Demand Response within Current Electricity Wholesale Market Design

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(1) Overview

The introduction of intermittent energy resources calls for the ability to modulate consumption patterns according to electricity availability. This paper provides a brief overview of the main electricity market design characteristics and places demand response within the framework of the existing timeline of market operation. The main differences between electricity markets lie in the price formation mechanisms where some markets pay-as- cleared and some pay- as- bid for the electricity transacted. The geographical area for which a price is determined also varies across markets, some determine a single price for an entire region and others opt for a price according to location or grid nodes. Differences between markets are also found in the procurement methods, be it bilateral contracting, or through a centralized platform such as an exchange or electricity pool for different time periods. Demand response can be introduced during either the bidding and contracting process as a special 'supplier', as a reserve mechanism, or separate from the market. Demand response is activated by the market depending on the desired objective, such as peak generator displacement, congestion relief, energy efficiency, renewable energy exploitation or cost savings.

(2) Methods

First, a series of wholesale market design characteristics were compared across different electricity market case studies in Europe, The United States, and Australia. Second, a literature review on market design characteristics was used to set the theoretical framework for the analysis. Third, common design characteristics, such as procurement, clearing and grid support designs were grouped in order to describe the variety of ways in which markets propose them. Finally, demand response was integrated into the existing designs based on case studies and existing literature on the subject.

(3) Results

Wholesale Market Design:

Much of the electricity is pre contracted in the forward markets, but is then re-nominated in the wholesale day ahead and intra-day markets through a double settlement methodology in order to provide the appropriate price signals for the system. There are three main stages of electricity wholesale market design: procurement, clearing and grid support.

Procurement refers to the contracting of electricity supply services by demand representatives. In addition to demand and supply bidding modes, some markets accept two sided bids for energy previously contracted in the forward markets. As a measure to add liquidity to markets financial bids are sometimes accepted, these being energy offer bids by parties that do not own generation assets but still engage in trade, these bids must be netted out at zero before the market closure.

Clearing is matching of both supply and demand bids in order to determine the prices to be paid to and by each party. The main differences across markets are whether they clear with a single marginal price (MP), with locational marginal prices (LMP) defined across geographic areas, or with different prices according to the cost bids of supply.

Grid Support or Ancillary Services (AS) are a range of services necessary to the efficient running of the electricity system which are outside the basic needs of energy, generating capacity, and power delivery [24].

Demand Response within Market Design

One of the main challenges of introducing demand response (DR) is to integrate it to the already existing market framework. The study performed shows that markets are dealing with this issue in a number of different ways. In some markets DR is allowed to 'offer' energy in the form of downward flexibility in the

wholesale and ancillary markets. Demand aggregators might be retailers or third party aggregators who bid in the market in name of a group of consumers. They are can be paid either through pre-contracted dynamic tariffs, and so they will bid at their pre-contracted price, or they can be paid at the MP or LMP market price. In times of scarcity DR participants can become the market price setters. The settlement can be either cost based or market price based. However, certain markets present hybrid settlements for DR, where they receive a pre-contracted amount for being available to participate in a DR event, and an energy price if the event is called forth. Similarly, DR can also be eligible to participate in the ancillary services markets alongside with traditional generation grid support. Figure 1 below explains the main characteristics encountered in the markets analyzed and places demand response within the market operation timeline.

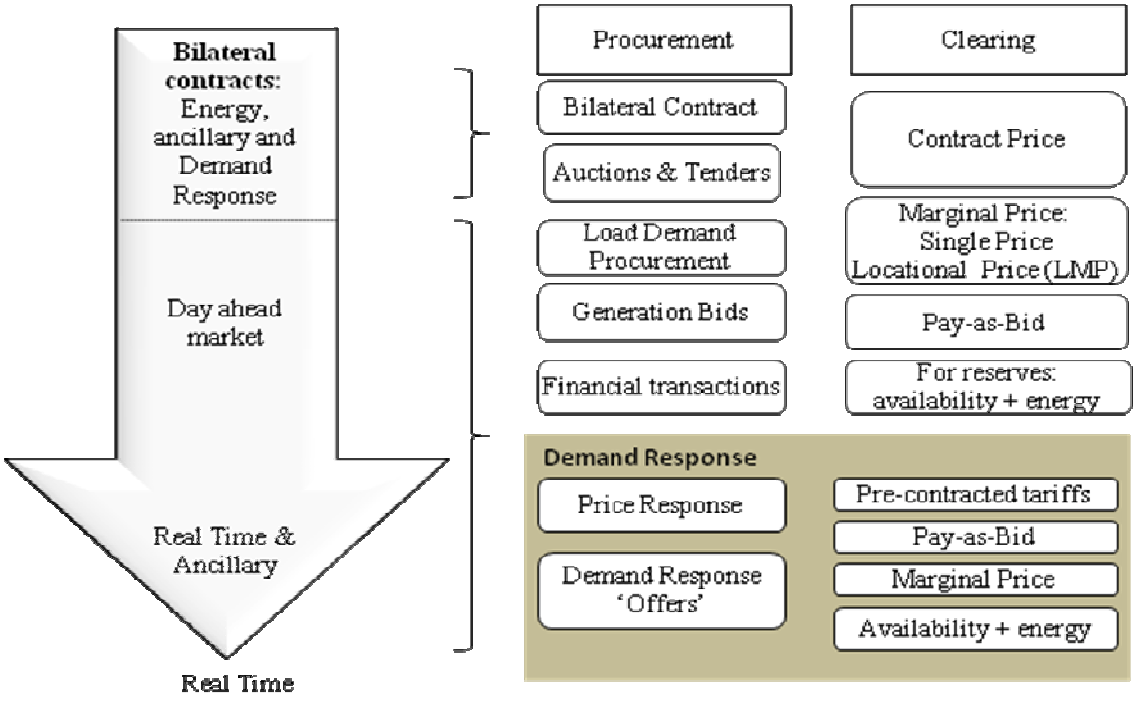

Fig. 1: Wholesale Market Design Configuration Possibilities & Demand Response Integration

(4) Conclusions

The largest difference across market designs is whether the market is cleared as a single node or as different nodes or zones resulting in either one or many electricity prices Electricity markets tend towards bilateral, forward trading, which would theoretically diminish the size of the day ahead and intraday markets. However, on most markets bilateral transactions must be declared on the day-ahead market as well. So, actors trade in the spot markets as if their whole capacity were available. The pool market, then, is a hedge against short term imbalances and as such gains importance with the introduction of renewable energy production which is hard to predict in the long term.

Demand response is a valuable resource that enables markets to deal with larger variability of generation. The type of response can be direct load control with a predefined notification period for changes, or price response based either on block tariffs or on real time prices. Demand response resources can be contracted as reserves and paid an availability component, perhaps in the form of rebates over the electricity bill, and an energy component in case they are called to curtail. Demand response can also participate directly as a type of 'offer' in the electricity market and set the marginal energy price. Allowing demand to set the price within a free market operation sheds light on the cost of scarcity or the reservation price at which users prefer to reduce their consumption rather than pay the market price.

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