electricity structure and will continue for next several decades. In the past, electric power industry has been either a government-controlled or a government-regulated industry (i.e. single owner), which existed as a monopoly where overall authority in generation, transmission and distribution of power is within its domain of operation. Everyone including household, businesses, and industries were required to purchase their electricity needs from the local monopolistic power company. This was not only a legal requirement, but also the only source they had to rely on to fulfill their day to day requirements. The restructuring has led the traditional electricity industry to become a competitive electricity market. The main driving forces for these reforms are due to economic inefficiencies and consumer dissatisfaction associated with the single owned electricity industry. Since electricity is an essential source of energy for everyone and due to its unique characteristics such as un-storability and lack of flexibility in controlling the power flow in transmission lines, the whole process of restructuring was a challenging and a complex task. While rules concerning horizontal market structure form the basis of antitrust policies in most countries, it is widely recognized that horizontal structure comprises only one piece of the competition puzzle. Vertical integration and other vertical arrangements between wholesalers and retailers will also impact the incentives of firms. In addition, regulators and many economists have focused on the effects that market rules, such as auction design, may have on equilibrium prices. This paper empirically examines the relative importance of horizontal market structure and vertical arrangements in determining prices in imperfectly competitive markets [1-4].

Over the past two decades, however, countries have begun to split up these monopolies in favor of the competitive market in order to introduce commercial incentives in generation, transmission and distribution. The main goals under competitive market design are system reliability, market efficiency, congestion management, market power mitigation and operational & investment incentives for all the participants. This is done by creating the competition between participants in the electricity market with open access [5-7].

Optimal nodal pricing is one of the effective pricing schemes for providing a higher profit to both the utility and the customers. Nodal prices contain valuable information useful for participants, operation and, hence the scheme is to accurately determine them, continue to be an active area of research [8-13].

This paper deals with LMP analysis from different views. Effect of several parameters on LMPs are tested and analyzed.

2. Illustrative Test System

A typical power system as shown in Figure 1 is considered as test system. The system data and also market data can be found in [14].

3. Analyzing LMPs

In this section, effects of different parameters on LMPs are investigated. Network visualization from view of LMP is depicted in Figure 2. The red areas have high LMPs and blue areas have low LMPs. The bar in right section of figure shows the LMPs of network by using color. It is clearly seen that the LMPs in bus 2 and bus 3 are low, while the LMPs in bus 1, 4 and 5 are high. This is because of placing high generations in buses 1 and 3 and high loads in buses 1, 4 and 5.

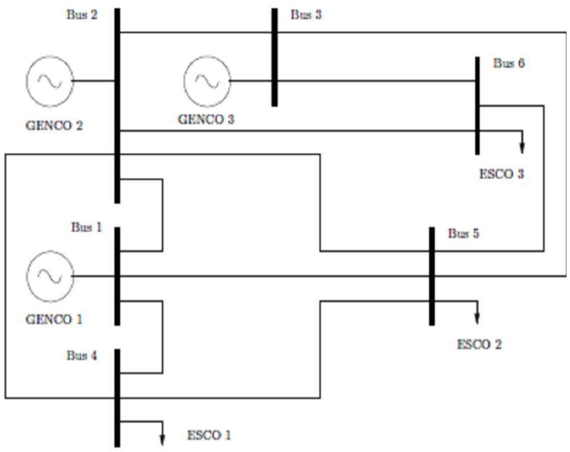

Figure 1. IEEE 6 bus test system

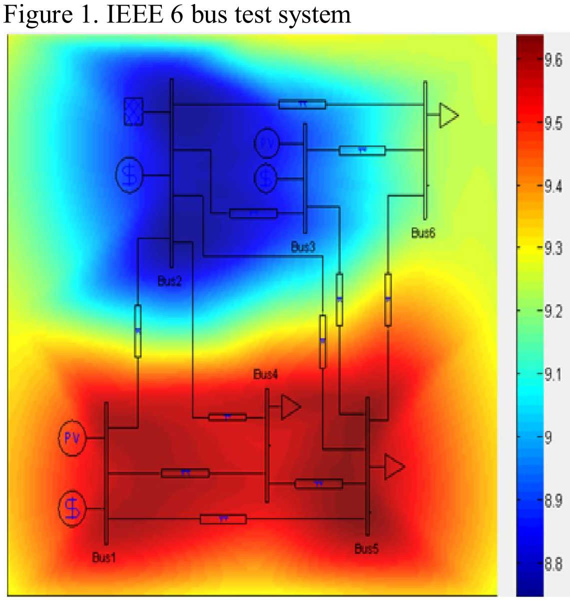

Figure 2. LMPs of network depicted in Figure 1

3.1. Effect of congestion on LMPs

The LMPs are closely related to capacity of lines and congestion in transmission lines. In this regard, it is very useful to show effect of congestion on LMPs. for this purpose, the capacities of following lines are increased to double:

- Line between bus 3 and bus 5
- Line between bus 1 and bus 2

The simulation results for this case are depicted in Figure 3. The figure shows that increasing capacity of lines affects on LMPs and nodal prices are reduced.

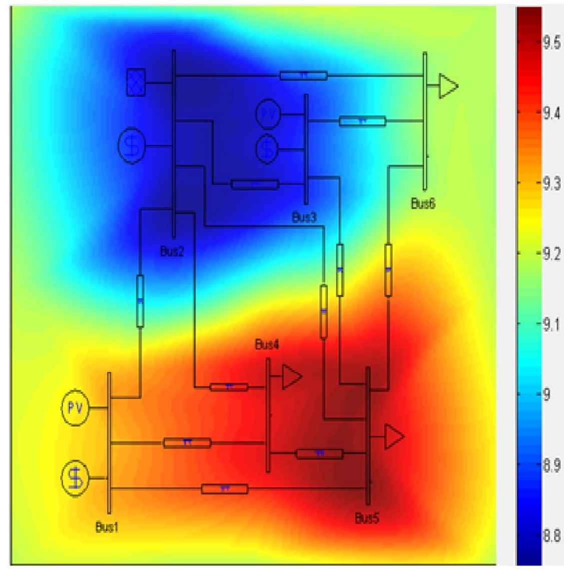

Figure 3. LMPs of network after increasing lines capacity

3.2. Effect of reactive power on LMPs

Locally feeding of reactive demands can affect on LMPs, because the power transfer in lines is reduced. In order to evaluated the effect of locally reactive sources on LMPs, it is assumed that reactive demand of bus 5 is supplied via a locally source placed at bus 5. Figure 4 shows the LMPs of system in this case. It is seen that the LMP in bus 5 in reduced in comparison with previous cases.

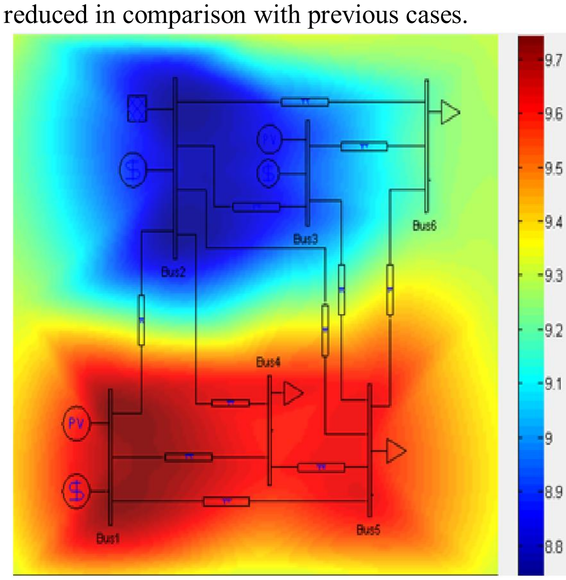

Figure 4. LMPs of network after installing reactive source at bus 5

3.3. Effect of DG on LMPs

Distributed generation (DG) can affect on LMPs, because the power transfer in lines is reduced. In order to evaluate the effect of DG on LMPs, it is assumed that a 10MW DG is installed at bus 5. Figure 5 shows the LMPs of system in this case. The effect of DG on LMPs can be visibly seen. The voltage profile of network in this case is also depicted in Figure 6. DG can control the voltage in a predefined limit.

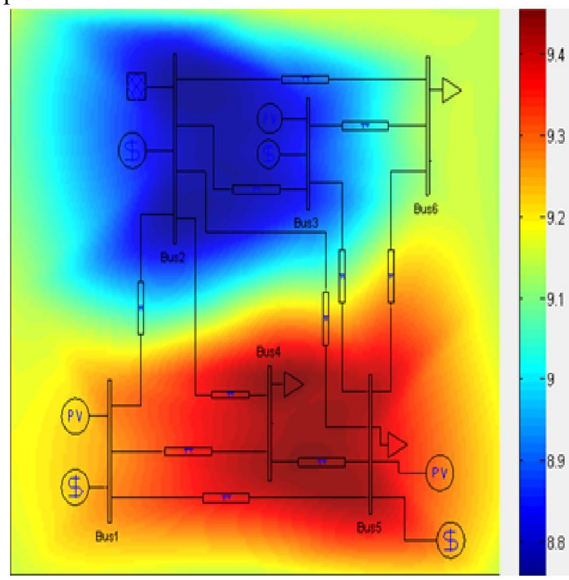

Figure 5. LMPs of network after installing a 10 MW DG in bus 5

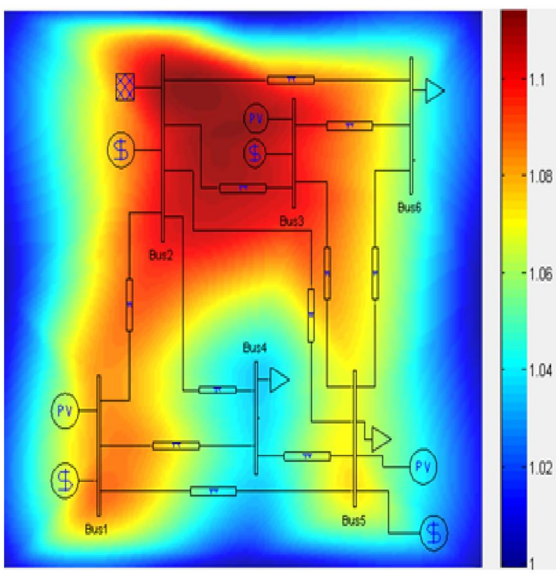

Figure 5. Voltage profile of network after installing a 10 MW DG in bus 5

4. Conclusion

In this paper LPMs were successfully investigated and analyzed. Effects of some general factors such congestion, reactive demands and distributed generation on LMPs were tested and showed. a visualization method was used to show LMPs.

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