California Independent
System Operator Corporation

July 22, 2011

The Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: Demand Response Compensation in Organized Wholesale Energy Markets
ISO Compliance Filing
Docket No. ER11-____-000

Dear Secretary Bose:

The California Independent System Operator Corporation (ISO)[1] hereby submits this filing to comply with the requirements regarding demand response compensation set forth in Commission Order No. 745 issued in Docket No. RM10-17-000 on March 15, 2011.[2] This filing includes proposed revisions to the ISO tariff and supporting documentation to satisfy the requirements of Order No. 745.

I. Background

A. Order No. 745

In Order No. 745, the Commission established new requirements regarding compensation to be provided for demand response in organized

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[1] The ISO is sometimes referred to as the CAISO. Capitalized terms not otherwise defined herein have the meanings set forth in Appendix A to the ISO tariff. Except where otherwise specified, references to section numbers are references to sections of the ISO tariff.

[2] *Demand Response Compensation in Organized Wholesale Energy Markets*, Order No. 745, FERC Stats. & Regs ¶ 31,322 (2011), *reh'g pending*.

wholesale energy markets overseen by ISOs and RTOs.[3] Order No. 745 requires each ISO and RTO to submit, by July 22, 2011, a compliance filing that addresses the following issues: (1) the net benefits test for demand response compensation described in Order No. 745; (2) the measurement and verification of demand response performance; and (3) the allocation of demand response costs.[4] The order also stated that "[i]n its compliance filing an RTO or ISO may attempt to show, in whole or in part, how its proposed or existing practices are consistent with or superior to the requirements of [Order No. 745]."[5]

In Order No. 745, the Commission found that, based on the record before it, payment by an ISO or RTO of compensation for demand response other than the locational marginal price would be unjust and unreasonable in circumstances where both of the following apply: (i) when a demand response resource has the capability to balance supply and demand as an alternative to a generation resource, and (ii) when dispatching and paying the locational marginal price to the demand response resource is shown to be cost-effective as determined by the net benefits test described in Order No. 745.[6] The order stated that, when both of these prerequisites are met, payment of the locational marginal price to the demand response resource will result in just and reasonable rates for ratepayers.[7]

Order No. 745 directed each ISO and RTO to undertake each month an analysis based on historical data and the RTO's or ISO's previous year's supply curve to identify a price threshold indicating where customer net benefits would occur.[8] Specifically, Order No. 745 stated that the ISO or RTO should determine, and should update on a monthly basis, the threshold price corresponding to the point along the supply stack for each month beyond which the benefit to load

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[3] *Id.* at P 1. Order No. 745 noted that the Commission's regulations define demand response as "a reduction in the consumption of electric energy by customers from their expected consumption in response to an increase in the price of electric energy or to incentive payments designed to induce lower consumption of electric energy," and that the regulations define a demand response resource as "a resource capable of providing demand response." *Id.* at P 2 & nn.2, 3 (citing 18 C.F.R. §§ 35.28(b)(4), -(5) (2010)).

[4] *Id.* at PP 6, 81,102. Two RTOs subsequently requested extensions of time to submit their compliance filings. The Commission granted those requests of the two RTOs. *See* notices of extension of time issued in Docket No. RM10-17-000 on July 8 and July 11, 2011.

[5] Order No. 745 at P 4 n.7.

[6] *Id.* at PP 2, 47-48.

[7] *Id.*

[8] The Commission also specified that the supply curve analysis should be updated monthly, by the fifteenth day of the preceding month. *Id.* at P 79.

from the reduced locational marginal price resulting from dispatching demand response resources exceeds the increased cost to load associated with the billing unit effect described in Order No. 745.[9] The order also included a mathematical formula representing the net benefits test for determining the monthly threshold price.[10] To determine the monthly threshold price, Order No. 745 specified that each ISO or RTO must "select a representative supply curve for the study month" and "smooth the supply curve using numerical methods."[11] Further, Order No. 745 required each ISO and RTO to "determine monthly threshold prices based on historical data" and to update its monthly analysis "for significant changes in resource availability and fuel prices with the process repeated monthly to reflect that month's data from the previous year."[12] Order No. 745 directed each ISO and RTO to include proposed tariff language to implement the net benefits test in its compliance filing, and to include in the compliance filing documentation to support the proposed tariff language.[13] The order also directed each ISO and RTO to post and update information regarding the net benefits test on its website.[14]

Order No. 745 requires each ISO and RTO to undertake a study, either individually or collectively, that examines the requirements for, costs of, and impacts of implementing a dynamic net benefits approach to determine when paying the locational marginal price to demand response resources results in net benefits to customers. The results of this study are to be filed with the Commission by September 21, 2012.[15]

Order No. 745 did not directly address an important feature of the ISO's demand response tariff provisions – the default load adjustment mechanism. The purpose of the default load adjustment is to ensure that demand response providers and load-serving entities are not both compensated in the ISO's market for a single reduction in demand, thereby ensuring the avoidance of a wholesale "double payment" for the demand response reduction. The Commission

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9 *Id.* at PP 4, 79. The Commission described the billing unit effect as the possibility that, depending on the change in locational marginal price relative to the size of the energy market, dispatching demand response resources may result in an increased cost per unit to the remaining wholesale load associated with the decreased amount of load paying the bill. *Id.* at PP 3, 50.

10 *Id.* at P 79 n.162.

11 *Id.* at P 79 n.161.

12 *Id.* at P 79.

13 *Id.* at P 81.

14 *Id.*

15 *Id.* at PP 7, 84. This compliance filing does not address the study required by 2012.

approved the default load adjustment in a July 2010 order accepting tariff provisions that allow a category of demand response resources – proxy demand resources – to participate in the ISO market.[16] The ISO also proposes to apply the default load adjustment to a new category of demand response resources – reliability demand response resources. Tariff revisions to implement the reliability demand response product are currently pending before the Commission.[17] As discussed further below, on April 14, 2011, the ISO filed a motion for clarification or, in the alternative, request for rehearing requesting confirmation that Order No. 745 does not require the elimination of the default load adjustment and thereby mandate wholesale double payments for demand response reductions.

Order No. 745 recognized that ISOs and RTOs already have measurement and verification protocols for their demand response programs.[18] The order directed each ISO and RTO to include in its compliance filing an explanation of how its measurement and verification protocols will continue to ensure that appropriate baselines for demand response providers are set and how demand response will continue to be adequately measured and verified as necessary to ensure the performance of each demand response resource. The Commission stated that, if necessary, each ISO and RTO should propose any changes needed to ensure that measurement and verification of demand response will adequately capture the performance (or non-performance) of each participating demand response market participant to be consistent with the requirements of Order No. 745.[19]

Order No. 745 also addressed how the costs associated with payment of the locational marginal price for demand response should be allocated within an ISO or RTO. The order found "just and reasonable the requirement that each RTO and ISO allocate the costs associated with demand response compensation proportionally to all entities that purchase from the relevant energy market in the area(s) where the demand response reduces the market price for energy at the time when the demand response resource is committed or dispatched."[20] Order

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16 *California Independent System Operator Corp.*, 132 FERC ¶ 61,045, at PP 25-26, 32 (2010), *order on compliance and reh'g*, 134 FERC ¶ 61,004 (2011) (describing proposed default load adjustment in detail in section of order entitled "Costs and Settlement" and directing that "[w]e accept the CAISO's cost and settlement provisions"). 132 FERC ¶ 61,045, at P 34 & n.24.

17 *See* ISO tariff amendment to implement reliability demand response resource product, Docket No. ER11-3616-000, at 24-25 (May 20, 2011).

18 Order No. 745 at P 93.

19 *Id.* at P 94.

20 *Id.* at P 102.

No. 745 directed each ISO and RTO to include in its compliance filing either a demonstration that its current cost allocation methodology appropriately allocates costs to those that benefit from the demand response reduction, or proposed tariff revisions that conform to that requirement.[21]

Order No. 745 states that each ISO and RTO filing accepted in compliance with Order No. 745 would become effective prospectively from the date of the Commission order addressing that filing.[22]

B. Types of Demand Response Under the ISO Tariff

Certain demand response resources, including aggregators of retail customers, may qualify as a proxy demand resource under ISO tariff provisions the Commission approved in 2010 and upheld on rehearing in 2011.[23] The ISO launched the proxy demand resource product on August 10, 2010. The tariff revisions proposed in this compliance filing apply to proxy demand resources.

As noted above, the ISO also has pending before the Commission, in Docket No. ER11-3616, proposed tariff provisions to implement a new demand response product – reliability demand response resources. These tariff provisions will enable qualifying emergency-responsive resources to provide day-ahead and real-time energy in the ISO market. The reliability demand response resource tariff provisions implement a settlement among the ISO, state utilities, and other interested parties, negotiated after several years of discussions as to how emergency-triggered demand response could be integrated into the ISO's wholesale market. This settlement was approved by the California Public Utilities Commission (CPUC). The reliability demand response resource product is being built on the same platform as, and will have many similarities to, the proxy demand resource product. In its April 14 motion for clarification in Docket No. RM10-17, the ISO requested confirmation that Order No. 745 applies to reliability demand response resources. This compliance filing assumes that it does.[24] If the Commission clarifies that reliability demand response resources are not subject to Order No. 745, the ISO will file further revisions to the tariff changes contained in this compliance filing that reflect the Commission's clarification.

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[21] *Id.*

[22] *Id.* at P 6. As discussed below, the ISO requests that the Commission accept the ISO's proposed effective date for this compliance filing.

[23] *California Independent System Operator Corp.*, 132 FERC ¶ 61,045, *order on compliance and reh'g*, 134 FERC ¶ 61,004.

[24] Based on this assumption, the ISO proposes to include tariff revisions in this compliance filing that are specific to reliability demand response resources. Some of the ISO's proposed tariff revisions are the same as tariff revisions the ISO has proposed in its pending tariff amendment to implement the reliability demand response resource product.

In addition, the ISO tariff permits a third category of demand response – participating loads – to take part in the ISO market. The ISO's participating load program enables qualifying resources to provide curtailable demand as energy and ancillary services in the ISO market.[25] The participating load program has been in effect since shortly after the ISO commenced operations in 1998.[26] Currently the only participant in the participating load program is the California Department of Water Resources State Water Project, which operates aggregated pump load facilities that take part in the program.[27] The directives in Order No. 745, however, relate more directly to proxy demand resources and reliability demand response resources than to participating loads. For example, the participating load program does not permit the entity providing demand response and the load-serving entity to be separate entities.[28] As such, the ISO has concluded that directives of Order No. 745 apply to proxy demand resources and reliability demand response resources but do not apply to participating loads.

C. The ISO's Stakeholder Process for Complying with Order No. 745

On June 6, 2011, the ISO initiated a stakeholder process to develop the revisions to the ISO tariff required to comply with Order No. 745.[29] As explained below, the only tariff revisions required to comply with the order concern the net benefits test. Therefore, the ISO stakeholder process focused solely on the design of the ISO's net benefits test and development of the tariff revisions needed to implement that test.

On June 6, the ISO posted an issue paper regarding the net benefits test for stakeholder review. The ISO held a conference call with stakeholders regarding the issue paper on June 13 and requested any written stakeholder comments by June 20. Three stakeholders submitted written comments. On June 29, the ISO posted for stakeholder review a final proposal for implementing

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[25] *See* "2010 Annual Report of the California Independent System Operator Evaluating Demand Response Participation in the ISO," Docket No. ER06-615-000, at 4 (Jan. 14, 2011).

[26] *See AES Redondo Beach, L.L.C.*, 87 FERC ¶ 61,208, at 61,816-17 (1999).

[27] 2010 annual report, *supra* note 25, at 4-5.

[28] *See* ISO May 17, 2010 response to April 16, 2010, letter requesting additional information regarding tariff amendment to implement proxy demand resource product, Docket No. ER10-765-000, at 3-4.

[29] Materials related to the stakeholder process are available on the ISO's website at http://www.caiso.com/informed/Pages/StakeholderProcesses/DemandResponseNetBenefitsTest.aspx.

the net benefits test. The ISO held a conference call with stakeholders regarding the final proposal on June 6 and requested any written stakeholder comments by July 8. One stakeholder submitted written comments on the final proposal. On July 14, the ISO posted the final proposal for implementing the net benefits test along with an appendix listing historical threshold prices for the past 12 months.[30]

On June 30, the ISO posted draft tariff language to implement the net benefits test, based on the issue paper, the final proposal, and stakeholders' comments, and requested any written stakeholder comments on the draft tariff language by July 7. One stakeholder submitted written comments. The ISO held a conference call to discuss the draft tariff language on July 8. The ISO posted incremental changes to the draft tariff language on July 15. The input provided by stakeholders was very helpful to the ISO in developing the final version of the tariff revisions to implement the net benefits test discussed below, including the use of more precise gas pricing indices and the inclusion of both on-peak and off-peak threshold prices.

II. ISO Compliance with Order No. 745

A. Net Benefits Test and Default Load Adjustment

1. The ISO's Proposed Tariff Revisions to Implement the Net Benefits Test Satisfy the Directives in Order No. 745

In Order No. 745, the Commission required each ISO and RTO to file tariff revisions setting forth the net benefits test to be used in determining when demand response resources will be paid the locational marginal price.[31] To comply with the Commission's directives, the ISO proposes to include its net benefits test in new Section 30.6.3 of the ISO tariff. Section 30.6.3 states that the ISO will apply a net benefits test to determine whether bids for proxy demand resources or reliability demand response resources qualify for such resources to be included in a schedule as set forth in Section 31 of the ISO tariff. The ISO also proposes to modify Section 30.6.1 of the ISO tariff, which concerns bidding and scheduling of proxy demand resources, and Section 30.6.2 of the tariff, which concerns bidding and scheduling of reliability demand response resources, to cross-reference Section 30.6.3.

Section 30.6.3.1 addresses the supply curve to be used in applying the net benefits test. Section 30.6.3.1 states that the ISO will generate necessary

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30 The issue paper regarding the net benefits test and the final proposal for implementing the net benefits test and accompanying appendix are provided in Attachment C to this compliance filing.

31 Order No. 745 at PP 2, 4, 47-48, 79, 81.

supply curves for each month that depict the market clearing prices for specified amounts of supplied power in the ISO markets within that month. Specifically, consistent with a methodology set forth in the business practice manual, the ISO will generate two supply curves for each month, one for on-peak and one for off-peak, by: (i) selecting representative supply curve data for the month that is 12 months prior to the month for which the ISO is generating the supply curves, using all bids into the real-time market from any generating unit; (ii) adjusting the representative supply curve data to reflect significant changes in resource availability and fuel prices that have occurred since the representative supply curve data were generated; and (iii) smoothing the supply curves using an exponential form function and applying a price window based on historical data.

These proposed tariff revisions in Section 30.6.3.1 satisfy the requirements of Order No. 745. As required by the Commission, Section 30.6.3.1 states that the ISO will determine monthly threshold prices based on historical data and will update its monthly analysis to account for significant changes in resource availability and fuel prices, with the process repeated monthly to reflect that month's data from the previous year.[32] Section 30.6.3.1 also contains provisions that satisfy the Commission's directives that each ISO or RTO must "select a representative supply curve for the study month" and "smooth the supply curve using numerical methods."[33]

Section 30.6.3.1 goes on to explain that, after the ISO generates the supply curves for a month, the ISO will determine a threshold market clearing price for the on-peak and a threshold market clearing price for the off-peak corresponding to the point on each supply curve beyond which: (i) the product of the amount of supplied power (prior to the dispatch of proxy demand resources and reliability demand response resources) and the reduction in market clearing price that results from the dispatch of proxy demand resources and reliability demand response resources exceeds (ii) the product of the market clearing price (prior to the dispatch of proxy demand resources and reliability demand response resources) and the reduction in the amount of supplied power that results from the dispatch of proxy demand resources and reliability demand response resources. This process for determining the threshold market clearing price under the net benefits test is consistent with the following mathematical formula representing the net benefits test as provided in Order No. 745:

> Thus, the test is to determine where: (Delta LMP x MWh consumed) > (LMP_{NEW} x DR); where LMP_{NEW} is the market clearing price after demand response (DR) is dispatched and Delta

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[32] *Id.* at P 79.

[33] *Id.* at P 79 n.161.

> LMP is the price before DR is dispatched minus the market clearing price after DR is dispatched.[34]

Proposed Section 30.6.3.1(i) sets forth the same calculation as the order's "(Delta LMP x MWh consumed)," and proposed Section 30.6.3.1(ii) sets forth the same calculation as the order's "(LMP_{NEW} x DR)." Moreover, the ISO's calculations reflect the nuance that the ISO will determine threshold market clearing prices separately for the on-peak and the off-peak. This will enable the ISO to establish threshold market clearing prices that are specific to the different market conditions that exist during on-peak and off-peak periods.

Section 30.6.3.1 also states that the ISO will post the threshold market clearing prices for each month on the ISO website by the fifteenth day of the immediately preceding month. This provision satisfies the requirement in Order No. 745 that each ISO and RTO should update its supply curve analysis monthly, by the fifteenth day of the preceding month.[35]

Section 30.6.3.2 provides for the rejection of bids for proxy demand resources or reliability demand response resources below the threshold price. Pursuant to Section 30.6.3.2, each bid for a proxy demand resource or reliability demand response resource must be equal to or greater than the threshold market clearing price for the applicable month and applicable time of use in order to be eligible for inclusion in a day-ahead schedule in accordance with Section 31 of the tariff or to be issued a dispatch instruction in the real-time market in accordance with Section 34 of the tariff. Section 30.6.3.2 specifies that the ISO will reject any bid for a proxy demand resource or reliability demand response resource that is less than the threshold market clearing price for the applicable month and applicable time of use. These tariff provisions are consistent with the test for payment of the locational marginal price set forth in Section 30.6.3.1 and with the directives of Order No. 745.[36]

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[34] *Id.* at P 79 n.162. Order No. 745 provided an alternative formulation of the same mathematical concept when it stated that each ISO or RTO must "find the price/quantity pair above which a one megawatt reduction in quantity that is paid LMP [locational marginal price] would result in a larger percentage decrease in price than the corresponding percentage decrease in quantity (billing units). Beyond that point, a reduction in quantity everywhere along an upward sloping supply curve would be cost-effective." *Id.* at P 79 n.161.

[35] *Id.* at P 79.

[36] In Order No. 745, the Commission limited itself to stating that its findings would not preclude it from determining that other approaches to demand response payments might be acceptable when the conditions for paying the locational marginal price set forth in Order No. 745 are not met. *Id.* at P 2 n.6; *id.* at P 47 n.115. However, the Commission imposed no obligation on ISOs and RTOs to propose such alternative payment approaches in their compliance filings.

The ISO also proposes to revise Section 31 of the tariff, which concerns the day-ahead market, to state that the ISO may issue schedules for supply from proxy demand resources or reliability demand response resources only where the ISO's conditions of the net benefits test set forth in Section 30.6.3 necessary for the issuance of schedules for supply from the proxy demand resources or reliability demand response resources have been satisfied. In addition, the ISO's market processes generally applicable to the dispatch of scheduled resources will determine whether the proxy demand resources or reliability demand response resources are able to displace generation resources in a manner that serves the ISO in meeting its balancing authority responsibilities.[37] This listed condition combined with the ISO's normal market processes correspond to the two prerequisites set forth in Order No. 745 for payment of the locational marginal price to demand response resources.[38]

In Order No. 745, the Commission also directed each ISO and RTO to include, in its compliance filing, the "data, analytical methods and the actual supply curves used to determine the monthly threshold prices for the last 12 months to show how the RTO or ISO would calculate the curves."[39] The ISO provides that supporting documentation in Attachment C hereto. Attachment C contains the following materials:

- The issue paper regarding the net benefits test that the ISO provided in its Order No. 745 compliance stakeholder process.[40]

- The final proposal for implementing the net benefits test and an appendix listing historical threshold prices for the last 12 months (*i.e.*, the trade months from July 2010 to June 2011) and including the corresponding supply curves and supporting data, as provided in the ISO's Order No. 745 compliance stakeholder process.[41]

In addition to the requirement to submit proposed tariff revisions and supporting documentation, Order No. 745 directed each ISO and RTO to post

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37 *See* ISO tariff, Sections 34, 34.5, 34.6, 34.8, 34.18.

38 Order No. 745 at PP 47-48.

39 *Id.* at P 81.

40 The issue paper regarding the net benefits test is also available on the ISO's website at http://www.caiso.com/Documents/IssuePaper_DemandResponseNetBenefitsTest.pdf.

41 The final proposal for implementing the net benefits test and accompanying appendix are also available on the ISO's website at http://www.caiso.com/Documents/FinalProposal_Appendix-DemandResponseNetBenefitsTest.pdf.

and to update information regarding the net benefits test on its website. Specifically, Order No. 745 stated:

> The Commission-approved net benefits test methodology must be posted on the RTO or ISO's website, with supporting documentation. The RTO or ISO must also post the price threshold levels that would have been in effect in the previous 12 months. In addition, when the net benefits test becomes effective, the supply curve analysis for the historic month that corresponds to the effective month should be updated for current fuel prices, unit availabilities, and any other significant changes to historic supply curve and posted on the RTO website (for example, the supply curve analysis for the March price threshold would be posted in mid-February). Finally, the supply curve analyses for all months should be updated and posted on the RTO website if a significant change to the composition or slope of the historic monthly curves occurs, such as extended outages or retirements not previously reflected.[42]

The ISO will post and update each of these pieces of information on its website consistent with the Commission's directives.

2. The ISO Should Be Permitted to Retain the Commission-Approved Default Load Adjustment

In its April 14 motion for clarification or, in the alternative, request for rehearing, the ISO noted that Order No. 745 did not directly address the default load adjustment set forth in the current ISO tariff. The ISO explained that, although its understanding was that Order No. 745 was not intended to eliminate the default load adjustment, some of the discussion of the net benefits test and other discussions in Order No. 745 could nevertheless be interpreted to require the default load adjustment to be eliminated. The ISO also explained that, consistent with the express authorization of the Commission in its Order No. 719 rulemaking, the ISO developed the default load adjustment to ensure that demand response providers and load-serving entities are not both compensated in the ISO's market for a single reduction in demand. Because demand response efforts in California have been premised on the assumption that such double payments will not occur, elimination of the default load adjustment would have devastating practical consequences for the ability of the ISO to implement its proxy demand resource and reliability demand response resource products, and for the ability of the CPUC to approve related retail demand response programs and financial settlement mechanisms. Therefore, the ISO requested

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[42] Order No. 745 at P 81.

clarification or rehearing that Order No. 745 does not require the elimination of the default load adjustment and thereby mandate wholesale double payments for demand response reductions.[43] For the reasons explained in the ISO's April 14 filing, the Commission should grant clarification or rehearing and find that Order No. 745 does not require the default load adjustment to be eliminated.

If the Commission does not grant such clarification or rehearing, the Commission should find, in its order on this compliance filing, that the ISO's retention of the default load adjustment is "consistent with or superior to the requirements of [Order No. 745]."[44] As explained in the ISO's April 14 filing, the default load adjustment was a significant feature cited by the CPUC in its June 4, 2010, decision affirming that the ISO's proxy demand resource design is consistent with the CPUC's own efforts to promote demand response in the State of California.[45] Further, the default load adjustment is an essential component of the implementation of reliability demand response resources in California pursuant to the "reliability-based demand response settlement" approved by the CPUC in 2010.[46] The express purpose of that settlement, which was reached only after extensive negotiations, is to "address the operation of investor-owned utilities' emergency triggered DR [demand response] programs in the wholesale electricity market and the integration of emergency triggered DR into wholesale market design."[47] The settlement requires the ISO to develop "a wholesale reliability demand response product . . . that is compatible with IOU [investor-owned utility] reliability-based demand response programs."[48] The reliability demand response resource product is designed to allow any demand response provider to bid reliability demand response resources into the ISO market. The settlement also states that information on the reliability demand response product is intended to be incorporated into the demand response program applications of the investor-owned utilities for 2012-2014. That information has already been included in the applications, which were filed earlier this year.[49] The settlement can be modified only by written agreement of all the parties.[50]

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[43] April 14 ISO filing at 21-34.

[44] Order No. 745 at P 4 n.7.

[45] April 14 ISO filing at 12 (citing CPUC decision 10-06-002, issued in proceeding R.07-01-041 (June 4, 2010)).

[46] *Id.* at 15, 33-34 (citing CPUC decision 10-06-034, issued in proceeding R.07-01-041 (June 25, 2010)).

[47] *Id.* at 15 (quoting reliability-based demand response settlement at 1).

[48] *Id.* at 15-16 (quoting reliability-based demand response settlement at Section A(1)).

[49] *Id.* at 16 (citing reliability-based demand response settlement at Section A(2)).

[50] *Id.* (citing reliability-based demand response settlement at 11).

Retention of the default load adjustment as part of the ISO's demand response compensation rules is consistent with or superior to the requirements of Order No. 745 due to this critical importance to the provision of demand response in California. Requiring elimination of the default load adjustment would substantially impede the development of additional proxy demand resources and the implementation of reliability demand response resources pursuant to the settlement approved by the CPUC. As explained above, that settlement is premised on the inclusion of information regarding reliability demand response resources in the demand response program applications for 2012-2014 that the investor-owned utilities filed earlier this year. If the ISO needs to radically modify that information in order to eliminate the default load adjustment and allow for wholesale double payments, the investor-owned utilities may be unable to implement their own demand response programs within the time frames contemplated due to regulatory uncertainty and the time it would take for the ISO to modify its existing systems.[51] Specifically, the terms of the settlement may be violated and the settlement may terminate unless the parties are able to renegotiate a new settlement. This settlement resolved years of discussion in various CPUC proceedings as to how emergency demand response resources can participate in the ISO market. If the settlement were to terminate, that could substantially delay or even prevent emergency demand response resources from participating directly in the ISO market.[52] For these reasons, the Commission should find that the default load adjustment is consistent with or superior to the requirements of Order No. 745.

B. The Provisions of the Existing ISO Tariff Satisfy the Directives in Order No. 745 Regarding the Measurement and Verification of Demand Response Performance

In Order No. 745, the Commission permitted each ISO and RTO to include in its compliance filing an explanation of how its current measurement and verification protocols will continue to ensure that appropriate baselines for demand response providers are set and how that demand response will continue to be adequately measured and verified as necessary to ensure the performance of each demand response resource.[53]

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[51] For example, the ISO explained in the Order No. 745 proceeding that it anticipated that altering its systems, tools, and market rules to accommodate new requirements would take at least a year. ISO comments, Docket No. RM10-17-000, at 14 (Oct. 13, 2010).

[52] April 14 ISO filing at 33-34.

[53] Order No. 745 at P 94.

The ISO's existing protocols ensure accurate measurement and verification of demand response performance consistent with the requirements of Order No. 745. Those protocols are included in Section 4.13.4 of the ISO tariff, which the Commission accepted as just and reasonable in the recent proceeding approving the tariff changes needed to implement proxy demand resources. Section 4.13.4 sets forth the methodology the ISO uses to determine the actual delivery by each proxy demand resource, based on the difference between actual metered load for that resource and the customer baseline for the resource.[54] The Commission recognized that, "in establishing its customer baseline calculation methodology, the CAISO has conducted many hours of stakeholder proceedings, learned from the experiences of other ISOs and RTOs, and relied on expert consultants to determine the most appropriate customer baseline."[55] The ISO proposes to employ virtually the same customer baseline calculation methodology in order to accurately measure and verify the performance of reliability demand response resources.[56]

Further, by definition, the output of a proxy demand resource or reliability demand response resource is required to be measurable and verifiable. A proxy demand resource is defined in Appendix A to the ISO tariff as "[a] Load or aggregation of Loads capable of *measurably and verifiably* providing Demand Response Services . . . ." (Emphasis added.) The ISO also proposes to define a reliability demand response resource in a similar manner, specifying that the resource must be capable of measurably and verifiably providing demand response services.[57]

No directives in Order No. 745 are inconsistent with the Commission's recent finding that the ISO's existing customer baseline calculation methodology is just and reasonable. The methodology already satisfies the requirements in Order No. 745 to accurately measure and verify the performance of demand response resources. Therefore, the ISO does not propose any revisions to the methodology included in its tariff.

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[54] 134 FERC ¶ 61,004, at P 24.

[55] 132 FERC ¶ 61,045, at P 68.

[56] Transmittal letter for ISO tariff amendment to implement reliability demand response resource product at 13.

[57] *Id.* at 10. Demand response services are currently defined in Appendix A to the tariff as "Demand from a Proxy Demand Resource that can be bid into the Day-Ahead Market and Real-Time Market and dispatched at the direction of the CAISO." The ISO proposes to extend this same definition to reliability demand response resources. *Id.*

C. The Provisions of the Existing ISO Tariff Satisfy the Directives in Order No. 745 Regarding the Allocation of Demand Response Costs

In Order No. 745, the Commission permitted each ISO and RTO to include in its compliance filing a demonstration that its current cost allocation methodology appropriately allocates costs to those that benefit from the demand response reduction.[58]

The ISO's existing tariff provisions satisfy the requirements of Order No. 745 regarding cost allocation because the tariff provisions require demand response costs to be allocated to those that benefit. Specifically, consistent with Order No. 745, payments of locational marginal prices made to proxy demand resources are allocated to the load that benefits from the demand response reduction, *i.e.*, to all load day-ahead and to deviations in real-time. The day-ahead dispatch cost for proxy demand resources is allocated to the buyers of the energy, just like for other supply resources.[59] The real-time imbalance energy cost for proxy demand resources is allocated in two tiers, just like for other imbalance energy. First, the real-time imbalance energy cost is allocated in tier 1 to those that required the service, *i.e.*, those that deviated from their schedules and therefore required backing by the ISO for additional supply. Second, any remaining real-time imbalance energy cost is allocated in tier 2 to the market based on measured demand.[60] The ISO also proposes to apply these same existing cost allocation methodologies in the ISO tariff to reliability demand response resources.[61]

These methodologies allocate the costs of proxy demand resources and reliability demand response resources to those that benefit from the demand response reduction. Therefore, the provisions of the existing ISO tariff satisfy the requirements of Order No. 745 regarding the allocation of demand response costs. The ISO does not propose any revisions to the allocation methodology set forth in its tariff.

III. Effective Date

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[58] Order No. 745 at P 102.

[59] *See* ISO tariff, Sections 11.2, 11.8.

[60] *See* ISO tariff, Sections 11.5, 11.8.

[61] Transmittal letter for ISO tariff amendment to implement reliability demand response resource product at 3-4.

Consistent with the directives in Order No. 745,[62] the ISO proposes that the tariff revisions contained in this compliance filing be made effective prospectively from the date of the Commission order addressing this filing. The ISO plans to implement the net benefits test on the fifteenth day of the month following the issuance of the Commission's order, assuming that the default load adjustment is not implicated. If, however, the Commission's directives require the ISO to make systems changes beyond implementation of the net benefits test as described in this filing, the ISO will assess the additional time necessary to comply and will seek relief from the Commission as may be appropriate under the circumstances.[63]

IV. Communications

Communications regarding this filing should be addressed to the following individuals, whose names should be placed on the official service list established by the Secretary with respect to this submittal:

Sidney M. Davies
Assistant General Counsel
John C. Anders
Senior Counsel
California Independent System
Operator Corporation
250 Outcropping Way
Folsom, CA 95630
Tel: (916) 351-4400
Fax: (916) 608-7296
E-mail: sdavies@caiso.com
janders@caiso.com

[62] Order No. 745 at P 6.

[63] Solely for purposes of submitting the proposed tariff revisions contained in this filing in eTariff, the ISO has tentatively identified October 1, 2011 as the effective date of the tariff revisions in eTariff. The ISO chose October 1 because that is the earliest effective date the ISO requests for proposed tariff revisions included in the tariff amendment to implement the reliability demand response resource product. If necessary, the ISO will revise the October 1 effective date in a further compliance filing in this proceeding to coincide with the date of the Commission's order as provided in Order No. 745.

V. Service

The ISO has served copies of this transmittal letter and all attachments upon all parties on the official service list for Docket No. RM10-17, the Commission proceeding in which Order No. 745 was issued. The ISO also has served copies of this transmittal letter, and all attachments, on the California Public Utilities Commission, the California Energy Commission, and all parties with effective scheduling coordinator service agreements under the ISO tariff. In addition, the ISO is posting this transmittal letter and all attachments on the ISO website.

VI. Attachments

The following documents, in addition to this transmittal letter, support the instant filing:

Attachment A	Revised ISO tariff sheets to comply with the directives in Order No. 745
Attachment B	ISO tariff revisions show in black-line format
Attachment C	Supporting documentation that includes data, analytical methods, and actual supply curves used by the ISO determine the monthly threshold prices for the last 12 months

VII. Conclusion

For the foregoing reasons, the Commission should accept the instant filing as satisfying the ISO compliance obligations with respect to the directives in Order No. 745.

Respectfully submitted,

/s/ Bradley R. Miliauskas

Nancy Saracino
General Counsel
Sidney M. Davies
Assistant General Counsel
John C. Anders
Senior Counsel
California Independent System
Operator Corporation
250 Outcropping Way
Folsom, CA 95630
Tel: (916) 351-4400
Fax: (916) 608-7246
E-mail: sdavies@caiso.com
janders@caiso.com

Sean A. Atkins
Bradley R. Miliauskas
Alston & Bird LLP
The Atlantic Building
950 F Street, NW
Washington, DC 20004
Tel: (202) 239-3300
Fax: (202) 654-4875
E-mail: sean.atkins@alston.com
bradley.miliauskas@alston.com

California Independent System Operator Corporation
Fifth Replacement FERC Electric Tariff

Attachment A – Clean Tariff

Net Benefits Test Compliance Filing

July 22, 2011

30.6.1 Bidding and Scheduling of PDRs

Unless otherwise specified in the CAISO Tariff and applicable Business Practice Manuals, and subject to Section 30.6.3, the CAISO will treat Bids for Energy and Ancillary Services on behalf of Proxy Demand Resources like Bids for Energy and Ancillary Services on behalf of other types of supply resources. A Scheduling Coordinator for a Demand Response Provider representing a Proxy Demand Resource may submit (1) Energy Bids only in the Day-Ahead Market and in the Real-Time Market; (2) RUC Availability Bids; and (3) Ancillary Service Bids in the Day-Ahead Market and Real-Time Market for those Ancillary Services for which the Proxy Demand Resource is certified. A Scheduling Coordinator for a Demand Response Provider representing a Proxy Demand Resource may Self-Provide Ancillary Services for which it is certified. The Demand Response Provider's Demand Response Services for Proxy Demand Resources will be bid separately and independently from the LSE's underlying Demand Bid.

30.6.2 Bidding and Scheduling of RDRRs

Unless otherwise specified in the CAISO Tariff and applicable Business Practice Manuals, and subject to Section 30.6.3, the CAISO will treat Bids for Energy on behalf of Reliability Demand Response Resources like Bids for Energy on behalf of other types of supply resources. A Scheduling Coordinator for a Demand Response Provider representing a Reliability Demand Response Resource may submit Energy Bids for the Reliability Demand Response Resource only in the Day-Ahead Market and in the Real-Time Market, but may not submit Energy Self-Schedules for the Reliability Demand Response Resource, may not Self-Provide Ancillary Services from the Reliability Demand Response Resource, and may not submit RUC Availability Bids or Ancillary Service Bids for the Reliability Demand Response Resource. The Demand Response Provider's Demand Response Services for Reliability Demand Response Resources will be bid separately and independently from the LSE's underlying Demand Bid.

30.6.3 Net Benefits Test for Scheduling of PDRs and RDRRs

The CAISO will apply a net benefits test to determine whether Bids for Proxy Demand Resources or Reliability Demand Response Resources qualify as a Schedule as set forth in Section 31.

30.6.3.1 Supply Curve Used in Applying the Net Benefits Test

The CAISO will generate necessary supply curves for each month that depict the Market Clearing Prices for specified amounts of supplied Power in the CAISO Markets within that month. Consistent with a

methodology set forth in the Business Practice Manual, the CAISO will generate two supply curves for each month, one for on-peak and one for off-peak, by: (i) selecting representative supply curve data for the month that is twelve (12) months prior to the month for which the CAISO is generating the supply curves, using all Bids into the Real-Time Market from any Generating Unit; (ii) adjusting the representative supply curve data to reflect significant changes in resource availability and fuel prices that have occurred since the representative supply curve data were generated; and (iii) smoothing the supply curves using an exponential form function and applying a price window based on historical data. After the CAISO generates the supply curves for a month, the CAISO will determine a threshold Market Clearing Price for the on-peak and a threshold Market Clearing Price for the off-peak corresponding to the point on each supply curve beyond which (i) the product of the amount of supplied Power (prior to the dispatch of Proxy Demand Resources and Reliability Demand Response Resources) and the reduction in Market Clearing Price that results from the dispatch of Proxy Demand Resources and Reliability Demand Response Resources exceeds (ii) the product of the Market Clearing Price (prior to the dispatch of Proxy Demand Resources and Reliability Demand Response Resources) and the reduction in the amount of supplied Power that results from the dispatch of Proxy Demand Resources and Reliability Demand Response Resources. The CAISO will post the threshold Market Clearing Prices for each month on the CAISO Website by the fifteenth day of the immediately preceding month.

30.6.3.2 Rejection of Bids for PDRs or RDRRs Below the Threshold Price

Each Bid for a Proxy Demand Resource or Reliability Demand Response Resource must be equal to or greater than the threshold Market Clearing Price for the applicable month and applicable time of use in order to be eligible for inclusion in a Day-Ahead Schedule in accordance with Section 31 or to be issued a Dispatch Instruction in the Real-Time Market in accordance with Section 34. The CAISO will reject any Bid for a Proxy Demand Resource or Reliability Demand Response Resource that is less than the threshold Market Clearing Price for the applicable month and applicable time of use.

*** * ***

31 Day-Ahead Market

The DAM consists of the following functions performed in sequence: the MPM-RRD, IFM, and RUC. Scheduling Coordinators may submit Bids for Energy, Ancillary Services and RUC Capacity for an

applicable Trading Day. The CAISO shall issue Schedules for all Supply and Demand, including Participating Load, Reliability Demand Response Resources, and Proxy Demand Resources, pursuant to their Bids as provided in this Section 31. The CAISO may issue Schedules for Supply from Reliability Demand Response Resources or Proxy Demand Resources only where the CAISO's conditions of the net benefits test set forth in Section 30.6.3 necessary for the issuance of Schedules for Supply from the Reliability Demand Response Resources or Proxy Demand Resources have been satisfied.

* * *

California Independent System Operator Corporation
Fifth Replacement FERC Electric Tariff

Attachment B – Marked Tariff

Net Benefits Test Compliance Filing

July 22, 2011

30.6.1 Bidding and Scheduling of PDRs~~Generally~~

Unless otherwise specified in the CAISO Tariff and applicable Business Practice Manuals, and subject to Section 30.6.3, the CAISO will treat Bids for Energy and Ancillary Services on behalf of Proxy Demand Resources like Bids for Energy and Ancillary Services on behalf of other types of supply resources. A Scheduling Coordinator for a Demand Response Provider representing a Proxy Demand Resource may submit (1) Energy Bids only in the Day-Ahead Market and in the Real-Time Market; (2) RUC Availability Bids; and (3) Ancillary Service Bids in the Day-Ahead Market and Real-Time Market for those Ancillary Services for which the Proxy Demand Resource is certified. A Scheduling Coordinator for a Demand Response Provider representing a Proxy Demand Resource may Self-Provide Ancillary Services for which it is certified. The Demand Response Provider's Demand Response Services for Proxy Demand Resources will be bid separately and independently from the ~~underlying demand for Proxy Demand Resources~~LSE's underlying Demand Bid.

30.6.2 Bidding and Scheduling of RDRRs

Unless otherwise specified in the CAISO Tariff and applicable Business Practice Manuals, and subject to Section 30.6.3, the CAISO will treat Bids for Energy on behalf of Reliability Demand Response Resources like Bids for Energy on behalf of other types of supply resources. A Scheduling Coordinator for a Demand Response Provider representing a Reliability Demand Response Resource may submit Energy Bids for the Reliability Demand Response Resource only in the Day-Ahead Market and in the Real-Time Market, but may not submit Energy Self-Schedules for the Reliability Demand Response Resource, may not Self-Provide Ancillary Services from the Reliability Demand Response Resource, and may not submit RUC Availability Bids or Ancillary Service Bids for the Reliability Demand Response Resource. The Demand Response Provider's Demand Response Services for Reliability Demand Response Resources will be bid separately and independently from the LSE's underlying Demand Bid.

30.6.3 Net Benefits Test for Scheduling of PDRs and RDRRs

The CAISO will apply a net benefits test to determine whether Bids for Proxy Demand Resources or Reliability Demand Response Resources qualify as a Schedule as set forth in Section 31.

30.6.3.1 Supply Curve Used in Applying the Net Benefits Test

The CAISO will generate necessary supply curves for each month that depict the Market Clearing Prices for specified amounts of supplied Power in the CAISO Markets within that month. Consistent with a methodology set forth in the Business Practice Manual, the CAISO will generate two supply curves for each month, one for on-peak and one for off-peak, by: (i) selecting representative supply curve data for the month that is twelve (12) months prior to the month for which the CAISO is generating the supply curves, using all Bids into the Real-Time Market from any Generating Unit; (ii) adjusting the representative supply curve data to reflect significant changes in resource availability and fuel prices that have occurred since the representative supply curve data were generated; and (iii) smoothing the supply curves using an exponential form function and applying a price window based on historical data. After the CAISO generates the supply curves for a month, the CAISO will determine a threshold Market Clearing Price for the on-peak and a threshold Market Clearing Price for the off-peak corresponding to the point on each supply curve beyond which (i) the product of the amount of supplied Power (prior to the dispatch of Proxy Demand Resources and Reliability Demand Response Resources) and the reduction in Market Clearing Price that results from the dispatch of Proxy Demand Resources and Reliability Demand Response Resources exceeds (ii) the product of the Market Clearing Price (prior to the dispatch of Proxy Demand Resources and Reliability Demand Response Resources) and the reduction in the amount of supplied Power that results from the dispatch of Proxy Demand Resources and Reliability Demand Response Resources. The CAISO will post the threshold Market Clearing Prices for each month on the CAISO Website by the fifteenth day of the immediately preceding month.

30.6.3.2 Rejection of Bids for PDRs or RDRRs Below the Threshold Price

Each Bid for a Proxy Demand Resource or Reliability Demand Response Resource must be equal to or greater than the threshold Market Clearing Price for the applicable month and applicable time of use in order to be eligible for inclusion in a Day-Ahead Schedule in accordance with Section 31 or to be issued a Dispatch Instruction in the Real-Time Market in accordance with Section 34. The CAISO will reject any Bid for a Proxy Demand Resource or Reliability Demand Response Resource that is less than the threshold Market Clearing Price for the applicable month and applicable time of use.

* * *

31 Day-Ahead Market

The DAM consists of the following functions performed in sequence: the MPM-RRD, IFM, and RUC. Scheduling Coordinators may submit Bids for Energy, Ancillary Services and RUC Capacity for an applicable Trading Day. The CAISO shall issue Schedules for all Supply and Demand, including Participating Load, Reliability Demand Response Resources, and Proxy Demand Resources, pursuant to their Bids as provided in this Section 31. The CAISO may issue Schedules for Supply from Reliability Demand Response Resources or Proxy Demand Resources only where the CAISO's conditions of the net benefits test set forth in Section 30.6.3 necessary for the issuance of Schedules for Supply from the Reliability Demand Response Resources or Proxy Demand Resources have been satisfied.

* * *

Demand Response
Net Benefits Test

Lin Xu, Ph.D.

Market Analysis and Development,

California Independent System Operator

July 14, 2011

Demand Response Net Benefits Test

1. INTRODUCTION

This paper covers the ISO's proposal to fulfill FERC order 745 regarding demand response compensation in the organized wholesale energy market. FERC order 745 requires:

- Demand response (DR) resources will be compensated at full LMP if the LMP is above a threshold price as will be determined by the Net Benefits Test.
- The Net Benefits Test will be performed monthly (by the 15th day) to establish the static monthly threshold price to be used in the next trade month.
- The threshold price is determined by the point where the net benefits of dispatching DR exceeds the marginal cost of DR.
- The net benefit of dispatching DR is estimated based on a representative aggregated supply curve for the trade month.

Per FERC order 745, the representative aggregated supply curve is created in the following way:

- Pick a representative curve of the trade month using previous year's curve.
- Adjust for resource availability.
- Adjust for fuel prices.
- Smooth the curve using numerical methods.

The theory behind the Net Benefits Test is illustrated in Figure 1. In Figure 1, an aggregated supply curve is drawn on the p-q plane, with p representing price and q representing supply quantity. As a convention, consider the aggregated supply curve as price function of supply quantity. A load curve is also drawn on the same p-q plane, which intersects the supply curve at the market clearing equilibrium. Demand response adds elasticity to load. Dispatching demand response will reduce the market clearing price.

- Dispatching an incremental amount (dq) of demand response will reduce the system marginal price (dp) according to the supply curve.
- The benefit to non-DR load for dispatching demand response is q*dp.
- The cost of dispatching demand response is p*dq.
- The net benefit is non-negative if q*dp >= p*dq, or dp/dq >= p/q.
- If there exists a point on the supply curve (p0, q0) with q0 > 0, p0 > 0 and q*dp = p*dq, or equivalently [dp/dq(@q0)] /[p0/q0] = 1 (where @q0 means being evaluated at q0), such that the net benefit is non-negative for all p > p0, then p0 is called the threshold price.
- Demand response should be dispatched only when the clearing price is above the threshold price.

The threshold point condition, q*dp = p*dq, or equivalently (dp/dq) / (p/q) = 1, is a first order necessary condition. It cannot distinguish positive net benefits and negative net benefits for p greater than the threshold price. In the appendix, two theorems are proved to provide second order necessary condition and second order locally sufficient condition for the threshold point. The

meaning of theorem 1 (second order necessary condition) is that in order for a point (q0, p0) that satisfies the first order necessary condition to have net non-negative benefits for p>p0, the supply curve must be convex at q0. The meaning of Theorem 2 (second order locally sufficient condition) is that if the supply curve has elasticity equal to one and is strictly convex at a point, then incremental price from this point will result in positive net benefits.

The two theorems further characterize the true threshold point locally beyond the first order necessary condition of elasticity equal to one. When there exists multiple candidate points satisfying the first order necessary condition (elasticity equal to one), the theorems will help find the correct threshold point.

The main body of the ISO's proposal will cover three major aspects:

- How to construct the representative supply curve?
- How to smooth the representative curve?
- How to find the threshold point on the representative curve?

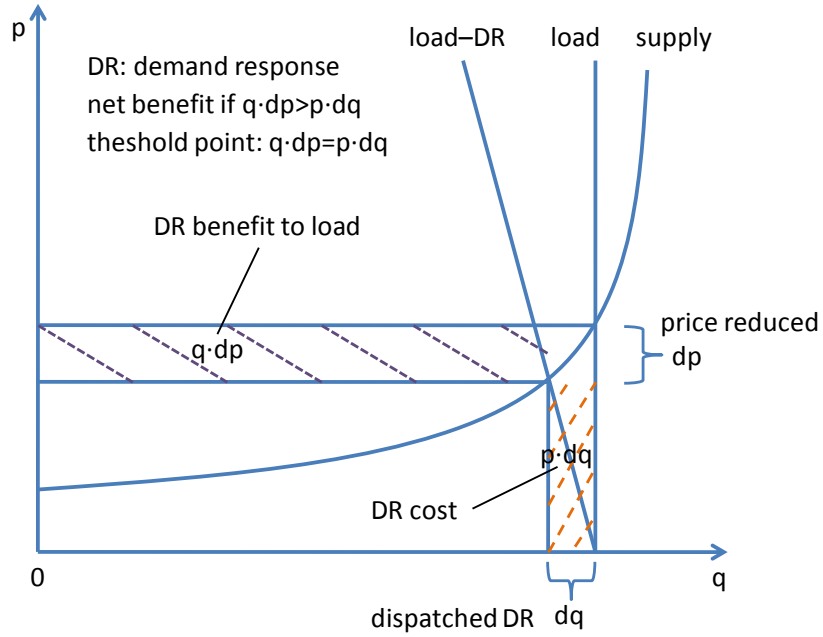

FIGURE 1: DEMAND RESPONSE COST AND BENEFIT

2. CAISO NET BENEFITS TEST DETAILS

2.1 CONSTRUCTING THE REPRESENTITIVE SUPPLY CURVE

The first and most important step of the Net Benefits Test is to construct a representative aggregated supply curve for the trade month, say July 2011. The ISO would publish the Net Benefits Test results by Jun 15th 2011 for July 2011. The construction of the representative supply curves

will be based on historical market offers from July 2010, which will be referred to as the reference month. The reference month aggregated supply curve will be called the reference supply curves.

The ISO will construct two reference curves, one for on-peak hours and the other for off-peak hours. The reference supply curves will be constructed based on real-time predispatch (RTPD) mitigated bids from all generation resources including tie-generators, both committed and uncommitted. Import and export bids are excluded.

The reference supply curve must also be adjusted for resource availability. The resource availability can be captured by averaging the hourly reference supply curves over the entire reference month (for every price level, the supply quantities will be averaged). For example, there are 416 on-peak hours and 328 off-peak hours (a total of the 744 = 31*24) in July 2010. The 416 on-peak hourly supply curves will be averaged to construct average on-peak reference supply curve, and the 328 off-peak hourly supply curves will be averaged to construct average off-peak reference supply curve. The on-peak and off-peak reference curves are illustrated in Figure 2.

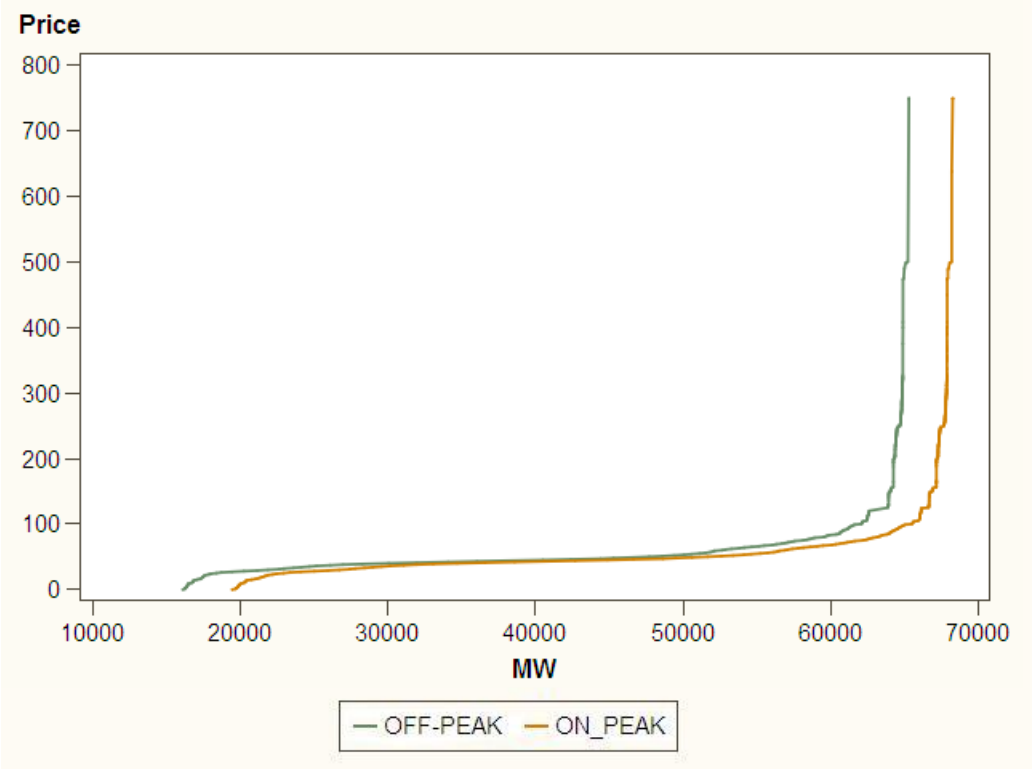

FIGURE 2: A SAMPLE SUPPLY CURVE FROM JULY 2010

FERC order 745 requires the reference curve be adjusted for fuel price differences between the reference month and the trade month. Gas fired units account for about 60% of the installed capacity in CAISO, while oil units and coal units each account for 1%. Because of the percentages from oil and coal are so small compared with gas, the ISO only adjusts for gas price differences in

the Net Benefits Test. To represent the California gas price, the ISO intends to use the simple average of :[1]

- PG&E Citygate, and
- Southern California Citygate

The scaling factor is defined as the forward gas price for the trade month divided by the historical average gas price for the reference month. The supply curve will be scaled by the scaling factor. More specifically, for every supply quantity, the corresponding price will be scaled by the scaling factor. For example, if the forward monthly average gas price is $4.73 for July 2011,[2] and the historical monthly average gas price was $4.25 for July 2010, then the GasScalar = 4.73/4.25 = 1.11.

Scaling the supply curve considers the fuel cost difference for gas fired units and the opportunity cost differences for generators of other fuel types. Although the whole supply curve is scaled, only the portion that is close to the threshold price is relevant for price calculation. With typical threshold prices around $45 to $60, the supply bids in this range are mainly from either gas fired units or generators of other fuel types whose bids incorporate opportunity costs. Therefore, it is valid to scale the system wide supply curve without drilling down to the unit-specific level.

In summary, for each trade month, the ISO will have an on-peak representative supply curve and an off-peak representative supply curve, which account for resource availability and is adjusted for fuel price differences between the reference month and the trade month.

2.2 CURVE SMOOTHING

FERC order 745 requires the supply curve be smoothed using numerical methods. The curve will be smoothed to twice differentiable so that theorem 1 and theorem 2 can be used to characterize the threshold point.

The smoothing method proposed by the CAISO is an exponential function curve fitting expressed as

p = exp(*a**q^3+*b**q^2+*c**q+*d*),[3]

where *a*, *b*, *c*, and *d* are coefficients to be determined by a regression on observations of supply quantities and prices.

The regression can be carried out by taking the natural logarithm of the price:

---

[1] The ISO is working on acquiring reliable data source for these two gas prices. However, if the data source is unavailable, the ISO will use the Henry Hub price instead.

[2] The $4.73 forward gas price is only intended to demonstrate how to calculate the gas scalar, and may not be the actual monthly average forward gas price.

[3] Midwest ISO adopts similar function form, https://www.midwestiso.org/Library/Repository/Meeting%20Material/Stakeholder/DRWG/2011/20110509/20110509%20DRWG%20Item%2003b%20Net%20Benefit%20Test%20for%20Demand%20Response%20Compensation.pdf

$\ln(p) = a*q^3+b*q^2+c*q+d$.

This converts the regression from non-linear to linear.

One technique to achieve a better fit is to apply a price window to the representative supply curves such that the threshold price is inside the price window. In this way, observations that are far away from the threshold, which are irrelevant for the Net Benefits Test, will not affect the regression. In other words, a properly chosen price window allows the regression to focus on observations that are close to the threshold in order to more accurately estimate the threshold point. On the other hand, the price window should not be too small. If the threshold is too small, it is possible that the threshold price resides outside this price window. If this happens, the price window needs to be adjusted, and the regression process repeated until the threshold price is well situated within the price window. Choosing a window from $25 to $100 typically produces good results for the historical data. Sample smoothed supply curves for July 2011 are illustrated in Figure 3 and Figure 4, where the "Raw supply curve" is the curve before smoothing, and the "Smoothed supply curve" is the curve after smoothing. In this example, the parameters of the smoothed curves are listed in Table 1.

Coefficients	Off-peak	On-peak
a (*10^(–9))	0.00004274	0.000046
b (*10^(–6))	-0.0049986	-0.0059874
c (*10^(–3))	0.20570776	0.2678375
d	0.96260595	-0.2399994

TABLE 1: JULY 2011 REGRESSION RESULTS

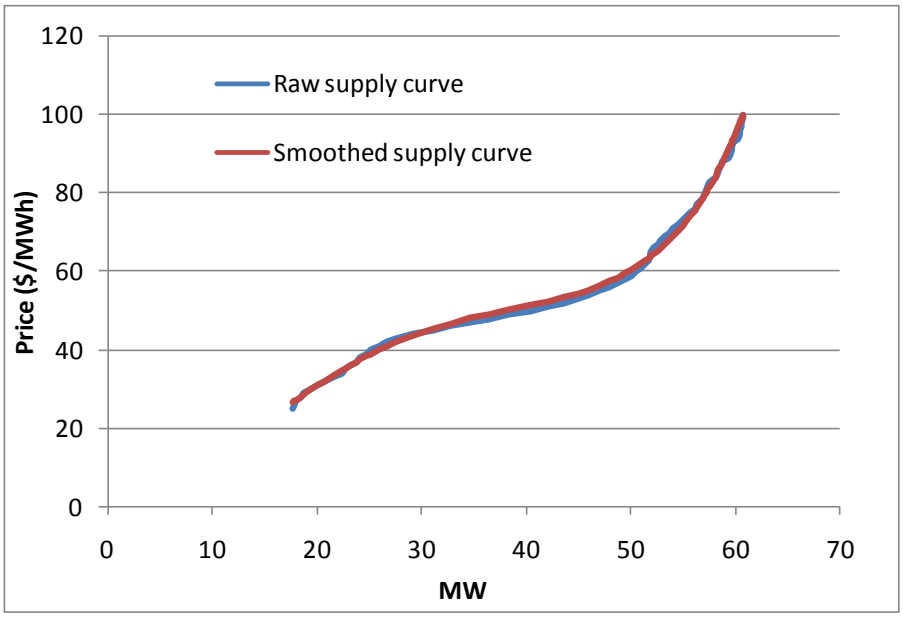

FIGURE 3: SMOOTHED OFF-PEAK SUPPLY CURVE FOR JULY 2011 WITH PRICE WINDOW [20, 100]

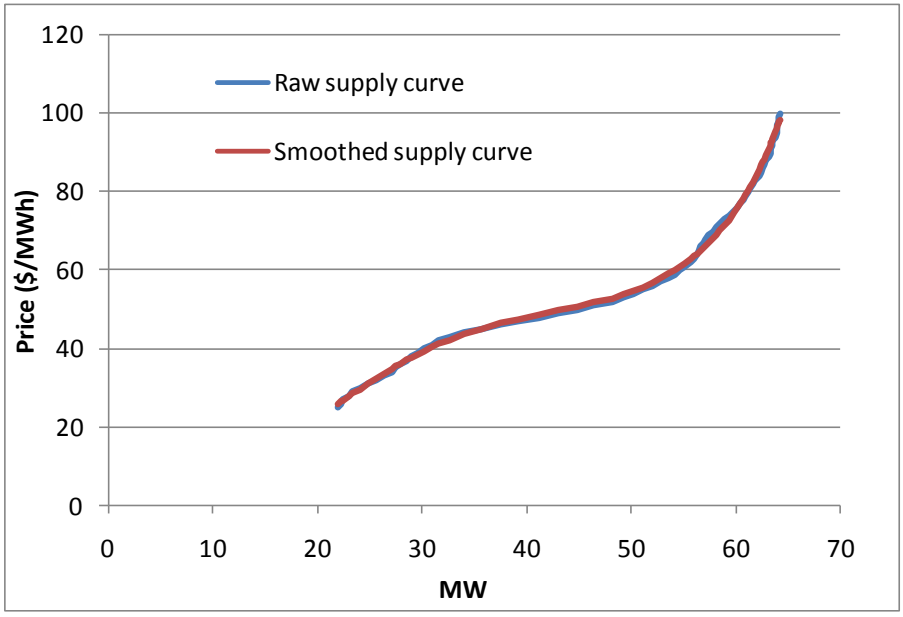

FIGURE 4: SMOOTHED ON-PEAK SUPPLY CURVE FOR JULY 2011 WITH PRICE WINDOW [20, 100]

2.3 FINDING THE THRESHOLD PRICE

Given the supply curve in the form of p = exp(a*q^3+b*q^2+c*q+d), the threshold price is first calculated using the first order necessary condition (the elasticity equal to one) as follows:

(dp/dq) /(p/q) = 1, or

(3*a*q^2+2*b*q+c)* exp(a*q^3+b*q^2+c*q+d) / [exp(a*q^3+b*q^2+c*q+d) / q] = 1, or

3*a*q^3+2*b*q^2+c*q =1.

Solve this cubic equation, and denote the root by q0.

This is a cubic equation, so there are three roots. If there is one real root, and two complex roots, then the real root should be used to calculate the threshold price. If there are three real roots, then:

- The one produces a price outside the price window should be discarded.
- The one, at which the supply curve is concave, should be discarded by theorem 1.

In the July 2011 on-peak example, the three roots are 3809.7, 31760.6, and 51473.8, and the corresponding prices are $1.2, $41.5, and $55.9. Price 1.2 is outside the price window, so it should be discarded. At price $41.5, the supply curve is concave, so it should also be discarded. Price $55.9 is the only point that satisfies theorem 1. In addition, because the supply curve is strictly convex at price $55.9, it is a true threshold price locally by theorem 2. Similarly, the true threshold price for July 2011 off-peak hours is $57.7.

3. RESULTS

Preliminary results based on actual historical market bids without gas price adjustment typically produce threshold prices around $45 to $60.

APPENDIX

Theorem 1 [second order necessary condition]: Assuming the supply curve is monotonically increasing and twice differentiable, if there exists a point (q0, p0) on the supply curve with q0 > 0 and p0 > 0 that satisfies the first order necessary condition (the supply curve has elasticity equal to one at q0), and for all p > p0, dp/dq >= p/q, then the supply curve is convex at q0, i.e.

$d^2p/dq^2(@q0) >= 0$.

Proof:

Suppose (q0, p0) is a point satisfies the first order necessary condition, [dp/dq(@q0)] / (p0/q0) = 1, and for all p > p0, dp/dq >= p/q.

By first order Taylor expansion, dp/dq = dp/dq(@q0) + [d^2p/dq^2(@q0)] * (q-q0).

By first order Taylor expansion, p/q = p0/q0 + [(dp/dq*q – p) / q^2](@q0) * (q-q0) = p0/q0.

Then, dp/dq >= p/q implies dp/dq(@q0) + [d^2p/dq^2(@q0)] * (q-q0) >= p0/q0, or

[d^2p/dq^2(@q0)] * (q-q0) >= 0.

Because the supply function is monotonically increasing, p > p0 implies q > p0. Therefore,

$d^2p/dq^2(@q0)>=0$.

Theorem 2 [second order locally sufficient condition]: Assuming the supply curve is monotonically increasing and twice differentiable, if the following conditions hold at a point (q0, p0) with q0 > 0 and p0 > 0 on the supply curve:

2A) the supply curve has elasticity equal to one at q0, i.e. [dp/dq(@q0)] / (p0/q0) = 1, and

2B) the supply curve is convex at q0, i.e. $d^2p/dq^2(@q0) > 0$,

then for all p > p0 in the vicinity of p0, dp/dq > p/q.

Proof:

Similar as the proof of Theorem 1,

$d^2p/dq^2(@q0) > 0$ implies $[d^2p/dq^2(@q0)] * (q-q0) > 0$ for all $p > p0$ in the vicinity of p0.

Because $[dp/dq(@q0)] / (p0/q0) = 1$, $dp/dq(@q0) = p0/q0$.

Therefore, $dp/dq(@q0) + [d^2p/dq^2(@q0)] * (q-q0) > p0/q0$.

By first order Taylor expansion of dp/dq and p/q, $dp/dq > p/q$ for all $q > q0$ in the vicinity of q0.

Because the supply curve is monotonically increasing, $dp/dq > p/q$ for all $p > p0$ in the vicinity of p0.

APPENDIX A: HISTORICAL 12 MONTHS THRESHOLD PRICES

This appendix reports the calculated threshold prices for trade months from July 2010 to June 2011 (based on market bids from reference months from July 2009 to June 2010).

The ISO currently does not track monthly forward gas prices. In the calculation, the trade month average spot prices are used to represent the monthly forward gas prices. The historical spot gas prices and calculated gas scalars are listed in Table 2. For example, the trade month July 2011 gas scalar is calculated as $4.27/$3.35 = 1.27.

Table 3 lists the calculated off-peak and on-peak threshold prices as well as the corresponding price windows applied in the regression. The regression results are illustrated from Table 4 to Table 27. In this 12 months period, there are three price windows applied, which are [25, 100], [40, 70], [40, 60]. The purpose of the different choices of price windows is to make sure a smoothed curve fits the original curve, especially for the portion close to the threshold price.

In the 12 month period, the off-peak threshold prices range from $46.59 to $54.38, and the on-peak threshold price range from $46.30 to $53.79. On average, the off-peak threshold price is $0.62 higher than the on-peak threshold price.

Trade Year	Trade Month	PG&E Citygate	Southern California Citygate	Average gas price	Gas scalar
2009	7	3.43	3.27	3.35	
2009	8	3.37	3.12	3.24	
2009	9	3.57	3.28	3.42	
2009	10	4.86	4.25	4.56	
2009	11	4.28	3.74	4.01	
2009	12	5.92	5.56	5.74	
2010	1	5.99	5.76	5.88	
2010	2	5.51	5.35	5.43	
2010	3	4.77	4.45	4.61	
2010	4	4.46	4.01	4.24	
2010	5	4.32	3.98	4.15	
2010	6	4.55	4.40	4.47	
2010	7	4.30	4.23	4.27	1.27
2010	8	3.92	3.83	3.87	1.19
2010	9	4.06	3.82	3.94	1.15
2010	10	3.87	3.42	3.65	0.80
2010	11	4.32	3.81	4.06	1.01
2010	12	4.34	4.20	4.27	0.74
2011	1	4.47	4.36	4.42	0.75
2011	2	4.15	4.04	4.10	0.75
2011	3	4.20	3.96	4.08	0.89
2011	4	4.41	4.25	4.33	1.02
2011	5	4.48	4.26	4.37	1.05
2011	6	4.77	4.56	4.66	1.04

TABLE 2: GAS PRICES AND GAS SCALARS

Year	Month	Off-peak	On-peak	Price window
2010	7	$52.25	$51.26	[25, 100]
2010	8	$46.59	$46.30	[40, 60]
2010	9	$49.51	$49.09	[25, 100]
2010	10	$46.67	$46.41	[40, 60]
2010	11	$49.78	$50.47	[25, 100]
2010	12	$52.71	$51.65	[40, 60]
2011	1	$51.52	$50.40	[40, 60]
2011	2	$47.27	$46.75	[40, 60]
2011	3	$47.91	$47.02	[30, 70]
2011	4	$50.05	$49.89	[40, 60]
2011	5	$51.82	$51.20	[30, 70]
2011	6	$54.38	$53.79	[40, 60]

TABLE 3: THRESHOLD PRICES FROM JULY 2010 TO JUNE 2011

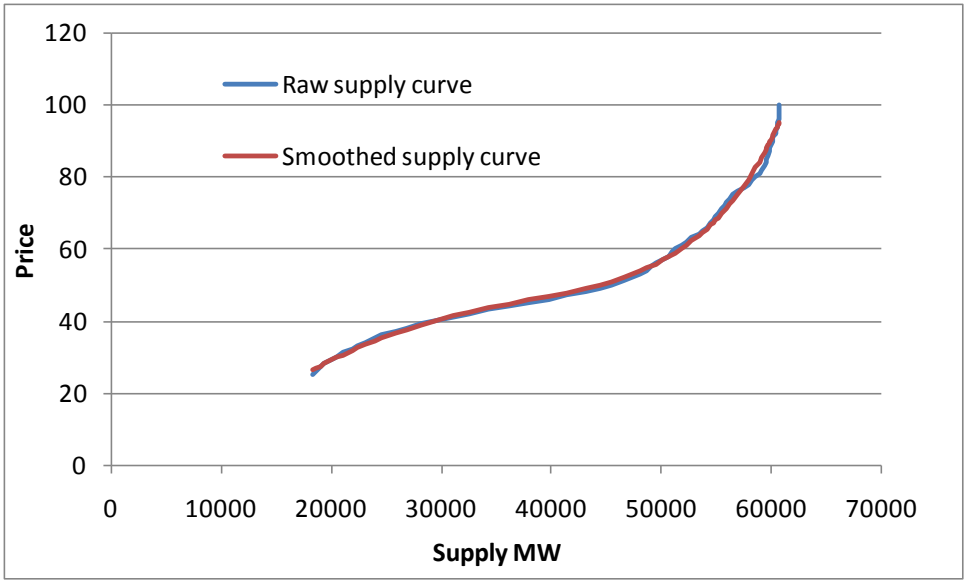

TABLE 4: JULY 2010 OFF-PEAK REGRESSION RESULT

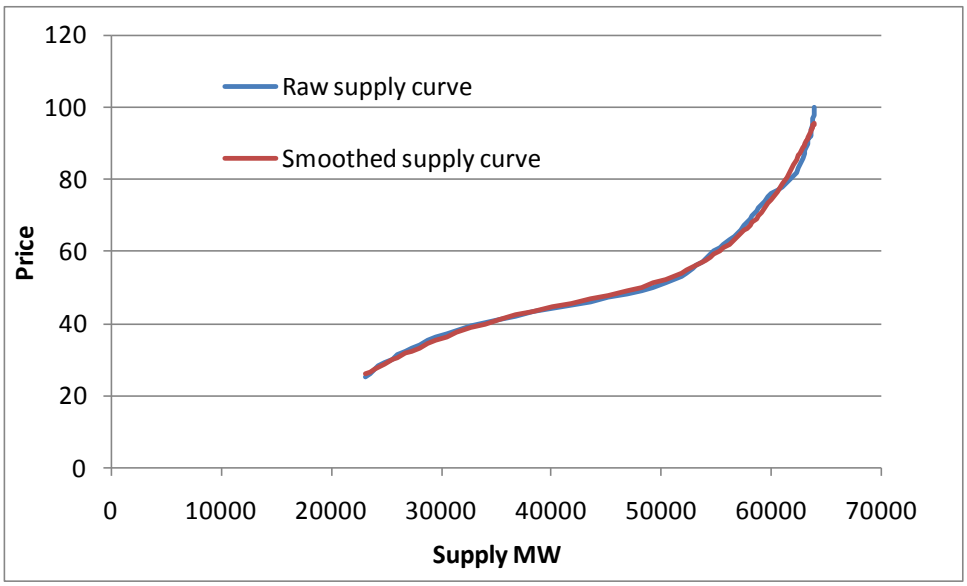

TABLE 5: JULY 2010 ON-PEAK REGRESSION RESULT

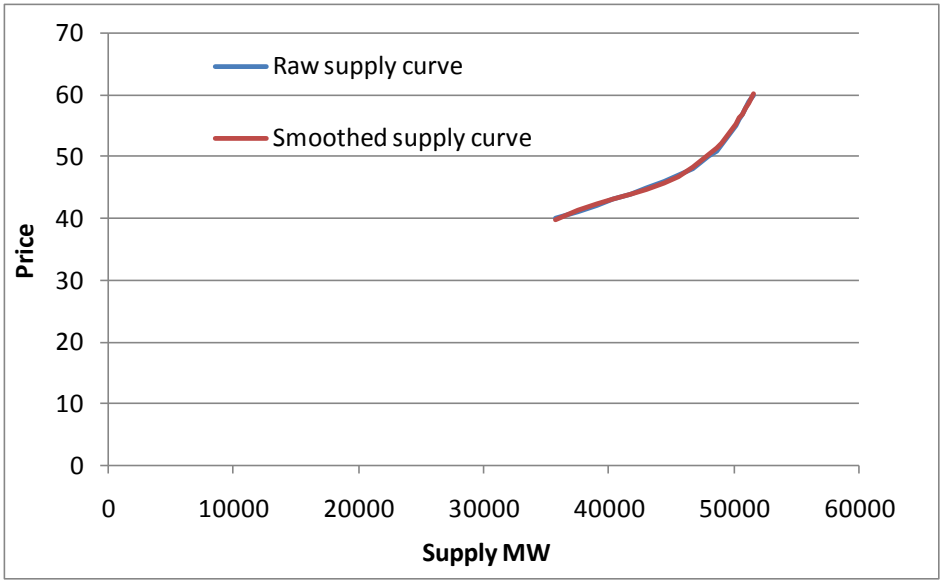

TABLE 6: AUGUST 2010 OFF-PEAK REGRESSION RESULT

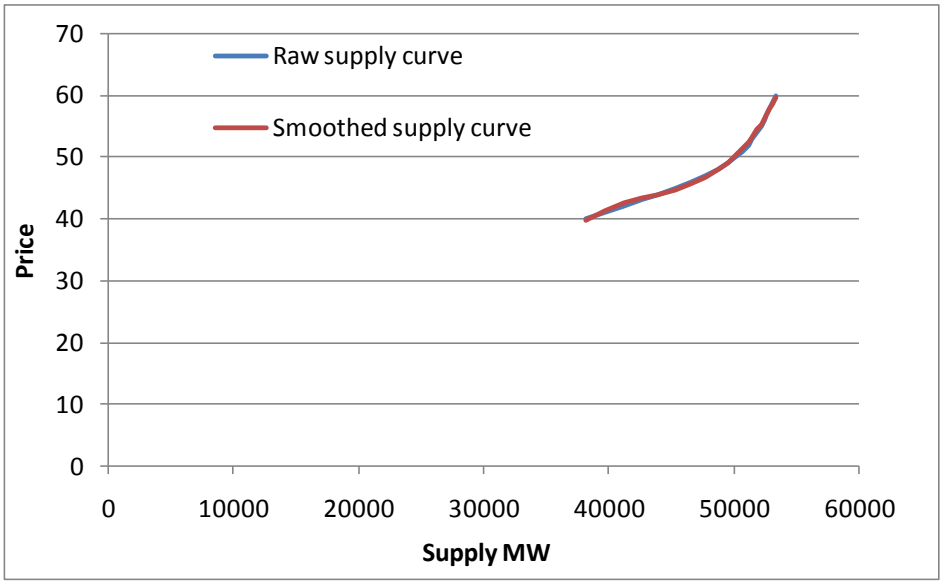

TABLE 7: AUGUST 2010 ON-PEAK REGRESSION RESULT

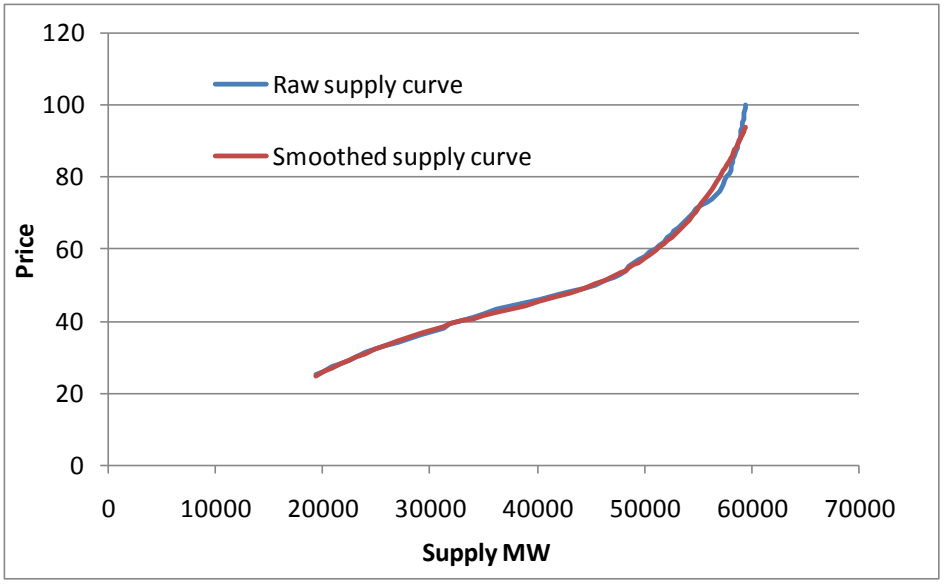

TABLE 8: SEPTEMBER 2010 OFF-PEAK REGRESSION RESULT

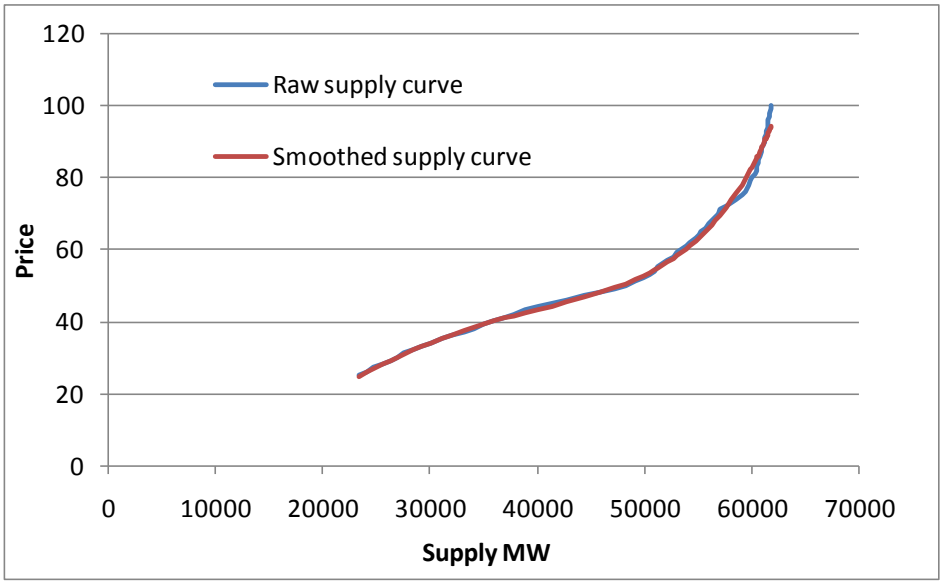

TABLE 9: SEPTEMBER 2010 ON-PEAK REGRESSION RESULT

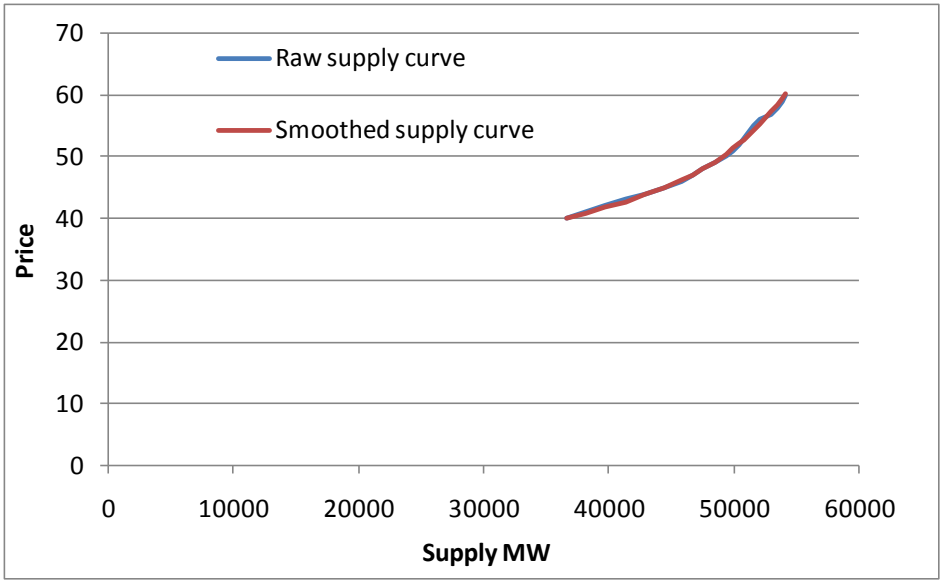

TABLE 10: OCTOBER 2010 OFF-PEAK REGRESSION RESULT

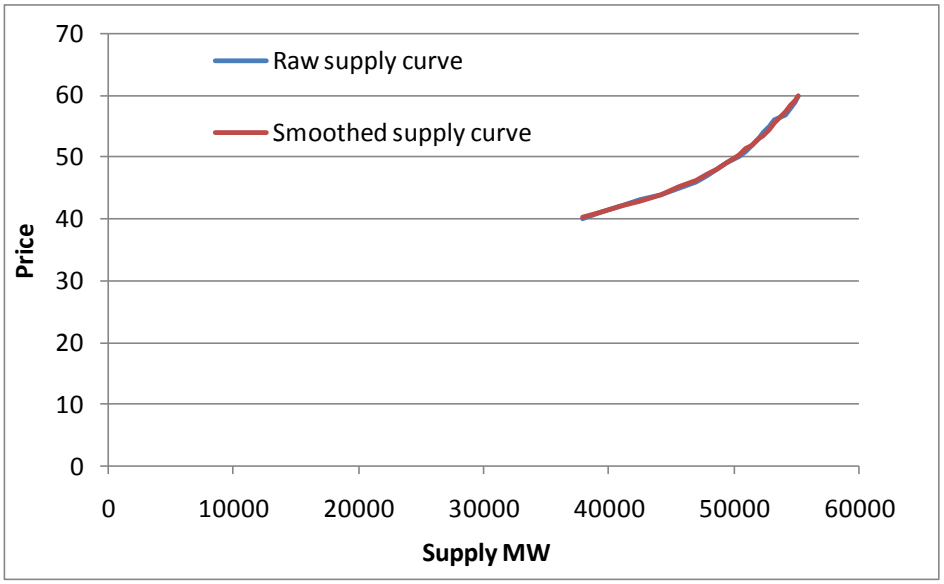

TABLE 11: OCTOBER 2010 ON-PEAK REGRESSION RESULT

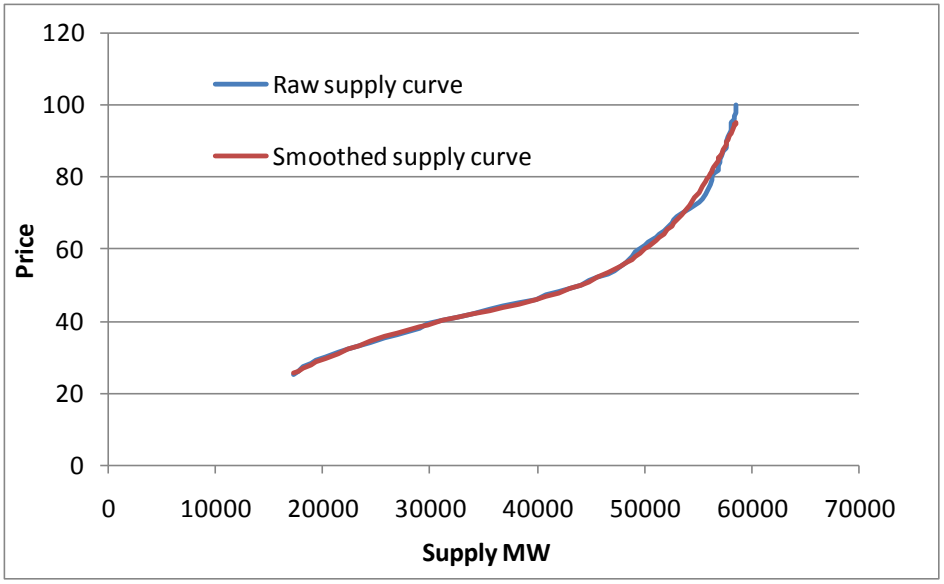

TABLE 12: NOVEMBER 2010 OFF-PEAK REGRESSION RESULT

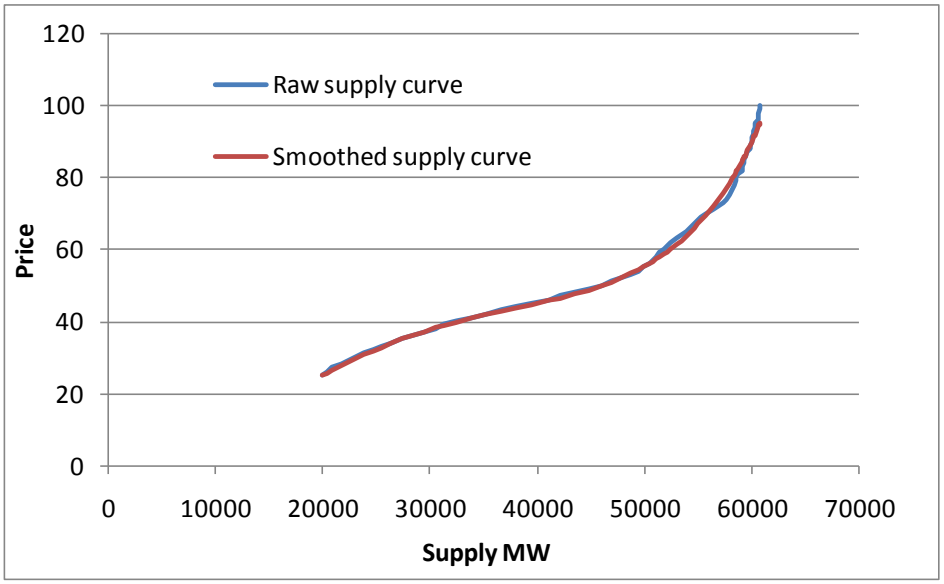

TABLE 13: NOVEMBER 2010 ON-PEAK REGRESSION RESULT

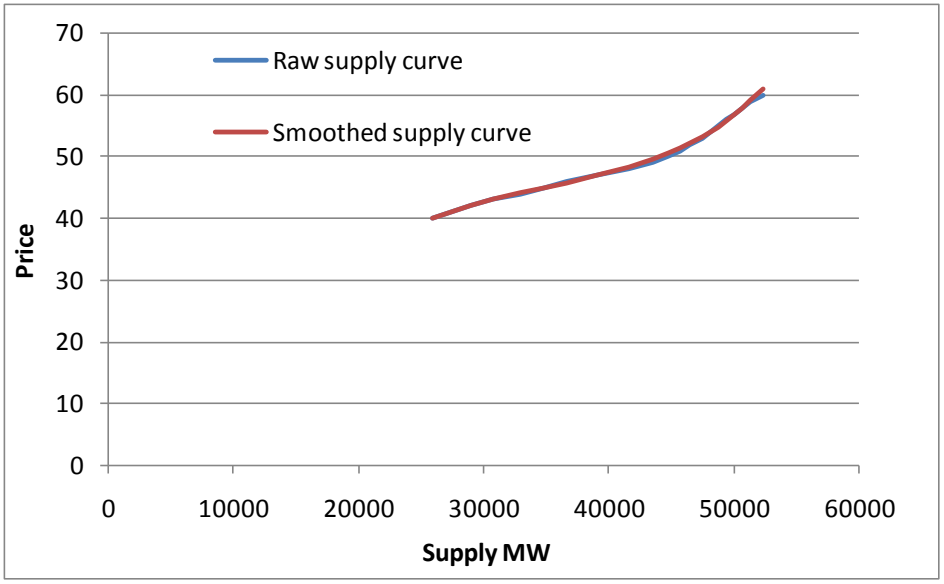

TABLE 14: DECEMBER 2010 OFF-PEAK REGRESSION RESULT

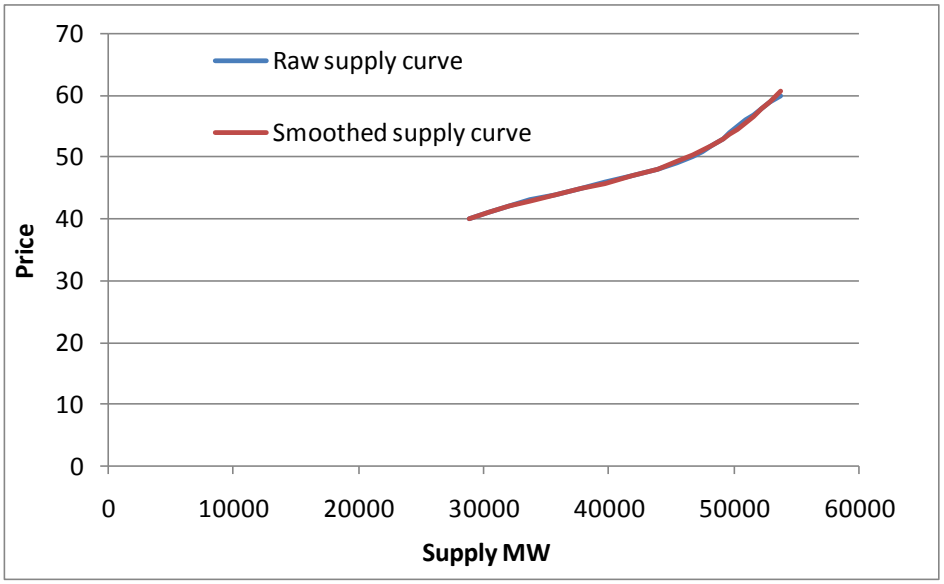

TABLE 15: DECEMBER 2010 ON-PEAK REGRESSION RESULT

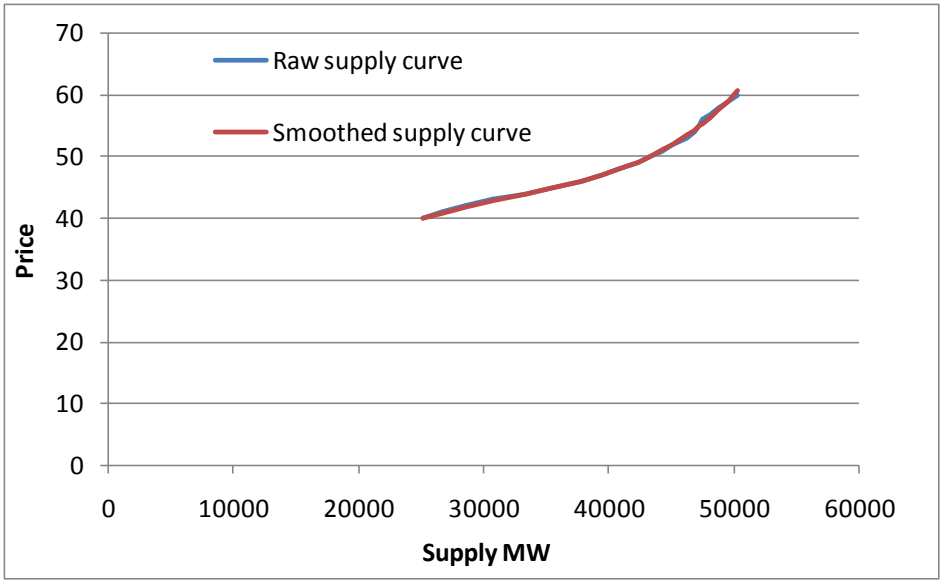

TABLE 16: JANUARY 2011 OFF-PEAK REGRESSION RESULT

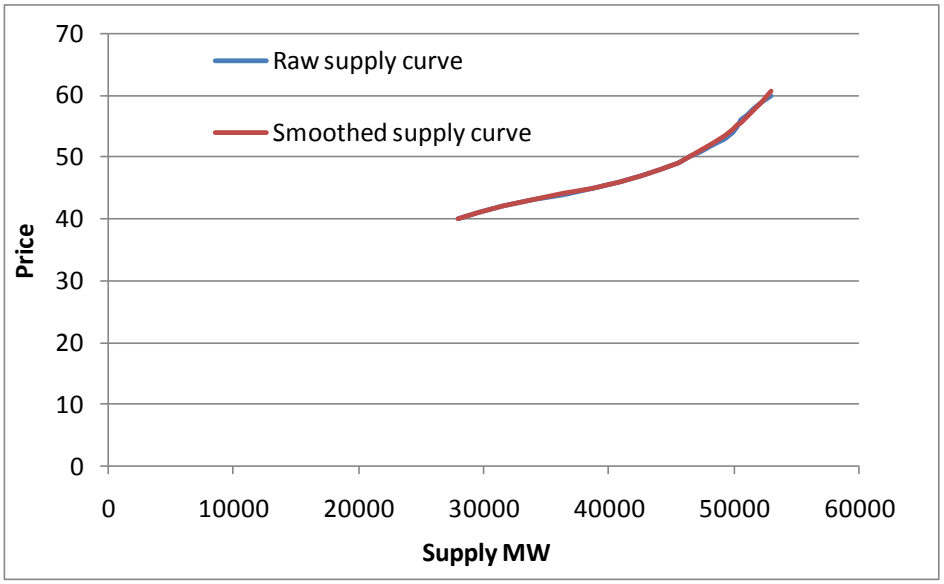

TABLE 17: JANUARY 2011 ON-PEAK REGRESSION RESULT

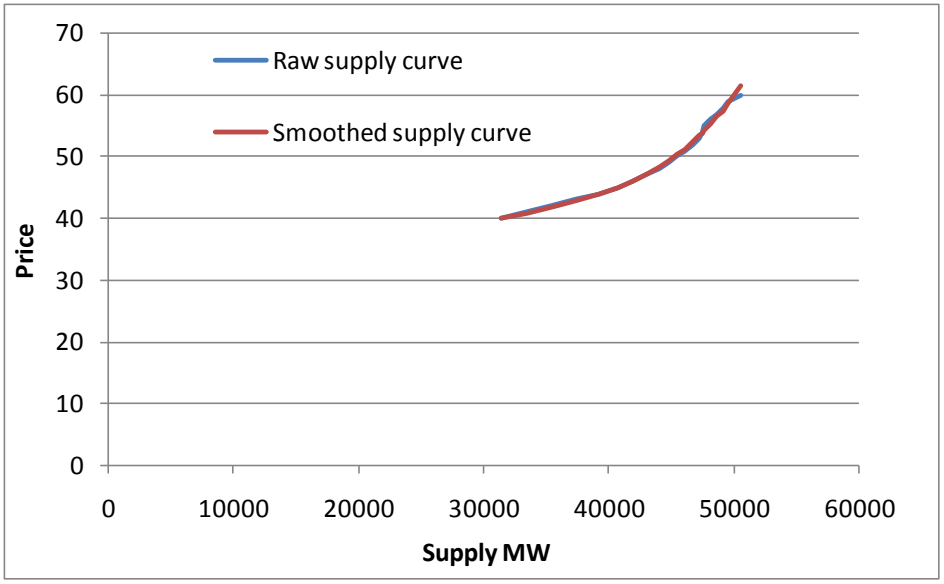

TABLE 18: FEBRUARY 2011 OFF-PEAK REGRESSION RESULT

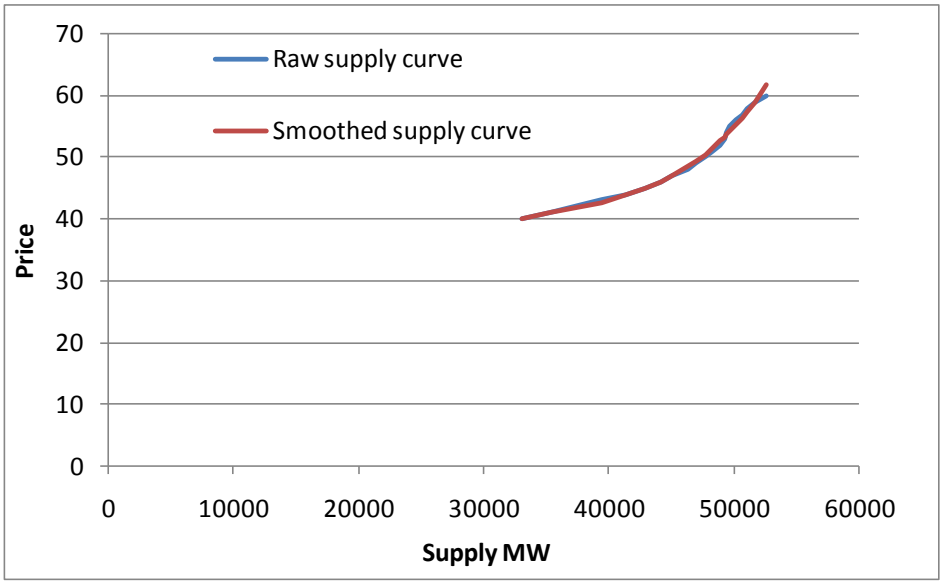

TABLE 19: FEBRUARY 2011 ON-PEAK REGRESSION RESULT

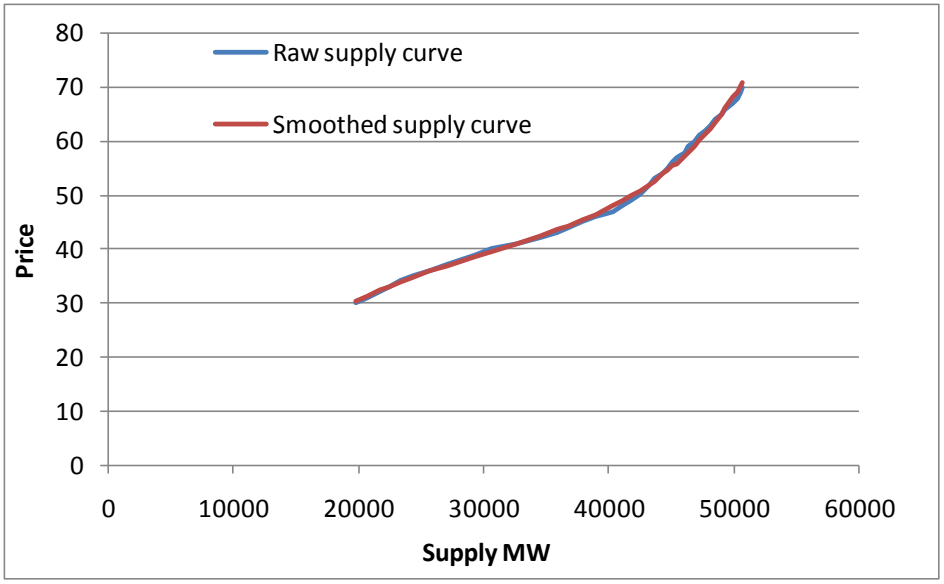

TABLE 20: MARCH 2011 OFF-PEAK REGRESSION RESULT

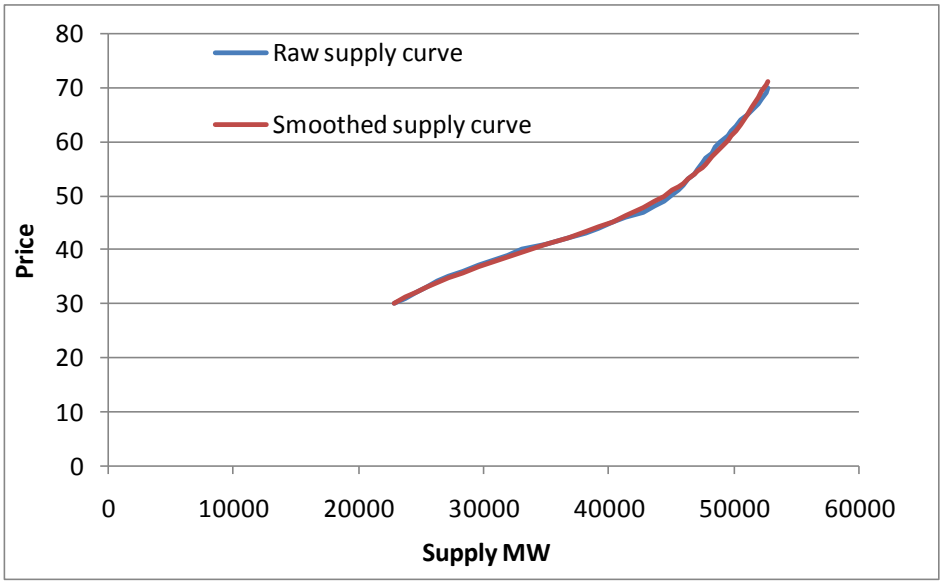

TABLE 21: MARCH 2011 ON-PEAK REGRESSION RESULT

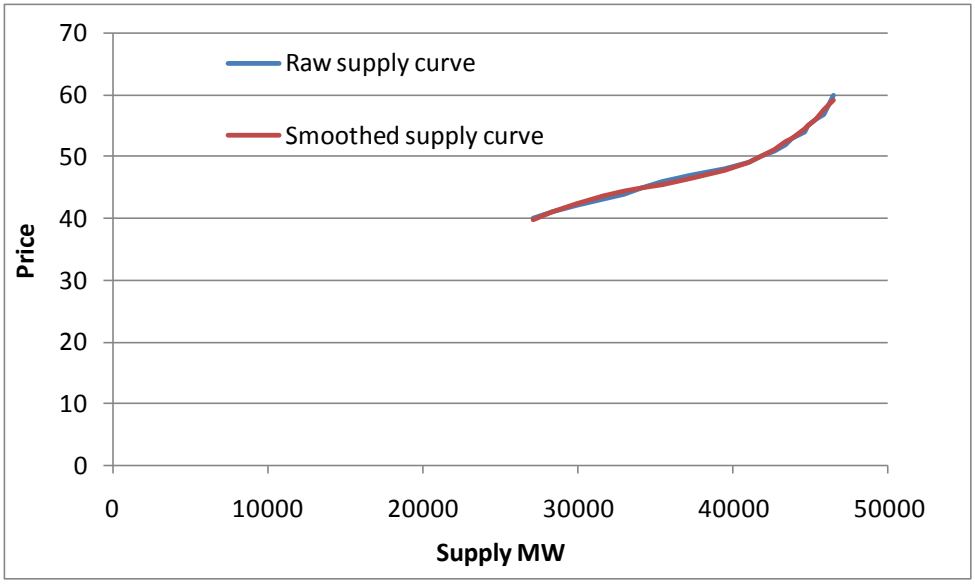

TABLE 22: APRIL 2011 OFF-PEAK REGRESSION RESULT

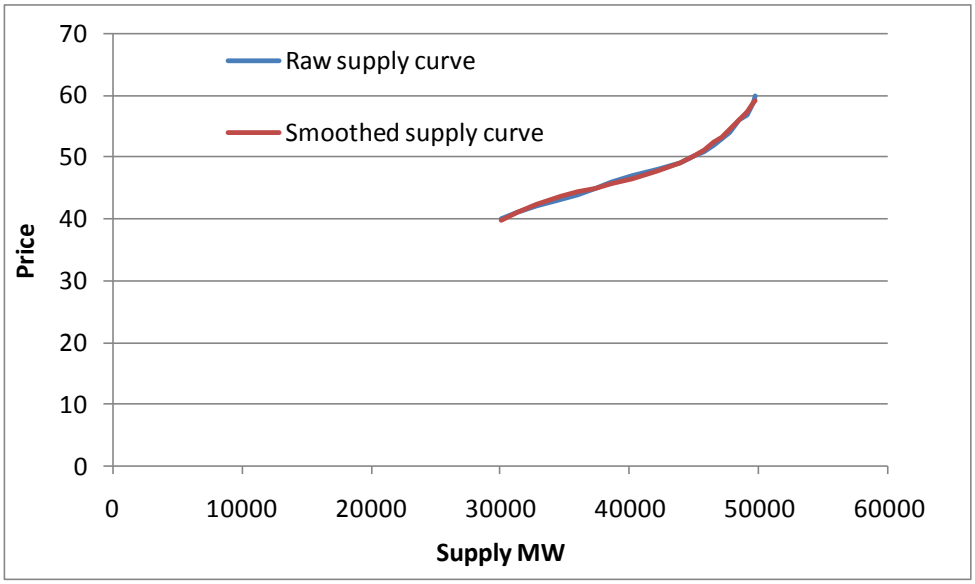

TABLE 23: APRIL 2011 ON-PEAK REGRESSION RESULT

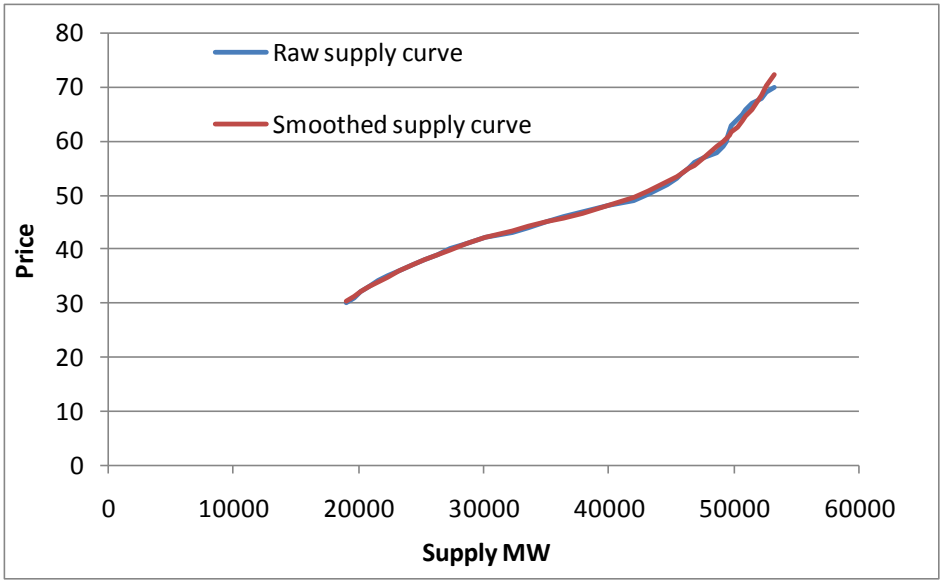

TABLE 24: MAY 2011 OFF-PEAK REGRESSION RESULT

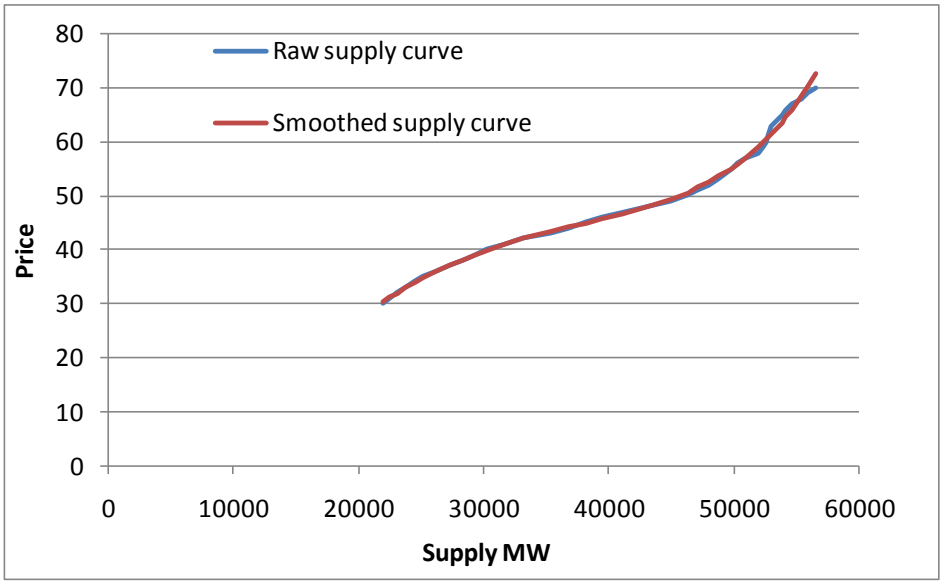

TABLE 25: MAY 2011 ON-PEAK REGRESSION RESULT

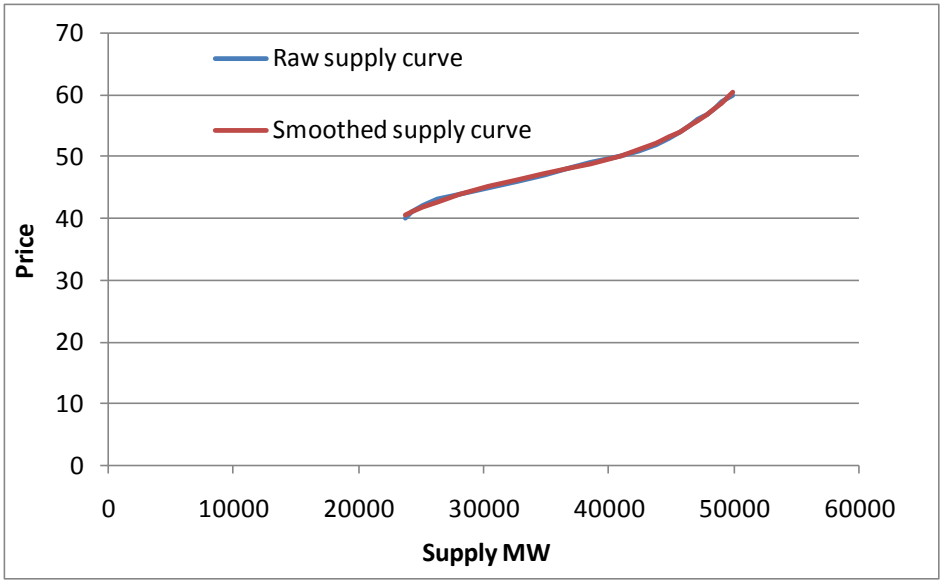

TABLE 26: JUNE 2011 OFF-PEAK REGRESSION RESULT

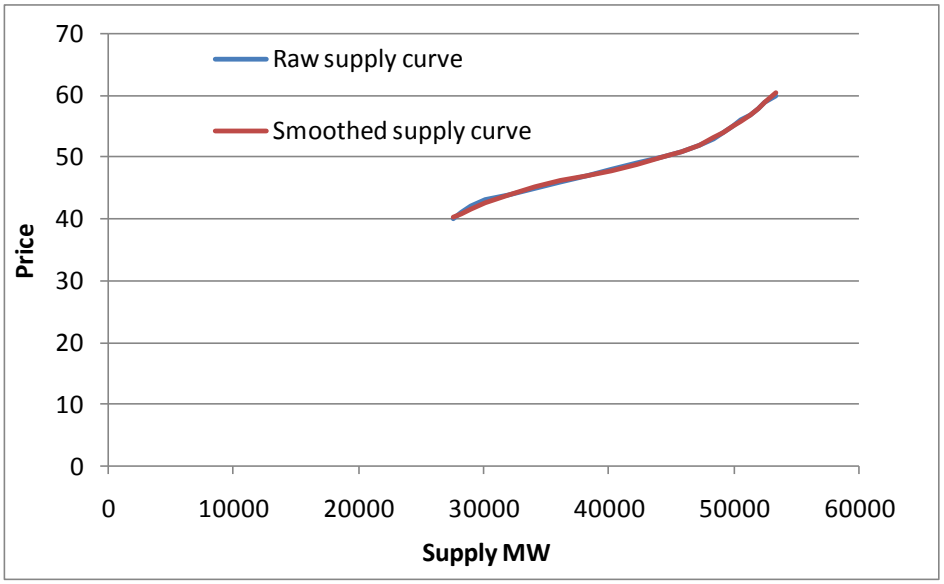

TABLE 27: JUNE 2011 ON-PEAK REGRESSION RESULT