FIRST
PRINCIPLES
ECONOMICS, LLC

Affidavit of Dr. Ronald R. McNamara

In the Matter of ETRACOM LLC and Michael Rosenberg

Before the Federal Energy Regulatory Commission

Docket No. IN16-2-000

1. Introduction

I was asked by counsel to review the market in May 2011 at the New Melones intertie and in particular to comment on one aspect of the Federal Energy Regulatory Commission (FERC) Office of Enforcement's (Staff) argument as to whether a "well-functioning market" existed there at that time.

2. Professional Background and Relevant Experience

I am an economist with over twenty-five years of diverse experience in electricity and energy markets. As relevant here, I was significantly involved in the design, implementation and operation of the New Zealand wholesale electricity market. The New Zealand market was the first in the world to be based on locational marginal prices (LMP) and I was responsible for the creation of the ex post LMPs used for settlement. From 2003 – 2006 I was the Vice President of Market Management and Chief Economist for the Midwest Independent System Operator ("MISO")[1] and was the officer responsible for the MISO market design and tariff. In this role, I had responsibility for managing/operating the Day Ahead Market, determining the LMPs for the Day Ahead and Real Time Markets, managing/operating the Financial Transmission Rights markets, and managing market and transmission service settlements. My curriculum vitae is attached as Attachment A.

3. Purpose of the Affidavit

My affidavit addresses two basic issues related to electricity market design and operation as they relate to this proceeding:

(1) The relevant aspects of the design and operation of the California Independent System Operator ("CAISO") as they relate to possible market manipulation at New Melones.

(2) Given the operation of the CAISO market at New Melones, whether it is possible to quantify the effects of a market participant's behavior on market outcomes at New Melones.

[1] Originally the Midwest Independent System Operator and now the Midcontinent Independent System Operator.

My affidavit does not deal with the specific behavior or trading strategies of ETRACOM or any other specific CAISO market participant at New Melones.

4. Electricity Markets are Unique

Given the ubiquity of "markets" in the overall economy it is easy to overlook that markets exist to reduce the transaction costs that are inherent in any exchange between buyers and sellers. The extent to which a market is a success of failure depends, therefore, on its ability to make transacting more efficient. Competition between the market – as one method for transacting – and other mechanisms,[2] theoretically provides both an incentive and a constraint on the operation of the market, providing that no single method of transacting is mandatory.

The underlying premise, therefore, is that markets face competition and are, as a result, voluntary. If a given market is, for whatever reason, not effective at reducing transaction costs then buyers and sellers will seek other ways to transact. The logical conclusion is that, to the extent there is active participation in a market, the existence of a market for a specific commodity or service provides evidence that the market is serving to improve the efficacy of transacting. That is, the existence of a viable market proves that the results from buyers and sellers exchanging are more efficient than if the market did not exist.

In this simplistic textbook view the very fact that a market exists and has some level of activity is proof that the design and operation of the market is net positive. An efficient market – so long as it is voluntary – by definition always improves the social outcome than would otherwise be achieved, i.e., improved price discovery, prices more accurately reflect costs and preferences, liquidity is enhanced, etc. Thus if a market is not "well functioning" the cause can be found with the buyers and/or sellers. Markets that are broken because of factors such as the existence and abuse of market power arise not because of a poorly designed or operated market but rather because of the characteristics inherent to either or both buyers and sellers.[3] Electricity markets, however, do not fit this narrative for several reasons.

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[2] Bilateral contracting, vertical integration, and horizontal integration, etc. are common ways to transact that occur outside of a market.

[3] The original electricity market design for the UK pool in the 1990's failed in large part because there was a duopoly on the generation side and the market design. Rather than focusing on the proper design of a market the market design attempted to mitigate market power through the market design and operation.

- Electricity markets are not voluntary. Because electricity, as a commodity, cannot be separated from the path it takes to travel from the generator to the load, a central coordinator or dispatcher must manage all the electrical flows, and not just a subset, to ensure reliable operation of the grid. While buyers and sellers may be able to partially insulate, i.e., hedge, themselves from the financial effects of the dispatcher's decisions, they cannot meaningfully "opt out" of the physical coordination process[4] including the creation of ex post prices intended to accurately reflect the results of the dispatch process.

- The primary function of a Regional Transmission Operator ("RTO") or Independent System Operator ("ISO") is to reliably balance supply and demand, minimizing the costs of production in efficiently serving load, and the scarce "commodity" that is being rationed is physical transmission capacity in real time. Thus, an electricity market is more correctly and accurately understood primarily as a derivative of the dispatch process rather than as a mechanism for the efficient exchange of electricity.

- An electricity market operated by an RTO/ISO is based on a non-discriminatory dispatch, which requires complex rules and processes to achieve. The institutional structure of an RTO/ISO administered electricity market contains all these rules and procedures and market participants are, either directly or indirectly, exposed to the requirements and effects of the totality of the rules not just the subset(s) that may be relevant to their level of participation. That is, electricity flows must be managed in the aggregate and cannot be physically separated during dispatch.

- There is no mandatory requirement that the resulting electricity markets administered by the RTO/ISO must reduce the transaction costs. While there is a requirement that the dispatch be optimal, there is no similar requirement that the electricity market reduces the costs of transacting.

With respect to electricity markets, the abstraction presumption that markets are always socially beneficial provided they exist suffers in being unable to explain the real world because it ignores the possibility that the markets are capable of negatively affecting the eventual outcomes.

Therefore, to the extent that an electricity market is not well functioning, it cannot automatically be assumed that the "fault" of inefficient outcomes lies with the actions of the buyers and/or sellers. The design, implementation and operation of the electricity market itself could provide the reason for less than optimal outcomes.[5]

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[4] More correctly, they cannot opt-out without imposing cost on other participants. In so doing the non opt-out participants end up subsidizing the opt-out customers.

[5] For example, at the start of the market in 2005, MISO operations inefficiently reduced the output from coal-fired generation and replaced the lost output with gas-fired generation set that was dispatched at the minimum-run which, according to the FERC-accepted MISO tariff at the time,

5. The Relevant Market is the Market at New Melones

Since the issue in this proceeding is alleged market manipulation, it is first necessary to accurately define and characterize the exact market that was allegedly manipulated. The CAISO is responsible, among other things, for providing non-discriminatory market-based access to the regional electricity grid. The mechanism by which this is accomplished is a bid-based security constrained economic dispatch ("SCED") process that is used to reliably match (or balance) physical supply and physical demand in real time.[6] While in practice the process involves separable components, I will refer to it in the aggregate as the "dispatch process."

While it can be convenient to refer to "the" electricity market or the "CAISO electricity market" such nomenclature is an oversimplification of actual operations. This simple abstraction can, and often does, hinder a correct understanding of what the CAISO actually does and, in particular, impairs the ability to fully understand the true nature of the dispatch process. In order to balance electrical supply and demand, i.e., dispatch the system, the dispatch process does more than simply match total supply against total demand as that would ignore the role the transmission system plays in determining a feasible dispatch and would almost always be unreliable.

Reliable operation of the transmission system requires the system to be disaggregated into the myriad of nodes or sub-parts and the SCED must ensure that supply and demand balances at each of these nodes. In effect, reliable non-discriminatory market-based access requires the CAISO to create and simulate a market at each node on their system and then find the price at which supply and demand are equal for every node simultaneously. There are several important characteristics of the CAISO electricity market:

1. Technically the CAISO does not operate a single electricity market. Rather it operates many markets simultaneously.
2. None of these "markets" constitute what is commonly understood to be an actual market. They are, instead, "markets" created by the SCED algorithm in which price, rather than serving as the means by which the desires and expectations of buyers and sellers are brought into equilibrium, is a mathematical residual of the dispatch process. That is, the price, which is called the LMP should be correctly understood to be the price that is consistent with a market outcome had there actually been a market at that location.

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meant that the gas-fired plants could not set the price. Thus expensive generation was producing power but not setting the price.

[6] Real time refers to the time period during which generation is actually being produced and consumed.

3. The relevant market is, therefore, the market at the New Melones node. And the relevant prices are those at New Melones market.

The relevant level of analysis is the design, operation and performance of the market at the New Melones node.

6. The CAISO Administers Several Related Markets

To support the dispatch process, the CAISO administers several other markets. Most notably there is a Day Ahead Market that serves as a near term futures market. This market is meant to be a mirror of the real time market and the extent to which it fulfills this objective then it: (1) provides market participants with an effective hedge to their exposure to real time electricity prices. To the extent Market Participants participate in the Day Ahead Market, i.e., provide the CAISO with accurate information about their intentions for the next day, then (2) make real time dispatch both more reliable and more efficient. The Day Ahead Market, therefore, serves as part of the scheduling process used by the CAISO in order to operate the grid reliably and efficiently in real time.

7. Price Calculation for the Market at New Melones

The LMP for any point on the grid is the price that is consistent with the existence of a competitive market. This language is very important. The price mechanism simply cannot allocate resource in the required time frame, i.e., quickly enough, to maintain a reliable electricity system. Instead we rely on software, both analytical algorithms and their implementation in a computer code to solve a complex optimization problem, and then find a price that is consistent with that solution. In a very real sense, therefore, the implementation and operation of the software algorithm is the *de facto* market. If the software is either incorrect or operated incorrectly then the prices do not reflect valid market solutions. Put differently, if the underlying algorithm or the resulting software is either wrong or operated incorrectly then the market is "broken" and cannot be described as well functioning.

The CAISO does not have discretion over the way in which it dispatches and calculates the associated prices. The rules for the dispatch process and the related pricing algorithm are part of the FERC-accepted Tariff. Thus the description of the dispatch process operated by the CAISO and hence the market at New Melones is provided for in the FERC-accepted Tariff. From this document it is possible to determine how prices are to be set at New Melones and every other individual nodal market in the CAISO's region. The Tariff effective in May 2011 was the Fifth Replacement FERC Electric Tariff and had an effective date of April 1, 2011. According to Section 27.1.1 of this Tariff:

> 27.1.1 Locational Marginal Prices For Energy
>
> As further described in Appendix C, the LMP for Energy at any PNode is the marginal cost of serving the next increment of Demand at that PNode consistent with existing Transmission Constraints and the performance characteristics of resources, also

considering, among other things, Energy Bid Curves. The LMP at any given PNode is comprised of three cost components: the System Marginal Energy Cost (SMEC); Marginal Cost of Losses (MCL); and Marginal Cost of Congestion (MCC).[7]

Furthermore, according to Appendix C,

A. LMP Composition

In each hour of the Day-Ahead Market for Energy, the CAISO calculates the LMP for each PNode, which is equal to the marginal cost of Energy available at the PNode in the hour, based on the Bids of sellers and buyers selected in the Day-Ahead Market for Energy as specified in the Day-Ahead Schedule. The CAISO designates a Reference Bus, r, for calculation of the System Marginal Energy Cost (SMECr). The CAISO uses a distributed Reference Bus to define an aggregate value of Energy for the CAISO Balancing Authority Area. The Locational Marginal Prices are not determined by resources that are not eligible to set the Locational Marginal Price, which includes resources that have constraints that prevent them from being marginal. For each bus other than the Reference Bus, the Transmission Provider determines separate components of the LMP for the marginal cost of Energy, Marginal Cost of Congestion, and Marginal Cost of Losses relative to the Reference Bus, consistent with the following equation:

LMPi = SMECr + MCCi + MCLi

LMPr = SMECr

where:

- SMECr is the LMP component representing the marginal cost of Energy (also referred to as λ) at the Reference Bus, r (System Marginal Energy Cost).
- MCCi is the LMP component representing the Marginal Cost of Congestion (also referred to as ρ) at bus i relative to the Reference Bus.
- MCLi is the LMP component representing the Marginal Cost of Losses (also referred to as γ) at bus i relative to the Reference Bus.

From this language we know that every LMP is the sum of three components: the Marginal Cost of Energy (MEC), the Marginal Cost of Congestion (MCC) and the Marginal Cost of Losses (MCL). In order to determine the later two values there needs to be a reference point from which to measure, i.e., the cost of congestion and losses is established

[7] CAISO Fifth Replacement Tariff, § 27.1.1.

relative to a specific point on the grid.[8] There was no language in the Tariff as of May 2011 that suggests the CAISO was allowed to use other pricing mechanisms at specific nodes. That is, the price at the New Melones market was required to be calculated in the same manner as the prices calculated for every other point on the CAISO grid.

While it is true that New Melones is an intertie, the definition of which according to the Tariff was: A Scheduling Point at a point of interconnection between the CAISO Balancing Authority and an Interconnected Balancing Authority,[9] the Tariff explicitly says that prices will be calculated through the same methodology as all other nodes in the system:

> G. Intertie Scheduling Point Price Calculation
>
> The CAISO calculates LMPs for Scheduling Points, which are represented in the FNM as PNodes or aggregations of PNodes, external to the CAISO Balancing Authority Area, through the same process that is used to calculate LMPs within the CAISO Balancing Authority Area.[10]

Thus the CAISO was required to determine the price in the Day Ahead Market at New Melones using the exact same methodology used at every other point on the transmission system.

8. New Melones as a Well-Functioning Market

In its Reply to the Answer of ETRACOM, Federal Energy Regulatory Commission ("FERC") Enforcement Staff ("Staff") states that the term "well-functioning market" means that any market operating under a FERC accepted tariff is necessarily, by definition, a well-functioning market.[11] According to this logic, there is no requirement to demonstrate the market is in fact operating in a "well-functioning" manner. Moreover, under that logic there is no need for Staff to provide either the definition or the observable characteristics, of what constitutes a well-functioning market for purposes of alleging fraudulent behavior.

There are two aspects of staff's response that require further analysis. First, there is the very real possibility that a non-well-functioning market design has in fact been accepted by the Commission. In 1997 PJM, operating under a FERC-accepted tariff, implemented and operated an inefficient zonal based congestion management scheme that was incompatible with a competitive market. FERC later found a new model, based on

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[8] For a given node, if the contribution by a given constraint to its MCC is negative then I term that node to be upstream of a constraint and vice versa for a location where the contribution of a given constraint to its MCC is positive, I term that location to be downstream of the that constraint.
[9] CAISO Fifth Replacement Tariff, Appendix A.
[10] CAISO Fifth Replacement Tariff, Appendix C.
[11] Staff construes the use of "well-functioning market" to refer to any Commission jurisdictional market operating under a tariff that the Commission has found to be just and reasonable. See March 17, 2016, Reply of Staff of the Office of Enforcement at 5.

locational marginal pricing in conjunction with the use of FTRs, to be just and reasonable. FERC approved the new market design to "promote efficient trading and [to] be compatible with competitive market mechanisms."[12] As a result, PJM implemented and operated a different market design – one that was built on bid-based security constrained economic dispatch and locational marginal prices – that was accepted by FERC.[13] There are other similar examples where FERC has accepted a market design that is not well functioning. The extent to which a market is well functioning is dependent on the (1) design, (2) implementation, (3), operation, (4) market structure and (5) behavior of the market participants and FERC acceptance is a necessary but certainly not sufficient pre-requisite.

Second, there is no reason to believe that "accepted" and "operating" are equivalent. The market design described in any particular tariff is necessarily a high level abstraction of the market that is in actual operation, i.e., how the market is actually functioning. That is, the accepted tariff does not, nor ever should, include all the detail that would be necessary to describe precisely how the market is actually being operated by the RTO/ISO. The tariff may have gaps, it may rely on high-level principles to inform the choice of details, and sometimes there may be errors. Nor is it necessarily true that the language, intent and instructions in the accepted tariff have been faithfully recreated in the underlying market software or operation of an actual functioning market.[14]

Relatively recent actual history has, in fact, shown that a market operated according to a FERC-accepted tariff is not a guarantee the market will, in actual operation, be well functioning. This is because the market design may be flawed, there may be gaps in the market design that require discretionary decision making by the grid operator that may be inconsistent with a well-functioning market, the actual implementation may not be consistent with the accepted market design or the actual operation of the market may be inconsistent with the accepted market design. Nor are these simply theoretical possibilities, each has actually occurred.

In regard to whether or not the market at New Melones was well functioning two questions must be answered. First, was the design of the market at New Melones consistent with the design of a well-functioning market? Second, was the operation of the market at New Melones consistent with the implementation and operation of a well-

[12] *Pennsylvania-New Jersey-Maryland Interconnection,* Order Conditionally Accepting Open Access Transmission Tariff, 81 FERC ¶ 61,257 (1997).

[13] The initial zonal market design of the CAISO that began operation on April 1, 1998 is a second example of a market design that was not well functioning in practice. There have also been several cases where individual market design elements such as the capacity market have been flawed and have had to be re-designed and re-implemented.

[14] As an example, the original tariff for the MISO market assigned uplift to virtual while the Business Practice Manuals and the market software did not. Thus while the FERC accepted market design required virtuals to be assigned a share of uplift costs, the functioning market did not.

functioning market? And specifically, were the results of the market at New Melones consistent with a well-functioning market?

As I have already stated, the FERC-accepted Tariff the CAISO was operating under in May 2011 contained no special instructions, exceptions or limitations on how prices at New Melones were to be calculated. Based on the language contained in the relevant CAISO Tariff and Business Practice Manuals in effect in May 2011, there was no reason for any market participant to believe that the methodology used to calculate the Day Ahead hourly LMPs at New Melones would be any different than that used at every other node in the CAISO system. That is, there was no language in the Tariff or the Business Practice Manuals that said the algorithm used by the CAISO to create such prices at New Melones was different than the algorithm used to create every other Day-ahead LMP in the system. The extent that interties were treated differently by the market design had to do with rules pertaining to scheduling and the aggregation of Pnodes. Accordingly dispatch and the associated pricing of the interties in the Day Ahead Market, because they were modeled within the full network model used by CAISO, was accomplished without any special rules.

The market design described by the Tariff in May 2011 was similar in most ways to the markets then operated by other RTOs/ISOs in the US. The foundation of the market was, as I have stated, bid-based security constrained economic dispatch which resulted in the creation of a real time spot market for electricity where prices were established for every dispatch interval. The CAISO operated several associated markets designed to improve the reliability and efficiency of the electrical network. Based on the experience of electricity markets in the United States and elsewhere, the basic theoretical design of the market at New Melones as described in the Tariff was consistent with the design of other FERC-jurisdictional markets. However, a sound theoretical design does not necessarily imply the market was implemented or operated correctly.

With respect to whether the implementation and operation of the market at New Melones was consistent with a well-functioning market in May 2011, we need to refer to actual results and in particular the actual prices the CAISO created for the New Melones market. The focus on prices is justified because the prices were created, (i.e., calculated), to be consistent with the prices that would result from a competitive market.

In actual operation, at any point in time, a market is only as good as the prices that it produces and this is certainly true of the market at New Melones. Whether or not a market is well functioning can therefore be revealed, in large part, by the characteristics of the prices the market produces. In particular we are looking for prices that:

(1) Can be understood – if only in hindsight – in terms of the relevant information, i.e., prices are known in the sense that they can be determined from known information, and

(2) Are stable, in that if the exact same conditions prevail, then the prices will be the same. In this sense the prices are knowable and are consistent with basic principles of supply and demand and the published market design.

In a well-functioning market the methodology by which prices are determined leads to prices that are both known and knowable given the requisite information. It is worth noting that this criterion does not determine or relate to the numerical values of the prices. Actual prices may be volatile, unpredictable, and even statistically random but they can still be understood and the price formation mechanism can be stable using the aforementioned definitions.

I use this paradigm to evaluate whether the prices at New Melones in May 2011 were consistent with those that would have occurred in a well-functioning market. I will review five examples in May 2011 where the pricing at the New Melones node was not consistent with the language in the FERC-accepted Tariff and the outcomes of a well functioning market.

9. Examples

I was responsible for managing the Day Ahead Market and the production of both the Day Ahead and Real Time LMPs for the market administered by the MISO i.e., the same types of prices for the MISO as the ones presented in the examples that follow, and I cannot explain how the CAISO calculated the final LMPs at New Melones, the subject of these examples.[15]

Example 1: May 1, 2011 and May 3, 2011

- For the six consecutive hours ending 0700 to 1200 for May 1, 2011 the Day Ahead Hourly LMPs at New Melones were as follows:

05/01/2011 – Hour Ending	Actual Day Ahead Hourly LMPs at New Melones
HE 0700	-$11.87
HE 0800	-$4.83
HE 0900	-$3.75
HE 1000	-$5.87
HE 1100	-$5.07
HE 1200	-$1.42

[15] All LMPs and their components in May 2011, which are the subject of the examples below, went through the CAISO price correction processes for both pricing and software errors.

- As provided above, the Tariff requires that: *As further described in Appendix C, the LMP for Energy at any PNode is the marginal cost of serving the next increment of Demand at that PNode consistent with existing Transmission Constraints and the performance characteristics of resources, also considering, among other things, Energy Bid Curves.*[16]

- Thus, following the Tariff, this means that the cost of serving the next increment of demand at New Melones for, say, the HE0700 was -$11.87.

- As shown the equilibrium prices at New Melones are identical to the offer prices of the virtual supply offers that did not clear in the market for those time periods:

05/01/2011 – Hour Ending	Offer Price of Uncleared Virtual Supply	Marginal Cost of Energy for the Entire System
HE 0700	-$11.87	$10.07
HE 0800	-$4.83	$23.40
HE 0900	-$3.75	$23.49
HE 1000	-$5.87	$18.98
HE 1100	-$5.07	$24.99
HE 1200	-$1.42	$27.71

- It is worth examining precisely how the price was determined during those hours. The price, calculated by the CAISO according to the tariff, was the marginal cost of serving one additional increment of demand at New Melones.

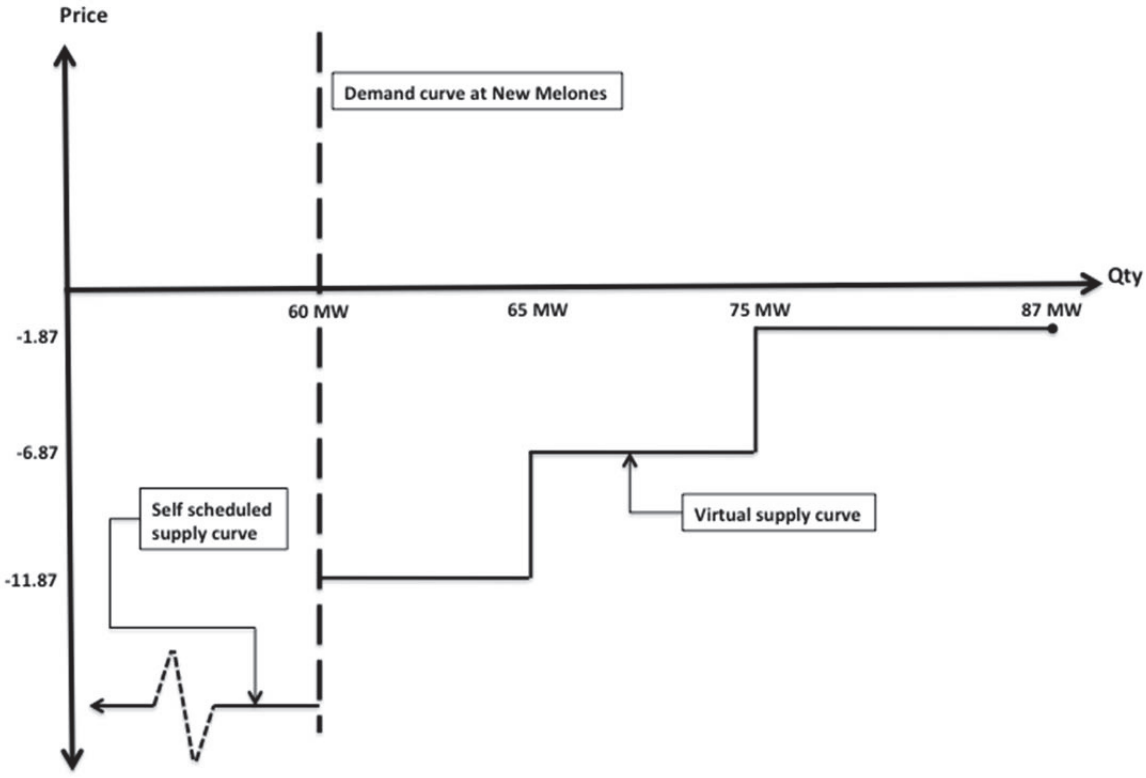
- When the CAISO solved the Day Ahead Market for those time periods there were no virtual supply megawatts transacted at those prices at New Melones. In other words, the virtual offers did not clear in the market. The complete situation for HE 0700 is graphically represented below.

- For this interval there was a self-schedule from the Western Area Power Administration ("WAPA") of 60 MW. Self-schedules are "must-take" and do not have an offer price associated with the supply. The dispatch and pricing software operated by the CAISO will treat a self-schedule as the least expensive

[16] CAISO Fifth Replacement Tariff, § 27.1.1 (emphasis added).

power. On the graph below, the self-scheduled supply comes before any other supply offer.

- For this hour there were also three tranches of virtual supply offers that comprise the virtual supply curve: 0-5 MW for -$11.87, 5–10 MW for -$6.87, and 10-17 MW for -$1.87. This is represented on the graph by the three "ladder" steps that occur after the self-scheduled supply.



- The only possible solution consistent with the price calculated by the CAISO for this interval is that the hypothetical demand curve, which was created by the dispatch software for the purpose of calculating the cost of serving the next increment of demand (i.e., the LMP) at New Melones, occurred right at the "step" between the self-scheduled supply and the first tranche of the virtual supply offer.

- We know this because there were no virtual bids/offers transacted in the market, i.e., the demand curve at New Melones did not intersect the supply curve where a virtual bid and offer was transacted, yet the price was set at -$11.87.

- Given the Tariff language and the published prices the only conclusion that aligns the Tariff and the published prices is that the CAISO determined that the least costly way to supply one more MW of power to New Melones was by using the virtual supply offer at -$11.87.

- However, when we move forward two days things become problematic. For the seven consecutive hours ending 1100 to 1700 on May 3, 2011 the Day Ahead Hourly LMPs at New Melones were as follows:

05/03/2011 – Hour Ending	Actual Day Ahead Hourly LMPs at New Melones
HE 1100	$18.00
HE 1200	$18.00
HE 1300	$18.00
HE 1400	$18.00
HE 1500	$18.00
HE 1600	$18.00
HE 1700	$18.00

- As with the example from May 1 no virtual supply or demand cleared the market.
- Thus the least cost method for supplying an increment of power at New Melones was at $18.00.
- For these intervals the offer price for the first tranche of virtual supply and the marginal cost of energy for the system were:

05/03/2011 – Hour Ending	Offer Price of Virtual Supply for the First Tranche	Marginal Cost of Energy for the Entire System
HE 1100	$21.36	$39.98
HE 1200	$26.72	$43.80
HE 1300	$28.11	$45.90
HE 1400	$35.46	$51.44
HE 1500	$38.34	$53.35
HE 1600	$45.71	$56.12
HE 1700	$43.39	$55.01

- In each interval the cost of available energy at New Melones on May 3 for HE 1100 – HE 1700, as expressed by the first tranche of the virtual supply offers, was below the system energy cost, as it was on May 1 for HE 0700 – HE 1200.

- However, unlike the interval on May 1 where the virtual supply offer at New Melones set the price, on May 3 it did not. That is, while the cost of energy being offered at New Melones was less expensive than the system marginal energy price, it was not being used to determine the LMP at New Melones.

- Thus the pricing methodology apparently was using more expensive system power (i.e., $39.98 > $21.36 in HE 1100) to fulfill the pricing requirements outlined in the tariff. For example, I would have expected the price for HE 1100 on May 3 to be $21.36.

- It is impossible for me to understand or to know how the CAISO calculated the $18.00 price that was the LMP for HE 1100 – HE 1700 on May 3, 2011. There is only one possible explanation. For this period of time the CAISO was not pricing according to the rules provided for in the FERC-accepted Tariff. There is no possible way to reconcile the inconsistent prices created by the CAISO on May 3, 2011 for HE 1100 – HE 1700 with the tariff language and the prices CAISO created on May 1, 2011 for HE 0700 – HE 1200.

- Any reasonable person must wonder (1) if the prices on May 1 were correct, (2) if the prices on May 3 were correct or (3) if the prices for the intervals on either day are correct. In other words on one, or even possibly both of these days the correct prices were in fact unknown even by the CAISO.

- The second conclusion from this example is that not only are the prices unknown but, since the CAISO did not follow the language of the Tariff during HE 1100 – HE 1700 on May 3, 2011, the prices are also unknowable. We simply do not know the process by which the CAISO determined prices for those intervals.

- While it is obvious, it is worth highlighting that the prices in this example are not the result of an open outcry market. Nor were they created manually. These prices are the direct result of an algorithm and the resulting software code embedded in the CAISO market operating systems. If human error was involved, then it likely occurred in the original coding long before these prices were created. Thus the price anomaly is unlikely to be explained by separate and independent human action during HE 1100 – HE 1700 on May 3, 2011.

- Given the actual prices published by the CAISO for the operating intervals used in this example, there is simply no way to determine which, if either, of the pricing mechanisms used by the CAISO on May 1 or May 3 is "correct" and hence there is no intellectually honest method to engage in a "but for" exercise, i.e.,

there is no way to determine what prices might have been "but for" a specific offer or set of offers; it is both unknown and unknowable.

Example 2: May 6, 2011

- The HE 1200 on May 6 provides another interesting example of the price calculation problem at New Melones. For that hour the hourly Day Ahead LMP for New Melones created by the CAISO was $0.00.[17]

05/06/2011 – Hour Ending	Actual Day Ahead Hourly LMPs	Offer Price of Virtual Supply for the First Tranche	Marginal Cost of Energy for the Entire System
HE 1200	$0.00	$35.53	$41.47

- As with the last example, the first question that must be asked is how the CAISO was able to calculate that the cost to serve the next MW of demand at New Melones was $0.00, given that (1) the cost of energy anywhere else on the grid at that time was $41.47, and (2) the cost of the next increment of supply at New Melones was $35.53.

- There is simply no way to understand why the price at New Melones for that interval was $0.00 or how it was calculated.[18]

- The impact of the arbitrary nature of the pricing mechanism used by the CAISO becomes clearer when we analyze the effect on congestion.

[17] This example is not subject to the conditions of the software error that resulted in zero ($0.00) prices being calculated by the CAISO for New Melones that was previously disclosed by Staff to ETRACOM. Staff disclosed to ETRACOM the following pricing error as described by CAISO Department of Market Monitoring (DMM): "**When the only virtual bids are virtual supply bids priced below the system marginal energy plus loss component of LMP at New Melones, the lowest priced virtual supply bid should set the LMP at New Melones.** However, DMM identified a software pricing error whereby in the above scenario, if the lowest priced virtual supply bid was positive, the LMP at New Melones was being set at $0.00 instead of at the price of the virtual supply bid. A variance has been submitted to the software vendor to fix this pricing error." (emphasis added.)

On May 6, 2011 for HE 1200 at New Melones there were no virtual demand bids and only positive supply offers with a virtual offer for 0-5 MW at $35.53 and then from 5-12MW for $40.53. The marginal cost of energy for the system for this interval was $41.47 and loss component was (-1.29) for a total the system marginal energy plus loss component of LMP at New Melones equal to 40.17 (adjusting for the rounding) which was below the highest price virtual offer of $40.53. Hence, conditions of the software error, previously disclosed by Staff, do not apply.

[18] Given this and other examples, it is possible that the software pricing error incorrectly produces a $0 LMP more often than just the circumstances disclosed by the Market Monitor.

- Physical congestion has the effect of creating electric "islands" within an integrated transmission system. When a transmission element becomes congested then no additional power can flow on that element without the risk of damaging it. Thus it is not always possible to use the lowest cost generation because the power from those plants may flow into congested transmission elements, thus overloading them. It is the job of the dispatcher to find the lowest cost mix of generation given the limits of the transmission system.

- That being said, there is no method to characterize physical electromagnetic waves carrying electric power as those that are "congestion free" and those that are there because of congestion. Therefore, disaggregating electrical flows into energy, congestion and losses is a mathematical and accounting exercise in choosing or constructing a reference bus and not a physical process.

- Differences between LMPs arise because of congestion and transmission losses. If the LMP at Point A is $25 and the LMP at another location, Point B, is $50 then we can say the effect of congestion and losses on an electric path from Point A to Point B is $25. As power flows from A to B it becomes more expensive because congestion and losses cause more expensive generation to be used. Alternatively as power moves from B to A, a so-called "counterflow," it becomes less expensive because the transmission system becomes less congested and/or losses become less.

- We are now in a position to understand an important aspect of the CAISO's arbitrary pricing mechanism. In the present example, setting the price at $0.00 rather than at $35.53 as would be the expected if virtual supply at New Melones was being used to determine the price has serious financial consequences.

- Relative to the marginal system energy cost of $41.47, an LMP of $0.00 suggests that the import congestion on the New Melones constraint is much greater than if the LMP at the New Melones nodes had been set at $35.53. In the former case the financial consequences of congestion from importing power across the New Melones intertie, as expressed by the shadow price of the constraint, are approximately $41.00 while in the latter case they are approximately $6.00.

- Importing power into New Melones suffered much more severe financial consequences than if the price had been set at $35.53. In the former case the financial consequences of congestion from importing power to New Melones are approximately $41.00 while in the latter case the effects are approximately $6.00.

- Any participant which traded at the New Melones node, such as a holder of a congestion revenue right or a virtual trader, was greatly affected by the arbitrary nature of the CAISO's price setting methodology because it misled traders about the supply and demand fundamentals at the location.

- To the extent the CAISO's pricing methodology at New Melones did not follow the Tariff language provided in Section 27.1.1 and Appendix C of the FERC-accepted Tariff, then the pricing outcome in this example was neither just nor reasonable.

- Lastly, as with the previous example, since it is impossible to determine how the CAISO determined the prices it is similarly impossible to determine what the price might have been given a different set of offers. Given the result for this single hour, how would a market participant attempt to manipulate the outcome? Clearly the price was not set by the virtual supply offer. Perhaps if the virtual supply offer had been lower it might have set price. But then again perhaps if the virtual supply offer had been higher than the marginal cost of energy for the system, it would have set the LMP at New Melones. There is simply no way to tell.

Example 3: May 7, 2011

- On May 7, 2011, for the hours ending 0400, 0800, and 2000 the Day Ahead Hourly LMPs at New Melones were as follows:

05/07/2011 – Hour Ending	Actual Day Ahead Hourly LMPs
HE 0400	$0.00
HE 0800	$0.00
HE 2000	$0.00

- As in the previous example, the submitted virtual supply did not clear at New Melones in these hours and neither did the virtual supply offers set the market clearing price.[19]

05/07/11 – Dispatch Interval	Offer Price of Virtual Supply for the First Tranche
HE 0400	$28.75

[19] As in Example 2, the "software error" discussed above is not applicable to this example.

HE 0800	$33.93
HE 2000	$59.40

- As with the examples from May 3 and May 6 the prices for these intervals are inconsistent with the methodology used on May 1 and disconnected from the virtual supply offers like they were on May 3 and May 6.
- While I cannot explain the mechanism that was used to calculate the prices, I can say that, as I explained in the previous example, the methodology, by arbitrarily setting the LMP at New Melones to $0.00 had the real world consequence of incorrectly, arbitrarily and, importantly, artificially pricing the effects of congestion on the grid.
- Using May 7, 2011 HE 0400 as an example, the marginal cost of energy for the system (MCE) was $14.11. With the financial effect of marginal losses only $0.10, when the CAISO calculated the price at New Melones to be $0.00 this necessarily meant the financial effect of congestion when importing power into New Melones was -$14.02. This is simply "phantom" congestion in the import direction resulting from the CAISO creating the uneconomic or, plainly wrong price. Given the actual virtual and physical offers at New Melones for this interval it is doubtful there should have been congestion in the Day Ahead Market on the New Melones constraint in the import direction for this interval.
- There are numerous other examples where the Day Ahead Hourly LMPs at New Melones were, for some unknown reason, arbitrarily set to $0.00 by the CAISO. In the first half of May 2011 all of these intervals exhibit the same phenomenon:
    - May 9 for HE 0800 and 2000,
    - May 10 HE 0800 and 2000,
    - May 12 HE 0800 and 2000,
    - May 13 HE 0800 and 2000,
    - May 14 HE 2000,
    - May 15 HE 2000.
- Importantly all of these instances where LMP was set to $0.00 occurred under circumstances that do not meet the criterion necessary for them to be explained by the software error described above.

- As would be expected, in each instance the incorrect pricing led to the creation of phantom congestion on the New Melones constraint in the import direction.

Example 4: May 9, 2011:

- On May 9, 2011 in HE 0300 there was a virtual supply offer of $27.87 and a virtual demand bid of -$23.13 and in HE 0400 there was a virtual supply offer at 34.64. In both hours there was a physical export schedule of 1 MW.

- On May 9 for these hours the Day Ahead Hourly LMPs at New Melones and Marginal Cost of System Energy were as follows:

05/09/2011	Actual Day Ahead Hourly LMPs	Offer Price of Virtual Supply for the First Tranche	Marginal Cost of Energy for the Entire System
HE 0300	$27.87	$27.87	$2.97
HE 0400	$1.81	$34.64	$1.82

- In HE 0300 it is obvious the CAISO set the LMP at New Melones equal to the virtual supply offer, i.e., the value of the next MW, similar to how they set the price on May 1, 2011 (see Example 1 above).

- However, for the next hour, HE 0400, the CAISO, for some reason, no longer used this methodology to determine the price, instead setting the LMP at New Melones equal to the marginal cost of energy for the entire system plus the marginal loss component.

- Thus for Monday, May 9, 2011 HE 0300 the cost of congestion at New Melones, i.e., exporting power from New Melones was nearly $25.00 while one hour later, in HE 0400, it was $0.00.

- In view of these apparent contradictions let us review the algorithm of price formation at New Melones node as provided to ETRACOM by Staff:

  - "Import and export congestion at New Melones occurs only as a result of virtual bids. If any virtual supply (imports) clears against virtual demand (exports), the marginal cleared virtual supply bid will set the day-ahead LMP. If no virtual bids clear, then the next economic MW of uncleared virtual supply or demand will set the day-ahead LMP. If the bid that set the LMP is below the system energy plus loss components of LMP, import congestion occurs because the price at New Melones is below the internal CAISO price. If the bid that set the LMP is above the sum of the system

energy and loss components of LMP, export congestion is created as a result of the price differential."[20]

- From the beginning this statement contains factual errors. For example, congestion on New Melones constraint was observed when virtual bidding was not in effect.[21]

- Furthermore, if we assume the LMP at New Melones for HE 0300 was determined in accordance with the description from Staff, then the description of the price formation algorithm contradicts the pricing outcome in HE 0400.

- The prices of non-clearing virtual supply offers in HE 0300 and HE 0400 are relatively similar and both offers are above the system marginal prices of energy for their respective hours. An identical physical export schedule is present in both hours. Yet somehow in HE 0300 the uncleared virtual supply offer was determined by the CAISO to be "the next economic MW" that sets the price, while the uncleared virtual supply offer in HE 0400 was ignored by the algorithm for price setting of LMP at New Melones.

- The only interpretation is that the price outcomes in HE 0300 and HE 0400 on May 9, 2011, if produced by the price formation algorithm provided by Staff, are contradictory.

- The same contradiction is observed, for example, for the same hours of the following day, May 10, 2011. The system marginal price of energy in HE 0300 and 0400 on this day appears to be the same, $1.06, while the virtual supply offers are close at $26.66 in HE 0300 and $27.92 in HE 0400. Both hours again have export physical schedule of 1 MW by WAPA. Yet the pricing outcomes for LMP at New Melones are again drastically different, with virtual supply offer setting the LMP and resulting in export congestion, while a similar offer in HE 0400 is ignored. As yet another example, the same contradictory pricing and congestion outcomes are observed later the same in adjacent hours HE 0700 and 0800.

- As with the other examples there is no way to understand how – or from what principles – the CAISO was creating the price at New Melones for HE 0400. In this example, there was a change in the pricing methodology in adjacent hours.

- Equally impossible to determine are the financial consequences of alleged manipulation. Suppose, instead of offering virtual supply for the HE 0300 on May 9, 2011 at $27.87, a market participant had tried to raise the LMP at New Melones by offering supply at, say, $34.64, the same price as the virtual supply

[20] July 17, 2014, Preliminary Findings letter of FERC Enforcement Staff at 9–10, fn. 21.
[21] February 16, 2016, Answer of ETRACOM LLC and Michael Rosenberg at Appendix A.

offer in HE 0400 on that day. How does anybody – including the CAISO – actually know what would have happened if this would have been the case? Would the methodology have then set the price for HE 0300 to $2.97, the system marginal price of energy plus losses in that hour as it did in for the HE 0400 or would it have set the LMP at $34.64?

9. Conclusion

A market that produces prices that are unknown and relies on a pricing mechanism that is unknowable cannot be described as well functioning. This is not a theoretical or abstract conclusion and I am not arguing about the difficulty of achieving the conditions of perfect competition in the real world. Rather, in actual practice the observable results of the market at New Melones in May 2011 clearly indicate the market was broken. There was obviously something wrong with the way in which the software was deriving the Day Ahead Hourly LMPs and in so doing the CAISO was arbitrarily creating phantom congestion in the import direction across the New Melones constraint.

In my career, I have been responsible for producing LMPs for two wholesale markets – the New Zealand Market and the MISO Market – and the prices created by the CAISO in May 2011 are problematic for several reasons. First, there does not appear to have been a consistent application of a single methodology across all time periods. In and of itself this is worrisome, but even more so when you consider that the calculation of prices is done according to an algorithm that has been replicated in the software and not manually. The correctness of either or both of these is suspect. Thus the apparent randomness of the pricing methodology was the result of some combination of an incorrect algorithm and incorrect coding, and this suggests that all prices created by the CAISO for the Day Ahead Market at New Melones are suspect.

Second, I have no reason to believe that during May 2011 and most likely for some period before and after May, the prices were actually known or understood. That is, given the pricing data, I have no reason to believe that had a given interval been re-run, say, for HE 1100 for May 3, 2001 that prices would have again been $18.00. Based on the data, I cannot conclude that the price for that interval might not have been $21.36 or something else. Third, given the apparent randomness and incorrectness of the pricing mechanism used by the CAISO at New Melones for this time period there is simply no robust and honest method to conduct any kind of counterfactual analysis. That is, any analysis that attempts to answer the question of what might the market results have been but for a given set of bids or offers is, given the problems with the pricing methodology, purely an exercise in uninformed speculation.

Pursuant to 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and accurate to the best of my knowledge, information, and belief.

May 2, 2016

Ronald R. McNamara

Attachment A

Ronald R McNamara

RESUME

FIRST PRINCIPLES ECONOMICS, LLC

WORK EXPERIENCE:

PRIVATE FOR-PROFIT SECTOR

First Principles Economics, LLC (USA)

Saracen Energy Advisors, LP (USA)

Bear Energy (USA)

American Electric Power (USA)

Enron (USA)

Duke Energy International (Australia)

Putnam, Hayes & Bartlett Asia-Pacific (New Zealand)

Electricity Market Company, Ltd. (New Zealand)

PUBLIC SECTOR

Queensland Competition Authority (Australia)

NOT-FOR-PROFIT SECTOR

Midwest Independent Transmission System Operator (USA)

ACADEMIC SECTOR

Queensland University of Technology (Australia)

University of Auckland (New Zealand)

Northeastern University (USA)

Bentley College (USA)

California State University (USA)

Colorado State University (USA)

EDUCATION:

PhD & MA, University of California, Davis

MA, University of Rhode Island

BA, University of California, Irvine

CONTACT:

First Principles Economics
4771 Sweetwater Blvd, Suite 310
Sugar Land, TX 77479

Tel: (01) 281.491.0750

Email: ron@fpeconomics.com

CAREER HIGHLIGHTS:

- Founder First Principles Economics.
- Successfully represented clients in contract disputes of over $100 million.
- Responsible for (1) separating fundamental analysis from risk management and then (2) creating, staffing and managing a fundamentals group to support power (forward and cash), financial transmission rights, natural gas, crude oil, refined products, emissions, and coal trading strategies for a $500 million Commodity Trading Advisor fund.
- Officer responsible for the design of the Midwest ISO electricity market. With 131,000 MW of generating capacity, 116,000 MW of peak load and 97,000 miles of transmission lines covering 15 Midwestern States and the Province of Manitoba, the Midwest Electricity Market, upon startup on April 1, 2005, was the largest geographical electricity market in the world.
- Developed an entirely new business unit to operate the market within the Midwest ISO. This included creating the organizational structure, staffing the unit over a period of 14 months, and then managing the department responsible for:
  - Market and transmission service settlements of approximately $US1.5-2 billion per month including the creation of over 4,200 invoices daily with an accuracy of greater than 98%,
  - Running the monthly and yearly financial transmission rights market,
  - Operating the per day, day-ahead market,
  - Market pricing, market design, analysis and regulatory policy, and strategic planning.
- Member of the 3-person team that designed and implemented market rules for the first true wholesale electricity market in the world (New Zealand) and then restructured the methodology by which electricity reliability standards are developed and implemented (New Zealand).
- Successfully predicted the results of the implementation of new market rules causing a profitable delay in investment in the electricity market (Australia).
- Completely changed corporate regulatory strategy - with a successful outcome for the company - for a $A450 million pipeline (765 km) linking the Bass Strait gas field to Sydney, Australia.
- Changed corporate commercial and regulatory strategy regarding power markets for two Fortune 100 companies (Australia and the United States).
- Led a team that completed the first analysis and subsequent investigation of monopoly activities for all thirteen ports in Queensland, Australia.
- Developed models for a wholesale water market, a global timber exchange, a national fish quota market, and a national emissions market. (New Zealand)
- Provided expert witness testimony on electricity market design/operation in US Federal and State proceedings as well as in New Zealand and Australia.

FIRST PRINCIPLES ECONOMICS, LLC **MANAGING DIRECTOR** 2009 - PRESENT

Clients have included: ACN, Active Power Investments, Alliant Energy, Asian Development Bank, Aspire Commodities, Barnes & Thornburg LLP, California ISO, DC Energy, Deutsche Bank, Dynegy, Électricité de France, First Energy, Frost Brown Todd LLC, Indianapolis Power & Light, Manitoba Hydro International, Skadden Arps Slate Meagher & Flom, Transmission Corporation of Nigeria, Volta River Authority, Vitol, Western Electricity Coordinating Council, Xcel Energy.

Projects have included: testifying before the Federal Energy Regulatory Commission on matters in PJM and the Midwest ISO, developing the energy strategy for an integrated (natural gas, wind, and biomass) generation project, integration of building intelligence into wholesale electricity markets, review of the Ghana Electricity Market Rules, development of a Power Purchase Agreement for the Volta River Authority, review of the West African Power Pool Market Rules, review and analysis of proposed Nigerian electricity market rules, development of pricing strategy for information on ship movements, evaluation of New Zealand and Australian natural gas and electricity markets for possible entry by a retail provider, intelligence on operation of MISO, CAISO, ERCOT, ISO-NE, NYISO, PJM and Ontario electricity markets, development of a cost/benefit strategy for implementation of a new wholesale market, estimating the variable operations and maintenance costs for all generators in an RTO footprint, analysis of potential market/price manipulation for ERCOT futures contracts traded on the Intercontinental Exchange, litigation support for lawsuit seeking damages against market manipulation under the Commodities Enforcement Act, counterparty support and expert witness testimony in a $100 million dispute of a 20-year power purchase agreement for wind generation in MISO that went to arbitration, arbitration support for dispute involving wind generation in SPP, estimating the implicit value of generation capacity for integrated utilities.

SARACEN ENERGY ADVISORS, LP **MANAGING DIRECTOR, FUNDAMENTALS** 2008 – 2009

Responsible for creating, staffing and managing a small team of analysts that supported trading across all energy related commodities - forward and cash power, financial transmission rights, natural gas, emissions (NO_x and SO_x), coal, and some crude oil and refined products – for a $500 million Commodity Trading Advisor fund. Separated fundamental analysis in support of trading from risk analytics. Team produced: (1) daily natural gas supply/demand and storage report; (2) daily and 7-day supply/demand and price forecasts for all RTO/ISO power markets in the Eastern Interconnect; (3) periodic reports on coal and emissions market fundamentals. Provided fundamentals support (entry, exit and duration) for trading hypotheses and on going positions. Provided macroeconomic, regulatory and legislative analysis related to trade hypotheses and existing positions. Member of the Risk Committee. Direct report to the CEO.

BEAR ENERGY **ASSOCIATE DIRECTOR** 2007

Provided strategic advice pertaining to the power assets Bear Energy acquired with the $512 million purchase of tolling capacity and full requirements power supply contracts. Assets were spread across the country and were located in organized markets (CAISO, MISO, PJM and NYISO) as well as in non-RTO regions. With over 4,500 MW of capacity in the CAISO, Bear Energy was one of the largest non-utility generators in the state and I was involved in developing a strategy for disposing of the assets. Led effort to become a partner in the Big Stone II coal project in South Dakota following the departure of some initial participants. Analyzed and submitted bids for transmission capacity in the Canadian Maritimes.

RON MCNAMARA CONSULTING **OWNER** 2006 – 2007

Provided consulting services, including expert witness testimony to the Federal Energy Regulatory Commission, on matters related to electricity market design, operation, implementation, regulation, and oversight. Clients included Indianapolis Power & Light, Constellation Energy, Cleveland Cliffs, Site Controls and the World Bank (where I advised the Energy Regulatory Commission of the Philippines on market monitoring/manipulation mechanisms).

MIDWEST ISO **VICE PRESIDENT AND CHIEF ECONOMIST** 2003 – 2006

Initially I was the Officer responsible for the conceptual design and regulatory approval of the Midwest ISO electricity market. Additionally, I was responsible for the regulatory strategy, including the initial filing and all subsequent related filings with the Federal Energy Regulatory Commission, which culminated with an approved tariff allowing market implementation and operation. This included providing direct testimony in FERC Dockets ER04-691-000 and EL04-104-000. Initially the Midwest Energy Market had several unique characteristics, including a large number of Grandfathered Agreements (contracts that pre-dated the existing Open Access Transmission Tariff that went into effect in September 1998), multiple Control Areas, and areas of high congestion combined with oversold transmission capacity, that required difficult and innovative solutions in order to gain acceptance from stakeholders and regulators. With 131,000 MW of generating capacity, 116,000 MW of peak load and 97,000 miles of transmission lines covering 15 Midwestern States and the Province of Manitoba, the Midwest Electricity Market upon startup on April 1, 2005, was the largest centrally dispatched electricity market in the world.

During the market design and implementation phase, I was also responsible for defining and then creating, staffing, training and, after market start, managing the Midwest ISO Market Management business unit. This was a 50+ person department with responsibility for all the financial market services and activities provided by the Midwest ISO, including:

- Settling the Day Ahead and Real Time Energy Markets, the Financial Transmission Rights Market and Transmission Service Market.
- Running the Day Ahead Energy Market which involved creating “as bid/offered” demand and supply curves and establishing a clearing price and quantity.
- Running the Financial Transmission Rights market in which nearly 85,000 MWs of financial transmission rights were either allocated (including those for Grandfathered Agreements) or auctioned to Market Participants.
- The creation of market prices, i.e. the calculation, validation, and posting of nearly 1,400 day ahead and real time locational marginal prices.

While I managed the unit, the headcount and total budget to provide these services was the lowest of any RTO/ISO in North America. Furthermore, the unit met or exceeded every KPI established by the Board.

As the Chief Economist I was responsible for:

- Market analysis,
- Market evolution,
- Being the liaison with the Independent Market Monitor,

- Market regulatory policy,
- Testifying at FERC as well as State regulatory and legislative hearings on market design and performance.

I reported to the CEO and was responsible for managing both the Market Committee and the Strategic Planning Committee of the Board of Directors.

AMERICAN ELECTRIC POWER **DIRECTOR, ENERGY MARKETS** 2001 – 2003

My activities ranged across almost all aspects of the business, e.g. regulatory, marketing/origination, and trading. Accomplishments included:

- Providing traders, originators, and developers with market and regulatory intelligence on issues affecting trading positions, bilateral energy sales/purchases, asset acquisitions, and asset management.
- Advising senior management and the Office of the Chair on wholesale market design and operation issues.
- Serving as AEP's representative on the ISO-NE Participants Committee, NYISO Management Committee, and PJM Members Committee.
- Serving as an elected representative from the power marketing sector on the MISO Advisory Committee and the SeTrans Stakeholder Advisory Committee.
- Drafting term sheets and contracts for the provision of management services for assets in NYISO and PJM.
- Testifying before the Texas PUC on the wholesale market requirements for implementing retail choice in non-ERCOT Texas.
- Drafting corporate positions on: standard electricity market design, financial transmission rights allocation mechanisms, the appropriate structure for establishing/changing electricity reliability standards, California market redesign, RTO West market design, and changing the wholesale market design in ERCOT.
- Working with customers to explain market design and regulatory changes relevant to both existing and new business/contracts.

ENRON **DIRECTOR** 2000 – 2001

While at Enron my primary responsibilities were focused on the commercial aspects of wholesale and retail market design and implementation in the Texas (ERCOT) and Southwest Power Pool (SPP) electricity markets. This included:

- Providing risk assessment on regulatory/market design issues for commercial contracts and trading positions.
- Serving as a voting representative of the power marketing sector on the SPP Board of Directors.
- Serving as Enron's representative on SPP working groups including the Engineering and Operations Committee, Commercial Practices Committee, Market Settlement Working Group, and Congestion Management Working Group.
- Serving as an elected representative from the competitive retail supplier sector on the ERCOT TAC.
- Serving as Enron's representative on ERCOT working groups including the Wholesale Market Subcommittee and the Protocol Review Subcommittee.

- Working closely with the East Power Desk to develop trading and origination strategies.
- Co-developing/drafting the white paper and the rules for a real time market in SPP.
- Preparing regulatory responses on wholesale and retail issues to state and federal regulatory authorities.
- Providing testimony to state regulatory authorities.
- Developing Enron's position on interconnection issues between electricity pools.

DUKE ENERGY INT'L (AUSTRALIA) **GM REGULATORY AFFAIRS** 1999 – 2000 (CONTRACT)

I joined Duke Energy International on a fixed term contract soon after they acquired natural gas assets in Australia. They were in the process of organizing their operations as well as trying to establish a commercial foothold in the energy industry and I contracted to provide leadership on several significant commercial and regulatory projects. Accomplishments included:

- Project managing Duke's response to the National Competition Council on an application for regulatory coverage of the US$300 million Eastern Gas Pipeline under the National Gas Access Code. The ultimate decision was to leave access to the pipeline unregulated and represented a complete change in Duke's initial strategy.
- Providing an assessment of commercial opportunities within the wholesale electricity market in Australia and New Zealand, including an evaluation of regulatory and market design risk for energy assets.
- Preparation of submissions on changes to the market rules to the National Electricity Code Administrator, National Electricity Market Management Company, and the National Gas Pipelines Advisory Committee.
- Preparation of submissions on regulatory and legislative issues related to gas and electricity to State and Federal government agencies or regulators.
- Providing testimony at regulatory hearings and proceedings.
- Providing assistance/advice on bilateral contracts related to the Eastern Gas Pipeline.
- Worked with staff in the Premier of Tasmania's Office, to ensure that the legislative and regulatory infrastructure was in place to support the introduction of gas to Tasmania. The US$250 million undersea pipeline (the first in Australia) was completed in 2002 and linked the island state (with no thermal resources) to the rest of Australia.
- Advised senior government officials on regulatory and/or electricity and gas market issues on behalf of Duke.

Reported to the Managing Director for Duke Energy Australia.

QLD COMPETITION AUTH. **DIRECTOR - ELECTRICITY, GAS AND PORTS** 1998 – 1999

The Queensland Competition Authority is the regulatory body for the State of Queensland, Australia. When I joined the Authority it had been operational less than 3 months and was in startup mode. My first responsibility was to staff a small team capable of meeting the legislative requirements regarding electricity (local distribution and retail), natural gas (local reticulation systems and retail) and ports. Within gas, my responsibilities/accomplishments included:

- Project managing the initial phase of the regulatory regime for third party access to gas pipeline distribution networks in Queensland as required by the *National Third Party Access Code for Natural Gas Pipeline Systems*.

- Developing the Authority's service definition policy, i.e. defining what constitutes access, for gas pipeline systems.
- Managing initial work on an asset valuation exercise (DAC, ODRC, DCF and ODV) for pipeline systems.
- Making recommendations to the Board regarding appropriate cost allocations and the cost of capital in the gas distribution network.
- Developing and implementing a ring-fencing regime for combined gas retailers and reticulators.
- Chairing an industry working group reviewing the relevant issues in the regulatory exercise.

Responsibilities/accomplishments within electricity included:

- Investigating the need for conduct rules governing behavior and information flows in the retail electricity market in Queensland.
- Initial work developing the ring-fencing regime for companies who are both electricity distributors and retailers.
- Initiating the Authority's first-ever review of Distribution Use of System Charges (i.e. access charges) for electricity distribution networks in Queensland.

With respect to Ports I was responsible for:

- Managing investigations of the activities of the Ports of Brisbane, Gladstone, Townsville, Rockhampton, Bundaberg, Lucinda, Karumba, Hay Point, Abbot Point, Weipa, Thursday Island, Cape Flattery, and Mourilyan with respect to the Government's criteria for monopoly service provision. The analysis, rather than treating the Port as an integrated provider, identified and separated all services each Port was responsible for and then identified whether or not it had undue market power and, if so, what the source of the monopoly power was (e.g. government legislation, natural amenity, etc.). This was the only investigation by the Authority that was initiated and completed during my tenure at the QCA.
- Conducting an investigation of the extent to which these Ports exploited monopoly positions.

I was an Officer of the Company and reported to the Chief Executive Officer and the Board.

ELECTRICITY MKT COMPANY (NZ) **MANAGER RESEARCH & DEVELOPMENT** 1997 – 1998

The electricity reform process in New Zealand stands in contrast to that of the United States. In particular, at the time of most of the reforms there was no industry specific legislation (e.g. the Federal Power Act) nor was there an industry specific regulator (e.g. FERC), rather the industry was managed by State Ownership and the Commerce Act (e.g. antitrust legislation). Additionally, New Zealand de-regulated the retail market prior to the wholesale market. EMCO was a vehicle created by the industry to develop and administer metering and reconciliation standards (to allow retail switching) and a wholesale electricity market. The EMCO designed wholesale market was the first nodal based centrally dispatched market in the world. Following completion of the market design, EMCO was responsible for developing and implementing the market information/trading software and communication protocols. The company was awarded the initial contracts for market administration, the clearing and settlement operation, the pricing function, and the information software. Following completion of the design and implementation phase, EMCO used its position as the administrator of the metering and reconciliation rules to initiate further reform in the retail sector including the introduction of profiling. It was also instrumental in helping Transpower New Zealand (the high voltage wires company) to implement a change in its

Statement of Corporate Intent by developing a governance structure that allows Grid Users to determine the grid security policy (i.e. reliability standards). At EMCO I:

- Coordinated all aspects of the rule making process for the wholesale electricity market.
- Wrote or managed the production of technical reports on issues related to grid security and dispatch as well as matters relating to pricing, bid and offer strategy by market participants, governance matters, clearing and settlement, reconciliation, demand-side management, and the allocation of pool fees.
- Reformed the decision making structure for the retail electricity market including the rules concerning governance as well as those for metering and reconciliation.
- Provided the economic analysis for a standard use of system agreement for distribution companies.
- Provided technical assistance in further enhancing the market information software.
- Was a member of the Reactive Support Working Group tasked with making recommendations to the Transpower Board regarding the quantity, pricing mechanism and procurement of reactive support to the Auckland region.
- Was a member of the Instantaneous Reserves Working Group instituted to make recommendations about an efficient cost allocation and procurement methodology for instantaneous reserves.
- Provided economic advice on various issues related to the setting of grid security standards during the industry review process initiated by the Transpower New Zealand Ltd. Board.
- Prepared an analysis of the effect of the instantaneous reserve market on the price of energy in the wholesale electricity market.
- Testified in front of various Government agencies and commissions.
- Prepared and delivered a report on the relationship between ancillary services and the energy market to the Market Surveillance Committee (the Market Monitor).
- Reviewed generator bidding behavior as well as the dispatch instructions of the grid operator where there was payment made for being constrained on.
- Advised the CEO and Board of Directors on strategic issues, including the preparation of annual Strategic Reviews.
- Developed the model for a worldwide Timber (Lumber) Exchange, i.e. a global exchange for wood products.
- Developed models for a local wholesale water market (Auckland).
- Developed a model for a fish quota exchange.
- Advised the New Zealand government on how market mechanisms could be implemented to facilitate the Kyoto Accord.
- Performed special projects for the Chairman of the Board.
- Met regularly with senior officials in the Prime Minister's Office, the New Zealand Treasury, the Ministry of Commerce, the Ministry for the Environment, and the Ministry of Consumer Affairs.

I was an Officer of the Company and reported to the Chief Executive Officer and the Board.

PHB ASIA-PACIFIC **SENIOR ADVISOR** 1995 – 1997

While EMCO was my primary client, I provided economic consulting services to several other companies, including:

- TransAlta,
- BHP (Australia),
- Electricity Corporation of New Zealand (ECNZ), and
- Transpower New Zealand Ltd.

Among the projects I completed were:

- The development of a wholesale electricity price path for the Australian National Electricity Market over the short to medium term. The results showed a declining price and led TransAlta to profitably delay/forgo investment in Australia.
- The provision of economic/commercial advice on the dispatch rules and price setting algorithm for the wholesale electricity market in New Zealand.
- A report that reviewed and commented on decisions made by the Australian Competition and Consumer Commission (ACCC) on the joint marketing of gas.
- The development of economic logic for the assignment of ancillary service costs in the New Zealand electricity market.
- Providing assistance in the development of a charging regime for ancillary services provided by Transpower New Zealand.

(Unable to relocate from Auckland to Wellington after I had been working at EMCO, I joined PHB Asia-Pacific and contracted back to EMCO for a majority of my time.)

ELECTRICITY MARKET COMPANY (NZ) **SENIOR ANALYST** 1995

Commonly misunderstood by industry observers in other countries, EMCO was a company whose product, as articulated in the Shareholders Agreement, was the creation of markets - not just electricity markets. We used other exchanges (i.e. NYSE, CBOT, NYMEX, etc.) as our model and adopted a "build, own, operate and transfer" strategy. Within electricity, our objective was to create the market, extract the inefficiencies inherent in the old system and then transfer the function to an operator. I was the 6th person to join the company. Given its small size EMCO required people to be multi-faceted and each of us was involved in many diverse projects.

- The first revenue generating function for EMCO was to produce the weekly wholesale electricity prices. Under the previous regime the monopoly State-owned electricity provider (Electricity Corporation of New Zealand) not only provided financial hedges but also produced the wholesale prices against which those hedges settled - an obvious conflict of interest. EMCO, under contract to the market participants, successfully took over this function with a resulting increase in liquidity in the market. I was the person responsible for ensuring the delivery of wholesale electricity prices for every half hour of the day (prior to the start of a real time market, prices were established before the fact on a weekly basis).
- EMCO established the governance structure for the New Zealand Electricity Market.

- EMCO wrote the rules for the New Zealand Electricity Market - including those pertaining to dispatch, bidding/offering, pricing, and clearing and settlement. I was involved in all aspects of this exercise.
- EMCO developed the first web-based electricity trading portal in the world.
- EMCO worked with Telecom NZ to develop an operational framework for creating a wholesale market for telecommunication bandwidth.
- EMCO advised the governments of Malaysia, China, Singapore, Indonesia, and South Africa on implementing market mechanisms in energy.

Reported to the Chief Executive Officer.

ACADEMIC POSITIONS:

ADJUNCT LECTURER, BUSINESS SCHOOL, QUEENSLAND UNIVERSITY OF TECHNOLOGY (1999 ACADEMIC YEAR), BRISBANE, QUEENSLAND, AUSTRALIA.

Taught the Economics of Strategy (2 Semesters) in the Graduate Business School (MBA Programme).

ADJUNCT LECTURER, DEPARTMENT OF ECONOMICS, UNIVERSITY OF AUCKLAND (1995, 1996 & 1997 ACADEMIC YEARS), AUCKLAND, NEW ZEALAND.

Taught two papers in the Graduate Division: Monetary Economics, Special Topics in Microeconomics – Regulation and Strategy

LECTURER, DEPARTMENT OF ECONOMICS, UNIVERSITY OF AUCKLAND (1993 & 1994 ACADEMIC YEARS).

Papers taught: Stages I, III, and IV (Graduate) Macroeconomics, Stage IV Environmental Economics, Stage IV Monetary Economics, Stage III Industrial Organization, and Stage II Environmental Science. Other activities: Ph.D. dissertation and research essay supervisor, course coordinator Stage I Macroeconomics (with over 1,400 students this was one of the largest single classes in the world) and Stage IV Monetary Economics. Supervised graduate research on electricity pricing, asset valuation and investment decisions, economic aspects of embedded generation, macroeconomic implications of LBO's, rules vs. discretion in monetary policy.

VISITING ASSISTANT PROFESSOR, DEPARTMENT OF ECONOMICS, UNIVERSITY OF CALIFORNIA, DAVIS, DAVIS, CALIFORNIA (FALL QUARTER 1994).

Taught Intermediate Microeconomics and Macroeconomics.

ASSISTANT PROFESSOR, DEPARTMENT OF ECONOMICS, BENTLEY COLLEGE (1991/92 & 1992/93 ACADEMIC YEARS), WALTHAM, MASSACHUSETTS.

Taught Introductory and Intermediate Microeconomics and Macroeconomics, upper division Monetary Economics, and Mathematical Economics.

ADJUNCT LECTURER, DEPARTMENT OF ECONOMICS, NORTHEASTERN UNIVERSITY (1991/92 & 1992/93 ACADEMIC YEARS), BOSTON, MASSACHUSETTS.

Taught year-long course in Graduate Monetary Economics.

ADJUNCT LECTURER, DEPARTMENT OF ECONOMICS, CALIFORNIA STATE UNIVERSITY, SACRAMENTO (1988/89 - 1990/91 ACADEMIC YEARS), SACRAMENTO, CALIFORNIA

Taught classes while pursuing my PhD at the University of California, Davis. Courses taught included Introductory and Intermediate Microeconomics and Macroeconomics, Monetary Economics, Industrial Organization.

TEACHING ASSISTANT/INSTRUCTOR, DEPARTMENT OF ECONOMICS, COLORADO STATE UNIVERSITY (1984/85 ACADEMIC YEAR), FORT COLLINS, COLORADO.

Taught Introductory Microeconomics and Macroeconomics.

PUBLICATIONS:

McNamara, Ron. (September 2010). *Power To The People Integrating Demand Response Into Electricity Markets*. EnergyRisk (pp. 38-41). London: Incisive Financial Publishing Ltd.

Drom, Richard A., Kessler, Michael L., and McNamara, Ronald R. (June 2005). *Midwest ISO Energy Markets by Design*. The Electricity Journal (pp. 31-39). New York: Elsevier Inc.

McNamara, Ronald R. (May 1994). *Inferring Long-Run Relationships in Macroeconomic Data*. Dept. of Economics Working Paper Series, No. 132. Auckland, The University of Auckland.

EDUCATION:

- PhD, Economics, University of California, Davis (1993)
  - Research/Teaching Assistant Scholarships
  - Teaching Assistant of the Year
  - Concentrations: Industrial Organization, Game Theory, Money & Banking, Econometrics
  - Dissertation: *Inferring Long-Run Relationships in Macroeconomic Data* (JEL Classifications: C1 (Econometric and Statistical Methods and Methodology), C22 (Time Series Models), C5 (Econometric Modeling), E6 (Macroeconomic Policy))
- MA, Economics, University of California, Davis (1990)
- MA, Economics, University of Rhode Island (1983)
  - Research/Teaching Assistant Scholarships, Elected to Phi Kappa Phi Honor Society
- BA in Economics and BA in Social Ecology, University of California, Irvine (1979)
  - Deans Honor List (1977 - 1979), Athletic Scholarship (Tennis), NCAA Champion, NCAA All American

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PERSONAL INFORMATION:

- US citizen
- New Zealand citizen (the Trans-Tasman Travel Arrangement between New Zealand and Australia allows New Zealand citizens to live and work in Australia without restrictions.)
- Office: 01.281.471.0750
- Cell: 01.281.222.4574
- Skype: rr_mcnamara
- Email: ron@fpeconomics.com