

## Locational Signals in Transmission Pricing

The harmonisation of transmission charges is an essential ingredient to liberalising the European electricity market. Generally arrangements for transmission charges should have two objectives. Firstly they will need to recover the revenue requirements of the network owners as determined by the regulatory authority. Secondly, in order to encourage economic efficiency in the siting of a user's plant and its operation (whether this is generation or a customer's load) they should also contain locational signals that reflect the marginal costs that the user places on the transmission system.

Four categories of transmission costs can be identified, namely:

1. The incremental costs of investment that result from the siting of a generator or load;
2. The costs of electrical losses on the transmission system;
3. Costs of congestion, which will often manifest themselves as costs of re-dispatching generation; and
4. A balance of revenue needed to meet the primary objective of earning the transmission owner a reasonable rate of return on its regulated asset base.

The trading of electricity will be facilitated if transmission charges are:

- Capable of being determined before a transaction is made (that is set ex-ante), and from published tariffs
- Reflect the physical properties of the network, and are not directly linked to the transaction
- Based on sound economic (marginal cost) principles such that their future movement in the longer term can be anticipated
- Determined by a transparent methodology
- Based on a harmonised approach in each TSO's area.

This paper addresses the locational signals that may be associated with the first of the above cost categories. The treatment of electrical losses is not considered at this stage, and a methodology for dealing with Congestion Costs is addressed in a companion paper. Economic theory dictates that any balance of revenues that may be required to meet a regulated target should be levied on the least price elastic user groups (Ramsey pricing), which will generally be loads that are not energy intensive.

Locational signals in transmission charges that reflect future investment costs can be derived from the use of a model of the transmission system that incorporates the disposition of load and generation, and the topography of the physical network. Generally these models will be represented by a collection of nodes connected by lines and cables. A locational signal for the siting of generation is created by assessing the impact on the overall cost of the system of an increment of demand at a reference node being met by an increment of generation at each of the system nodes. A locational signal for the siting of load can be created by examining the marginal cost of meeting an increment of load at each of the system nodes from an increment of generation at the reference node.

Locational signals derived in this fashion implicitly assume that the increment of load that has been added will give rise to either additional transmission investment, or a

saving in transmission investment. Thus they give “long run” signals, whereas locational signals in respect of congestion and losses will generally reflect costs in operational time-scales and will therefore be “short run” signals.

Various mathematical techniques are possible in simulating the functioning of the system. A relatively simple approach is to configure the model as a transport model where the cost minimising algorithm assumes that additional transmission capacity is provided over the shortest route available. More sophisticated approaches would be to configure the model to represent actual power flows (DC power flow model), or perhaps make the model more sophisticated through the recognition of system security requirements. At its most complex an AC power flow model (of the type generally used by TSOs in the planning of their systems) that recognises both current and voltage constraints might be employed.

The output from all these models will be a series of nodal shadow costs that indicate the marginal cost of adding generation or load at each node on the system. These may be averaged into zonal costs for administrative ease and to remove volatility to short term repositioning of generation and load. The costs can be biased to create an overall revenue recovery for G or L by the addition of a constant amount.

Generally charges derived in this fashion will show positive charges to generation in areas where there is a surplus of generation over demand and credits for generation in areas where there is a preponderance of load. Conversely charges to load will be high in areas where there is an inflow of generation, but relatively low in areas where there is a generation surplus, and from which there is an export of power.

Such charges should be applied at times of relatively high demand since it will be peak demands on the system that drive prospective new investment. This implies that they will either be formulated as kW related charges or charges linked to kWh consumed (or produced) at time of system stress. Generally such charges (or credits) will fall on generators, or suppliers of end customers. Traders dealing in transactions at a wholesale level should not be subject to such charges unless they also undertake the supply to the end customer.

These locational signals are derived in relation to the physical arrangement of the transmission system and are calculated on a basis that does not recognise TSO or Member State boundaries. As a result the approach applies a consistent methodology that automatically creates the basis for a harmonised approach. The approach is divorced from any arrangement that may be introduced between TSOs that provide compensation by a TSO in one region for the use of an adjacent system. Indeed any compensations of this type should not be allowed to pervert the economic basis for the locational signal, but instead adjust the regulatory asset base and overall revenue recovery permitted by the TSO. As a consequence the cost of these compensations will naturally fall on the price inelastic component of L.

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