

### **The System Operator**

Unlike in other jurisdictions where a single entity performs the role both of the Market Operator and System Operator, the Philippine WESM is so structured such that an entity, the PEMC herein, carries out the role of the Market Operator independent of the System Operator who, in turn, is "responsible for generation dispatch, the provision of ancillary services and operations and control to ensure safety, power quality, stability, reliability and security of the grid." (WESM Rules, Chapter 11, Glossary). For purposes of system reliability and security, supply and demand must always be balanced within the trading interval hour and said real time management is undertaken by the System Operator.

The Commission sought testimony from the System Operator considering limited information provided by PEMC on how the System Operator will maintain the system balance within the hour and the failure of PEMC's witness to discuss at length details on matters relative to system operations. The Commission is likewise concerned that with the role of the System Operator not clearly defined, there is a greater propensity for the System Operator to abuse its position in the market.

Mr. Claudio, AVP for Luzon System Operations, appeared during the 10 May 2006 hearing of the case. Briefly, Mr. Claudio discussed the parameters used by the System Operator in moving plants within the hour and in accounting for the ancillary services within the hour:

MR. CLAUDIO:

generation the regulating plants take care of that. So, if there is a generation load imbalance let's say there is a slight under generation then the regulating plant will increase its generation and that is true also for the reverse. If there is a slight over generation the generating plant will reduce its generation.

xxx

xxx

xxx

HON. BUTALID:

Are there hours wherein you need two regulating plants or you only need one at any particular hour.

MR. CLAUDIO:

It depends upon the capacity of the regulating plant. If it is enough to regulate the system frequency then it is the sole regulating plant. If the capability of single generating plant is not sufficient to regulate the system frequency then another regulating plant is called in to participate.

HON. BUTALID:

So, how do you determine the order by which you call in the additional plant if it is more than one regulating plant.

MR. CLAUDIO:

It is dependent upon the nomination of the ancillary service provider. So, in this case NPC is the sole provider now so it nominates which plant will participate in frequency regulation.

HON. BUTALID:

So, there's a very clear order for that priority call list.

MR. CLAUDIO:

Yes. Sir.

HON. BUTALID:

So, it's not like the system operator makes an operator judgment. It's really pre determined already.

MR. CLAUDIO:

It's pre determined.

HON. BUTALID:

hour where the ramping up is very fast. How do you handle that?

MR. CLAUDIO:

For example during 7 to 8 in the morning the load increases sharply. The load following and frequency regulating plant will ramp up to follow the load.

HON. BUTALID:

Excuse me. The generator that is generated at the start of the trading interval is to cover only the demand at the beginning of the hour or it's like an average for what you anticipate will happen through the whole hour.

MR. CLAUDIO:

It is the dispatch target at the end of the hour. Not the average of the hour.

HON. BUTALID:

Beginning of the hour.

MR. CLAUDIO:

At the end of the trading hour.

(TSN dated 10 May 2006, pp. 9-11)

### **The Commission's Evaluation**

To reiterate, the instant submission is founded on Section 30 of the EPIRA, which provides that "the said rules [referring to the WESM Rules] shall provide the mechanism for determining the price of electricity not covered by bilateral contracts between sellers and purchasers of electricity users. The price determination methodology contained in said rules shall be subject to the approval of the ERC. xxx" (Insertion supplied)

It is evident from the aforequoted provision of the EPIRA that the entire

of electricity is subject to the approval of the Commission. Thus, to such extent, the WESM Rules will be subject to the approval of the Commission.

As a preliminary to the instant application, PEMC relies on the Department of Energy (DOE) Circular No. 2006-01-0002 which allegedly clarifies the scope of the PDM and the extent of the DOE's and PEMC's authority over the WESM.

Section 3, paragraph 3 of the said DOE Circular states that:

Except for the MDOM, all the other components or elements of the WESM as described in Section 2 hereof are considered integral parts of the design and structure of the market and, thus, PEMC shall ensure that no changes are made to these components or elements without the prior approval of the DOE or as may be necessary pursuant to any amendments to the WESM Rules. However, PEMC is authorized to provide information or to expound on any issue or question from the public, the ERC or any government agency as regards the non-PDM components of market design.

Said Circular attempts to define the limits of the authority granted by the EPIRA to the Commission to pass judgment on the PDM. In the instant application, PEMC asserts that the "[t]he PDM was developed based on the principles and processes set out in WESM Rules clauses 3.2 through 3.10, inclusive. In developing the final version of the PDM, PEMC was also guided by DOE Circular 2006-01-0001." (Judicial Affidavits, Mario R. Pangillinan; Robinson P. Descanzo)

The application likewise states that the PDM consists of various principles and procedures, which are set forth primarily in clauses 3.2 through 3.10 and Appendix A of the WESM Rules, and expressed in a corresponding mathematical formula or algorithm, which in turn are embodied in the MDOM of the WESM.

The Commission does not agree with such interpretation as it ignores the broad regulatory authority vested upon the Commission as an independent quasi-judicial and quasi-legislative regulating body. The law must not have intended the Commission to be merely consigned to simply approving the MDOM or the market clearing algorithm alone. Such argument is simply untenable since the MDOM or the market clearing algorithm is only a component of the entire set of rules and procedures by which energy and reserve transactions in the WESM will be scheduled and priced. Testimonies of the very same witnesses presented by PEMC affirmed such when they stated that the principles, processes and procedures set forth in the WESM Rules, particularly Sections 3.2. through 3.10 underpinned the PDM formulation, thus:

"Q19: What bases, if any, did PEMC rely on in developing the MDOM formulation?

A19: PEMC based the formulation on the principles, processes and procedures set forth in the WESM Rules, particularly Sections 3.2 through 3.10." (p.3, Affidavit, Robinson P. Descanzo; p. 3, Q20/A20, Affidavit, Mario R. Pangilinan)

The PEMC maintains that the MDOM embodies the PDM. On the contrary, it is the opposite, the MDOM forms part only of the entire PDM which is evident under the definition adopted by the WESM Rules of the MDOM:

**Market Dispatch Optimization Model.** The optimization model which contains the mathematical algorithm approved by the PEM Board to be used for the purposes of determining dispatch schedules and energy prices, and preparing market projections based on the price determination approved by the ERC.

The PDM encompasses all other principles referred to by Sections 3.2 to

to the provision of Section 3.6 alone but refers to the entire set of principles, processes and procedures which lead to the determination of the prices and dispatch quantities in the WESM.

The Commission, in the exercise of its mandate is guided by the state policy to "ensure customer protection and enhance the competitive operation of the electricity market." Consequently, relative to the approval of the PDM, the Commission shall evaluate the totality of the principles, processes and procedures for the determination of the prices and dispatch quantities in the WESM. The Commission shall not allow itself to be straightjacketed by the DOE's and PEMC's erroneous assertions.

The Commission shall thus proceed to discuss the pricing principles espoused by the WESM, particularly, the adoption of the locational marginal pricing concept, which raises a number of issues as discussed hereunder.

Under the WESM Rules, shadow price has been defined as the marginal net benefit from a unit relaxation of the capacity limitation of a constraint in the market optimization model. As contained in the WESM Rules, as amended, specifically Sections 3.10.2 and 3.10.6 thereof, the marginal prices are determined as described by the following provisions:

#### Determination of Ex-Ante Nodal Energy Price

The ex-ante nodal energy price for each market trading node in any trading interval shall, subject to clause 3.10.5, be determined as the shadow price on the energy balance equation or equivalent mathematical formulation, for that market trading node formed in accordance with clause 3.6.14 (c), in the dispatch optimization performed for that trading interval in accordance with clause 3.8.1.

### Determination of Ex-Post Nodal Energy Price

The ex-ante nodal energy price for each market trading node, shall be as the shadow price on the energy balance equation for that market trading node, formed in accordance with clause 3.6.14 (c), in an ex-post dispatch optimization performed, in accordance with the timetable, to determine target dispatch levels for the end of that trading interval xxx.

It is necessary to discuss said shadow pricing concept herein for information purposes and to obviate any confusion that may arise in the interpretation of the manner by which the energy is priced under the WESM.

The common misconception of the pricing for the WESM being that the marginal price is set by the generator providing the last unit of electricity to the required load in the system. The Commission has sought clarification from PEMC's expert witness, Dr. Chiao on whether the marginal price is the price of the last increment of energy actually dispatched or the next increment to be dispatched. From Dr. Chiao's testimony, it becomes clear that marginal price is actually the price of the next increment of energy to be dispatched, thus:

COMM. TAN:

You mentioned about the term marginal price?

DR. CHIAO:

Yes.

COMM. TAN:

How exactly do you determine the marginal price? Is it the cost of the, like in the ex-ante is it the cost of the last generation bid that is actually able to address the load? And in the ex-post is it the cost of the last generator that is able to deliver the energy?

DR. CHIAO:

The term used by the economists or the operation research people is the shadow price or the mathematical term is the dual price. What it means is that you have given parameters characterizing the grid and demand and supply that goes with the optimization to find the solution, there is either the total cost to the society that includes the energy, including the reserve cost and that's optimal and the next scenario. To calculate the marginal price of particular node what it does is actually to increase the load at that particular node by one megawatt and goes with the same process find the optimization function of the difference between the two. That's called the marginal price. Now, if you want to consume one extra unit of electricity what's the impact on the entire system not just the generation cost associated with one additional unit not the last unit and you need to take into account the losses, the congestions and the reserve, everything in the system.

COM. TAN:

Then I think we've been using the definition a little bit loosely because just earlier in the previous affidavit, in the previous testimony it was impressed upon us it was the cost of the last plant. So, now what is going to happen it is not the cost of the last plant but it's the cost of the next plant that is going to address any increase in the node?

DR. CHIAO:

The cost involved in the entire system in order to satisfy the next one extra megawatt of demand.

COM. TAN:

So, it's the next not the actual?

DR. CHIAO:

That's correct." (TSN dated 25 April 2006, pp. 133-135)

The approach, therefore, is not the determination of a market clearing price in the system, which is simply the price where demand is equated with supply. In the optimization process, the determination of a marginal price in the system is through the shadow price on a system constraint deemed to represent



Further, as aforesaid, the WESM has adopted the locational marginal pricing concept and the full nodal pricing scheme for settlement purposes. Section 3.2.2.1 of the WESM Rules, as amended, defines a market trading node in this manner:

A market trading node is a designated point in the market network model where energy is bought or sold based on the schedules and prices determined by the Market Dispatch Optimization Model. A market trading node where energy is primarily sold into the WESM is referred to as the generator node while a market trading node where energy is primarily bought from the WESM is referred to as the customer node.

As it stands, each market trading node will be assigned to a particular trading participant that intends to buy or sell energy in the WESM. There will be such number of prices generated in a particular interval hour, as there are nodes in the system. Under the current configuration of the system, some of the nodes will consist of multiple units located at the same point in the network and will reflect the same prices.

And as described earlier, the marginal costs of losses and congestion are to be reflected in the resulting locational marginal prices. This pricing scheme is so designed such that where congestion within the network occurs, a higher priced generation may be dispatched to relieve such congestion, and the cost for this generation is borne only by buyers from the location where it occurs, with the nodal price in such location being higher than those in other locations. It thus includes the cost of supplying the more expensive electricity in these locations and provides a precise method for pricing energy that includes transmission congestion costs. Effects of congestion, therefore, will be easily identifiable under the full nodal pricing scheme. In the absence of constraints in the system,

Originally, the WESM Rules provided that customer nodes may be grouped into zones whereby customers within a zone shall pay the same price for electricity consumed within zone. (Section 3.2.3). The WESM Rules however, have since been amended such that nodal pricing is likewise adopted for customers and the zonal pricing scheme for settlement purposes is merely provided as an option for customers.

In the course of the proceedings, intervenor PSALM brought to fore its concerns on the adoption of a full nodal pricing scheme for the WESM. Primarily, PSALM averred that the nodal pricing scheme raises political issues arising out of the disparity in rates within a franchise area and the adoption of a zonal pricing scheme would address such issue. Further, PSALM argued that a full nodal pricing regime introduces a high level of complexity in the sets of volumes and prices to be negotiated between generator and load. Zonal pricing would simplify contracting within a zone by reducing what would have been multiple sets of volumes and prices to just a single set of prices within a zone. According to Mr. Nonito R. Bernardo, Jr., VP for Finance of PSALM, nodal pricing would render contracting extremely difficult and this would impede privatization of generation companies since a precondition to it would be to assign supply contracts to cover a portion of its capacity. (TSN dated 24 April 2006, p. 69-70). In consideration of the above issues, PSALM prayed that the Commission adopt a compulsory zonal pricing scheme at the settlement level for each trading participant, instead of optional zonal scheme being adopted by the WESM.

After careful analysis of the arguments of the parties on the advantages

and disadvantages of nodal pricing, the Commission finds that the adoption of a

system congestion and losses on the market price as inasmuch as these affect the resulting nodal prices to significant levels.

Arguably, the consideration for the choice of the appropriate pricing scheme is not so much the determination of the actual cost of congestion but the long-term incentives that may arise given the existing constraints in the system. The locational value of electricity will prove to be an effective economic indicator to determine future resource allocation including transmission expansion. Trading participants and potential investors will ascertain, to a certain extent, the value of investing in generation and transmission in those areas. Moreover, projects of the National Transmission Corporation (TransCo) will be set in the appropriate order of priority as it aligns its expansion plans to the resulting prices in the WESM. To treat fundamentally different locations as though they are the same will result in poorer incentives for investments as incorrect signals are produced.

Given the overriding objective of the EPIRA "to enhance the inflow of private capital and broaden the ownership base of the power generation, transmission and distribution sectors" (Section 2(d), EPIRA), the Commission allows the adoption of the nodal pricing scheme for the WESM in consideration of the long term incentives that it creates for the WESM. The Commission finds the adoption of the locational marginal pricing concept consistent with the policy of the state "to ensure transparent and reasonable prices of electricity in a regime of free and fair competition and full public accountability." The Commission believes that the above considerations are paramount and unless there are persistent arguments that would persuade the Commission to rule otherwise, it maintains that a mandatory full nodal pricing scheme shall apply for the WESM.

PSALM invokes additional argument in its "Manifestation" dated 31 May 2006, on the effect of zonal pricing on market power, thus:

xxx. Under nodal pricing, a generator behind a constraint may exercise market power which may result in customers who are located within the congested area paying higher rates. Zonal pricing socializes market power because the impact of transmission losses will not be charged solely to customers located in the affected node, but will be spread among customers within the same franchise area. (p.2, Manifestation, 31 May 2006)

On the contrary the boundaries under zonal pricing may obscure the existence of local market power especially so if the definition of zones covers large geographic areas. To illustrate, a generator taking advantage of the constraints will be paid higher prices yet these prices are averaged and socialized at the customer level hence, identification of the existence of market power in such areas will be difficult. The position of the Commission that nodal pricing should be used for customers still holds as it avoids the cross-subsidies that will come about among customers within a zone. The Commission likewise recognizes that the proposed adoption of a zonal pricing scheme may bring about difficulties in defining and determining the zonal boundaries which as yet have not been sufficiently established. It also realizes that the definition of boundaries should be set such that differences in prices along these nodes will have to be considered so as not to affect investment behavior in generation and transmission. The Commission thus directs the PEMC that for settlement purposes, full nodal pricing shall apply.

For the above reasons, the Commission hereby approves the principles espoused by the WESM, such as the adoption of a gross pool market to ensure

central coordination of the scheduling and dispatch in the system; the adoption of

as the ex-ante and ex-post pricing scheme in order to account for discrepancies between planned and actual outcomes.

Still on the issue of the locational marginal price, the Commission has raised concerns on the treatment of the net settlement surplus that arises from difference in prices between generators and customers due to the loss factors and congestion revenues. The Commission is wary about the manner of distributing the net settlement surplus considering its impact on the incentive of market participants to cause locational price differences.

Pursuant to Section 3.13.16.2 (a) of the WESM Rules, as amended, the net settlement surplus may be "retained by the Market Operator to fund deficit as a result of transactions required in clauses 3.13.14, or may be flowed back to the Market Participants in accordance with the procedures to be developed under clause 3.13.16.3 of the WESM Rules, or may be used by the Market Operator to establish and support the market for Financial Transmission Rights subject to the approval of the PEM Board." The WESM Rules further state that the net settlement surplus shall be clearly accounted for and taken into account when setting the allowable charges under any regulatory instruments applying to the Market Operator. Further, Section 3.13.16.3 thereof requires the Market Operator to:

- a.) publish regular summary reports on the amount of any net settlement surplus being generated;
- b.) within one year from spot market commencement date, and every year thereafter, publish a review of the underlying factors giving rise to any net settlement surplus, and attempt to identify any binding constraints which may have caused or contributed to such net settlement surplus;

c.) determine, in consultation with Trading Participants, and

any particular set of constraints is of such magnitude as to justify development of a regime similar to that implemented in the WESM Rules with respect to transmission line rentals and transmission rights;

- d.) develop procedures on the possible uses of net settlement surplus subject to approval by the PEM Board;
- e.) continuously review the procedures on possible uses of net settlement surplus to the extent the Market Operator considers it to be reasonably necessary to promote WESM objective. Any changes made on the procedures shall have approval from the PEM Board.

As stated, a portion of the said surplus will have to be retained by the PEMC for settlement purposes in the event that payment to generators will exceed payment to the customers. Where there is a surplus, net of such deficit payment to generators, the PEMC has declared options for the utilization of the same in the form of a flow back to the participants or through the establishment of a market for Financial Transmission Rights. The Commission finds the amendment and the present processes wanting in details in that there is no definitive determination still on the treatment of the surplus, which would apply upon opening of the market. The Commission thus is of the view that, the net settlement surplus must be simply redistributed to the market participants, given the approaching commercial operations of the WESM.

Nowhere in the instant submission does it state however, that procedures for flow back are already in place. The procedure on flow back or redistribution must be formulated early on as the net settlement surplus has an impact on the manner by which the market participants will bid on the market. Hence, the PEMC is hereby directed to develop the said procedures within three (3) months after the commencement of WESM commercial operations in Luzon and to

account the specific load-weighted share of the respective load entities in the congestion charges. Likewise, PEMC is hereby ordered to annually submit to the Commission a comprehensive report on the net settlement surplus including, but not limited to, the monthly levels thereof and the underlying causes of the same.

The development of a transmission rights market through the sale of Financial Transmission Rights (FTR) is a highly complicated undertaking. the Commission maintains the view that the same must not be carried out until after a determination that the industry and the market is well prepared and equipped to adopt the same as a reasonable regime of dealing with the net settlement surplus. The mechanics of administering an FTR market must be submitted to this Commission for its approval.

In the evaluation of the instant application, the Commission has the obligation to ensure that the MDOM is compliant with the provisions of the WESM Rules and it must further ensure that the MDOM is certified as such by an independent reviewer pursuant to Section 10.4.10.3, which states that:

The formulation of the *market dispatch optimization model* developed under clause 10.4.10.1 and the performance standards developed under clause 10.4.10.2 are to be approved by the *PEM Board, having been certified as compliant with the WESM Rules by an independent reviewer* appointed by the *PEM Board*. (Emphasis supplied)

According to the PEMC, the formulation of the MDOM and the MDOM software itself was reviewed and certified by an independent auditor, the PA Consulting Group, Inc., which was engaged solely for such purpose.

On 27 and 28 April 2006, PEMC presented Dr. John George of PA

MDOM software complied with the requirements set by the WESM Rules. He testified on the scope of the audit, as follows:

The scope of the audit included:

- (1) Examination of the algorithms used in the MDOM software to determine if the algorithms are mathematically equivalent to the formulation described in the WESM Rules;
- (2) Having confirmed that this appeared to be so, we then prepared detailed test cases, which would test all of the requirements of the WESM Rules. These tests were then provided to PEMC staff so that they could be loaded into the MDOM software before our arrival in Manila. (Judicial Affidavit, Dr. John George, p. 4)

On the audit procedures, Dr. George described the process undertaken as follows:

- (1) Examination of the MDOM and WESM Rules documents to fully understand what function the software is required to perform, what data the software is required to use, what results the software is required to produce, and how it is to calculate them; and then
- (2) Conduct of a series of tests on the software to determine whether the software properly performs these functions and correctly calculates the results required. In this respect, the software was tested for its accuracy in representing the requirements of WESM Rules. (ibid.)

Dr. George's testimony revealed that, although the MDOM software generally complies with the WESM Rules, and despite retests conducted thereon, there exists several limitations which the supplier of the software has not been able to remove entirely after the conduct of said retests. While he testified that the occurrence of these limitations is unlikely to have any significant impact on the dispatch schedule and prices, Dr. George took exception to the limitation



on the under-application of the binding line limits. This, he said, may have a material impact on the resulting locational marginal prices.

Further, during the cross examination, Dr. George testified that while the audit was being conducted, inconsistencies between the software and the WESM Rules were resolved through the amendment of the WESM Rules to conform to the algorithm, thus:

COM. BUTALID:

Now, in the same slide, there were certain discrepancies. It appears that resulted after you checked and if I understand it right in this slide, you said that because you did not strictly conform to the rules, you recommended and PEMC followed the recommendation that they change the rules. I thought it was a case of... a mathematical formulation, that had to be consistent with the rules. What I understand is, it was not consistent, and so therefore what changed were the rules. Isn't it like the other way around? The software should conform to the rules, but since it did not, so you changed the rules. So now it conforms.

DR. GEORGE:

You need me to answer that?

COM. BUTALID:

Please.

DR. GEORGE:

There is more than one way of specifying the market, the running of the Market Clearing Agent. That is what we've been talking about. Mathematically, there is more than one way of actually stretching down the mathematical equation, and each relate to the issues that I raised a little earlier to where the model is a single one-tranche model which has DC load flow as part of the model. For alternative method, the software is directed between two separate models and came up with the answers during the process. Now the mathematics of those two methodologies are slightly different. The rules were written because the team that I was part of for the WESM rules has a preference of a particular mathematical formulation. Now, there are good

speculate if I had been part of the team, that there would be good reason why the alternative methodology is the one that were written in the rules might have been chosen by PEMC. So there are two possible way of writing down some of the aspects of the mathematics. The rules had assumed that there would be one form of mathematics. The software that was purchased was designed rather an alternative similar but slightly different set of mathematical equation.

COM. BUTALID:

Was that developed based on the rules?

DR. GEORGE:

If I may comment, the software that was used in almost every electricity market is an adoption from a previous piece of software that had been implemented in another market. I mean, people don't...

COM. BUTALID:

It's not a tailor-made software, it's an off-the-shelf?

DR. GEORGE:

Well it's partially off-the-shelf, partially redesigned to cope with the fact that every market is different. There are no two markets, which are identical. And so there has to be certain changes to the software as a result of the slightly different design of the software.

COM. BUTALID:

And if it's off-the-shelf software, it's indeed flexible to adopt to the conditions of any jurisdiction, why could it not have been adopted specifically so that it conforms with the rules. What I fail to appreciate is you get a contractor, ABB, to make software based on the set of rules. And the work comes out, according to your audit, that it is not consistent. And instead of asking the software developer to fine tune the software, we are asking the PEMC Board to change the rules. So that is what I find a little bit of a dangerous situation wherein the software developer is the one now setting the tone of modification. xxx No, my question is this is, like you said normal, all of the market pools in the world buy a certain software and they modify it. Correct? Did I understand that correct? So PEMC contracted ABB to modify the software to conform with our rules; and in your audit it turns out that some elements are not consistent with the rules. Why could we not have asked for them to modify

change the rules instead of the software to change the software, or to refine that particular element of the software? Yes. If you would please respond.

DR. GEORGE:

I can't speak for PEMC, of course. And I was not part of the software purchase decision.

(TSN dated 27 April 2006, pp.61-66)

To the mind of the Commission, this is a highly irregular exercise in view of the underlying presumption that the algorithm must be fashioned after and is supposed to be consistent with the WESM Rules. Such being the case, the MDOM algorithm deserves a more thorough regulatory scrutiny to examine the adverse consequences of the limitations in the algorithm. The Commission is mindful that in performing its duty to protect the consumers, it must ensure that the software will not produce inaccurate locational marginal prices and dispatch quantities.

As borne out by the test reports dated 29 June 2005 (Exhibit "II") and 05 December 2005 (Exhibit "JJ"), major issues still arose including one shortcoming of the software that increases the difficulty in validating its accuracy.

The first problem identified is the non-convergence of the MDOM software. The problem that was thought to be a miscalculation of losses was in fact caused by the inability of the software to converge to an answer, hence subject to endless oscillation. Dr. George found cases where this algorithm failed to converge for his 5-node model. This resulted in locational marginal prices that deviated by as much as ten per cent (10%) from the prices computed

non-convergence using the 5-node model to ABB, the software vendor. According to him, the vendor ABB assured the software auditor that in full-sized market systems where the software is used, non-convergence has very rarely occurred and that this non-convergence is likely to not occur as well in the case of WESM. Dr. George admitted, however, his failure to verify this claim by the vendor ABB.

The second problem identified is that the software does not appear to apply line flow constraints correctly. The discrepancy between the line flow constraint and actual rated capacity of the line was raised by the auditor to the PEMC inasmuch the MDOM does not appear to allow a schedule that exactly meets the transmission line flow limit. Specifically, the MDOM does not impose the flow constraint at exactly the level specified in the network model. It is unclear how this under-scheduling of the line limits impacts dispatch quantities and the locational marginal prices and the Commission considers it material that Dr. George was unable to undertake an exhaustive analysis of the cause of this under-scheduling of the transmission lines. The Commission found noteworthy the testimony of Dr. George concerning the line limits, thus:

COM. BUTALID:

Correct, but that is not my question. My question is, all of this values below 1% were true for the 5-node network model?

DR. GEORGE:

Yes.

COM. BUTALID:

If we use more nodes, what would be the degree of error?

DR. GEORGE:

I would not ... (inaudible) I think we already discussed whether PEMC took the impact on the full system.

Logically, if the line constraints that are reflected in the software are always below the actual flow limits, naturally you'll have to dispatch more because the software will say that this is the constraint so the capacity is always understated, therefore, there will have to be some compensation to dispatch more and the solution would be different. Isn't it?

DR. GEORGE:

Just let me think about that one for a moment and make sure I have a clear mind to what you are saying and what am I supposed to respond to. When the software solves, it will solve for dispatch and the pricing solution. The dispatch will be seen in terms of these previous illustration I made. Dispatch will be seen as 199.5 megawatts whereas it could also join the 200 megawatts according to the model. Now there are two things that can go wrong. One is the dispatch of course has met the demand, otherwise it wouldn't have been a feasible dispatch. So there is no more that has to be dispatched than what was dispatched because the model has actually a quite supply and demand reliably on all the nodes. So the issue that you were concerned about is this is 0.5 dispatch...

COM. BUTALID:

I'd like to clarify that. In order to meet demand, because what will be dispatched would be 199.5, so in order to meet demand of 200, it will have to come from somewhere. So there would have to be some instruction for someone to send 0.5 megawatts. Right? Because the demand is 200, the software will indicate that the line limit is 199.5 so the order to dispatch 199.5 will be given to that generator. But the demand is 200 so it would have to come from someone, the 0.5, where will it come from? And if we factor its loss, it's even more, isn't it?

DR. GEORGE:

Well, the short answer is, you're right. The long answer is...

COM. BUTALID:

Thank you.

DR. GEORGE:

The long answer is that there are so many other inaccuracies within the parameters of...

COM. BUTALID:

Thank you for confirming that I don't have an imaginary fear, that it is a real concern. All I am saying Dr. George is I'm trying to reconcile in my mind how can a dispatch error not lead to some consequence of a price error because it is a price and quantity pair. So when the quantity is defective, the solution would have to recognize that and compensate it from another possible source. We will ask you to cover it after this... Because your testimony was... it sounded to me that I can sleep soundly knowing that the line limit errors do not affect prices but... well, I am concerned that it might affect prices in some circumstances.

DR. GEORGE:

There is a question of materiality, isn't there?

COM. BUTALID:

Yes.

DR. GEORGE:

And the materiality whether you could sleep at night with this issue, depends on how many inaccuracies and errors there are in the specification of the network.

COM. BUTALID:

Yes but the problem is, the materiality of 1% and below that we all discussed already happened in a 5-node network model. Now I would not be belabouring this point if we did the 177 nodes and indeed it is below 1%, but the problem is, the 1% and below error happened in a 5-node model. We don't know what the errors will be if we use it for 177 nodes. So we can't really say it is immaterial.

DR. GEORGE:

We can't.

(TSN dated 28 April 2006, pp. 92-97)

The final shortcoming of the software complicates the process of validating it. The MDOM does not produce the value of the objective function the optimization problem employs to compute the dispatch quantities and prices. A necessary condition to validate the MDOM software is that the vendor allows the

objective function value, it becomes difficult to validate the accuracy of the prices, using the "bump test", which involves solving the model for one load configuration and then re-solving it with the same load configuration except that the demand at one node is incremented by a small amount MWs. Since the ABB software did not produce this objective function value, Dr. George was forced to compute it manually using the output of the model. This unnecessarily introduced significant numerical inaccuracies into the estimated locational marginal prices he computed using the "bump test."

Finding that several concerns have not been sufficiently addressed by the re-tests and the testimony of Dr. George and considering its view that the 5-node test has not been an exhaustive exercise, the Commission, in an Order dated 03 May 2006, directed the PEMC to conduct validation tests using the full network model to ascertain that said unaddressed concerns will not lead to significant inaccuracies in the prices and dispatch quantities.

In its Compliance dated 02 June 2006, the PEMC reported that the "bump test" was conducted on thirty (30) nodes in the system on four-day types: system peak, system off-peak, typical dry season day and typical wet season day. Data were extracted from the 2005 historical WESM Trial Operations Data. Line constraints were induced in some parts of the system by simulating outages in the network. Based on the account of the PEMC, non-convergence was not encountered in all the test case solutions. In all tests cases conducted for all bump test points, all errors were computed to be less than one per cent (1%) with approximately seventy per cent (70%) falling in the +/- 0.5% range.

capacity. The maximum difference between the constrained line flow and the maximum line capacities was observed to be only 0.348%.

In verifying the results of such test conducted by the PEMC, Dr. George has in fact recommended that the Commission engage an independent person to provide the necessary assistance to it. While the Compliance by the PEMC revealed apparent unremarkable results, the Commission still invokes its reservations on the accuracy of the tests conducted solely by the PEMC as against the testimony of the independent auditor on the materiality of such concerns. However, given the limited resources and technical expertise by which the regulator is able to conduct a comprehensive audit of its own, the Commission is constrained to rely on the audit conducted by the PA Consulting Group, Inc. as well as the test conducted by the PEMC. There still remains no assurance to the Commission that the issues will not endure during WESM commercial operations.

While the Commission is cognizant of the provisions of the WESM Rules, specifically Section 10.3.1.2 thereof, which states that: "the composition of the market network model may be limited in scope during the operation of the interim WESM," it is deemed crucial that the PEMC ensure that the said MNM represents fairly the existing system conditions. Thus, in recognition of the procedures contained in the MNM Manual, the PEMC is hereby directed to ensure that "prior to the commencement of the final WESM," an independent auditor elected by the PEM Board shall verify the correctness and applicability of the Market Network Model.