Privatizing Electric Reliability through Smart Grid Technologies and Priority Service Contracts

Shmuel S. Oren, *Fellow*, IEEE[1]

***Abstract*— Smart grid technologies in combination with the methodological foundation laid by the economic theory of Priority Service, enable the conversion of electric service reliability from a public good to a private good. Such a transformation is achieved by offering electricity service as a product line differentiated according to service reliability from which customers can self-select the level of reliability that fits their needs and pocketbook. This conceptual paradigm is illustrated through a specific proposal for a multilevel Emergency Interruptable Load Response Service (EILS) program at ERCOT.**

Keywords: Load Response, Priority Service, EILS.

I. Introduction

A public good is a good that is nonrivaled and not excludable, i.e., its consumption does not diminish its availability to others and it is not possible to exclude someone from enjoying it. Consequently, a pricing based system for recovering the cost of providing a public good based on consumption is not sustainable due to the possibility of free ridership. Supply reliability in electric power systems is often considered a public good and is compared to fire protection and national defense. Proponents of this point of view advocate uniform reliability provision based on engineering criteria through the use centrally procured resources whose cost is imposed on customers according to some cost allocation scheme. We argue that the above public good paradigm is based on an outdated technological framework that does not allow differential provision of reliability to end use customers of electricity. We further claim that smart grid technologies that enable load response and load control change the technological landscape in ways that enable conversion of electric service reliability from a public to a private good.

Voluntary subscription by customers to load control under agreed upon contingencies enables customers' choice among different levels of service reliability at different prices. Furthermore, when customers subscribe to load control or curtailable service and by doing so agree to receive a lower level of service reliability, they enable the provision of more reliable service to other customers who purchase non curtailable service. Hence, differential load control based on customer self-selection makes electric reliability both rivaled and excludable so it is no longer a public good.

The key elements underlying the conversion of service reliability from a public to a private good are the enabling smart grid technologies and the design of a product line that enables customers to self-select the service reliability that best matches they needs and pocketbook. Priority service pricing [1],[2] and multilevel demand subscription pricing [3], provide a methodological and economic framework for designing such a product line.

In this presentation we will describe a specific proposal presented to the ERCOT Demand Side Working Group and to the Long Term Solutions Task Force by Dr. Jay Jarnikau and the author , based on the priority service methodology, for an enhanced multilevel Emergency Interruptible Load Service (EILS) program. The basic idea of this proposal is to recruit blocks of interruptible firm load, through an auction process, whose interruption is triggered by a specific level of the balancing energy price or an Emergency Electric Curtailment Plan (EECP) event. The proposal can be interpreted in several ways. It can be viewed as a supplement to a forward capacity market, like the New England FCM, targeted at meeting short term capacity shortfalls using dispatchable load. The current FCM allows demand side participation but procured demand side capacity is not dispatchable. Alternatively, the proposal can be viewed as a risk management program aimed at mitigating price spikes through centralized procurement of call options from firm load at different strike prices which allows the system operator to recall service to interruptible load blocks when the spot price reaches their strike price. Under this framework load blocks selling call options with higher strike price are called less often and paid a lower option premium. From a reliability perspective, subscribing to a particular strike price translates to a curtailment probability or to a level of service reliability. Accepting a lower level of service reliability is a mechanism through which load can opt out of paying its share of capacity cost or scarcity rents. These charges are levied by the ISO as a way of recovering the cost of "public good reliability" which is based on conventional planning reserves criteria.

It is important to distinguish between a program that enables differentiated service reliability provision through contractual load control arrangements and load response to real time or even day ahead prices. The main difference is in "who bears the risk?" which is what service reliability is all about. The lack of early commitment characterizing demand response to real time prices leaves the option to request service in the hands of the customer and the obligation to provide service, if requested, on the ISO side. Therefore, such demand response cannot be characterized as acceptance of reduced reliability by the customer. By contrast, an interruptible service contract commits the customer to a lower level of service reliability and relieves the ISO from the

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responsibility to procure resources so as to be able to serve the customer under certain contingencies.

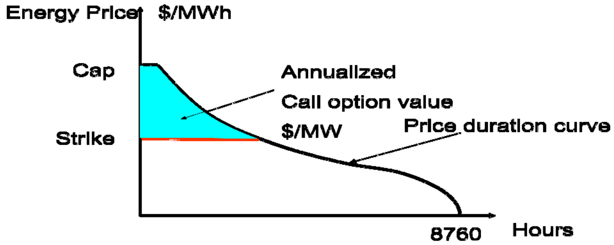
II. Priority Service Program Proposal

A. Base plan

Under our proposed priority service program, energy consumers or demand side resource aggregators that sign up for this voluntary program would contractually agree to commit to curtail their electricity purchases from the grid at their selected strike price out of three pre-determined levels, which shall initially be set at $750 per MWh, $1,000 per MWh, and $1,500 per MWh.[2] The contractual arrangements would involve agreements between the ERCOT ISO and the Qualified Service Entities (QSE's) representing the participating loads. The ideal participants for this program would include: Industrial loads that can tolerate short-term interruptions in their electricity purchases, and direct load control programs involving residential and commercial loads, through which end-use equipment such as water heaters, pool pumps, and air conditioners may be controlled by a demand-side resource aggregators or a load serving entity (LSE). The same formulas and procedures that the ERCOT Staff developed for their current EILS program may be used for determining the quantity of demand reduction provided by industrial and commercial energy consumer participants in this program.

B. Compensation to program participants

In calculating the compensation we will assume that the program participant has title to the curtailed energy through a bilateral contract, a supply contract with a REP, or as a default service customer of a utility. To the extent that this is not the case, any payment owed by the participant for the energy procured through such contractual arrangement should be netted from the compensation. The compensation to participants in the program consists of two parts. A fixed monthly payment based on the expected avoided energy cost in excess of the strike price (this is the premium payment for the call option) plus payment of the strike price for the actual curtailed energy. At least at the introduction of the program, participants who signed an annual contract would receive fixed monthly payments equal to one-twelfth the annual value of the energy costs in excess of the strike price. Conceptually, this is shown in the following diagram:



[2] These strike prices might change as offer caps increase or based on subscription levels under these three prices.

In reality, the number of intervals during which the price exceed the strike price and the magnitude of the price spikes may be above or below the expected values reflected by the expected price duration curve. Thus the amount of curtailed energy for program participants may deviate from the expected value. A second variable portion of the compensation will pay market participants the strike price times the amount of curtailed energy. However, an additional adjustment will be made in order to assure program participants that no curtailment will last less than an hour. In other words, even if after one 15 minute interval the price drops below the strike price, the curtailment will continue for a full hour and the participants will be paid the full strike price for that curtailed energy. It should be noted that without the later adjustment, if the actual price spikes conformed with the expectations, the total of the fixed call option premium and the variable payment for curtailed energy would add up to exactly what the program participates would could have gotten from the spot market by curtailing their load whenever the spot price exceeds the strike price. To the extent that actual price spikes differ from expectations, the variable payments at the strike price could be higher or lower than expected value and therefore total payments to program participants could be higher or lower than from passive response to spot prices (but equal on average). Guaranteeing a minimum of full hour curtailments under the program, however, is a definite bonus for program participants since it pays them the strike price even if the spot price falls below the strike price during the hour. This is the only distortion introduced by the program and it is intended to incentivize program participation. We believe that the added compensation resulting from this distortion above what participants could get through passive demand response in the spot market is justified by the value that the early knowledge of demand response provides to an ISO. From the participants point of view the fact that part of the compensation comes as a fixed rather than uncertain cash flow may also be seen as a benefit (due to risk aversion), however, that comes at no cost to the market since in expectation the market is revenue neutral with respect to that arrangement.

C. Forecast of Price Duration Curve

Next-year prices must be forecast so that the expected price spikes and the expected value of curtailments can be calculated. Ideally, a forecast of the price duration curve would be obtained from "the market." Financial intermediaries, power plant owners, and retail energy providers (REPs) develop and rely upon such information to project the dispatch of power plants, value generation assets, and establish hedging strategies for procuring power. However, the confidential nature of such forecasts, asymmetric information, and differences in expectations may make it difficult to rely on market sources for such information. Consequently, it may prove more practical to rely upon wholesale price information from the previous year, adjusted for any anticipated changes in offer cap levels, reserve margins, administrative price floors during an EECP, and natural gas prices.

It has been argued that historical prices at ERCOT as in other ISOs have not been high enough to produce call option premiums that will attract participation. If this is the case, energy prices will not be sufficiently high to attract new generation either. The presumption of the energy only market in Texas is that energy prices which will be reflected in the price duration curve will produce sufficient inframarginal profits to induce new generation investment. However, historical prices preceding the energy only rule may indeed have been too low. Until a price record is established to enable realistic price forecast, we propose to use the historical price duration curve and scale it up to a level at which a CT breaks even. At that level, the area under the price duration curve above the marginal cost of a CT equals to the annual fixed cost of a CT. In other words, a CT operating when the spot price exceeds its marginal cost will collect sufficient inframarginal profits to cover its annualized fixed cost. Once we obtained such a scaled up price duration curve we can use it to calculate the fixed payment to demand subscribing to priority service at different strike price levels.

An alternative approach to pricing priority service contracts is of course to conduct an auction. Specifically, a simultaneous multiproduct descending clock auction can be designed where different strike prices will be treated as different products and load resources will be allowed to offer curtailment capacity and annual premiums for curtailment contracts with different strike prices.

D. Cost recovery and nonperformance penalties

The cost of the incentive payments could be assigned to load-serving QSEs based on their load ratio share. A more sophisticated approach might be to assign the cost associated with each strike price as a surcharge on load that persists above that price.

Finally, nonperformance can take several forms. If available load for curtailment is persistent below the original rating the rating can be adjusted going forward. If, on the other hand the load does not curtail when asked, it should be liable for the difference between the marginal cost price (MCPE) and the strike price in addition to a *pro rata* share of the program cost.

III. REFERENCES

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