

**ONTARIO ENERGY BOARD**

**IN THE MATTER OF** the *Ontario Energy Board Act, 1998*,  
S.O. 1998, c.15, Schedule B;

**AND IN THE MATTER OF** an application by Toronto Hydro-  
Electric System Limited for an order approving just and reasonable  
rates and other charges for electricity distribution to be effective  
May 1, 2010

**Pre-filed Evidence of the  
Smart Sub-Metering Working Group**

**SUMMARY**

1. The Toronto Hydro-Electric System Limited ('THESL') has made application before the Ontario Energy Board ('OEB') in respect of its 2010 Electricity Distribution Rate Application ('Application'). In that Application, THESL has provided information regarding its historic and projected costs with regard to its offering so-called 'suite metering' as a service for condominiums. THESL has also provided information through its answers to a series of interrogatories to the Smart Sub-metering Working Group ('SSMWG') and other intervenors. Based on the information in that Application and THESL's answers interrogatories, it appears that THESL's provision of smart suite metering service is being cross-subsidized by rate payers that do not receive such service. As such, THESL's rate design is not in keeping with generally accepted regulatory principles. I provide evidence of the degree to which the revenues from the provision of this service fail to fully cover the costs of such services resulting in a

cross-subsidization from THESL's regulated business to a competitively offered service in a series of tables at the end of this statement.

2. Some cross-subsidization within a rate class is inevitable. However, cross-subsidizing services that can be provided by competitive service providers can harm the competitive market. While I have not quantified the degree to which such cross-subsidization is likely to preempt other parties from offering the metering service or estimate the magnitude of the long-term harm to the market, it is a general principle of utility regulation that utilities are prohibited from using cross-subsidization as a means to enhance their position in a competitive market. If THESL wishes to offer suite meter service, I would recommend that it consider following the example of U.S. utilities that have chosen to participate in competitive markets and set up an affiliate that operates at arm's length from THESL.
3. My statement is organized as follows. I discuss some of the general principles that guide cost allocation and rate design. I then discuss the issue of utilities participating in competitive markets and some of the principles that guide their participation. I then provide an analysis of the data in the Application and the interrogatories that provide evidence of cross-subsidization.

#### **COST ALLOCATION AND RATE DESIGN**

4. The principles of rate design have largely been codified by James C. Bonbright in his classic Principles of Public Utility Rates<sup>1</sup>. One of the most fundamental

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<sup>1</sup> Bonbright, James C. *Principles of Public Utility Rates* (New York: Columbia University Press, 1961)

principles of assessing the reasonableness of utility rates is the standard of cost of service. As Bonbright notes, "one standard of reasonable rates can fairly be said to outrank all others in the importance attached to it by experts and by public opinion alike – the standard of cost of service". As he further notes, "A cost standard of rate making has been most generally accepted in the regulation of the levels of rates charged by private utility companies. But even more significant is the widespread adherence to cost, or to some approximation of cost, as a basis of rate making under public ownership. Thus, the great Hydro-Electric Power Commission of Ontario purports to apply the principle of 'service at cost' in its charges for wholesale power supplied to the various municipal distribution systems of the province."<sup>2</sup>

5. By using 'cost of service' as the basis for rates is meant that the rates that utilities charge for the services they provide should hew as closely as possible to the costs incurred for providing the services. This is also known as the standard of cost causation. For example, when fuel is classified as an energy-related cost, that cost is the cost incurred by the utility to provide for the energy consumed by its customers. The cost causation principle is also applied to the methods for allocating costs among customers. For example, the allocation of fuel costs among users on the basis of each user's relative share of total kilowatt-hours is done so because fuel is a variable cost primarily caused by the total kilowatt-hours produced and consumed. Thus the user that uses more would pay a larger portion of the total energy cost than the user that uses less.

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<sup>2</sup> Op. cit., pp. 67-68.

6. According to Bonbright, there are at least three economic rationales for this standard. The first is the consumer rationing function. Under the principle of consumer sovereignty, consumers should be free to consume whatever they wish of a particular good, so long as they compensate the producers of the service for the costs of producing the services. When the rates of a service are set at less than the cost of providing that service, either some form of rationing may be required or the service will be supplied in wasteful amounts. Secondly, setting rates at costs (including the return on and of capital) also provides the incentives to the company to supply the services at the amount demanded. If rates are set too high, the company has the incentive to provide more of the service than is efficient. Thirdly, there is the income distribution function of rates. A purchaser of a utility service gives up the opportunity to purchase other goods with equivalent costs. These three rationales are known under the rubrics of consumption efficiency, production efficiency, and distributive efficiency.<sup>3</sup>
7. A fourth rationale that comes into play in the particular situation of the smart suite meters is the impact on the competitive provision of such services by other suppliers. Although discounting the price of services in competitive market is a reasonable strategy, such discounting would drive down the market price for providing that service. In a market where all competitors are non-regulated, driving down the market price of a particular service would reduce the profitability, at least temporarily. Thus, a competitive entity undertakes such a strategy with great caution. However, a regulated utility may use the mechanism of cross-subsidization from its regulated services to the

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<sup>3</sup> Op. cit., pp. 69-71.

competitively supplied market service and maintain its level of profitability despite reducing the price of the competitively supplied service.

8. Such behavior by a utility is troublesome because the utility can damage the competitive market. In such situation, non-regulated competitors may exit the market, reducing, and possibly eliminating competition and the potential positive attributes associated with competitive markets, such as efficiency in production, innovation in service or product design. Even if the utility may not mean to harm the market, by providing what it sees as a value-added service at a discounted price, it could block competition and place substantial stress on the market.
9. The issue of cross-subsidization is significant enough that the National Association of Regulatory Utility Commissioners ('NARUC') issued a 'Resolution Regarding Cost Allocation Guidelines for the Energy Industry' in July of 1999<sup>4</sup>. The specific focus of that resolution is to reduce the potential of regulated utilities to carry on undue burden by the utility's attempt to compete in non-regulated markets. Indeed, the resolution's appendix on cost allocation principles begins with "To the maximum extent practicable, in consideration of administrative costs, costs should be collected and classified on a direct basis for each asset, service or product provided."<sup>5</sup> It continues with "The general method for charging indirect costs should be on a fully allocated cost basis." To the extent that THESL fails to fully recover its costs associated with converting

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<sup>4</sup> See <http://www.sec.gov/rules/proposed/s70501/ramsay1.htm>

<sup>5</sup> Ibid., Appendix A

condominiums from bulk meters to suite meters in the direct charges for those conversions, it would place a significant burden on its other customers, either in terms of additional allocated costs or reduced services.

10. From the information gathered through THESL's answers to interrogatories, it appears that THESL does not collect payments from the condominium customers that it converts or from new condominium developers. In its promotional material that THESL provided to SSMWG's Interrogatory #6, THESL indicated that "We supply and install our Smart Meter system at no cost to the condominium or suite owners." Further, in the same materials, THESL suggests that it would provide superior service at lower costs because it is regulated. This rationale suggests that THESL is subsidizing the suite meter costs through the charges that it collects from its other customers. If this is indeed the case, THESL's action is a violation of any reasonable cost of service standard with regard to the behavior of a regulated monopoly participating in a competitive market. For regulated monopolies such as utilities, it is required that the regulated entity should either offer its services on an equal footing as other non-regulated and competitive entities in the market or its services should be regulated. THESL should not participate in a competitive market while relying on regulated cost recovery simultaneously.

11. The most common solution to the difficulty that arises from a utility entering a competitive market is to create an unregulated affiliate entity which operates at arm's length from the utility. That entity would have separate accounting systems, management structure, information and financial management systems,

but could be owned by the utility. The unregulated entity would be free to offer services in the competitive market, but regulated by competition authorities, not the Ontario Energy Board ("OEB"). The OEB would become involved only in circumstances in which a code of conduct had been violated by THESL with regard to its interactions with its non-regulated affiliate.

#### **ESTIMATED REVENUE SUFFICIENCY/(DEFICIENCY)**

12. Based on the information provided by THESL in its rate filing and its responses to various interrogatories, I prepared an analysis to compare the increase in capital costs and costs associated with operation, maintenance and administration ("OM&A") of suite meters to the increase in revenues associated with the installed suite meters (after netting the reduction in commercial revenues from bulk-metered customers).
13. To perform the revenue sufficiency analysis, I rely primarily on public data from THESL's 2010 Electricity Distribution Rate Application which it filed before the Ontario Energy Board on August 29, 2009. I also rely on information contained in THESL's responses to interrogatories in this proceeding.
14. I performed two groups of analyses. The first analysis examines only the incremental revenue sufficiency/(deficiency) arising from THESL's projected additions to its suite metering program for 2010 alone. The second analysis examines the cumulative revenue sufficiency/(deficiency) from the suite meter program for the period 2007 through the projected rate year.

15. My incremental analysis for 2010 contains two main scenarios, each with high and low meter cost assumptions. For ease of reference, I have named these cases High Cost 1 and 2, and Low Cost 1 and 2. The cases labeled as '1' calculate revenue sufficiency/(deficiency) for new residential building suite meters only; the cases labeled '2' calculate revenue sufficiency/(deficiency) for bulk-converted residential suite meters.
16. The high end of my cost assumption for each suite-meter is \$747. It is derived by dividing the total 2007-2010 external capital costs related to suite metering (\$6.4 million) by the total 2007-2010 installed suite meters (8,564). The data for this computation were provided by THESL's responses to SSMWG's Interrogatories #1 and #3. On the lower cost end, I have assumed a \$444 cost per suite-meter. This cost is derived by dividing the THESL's total 2010 capital cost related to suite metering (\$2.4 million) by the number of 2010 forecasted installed suite meters (5,600).<sup>6</sup>
17. The results show that THESL's incremental revenue deficiency for 2010 is in the range between \$96,000 to about \$308,000.[C] I have assumed that 1419 bulk meters converted to suite meters in the analysis below<sup>7</sup>. Table 1 below presents my results

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<sup>6</sup> The source of these numbers is THESL's Exhibit D1, Tab 8, Schedule 7, Page 3.

<sup>7</sup> This number is calculated as the delta of cumulative bulk meter conversions from 2009 to 2010, which is presented in response to SSMWG Interrogatory Response 1A



**Table 1**  
**2010 Revenue Deficiencies By Case**

<b>Residential Revenue Derived From</b>		<b>Suite Meter Unit Cost</b>	
		<b>High</b>	<b>Low</b>
		<b>[A]</b>	<b>[B]</b>
[1]	New	(190,287)	(95,608)
[2]	Bulk	(307,630)	(246,030)

18. I have also performed a similar analysis for the cumulative revenue deficiency for beginning in 2007 through the projected 2010. My cumulative analysis contains two main scenarios, each with high and low meter cost assumptions. For ease of reference, I have named these cases High Cost 3 and 4, and Low Cost 3 and 4. The cases labeled as '3' calculate revenue sufficiency/(deficiency) for new residential building suite meters only; the cases labeled '4' calculate revenue sufficiency/(deficiency) for bulk-converted residential suite meters.
19. I follow similar assumptions as above, with the high end of the cost assumption for meters at \$747 per meter and the low end at \$444 per meter, based on the same rationale as above.
20. The results show that THESL's cumulative revenue deficiency for 2007 and projected through 2010 is in the range between \$215,000 to about \$635,000.[C]  
Table 2 below presents my results

**Table 2**  
**Cumulative 2007-2010 Revenue Deficiencies By Case**

Cumulative 2007-2010 Revenue Deficiencies By Case			
Residential Revenue Derived From		Suite Meter Unit Cost	
		High	Low
		[A]	[B]
[3]	New	(435,707)	(214,544)
[4]	Bulk	(634,802)	(511,404)

21. Whether viewed from an incremental standpoint for 2010 or viewed cumulatively, it appears that THESL is not recovering sufficient revenues from its suite metered customers to offset the increased capital and OM&A expenditures associated with the installation and operation of the suite meters. Thus, it appears that THESL is cross-subsidizing its suite meter program through revenues from other customers.

## Worksheet-Assumptions

		Source
Working Capital Allowance	14.1%	Exhibit J1, Tab 2, Schedule 7, Page 1
Debt	60%	Exhibit J1, Tab 2, Schedule 2, Page 1
Return on Debt	5.32%	Exhibit J1, Tab 2, Schedule 2, Page 1
Equity	40%	Exhibit J1, Tab 2, Schedule 2, Page 1
Return on Equity	8.01%	Exhibit J1, Tab 2, Schedule 2, Page 1
Cost of Capital	6.39%	Exhibit J1, Tab 2, Schedule 2, Page 1
Number of Revenue Generating Suite Meters in 2010	3600	Response to SSMWG #2
Number of Installed Suite Meters in 2010	5400	Exhibit D1, Tab 8, Schedule 7, Page 3
Total Cost of 5,400 Suite Meters	\$2,400,000	Exhibit D1, Tab 8, Schedule 7, Page 3
Total 2007-2010 External Capital Costs Related to Suite Metering	\$6,400,000	Response to SSMWG #3
Total 2007-2010 Installed Suite Meters	8,564	Response to SSMWG #1
Number of Smart Meter Converted from Bulk Meters in 2010	1419	Response to SSMWG #1
Number of Smart Meter Converted from Bulk Meters in 2007-2010	3010	Response to SSMWG #1
Unit Costs		
HIGH	\$747	\$6,400,000 / 8,564
LOW	\$444	\$2,400,000 / 5,400
HIGH Depreciated New	\$686	Exhibit 1: Workpaper-New Meters
LOW Depreciated New	\$408	Exhibit 1: Workpaper-New Meters
HIGH Depreciated Bulk	\$706	Exhibit 2: Workpaper-Bulk Converted Meters
LOW Depreciated Bulk	\$420	Exhibit 2: Workpaper-Bulk Converted Meters
OM&A cost "related" to suite-metering in 2010	\$300,000	Response to SSMWG #5
OM&A cost "related" to suite-metering in 2007-2010	\$713,667	\$300,000 x (8,564 cumulative meters / 3,600 revenue generating meters installed in 2010)
Average O&M Cost for Rate Class 1 (Residential) for 2010 Test Year	\$190	Exhibit D1, Tab 8, Schedule 3-2, Page 3
Administration Cost in 2009	10.57%	Exhibit D1, Tab 8, Schedule 3-2, Page 2
OM&A per residential customer	\$210.41	
Amortization	6.70%	Response to SSMWG #5
2010 Payment in Lieu of Taxes	23,400,000	Exhibit H1, Tab 1, Schedule 1, Page 6
Utility Income Before Taxes	84,000,000	Exhibit J1, Tab 2, Schedule 5, Page 1
PILs	27.86%	PIL/ Utility Income Before Taxes
Residential Monthly Customer Charge	18.82	Exhibit M1, Tab 2, Schedule 2, Page 2 (service charge + smart meter rate rider)
Residential Monthly Variable Distribution (\$ / kWh)	0.01684	Exhibit M1, Tab 2, Schedule 2, Page 2
Average Residential kWh per Month	450	Exhibit R1, Tab 3, Schedule 5, Page 1
General Service Less Than 50 kW Monthly Variable Distribution (\$ / kWh)	0.02399	Exhibit M1, Tab 2, Schedule 2, Page 2
Peak Demand (kW) per Residential Customer Served Under GS	2	Assumption
Number of Months	12	

**Attachment: Case 1A**  
**Cost and Revenue Associated with Toronto Hydro's 2010 Proposed Suite Metering**  
**Case 1A: New Meters, High Unit Cost**

Line	Item	Amount	Calculation
[1]	Number of Installed Revenue Generating Suite Meters	2,181	
[2]	Unit Cost	747	
[3]	Total Capital Cost	\$1,629,893	[1] x [2]
[4]	Working Capital Allowance		
[5]	Operation Expense	\$640,664	[15]
[6]	Working Capital Allowance 14.1%	\$90,334	[5] x 14.1%
[7]	Suite Metering Rate Base	\$1,720,226	[3] + [6]
[8]	Return on Rate Base		
[9]	Debt 60% @ 5.32%	\$54,910	[7] x 0.6 x 5.32%
[10]	Equity 40% @ 8.01%	\$55,116	[7] x 0.4 x 8.01%
[11]	Return on Rate Base	\$110,026	[9] + [10]
[12]	Operation Expense		
[13]	Incremental Operating Expenses	\$181,750	\$300,000 x (2181 / 3600)
[14]	OM&A \$210 / customer	\$458,914	\$210 x 2181
[15]	OM&A	\$640,664	[13] + [14]
[16]	Amortization	\$109,203	[3] x 6.7%
[17]	Total Operating Expenses	\$749,867	[15] + [16]
[18]	Revenue Requirement Before PILs	\$859,893	[11] + [17]
[19]	Payment in Lieu of Taxes @ 27.86 %	\$21,282	[(10) / (1-PILS)] - [10]
[20]	Suite Meter Revenue Requirement	\$881,175	[18] + [19]
[21]	Residential Revenues (Proposed 2010 Rates)		
[22]	Number of Installed Smart Meters	2,181	
[23]	Yearly Customer Charge @ \$18.82 / mo.	\$492,557	[22] x \$18.82 x 12
[24]	Variable Distribution @ 1.684 cents/kWh	\$198,331	[22] x 450 kWh x 1.684 cents/kWh x 12
[25]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[26]	Variable Distribution @ \$0.02399/kWh	0	0.02399 \$/KWh x 450 KWh x 12 x 0
[27]	Total Revenue	\$690,888	[23] + [24] + [26]
[28]	Annual Suite Meter Program Sufficiency/(Deficiency)	(190,287)	[27] - [20]

**Attachment: Case 1B**  
**Cost and Revenue Associated with Toronto Hydro's 2010 Proposed Suite Metering**  
**Case 1B: New Meters, Low Unit Cost**

Line	Item	Amount	Calculation
[1]	Number of Installed Revenue Generating Suite Meters	2,181	
[2]	Unit Cost	444	
[3]	Total Capital Cost	\$969,333	[1] x [2]
[4]	Working Capital Allowance		
[5]	Operation Expense	\$640,664	[15]
[6]	Working Capital Allowance 14.1%	\$90,334	[5] x 14.1%
[7]	Suite Metering Rate Base	\$1,059,667	[3] + [6]
[8]	Return on Rate Base		
[9]	Debt 60% @ 5.32%	\$33,825	[7] x 0.6 x 5.32%
[10]	Equity 40% @ 8.01%	\$33,952	[7] x 0.4 x 8.01%
[11]	Return on Rate Base	\$67,776	[9] + [10]
[12]	Operation Expense		
[13]	Incremental Operating Expenses	\$181,750	\$300,000 x (2181 / 3600)
[14]	OM&A \$210 / customer	\$458,914	\$210 x 2181
[15]	OM&A	\$640,664	[13] + [14]
[16]	Amortization	\$64,945	[3] x 6.7%
[17]	Total Operating Expenses	\$705,610	[15] + [16]
[18]	Revenue Requirement Before PLs	\$773,386	[11] + [17]
[19]	Payment in Lieu of Taxes @ 27.86 %	\$13,110	[(110) / (1-PLs)] - [10]
[20]	Suite Meter Revenue Requirement	\$786,496	[18] + [19]
[21]	Residential Revenues (Proposed 2010 Rates)		
[22]	Number of Installed Smart Meters	2,181	
[23]	Yearly Customer Charge @ \$18.82 / mo.	\$492,557	[22] x \$18.82 x 12
[24]	Variable Distribution @ 1.684 cents/KWh	\$198,331	[22] x 450 kWh x 1.684 cents/KWh x 12
[25]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[26]	Variable Distribution @ \$0.02399/KWh	0	0.02399 \$/KWh x 450 KWh x 12 x 0
[27]	Total Revenue	\$690,888	[23] + [24] + [26]
[28]	Annual Suite Meter Program Sufficiency/(Deficiency)	(95,608)	[27] - [20]

**Attachment: Case 2A**  
**Cost and Revenue Associated with Toronto Hydro's 2010 Proposed Suite Metering**  
**Case 2A: Converted, High Unit Cost**

Line	Item	Amount	Calculation
[1]	Number of Installed Revenue Generating Suite Meters	1,419	
[2]	Unit Cost	747	
[3]	Total Capital Cost	\$1,060,439	[1] x [2]
[4]	Working Capital Allowance		
[5]	Operation Expense	\$416,828	[15]
[6]	Working Capital Allowance 14.1%	\$58,773	[5] x 14.1%
[7]	Suite Metering Rate Base	\$1,119,212	[3] + [6]
[8]	Return on Rate Base		
[9]	Debt 60% @ 5.32%	\$35,725	[7] x 0.6 x 5.32%
[10]	Equity 40% @ 8.01%	\$35,860	[7] x 0.4 x 8.01%
[11]	Return on Rate Base	\$71,585	[9] + [10]
[12]	Operation Expense		
[13]	Incremental Operating Expenses	\$118,250	\$300,000 x (1419 / 3600)
[14]	OM&A \$210 / customer	\$298,578	\$210 x 1419
[15]	OM&A	\$416,828	[13] + [14]
[16]	Amortization	\$71,049	[3] x 6.7%
[17]	Total Operating Expenses	\$487,878	[15] + [16]
[18]	Revenue Requirement Before PILs	\$559,463	[11] + [17]
[19]	Payment in Lieu of Taxes @ 27.86 %	\$13,847	[(10) / (1-PILs)] - [10]
[20]	Suite Meter Revenue Requirement	\$573,309	[18] + [19]
[21]	Residential Revenues (Proposed 2010 Rates)		
[22]	Number of Installed Smart Meters	1,419	
[23]	Yearly Customer Charge @ \$18.82 / mo.	\$320,467	[22] x \$18.82 x 12
[24]	Variable Distribution @ 1.684 cents/kWh	\$129,038	[22] x 450 kWh x 1.684 cents/kWh x 12
[25]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[26]	Variable Distribution @ \$0.02399/kWh	(183,826)	0.02399 \$/kWh x 450 kWh x 12 x 1419
[27]	Total Revenue	\$265,679	[23] + [24] + [26]
[28]	Annual Suite Meter Program Sufficiency/(Deficiency)	(307,630)	[27] - [20]

**Attachment: Case 2B**  
**Cost and Revenue Associated with Toronto Hydro's 2010 Proposed Suite Metering**  
**Case 2B: Converted, Low Unit Cost**

Line	Item	Amount	Calculation
[1]	Number of Installed Revenue Generating Suite Meters	1,419	
[2]	Unit Cost	444	
[3]	Total Capital Cost	\$630,667	[1] x [2]
[4]	Working Capital Allowance		
[5]	Operation Expense	\$416,828	[15]
[6]	Working Capital Allowance 14.1%	\$58,773	[5] x 14.1%
[7]	Suite Metering Rate Base	\$689,439	[3] + [6]
[8]	Return on Rate Base		
[9]	Debt 60% @ 5.32%	\$22,007	[7] x 0.6 x 5.32%
[10]	Equity 40% @ 8.01%	\$22,090	[7] x 0.4 x 8.01%
[11]	Return on Rate Base	\$44,097	[9] + [10]
[12]	Operation Expense		
[13]	Incremental Operating Expenses	\$118,250	\$300,000 x (1419 / 3600)
[14]	OM&A \$210 / customer	\$298,578	\$210 x 1419
[15]	OM&A	\$416,828	[13] + [14]
[16]	Amortization	\$42,255	[3] x 6.7%
[17]	Total Operating Expenses	\$459,083	[15] + [16]
[18]	Revenue Requirement Before PLs	\$503,180	[11] + [17]
[19]	Payment in Lieu of Taxes @ 27.86 %	\$8,530	[(10) / (1-PLs)] - [10]
[20]	Suite Meter Revenue Requirement	\$511,709	[18] + [19]
[21]	Residential Revenues (Proposed 2010 Rates)		
[22]	Number of Installed Smart Meters	1,419	
[23]	Yearly Customer Charge @ \$18.82 / mo.	\$320,467	[22] x \$18.82 x 12
[24]	Variable Distribution @ 1.684 cents/kWh	\$129,038	[22] x 450 kWh x 1.684 cents/kWh x 12
[25]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[26]	Variable Distribution @ \$0.02399/kWh	(183,826)	0.02399 \$/kWh x 450 kWh x 12 x 1419
[27]	Total Revenue	\$265,679	[23] + [24] + [26]
[28]	Annual Suite Meter Program Sufficiency/(Deficiency)	(246,030)	[27] - [20]

**Attachment: Case 3A**  
**Cumulative Cost and Revenue Associated with Toronto Hydro's 2007-2010 Proposed Suite Metering**  
**Case 3A: Cumulative, New Meters, High Unit Cost**

Line	Item	Amount	Calculation
[1]	Cumulative Depreciated Capital Cost	\$3,809,656	See Exhibit 1
[2]	Working Capital Allowance		
[3]	Operation Expense	\$1,631,477	[13]
[4]	Working Capital Allowance 14.1%	\$230,038	[3] x 14.1%
[5]	Suite Metering Rate Base	\$4,039,694	[1] + [4]
[6]	Return on Rate Base		
[7]	Debt 60% @ 5.32%	\$128,947	[5] x 0.6 x 5.32%
[8]	Equity 40% @ 8.01%	\$129,432	[5] x 0.4 x 8.01%
[9]	Return on Rate Base	\$258,379	[7] + [8]
[10]	Operation Expense		
[11]	Incremental Operating Expenses	\$462,833	\$713,667 x (\$554 / 8564)
[12]	OM&A \$210 / customer	\$1,168,643	\$210 x 5554
[13]	OM&A	\$1,631,477	[11] + [12]
[14]	Amortization	\$255,247	[1] x 6.7%
[15]	Total Operating Expenses	\$1,886,724	[13] + [14]
[16]	Revenue Requirement Before PTLs	\$2,145,102	[9] + [15]
[17]	Payment in Lieu of Taxes @ 27.86 %	\$49,979	([8] / (1-PTLs)) - [8]
[18]	Suite Meter Revenue Requirement	\$2,195,081	[16] + [17]
[19]	Residential Revenues (Proposed 2010 Rates)		
[20]	Number of Installed Smart Meters	5,554	
[21]	Yearly Customer Charge @ \$18.82 / mo.	\$1,254,315	[20] x \$18.82 x 12
[22]	Variable Distribution @ 1.684 cents/kWh.	\$505,059	[20] x 450 kWh x 1.684 cents/kWh x 12
[23]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[24]	Variable Distribution @ \$0.02399/kWh	0	0.02399 \$/KWh x 450 KWh x 12 x 0
[25]	Total Revenue	\$1,759,374	[21] + [22] + [24]
[26]	Annual Suite Meter Program Sufficiency/(Deficiency)	(435,707)	[25] - [18]



**Attachment: Case 3B**  
**Cumulative Cost and Revenue Associated with Toronto Hydro's 2007-2010 Proposed Suite Metering**  
**Case 3B: Cumulative, New Meters, Low Unit Cost**

Line	Item	Amount	Calculation
[1]	Cumulative Depreciated Capital Cost	\$2,266,640	See Exhibit 1
[2]	Working Capital Allowance	\$1,631,477	[13]
[3]	Operation Expense	\$230,038	[3] x 14.1%
[4]	Working Capital Allowance 14.1%		
[5]	Suite Metering Rate Base	\$2,496,679	[1] + [4]
[6]	Return on Rate Base	\$79,694	[5] x 0.6 x 5.32%
[7]	Debt 60% @ 5.32%	\$79,994	[5] x 0.4 x 8.01%
[8]	Equity 40% @ 8.01%		
[9]	Return on Rate Base	\$159,688	[7] + [8]
[10]	Operation Expense	\$462,833	\$713,667 x (\$554 / 8564)
[11]	Incremental Operating Expenses	\$1,168,643	\$210 x 5554
[12]	OM&A \$210 / customer	\$1,631,477	[11] + [12]
[13]	OM&A	\$151,865	[1] x 6.7%
[14]	Amortization		
[15]	Total Operating Expenses	\$1,783,342	[13] + [14]
[16]	Revenue Requirement Before PILs	\$1,943,029	[9] + [15]
[17]	Payment in Lieu of Taxes @ 27.86 %	\$30,889	([8] / (1-PILs)) - [8]
[18]	Suite Meter Revenue Requirement	\$1,973,918	[16] + [17]
[19]	Residential Revenues (Proposed 2010 Rates)	5,554	
[20]	Number of Installed Smart Meters	\$1,254,315	[20] x \$18.82 x 12
[21]	Yearly Customer Charge @ \$18.82 / mo.	\$505,059	[20] x 450 kWh x 1.684 cents/kWh x 12
[22]	Variable Distribution @ 1.684 cents/kWh		
[23]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)	0	0.02399 \$/KWh x 450 KWh x 12 x 0
[24]	Variable Distribution @ \$0.02399/KWh		
[25]	Total Revenue	\$1,759,374	[21] + [22] + [24]
[26]	Annual Suite Meter Program Sufficiency/(Deficiency)	(214,544)	[25] - [18]

**Attachment: Case 4A**  
**Cumulative Cost and Revenue Associated with Toronto Hydro's 2007-2010 Proposed Suite Metering**  
**Case 4A: Cumulative, Converted, High Unit Cost**

Line	Item	Amount	Calculation
[1]	Cumulative Depreciated Capital Cost	\$2,125,600	See Exhibit 2
[2]	Working Capital Allowance		
[3]	Operation Expense	\$884,182	[13]
[4]	Working Capital Allowance 14.1%	\$124,670	[3] x 14.1%
[5]	Suite Metering Rate Base	\$2,250,269	[1] + [4]
[6]	Return on Rate Base		
[7]	Debt 60% @ 5.32%	\$71,829	[5] x 0.6 x 5.32%
[8]	Equity 40% @ 8.01%	\$72,099	[5] x 0.4 x 8.01%
[9]	Return on Rate Base	\$143,927	[7] + [8]
[10]	Operation Expense		
[11]	Incremental Operating Expenses	\$250,833	\$713,667 x (3010 / 8564)
[12]	OM&A \$210 / customer	\$633,348	\$210 x 3010
[13]	OM&A	\$884,182	[11] + [12]
[14]	Amortization	\$142,415	[1] x 6.7%
[15]	Total Operating Expenses	\$1,026,597	[13] + [14]
[16]	Revenue Requirement Before PLLs	\$1,170,524	[9] + [15]
[17]	Payment in Lieu of Taxes @ 27.86 %	\$27,840	([8] / (1-PLLs)) - [8]
[18]	Suite Meter Revenue Requirement	\$1,198,364	[16] + [17]
[19]	Residential Revenues (Proposed 2010 Rates)		
[20]	Number of Installed Smart Meters	3,010	
[21]	Yearly Customer Charge @ \$18.82 / mo.	\$679,778	[20] x \$18.82 x 12
[22]	Variable Distribution @ 1.684 cents/kWh	\$273,717	[20] x 450 kWh x 1.684 cents/kWh x 12
[23]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[24]	Variable Distribution @ \$0.02399/kWh	(389,933)	0.02399 \$/KWh x 450 KWh x 12 x 3010
[25]	Total Revenue	\$563,562	[21] + [22] + [24]
[26]	Annual Suite Meter Program Sufficiency/(Deficiency)	(634,802)	[25] - [18]

**Attachment: Case 4B**  
**Cumulative Cost and Revenue Associated with Toronto Hydro's 2007-2010 Proposed Suite Metering**  
**Case 4B: Cumulative, Converted, Low Unit Cost**

Line	Item	Amount	Calculation
[1]	Cumulative Depreciated Capital Cost	\$1,264,673	See Exhibit 2
[2]	Working Capital Allowance	\$884,182	[13]
[3]	Operation Expense	\$124,670	[3] x 14.1%
[4]	Working Capital Allowance 14.1%		
[5]	Suite Metering Rate Base	\$1,389,343	[1] + [4]
[6]	Return on Rate Base	\$44,348	[5] x 0.6 x 5.32%
[7]	Debt 60% @ 5.32%	\$44,515	[5] x 0.4 x 8.01%
[8]	Equity 40% @ 8.01%	\$88,862	[7] + [8]
[9]	Return on Rate Base		
[10]	Operation Expense	\$250,833	\$713,667 x (3010 / 8564)
[11]	Incremental Operating Expenses	\$633,348	\$210 x 3010
[12]	OM&A \$210 / customer	\$884,182	[11] + [12]
[13]	OM&A	\$84,733	[1] x 6.7%
[14]	Amortization	\$968,915	[13] + [14]
[15]	Total Operating Expenses		
[16]	Revenue Requirement Before PILs	\$1,057,777	[9] + [15]
[17]	Payment in Lieu of Taxes @ 27.86 %	\$17,189	([8] / (1 - PILs)) - [8]
[18]	Suite Meter Revenue Requirement	\$1,074,966	[16] + [17]
[19]	Residential Revenues (Proposed 2010 Rates)		
[20]	Number of Installed Smart Meters	3,010	
[21]	Yearly Customer Charge @ \$18.82 / mo.	\$679,778	[20] x \$18.82 x 12
[22]	Variable Distribution @ 1.684 cents/kWh	\$273,717	[20] x 450 kWh x 1.684 cents/kWh x 12
[23]	Forgone Commercial Revenues (Proposed 2010 Rates for GS < 50 kW Class)		
[24]	Variable Distribution @ \$0.02399/kWh	(389,933)	0.02399 \$/KWh x 450 KWh x 12 x 3010
[25]	Total Revenue	\$563,562	[21] + [22] + [24]
[26]	Annual Suite Meter Program Sufficiency/(Deficiency)	(\$11,404)	[25] - [18]

## Exhibit 1: New Suite Meters Installed By Year

		@ High Unit Cost		@ Low Unit Cost	
		Capital Cost Prior to Depreciation @ High Unit Cost	Depreciation [3]	Capital Cost in 2010 @ High Unit Cost	Capital Cost Prior to Depreciation @ Low Unit Cost
New	[1]	[2]	[3]	[4]	[5]
2007	1,409	\$1,052,523	\$211,557	\$840,966	\$626,222
2008	586	\$437,742	\$58,657	\$379,085	\$260,444
2009	1,378	\$1,029,366	\$68,968	\$960,398	\$612,444
2010	2,181	\$1,629,207	\$0	\$1,629,207	\$969,333
<b>Total</b>	<b>5,554</b>	<b>\$4,148,838</b>	<b>\$339,182</b>	<b>\$3,809,656</b>	<b>\$2,468,444</b>
				<b>\$201,804</b>	<b>\$2,266,640</b>

Source:

[1]: Toronto Hydro Responses to Interrogatory #1

[2]: [1] x \$747

[3]: [2] x 6.7% x number of years

[4]: [2] - [3]

[5]: [1] x \$444

[6]: [5] x 6.7% x number of years

[7]: [5] - [6]

## Exhibit 2: Bulk Conversion Suite Meters Installed By Year

		@ High Unit Cost		@ Low Unit Cost	
		Capital Cost Prior to Depreciation @ High Unit Cost	Depreciation [3]	Capital Cost Prior to Depreciation @ Low Unit Cost	Depreciation [6]
Bulk Conversions	[1]	[2]	[3]	[4]	[5]
2007	154	\$115,038	\$23,123	\$91,915	\$68,444
2008	556	\$415,332	\$55,654	\$359,678	\$247,111
2009	881	\$658,107	\$44,093	\$614,014	\$391,556
2010	1,419	\$1,059,993	\$0	\$1,059,993	\$630,667
<b>Total</b>	<b>3,010</b>	<b>\$2,248,470</b>	<b>\$122,870</b>	<b>\$2,125,600</b>	<b>\$1,337,778</b>
					<b>\$73,104</b>
					<b>\$1,264,673</b>

Source:

[1]: Toronto Hydro Responses to Interrogatory #1

[2]: [1] x \$747

[3]: [2] x 6.7% x number of years

[4]: [2] - [3]

[5]: [1] x \$444

[6]: [5] x 6.7% x number of years

[7]: [5] - [6]

	Scope	New/Bulk	Total Meters	Assumed Bulk Converted				Description	Note
Case 1A	2010	New	3600	1419	2181	0	747	New Meters, High Unit Cost	
Case 1B	2010	New	3600	1419	2181	0	444	New Meters, Low Unit Cost	
Case 2A	2010	Bulk	3600	1419	1419	1419	747	Converted, High Unit Cost	
Case 2B	2010	Bulk	3600	1419	1419	1419	444	Converted, Low Unit Cost	
Case 3A	2007-2010	New	8,564	3,010	5554	0	408	Cumulative, New Meters, High Unit Cost	See Exhibit 1
Case 3B	2007-2010	New	8,564	3,010	5554	0	408	Cumulative, New Meters, Low Unit Cost	See Exhibit 1
Case 4A	2007-2010	Bulk	8,564	3,010	3010	3010	706	Cumulative, Converted, High Unit Cost	See Exhibit 2
Case 4B	2007-2010	Bulk	8,564	3,010	3010	3010	420	Cumulative, Converted, Low Unit Cost	See Exhibit 2

**ONTARIO ENERGY BOARD**

**IN THE MATTER OF** the Ontario Energy Board Act, 1998, S.O. 1998, c.15,  
Schedule B;

**AND IN THE MATTER OF** an application by Toronto Hydro-Electric System  
Limited for an order approving just and reasonable rates and other charges for  
electricity distribution to be effective May 1, 2010

***CURRICULUM VITAE OF***

**PHILIP Q. HANSER, THE BRATTLE GROUP**

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Office: Cambridge, MA ♦ Phone: +1.617.864.7900 ♦ Email: Philip.Hanser@brattle.com

**Mr. Philip Q Hanser** is a principal of *The Brattle Group* and has over twenty-five years of consulting and litigation experience in the energy industry. His expertise includes issues ranging from industry structure, market power and associated regulatory questions, to specific operational and strategic questions such as transmission pricing, generation planning, tariff strategies, fuels procurement, environmental issues, forecasting, demand-side management, and other management and financial issues. He has supported clients' efforts in insurance recovery of environmental liabilities arising from former manufactured gas plant sites, assessed liability risk in mass tort suits, and designed statistical database auditing procedures.

He has appeared as an expert witness before the U.S. Federal Energy Regulatory Commission (FERC), the California Energy Commission (CEC), the New Mexico Public Service Commission (NMPSC), the Public Service Commission of Wisconsin (PSCW), the Vermont Public Service Board (VPSB), the Public Utilities Commission of Nevada (PUCN), the Connecticut Siting Commission, the Pennsylvania Department of Environmental Protection, before arbitration panels, and in Federal and state courts. He served for six years on the American Statistical Association's Advisory Committee to the Energy Information Administration (EIA). He serves on CIGRE's (Conseil International des Grands Reseaux Electriques) Working Group C5-8, Working Group on Renewables and Energy Efficiency in a Deregulated Market. Prior to joining *The Brattle Group*, he served as the manager of the Demand-Side Management Program at the Electric Power Research Institute (EPRI). He has published widely in leading industry and economic journals. Mr. Hanser has taught at the University of the Pacific, University of California at Davis, and Columbia University, and guest lectured at the Massachusetts Institute of Technology, Stanford University, and the University of Chicago.

## **AREAS OF EXPERTISE**

- ♦ *Analysis of Electricity Generation, Contracts, and Wholesale Markets*
- ♦ *Resource Planning and Procurement*
- ♦ *Environment*
- ♦ *Energy Efficiency, Demand-Side Management, and Renewables*
- ♦ *Analysis of Market Power*
- ♦ *RTO Design and Participation*
- ♦ *Forecasting and Weather Normalization*
- ♦ *Rate Design and Related Issues*
- ♦ *Transmission*
- ♦ *Plant Performance and Strategy*



## EXPERIENCE

### *Analysis of Electricity Generation, Contracts, and Wholesale Markets*

- ◆ For the California Department of Water Resources provided expert testimony in federal bankruptcy court with regard to the public interest standard to be applied to Calpine Corporation's rejection of its contracts. This assignment included a valuation of the contract over time through the use of a simulation model of the California market, as well as an assessment of the potential reliability implications for the California market.
- ◆ For the California Department of Water Resources and the California Attorney General's Office, provided expert testimony on damages resulting from Sempra Energy Resources breaches of its power purchase agreement in both arbitration hearings and California state court. Analyzed two years of hourly data on energy deliveries, market prices, ISO charges, and invoice charges to identify and evaluate performance violations and invoice overcharges. Assisted counsel in developing the theory of the case and provided general litigation support in preparation for and during arbitration.
- ◆ For Dominion Electric Marketing, Inc. (DEMI), provided assistance in their response to a complaint by United Illuminating (UI) regarding their wholesale supply contract. The dispute centered on the allocation of reliability must run costs between UI as a load-serving entity and DEMI as wholesale supplier.
- ◆ For the California Department of Water Resources critically reviewed the California ISO's proposed implementation of locational marginal pricing (LMP) and analyzed implications for "seller's choice" supply contracts. Developed a framework for quantifying the incremental congestion costs that ratepayers would face if suppliers financially delivered power to the lowest priced nodes; estimated potential incremental contract costs using a third party's GE-MAPS market simulations (and helped to improve their model inputs to more accurately reflect the transmission system in California). Made recommendations to the CAISO as to how to address the issue.
- ◆ Provided expert testimony in Massachusetts state court on the damages incurred by a power plant developer as a result of alleged contractual violations by a supplier for a plant constructed in ISO-NE.
- ◆ For a Florida utility, provided a confidential expert report evaluating the benefits of the power from a co-generator and its potential rate implications, and assisted in the negotiation of a co-generation contract with a large industrial customer.
- ◆ Assisted a U.S. electric utility in the preparation of a bid proposal to an industrial firm for the leasing of a new power plant. The assignment included risk analysis of the proposal, assessment of financial and rate impacts, and market assessment of competitors' potential offerings.

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*Resource Planning and Procurement*

- ◆ For the Edison Electric Institute, co-authored a report on the general inapplicability of standard financial portfolio theory to the resource portfolios of utilities.
- ◆ For the investor-owned utilities of Wisconsin, provided testimony before the Public Service Commission of Wisconsin on cost of capital issues for use in its statewide resource planning exercise.
- ◆ For an international development bank, evaluated generation resource needs for an Eastern European country as well as a determination of alternative means to meet those generation needs. This assignment included analysis of the impact of privatization on the country's economy, its import and export sectors, and future development of electricity and gas resources.

*Environment*

- ◆ For an Eastern utility with substantial coal-generating facilities, provided advice with regard to maintenance procedures and risk exposure to New Source Review standards under the Clean Air Act Amendments.
- ◆ For a Western generator with substantial coal-generating facilities he has provided assistance with regard to responding to allegations by the Environmental Protection Agency of failure to comply with the New Source Review standards under the Clean Air Act Amendments.
- ◆ For Illinois Power Company, provided expert testimony in federal court on the regulatory and rate base implications of the Clean Air Act Amendments, in support of the calculation of noncompliance economic damages arising from New Source Review.
- ◆ For a gas utility, assisted in the development of potential manufactured gas liabilities for use in insurance recovery and in estimating potential recovery under a variety of insurance allocation theories and estimated the risk distribution of the estimates.
- ◆ For a gas utility, assisted in the assessment of the announcement effect of environmental liabilities on its cost of capital. This assignment included estimation of changes in market betas for pre- and post- environmental liability announcement.

*Energy Efficiency, Demand-Side Management, and Renewables*

- ◆ For a large utility in the Southern United States, prepared expert report investigating alternative cost allocation approaches for generation capacity, fuel, and demand-side management (DSM) costs both through a review of the methods and surveys of practice.
- ◆ For Central Vermont Public Service, provided expert testimony on the impact of its demand-side management programs before the Vermont Public Service Board.

- ◆ For Ameren/UE's Illinois subsidiaries, provided expert testimony on the potential for gas demand-side management and resulting potential rate implications.
- ◆ For a Northeast utility developed an assessment of the potential penetration rate of microturbines. For the utility service territories under consideration, evaluated the back-up generation rates and connection charges likely to be incurred for such systems to determine customer costs and benefits.
- ◆ For a utility located in WECC procuring renewable resources, provided a system integration study for a range of renewable project proposals. Used production costing and power flow models to estimate the "deliverability" of various proposals, including estimating the LMP prices and the potential congestion costs. Ranked the proposed renewable power projects by their estimated benefits and costs, and delivered a formal presentation at the completion of the project.
- ◆ For a power marketer and developer of independent power projects in Great Britain, assisted in the preparation of comments on proposals by the UK pool regarding the role of demand-side bidding and the pricing of transmission losses.
- ◆ For a Texas utility, provided expert testimony regarding breach of contract claims made against it by an industrial participant in an energy efficiency project. Reviewed the energy efficiency impacts of program. Calculated the net present value of the project in relation to various rate options and market prices.
- ◆ For Connecticut Light and Power, provided testimony in support of an application for a Certificate of Environmental Compatibility and Public Need for the construction of a 345-kV electric transmission line and reconstruction of an existing 115-kV electric transmission line. At issue was the use of distributed resources to substitute for the proposed lines.

### *Analysis of Market Power*

- ◆ For the California Parties, provided litigation support and testimony regarding manipulation of energy and ancillary service market prices and the outage behavior of gas fired power plants during 2000-01. The proceeding, before the Federal Energy Regulatory Commission involved Enron, Dynegy, Mirant, Reliant, Williams, and other suppliers in the U.S. and Canada. The analyses focused on the use by suppliers of generation outages to affect market prices through physical withholding, as well as the use of pricing to yield economic withholding.
- ◆ For the California Parties, provided litigation support and testimony regarding Enron's transmission and ancillary services market manipulation strategies, including 'Death Star' and 'Get Shorty.'
- ◆ For Southern California Edison, submitted testimony before the FERC describing the implications for the electricity market of the manipulation of gas market prices.

- ◆ For Sierra Pacific Resources Company, provided expert testimony before the Public Utilities Commission of Nevada and the FERC regarding the market power implications of generation asset divestiture required for the merger of Sierra Pacific Power and Nevada Power Company. Developed a Cournot market model to assess the market power implications of selling off alternative groupings of generation.
- ◆ For the Pennsylvania-New Jersey-Maryland Interconnection, LLC (PJM) co-authored annual report on the state of its markets. The report included an assessment of the market's competitiveness and potential structural deficiencies, and identified potential instances of market abuse.
- ◆ For PJM, developed an ensemble of metrics for assessing market power in its markets. The metrics included an early warning system to permit PJM interventions into market abuse at the earliest possible stage.
- ◆ For PJM, developed software for unilateral market power assessment and assisted PJM in its preliminary implementation. Its use was demonstrated with an incident involving potential market power abuse by PJM members.

### *RTO Design and Participation*

- ◆ For Northeast Utilities provided testimony before the FERC with regard to the economics of imposing local installed capacity (LICAP) requirements on ISO-NE. Also has provided expert testimony before the FERC in support of its applications for market-based rate authority.
- ◆ For NSTAR provided testimony before the FERC on several matters including the necessity of imposing bid caps on the New England electricity market, replacement energy rates for generators when transfer capability into a transmission-constrained zone was reduced because of system upgrades, and the appropriateness of granting market-based rate authority to a generator in a transmission-constrained zone. Developed a Cournot market model to forecast the potential impact on market prices in the transmission-constrained zone that the majority of NSTAR's service territory is located.
- ◆ For Nevada Power Company, provided expert testimony before the FERC for its market-based rate authority application.
- ◆ For Otter Tail Power Company, provided an affidavit to the FERC assessing how the Midwest ISO's proposed Transmission and Energy Market Tariff would affect Otter Tail Power both operationally and financially. Based on the strategies that were pursued by some market participants during the 2001 California electricity market crisis, demonstrated the potential to pursue similar strategies in MISO and harm Otter Tail and its customers.
- ◆ For Edison Mission Energy's subsidiary Midwest Gen, provided expert testimony to the FERC for its market-based rate authority application.

- ◆ For a Midwest utility, examined the implications of differing configurations of the independent system operator on potential market power concerns. The issue particularly examined was the question of seams and how different ISO configurations affected the costs of transactions.
- ◆ Co-authored a report for the New York Independent System Operator's (NYISO) assessing the reliability implications of modifying its rules regarding installed capacity.
- ◆ Submitted testimony to the Public Utilities Commission of Texas (PUCT) regarding a proposed rule to allocate costs of procuring replacement reserves to market participants in ERCOT. The proposed rule required ERCOT to assign the majority of such costs directly to market participants who relied on ERCOT's balancing energy (*i.e.*, real-time energy) market. However, a review of the market rules and the historical evidence indicated that the majority of the procurement of replacement reserves was not caused by this behavior. The PUCT rejected the proposed cost allocation rule, and instead required ERCOT to uplift the replacement reserve costs based on the load ratio shares of market participants until the implementation of a reasonable allocation rule or the start of the Texas Nodal Market.
- ◆ For the Edison Electric Institute, authored a report on standard market design and its implications for utilities within regional transmission organizations.

### *Forecasting and Weather Normalization*

- ◆ For an electric utility in the Southeast, reviewed the existing weather normalization process and diagnosed problems with weather data and regression model. Developed alternative daily and monthly normalization models, improved degree day specification, selection of weather stations, and regression specification to double prediction accuracy and improve stability of normalization process.
- ◆ For PJM, conducted a comprehensive review of its models for forecasting peak demand and re-estimated new models to validate recommendations. Individual models were developed for 18 transmission zones as well as a model for the entire PJM system.
- ◆ For a Southwestern utility, developed models for forecasting monthly sales and loads for the residential, commercial and industrial customer classes using primary data on customer loads, weather conditions and economic activity.
- ◆ For the Public Service Company of New Mexico, provided expert testimony before the Public Utilities Commission of New Mexico regarding the forecasted growth of the El Paso, Texas and Juarez, Mexico markets and their electricity requirements.
- ◆ For a Southeastern utility, developed a model for forecasting monthly demand that incorporated the impacts of its significantly declining housing market and which served the basis for its treasurer's revenue forecast.

*Rate Design and Related Issues*

- ◆ For Ameren/UE's Missouri subsidiary, provided expert testimony on its rate design before the Missouri Public Utility Commission. Assisted the development of company witnesses' rationale for the choice of cost of service allocation method, developed benchmarks for the rate increase against similarly situated utilities, as well for other commodities' escalations, and evaluated proposed demand-side management programs and rate options.
- ◆ For Ameren/UE's Illinois subsidiaries, provided expert testimony on the potential for gas demand-side management. The testimony discussed potential rate implications of such programs on the revenue of the utilities.
- ◆ For the Edison Electric Institute, co-authored a series of papers with regard to issues facing utilities. The reports covered the issues of fuel adjustment clauses, mitigating large rate increase impacts, and the Energy Policy Act of 2005.
- ◆ For a U.S. electric utility, assisted in the valuation of generation assets for use in its testimony on stranded costs. This included development a financial model to determine the generation assets' market value, development of a convolution algorithm to convert market scenarios into a probability distribution of asset values, and statistical analysis of the relationship of the utility's generation assets' operating costs in comparison to its competitors. The assignment also included testimony preparation, interrogatories, and rebuttals.
- ◆ For the City of Vernon submitted testimony to the FERC regarding its revenue requirements for transmission.

*Transmission*

- ◆ Before staff members of the FERC, assisted in the development of a review of the implications of the restructuring in transmission assets' cost of capital.
- ◆ For a power marketer and developer of independent power projects in Great Britain, assisted in the preparation of comments on proposals by the UK pool regarding the pricing of transmission losses and the role of demand-side bidding.
- ◆ For a European transmission company, provided an analysis of the likely development of the European electricity market. Also assessed market implications for the transmission company of modifications to the transmission grid.
- ◆ For Hydro Quebec, provided expert testimony before the Regie d'Energie regarding whether a set of privately held transmission facilities constituted a looped transmission system and, thus, was subject to requests for transmission service.

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*Plant Performance and Strategy*

- ◆ For the Keystone-Conemaugh Project Office, performed a benchmarking analysis to identify the areas in which Keystone and Conemaugh coal units were better performing or under-performing compared to other units with similar characteristics. This involved comparing the historical operational and cost performance of the Keystone and Conemaugh coal units against their peer groups; identifying the areas where the performance of the Keystone and Conemaugh coal units were above and below the average quartile of their peer groups; and developing metrics and methodologies to combine the results of individual comparisons across the operational and cost performance assessments.
- ◆ For a U.S. electric utility, assisted in the development of a legislative and regulatory strategy with regard to restructuring. This assignment included generation asset valuation in a competitive market, development of stand-alone transmission and distribution rates under cost-of-service and performance-based regulation, and estimation of stranded costs.

*Other energy experience*

- ◆ For the Edison Electric Institute, conducted Pre-Course Workshop for Electric Rate Advanced Course, “Traditional Embedded Costing and Pricing Concepts,” University of Wisconsin, Madison, July 26, 2009.
- ◆ For the Edison Electric Institute, conducted workshop for Electric Rate Advanced Course, “Unbundling Methodologies”, University of Wisconsin, Madison, July 26, 2009.
- ◆ For the Indiana Energy Conference, presented “It Ain’t Your Father’s IRP, Meeting Today’s Challenges,” October 2, 2008
- ◆ For the Edison Electric Institute, conducted webinar “Long-Term Energy Forecasts: Challenges and Approaches,” June 17, 2009.
- ◆ For the NEPOOL Forecasting Committee Summer Meeting, presented “I’m a Forecaster – And You Can Too!” July 17, 2008
- ◆ For the Electric Power Research Institute (EPRI), developed and directed a research program to provide electric utilities the following capabilities: marketing research, pricing and rate design, integrated resource planning, capital budgeting, environmental impacts of electric utilities and end-use technologies, load research, forecasting, and demand-side management through software tools, database development and technology development. Assisted in the development of the Load Management Strategy Testing Model (LMSTM), enhancements to the Electric Generation Expansion Analysis Model (EGEAS). Co-wrote reports on the environmental impacts of electric technologies, environmental externalities, cost-benefit analysis of evaluation of DSM programs, rate design and costing, integrated resource planning, impacts of interruptible and curtailable loads, product differentiation, activity-based costing, DSM program evaluation, and others. Served as project manager of the Edison Electric Institute (EEI), National Rural Electric



Cooperatives Association (NRECA), American Public Power Association (APPA), and National Association of Regulatory Utility Commissioners (NARUC) jointly sponsored Electric Utility Rate Design Study (EURDS). Represented the Institute before various regulatory commissions, Federal agencies, and utility executives. He served on the Environmental Protection Agency's advisory committee for the Clean Air Act Amendments. He also served as the operating agent for Annex IV, Improved Methods for Integrating Demand-Side Options into Utility Resource Planning, of the International Energy Agency Agreement on Demand-Side Management.

- ◆ For a California utility, supervised short- and long-term forecasts of sales and peak demand for use in resource and corporate planning. Supervised and helped prepare forecast documentation for public hearings before the California Energy Commission and represented the utility to the Commission on the forecast. Supervised the design and implementation of long-term strategic planning and financial models, and prepared both marginal and embedded cost of service studies for the utility and assisted in their use for the design of customer rates. Evaluated the impact of energy conservation programs and legislation on long-term system resource requirements. Designed and implemented the residential survey of appliance holdings and commercial customer equipment survey.

### *Non-energy Related*

- ◆ Submitted testimony in bankruptcy court regarding the estimation of inventory subject to reclamation by a wholesale pharmaceuticals supplier which was sold to a bankrupt retail drug chain. The retail chain failed to maintain proper inventory records and a statistical approach which used a combination of data on overall inventory and the shipment and replenishment records of the supplier was used to develop the estimate.
- ◆ Designed a statistically valid database sampling procedure for assessing the validity of insurance claims arising from mass tort actions. The database contained summary information on the claims and for each claim there was, at times, voluminous information on the individual cases. The sampling procedure was used to determine which records would be chosen and assessed the individual's claim eligibility.
- ◆ Assessed the liability risk of an insurance company that provided coverage relevant to a mass tort suit. A Markov chain model was developed to estimate the size of the potential population and then a risk model was developed to calculate potential exposure.



## TESTIMONY AND REGULATORY FILINGS

Before the Florida Public Service Commission on Behalf of Florida Power and Light Company, prepared Rebuttal Testimony of Philip Q Hanser, Docket No. 080677-EI, August 6, 2009.

Before the Federal Energy Regulatory Commission on Behalf of the City of Vernon, California, prepared Petition for Declaratory Order and Request for Waiver of Filing Fee of City of Vernon, California, Docket No. EL09-\_\_\_-000, July 15, 2009

Before the Régie De L'Énergie, prepared Supplemental Expert Report of Philip Q Hanser on Behalf of Hydro-Québec TransÉnergie, in response to Newfoundland and Labrador Hydro's complaint P-110-1692, June 2009.

Before the Federal Energy Regulatory Commission, on Behalf of The People of the State of California, *ex rel.* Edmund G. Brown Jr., Docket No. EL09- \_\_ (filed May 22, 2009) ("Brown Complaint"), filed direct testimony regarding emergency purchases the State authorized the California Energy Resources Scheduling division of the California Department of Water Resources ("CERS") to make when the California investor-owned utilities (IOUs) could not purchase the power needed to serve their customers.

Before the Florida Public Service Commission on Behalf of Florida Power and Light Company, prepared Direct Testimony of Philip Q Hanser, Docket No. 080677-EI, April 23, 2009.

Before the Office of the Attorney General of the State of California, prepared Addendum to Expert Report of Philip Q Hanser on Behalf of California Department of Water Resources, Case No. GIC 789291, March 31, 2009.

Before the Pennsylvania Public Utility Commission on Behalf of Wellsboro Electric Company, prepared Rebuttal Testimony of Philip Q Hanser and Metin Celebi concerning the Causes and Pricing of Transmission Congestion, Docket No. P-2008-2020257, January 16, 2009.

Before the Pennsylvania Public Utility Commission, Docket No. P-2008-2020257, prepared testimony on behalf of Wellsboro Electric Company concerning the causes and pricing of transmission congestion, July 30, 2008.

Before the Regie De L'Energie, Prepared Affidavit on Behalf of Hydro-Quebec regarding the public availability of SIS reports performed by a transmission provider, June 19, 2008.

Before the Federal Energy Regulatory Commission, Docket No. EL08-\_\_\_-000, Prepared Direct Testimony on Behalf of the City of Vernon's revised TRR filing with the FERC, April 3, 2008.

Before the Regie De L'Energie, Prepared Expert Report on Behalf of Hydro-Quebec TransEnergie to assess whether the transmission facilities owned by ELL may be considered as a "radial generator lead", March 13, 2008.

Before the American Arbitration Association, Case No. 74Y1980019606MAVI, Prepared Rebuttal Report on Behalf of the California Department of Water Resources to evaluate the reports that William Hogan, Jeffrey Tranen, and Ellen Wolfe provided on behalf of Sempra Generation, June 4, 2007.

Before the American Arbitration Association, Case No. 74Y1980019606MAVI, Prepared Expert Report on Behalf of the California Department of Water Resources to evaluate certain claims made by the California Department of Water Resources (“DWR”) in its Demand for Arbitration regarding the performance of Semptra Energy Resources, now known as Semptra Generation, under the Energy Purchase Agreement between the parties, and to calculate amounts that Semptra would owe to DWR assuming liability is established, May 14, 2007.

Before the United States Bankruptcy Court, Northern District of Ohio, Eastern Division, Case Nos. 01-44007 through 01-44015, Expert Report in regard to McKesson’s inventory reclamation in the Phar-Mor bankruptcy, March 9, 2007.

Before the Public Utility Commission of Texas, Docket No. 33416, Prepared Rebuttal Testimony on Behalf of Constellation New Energy, Inc.’s appeal and complaint of ERCOT decision to approve PRR 676, PRR 674 and request for expedited relief, January 11, 2007.

Before the Public Utility Commission of Texas, Docket No. 33416, Prepared Direct Testimony on Behalf of Constellation NewEnergy, Inc. to analyze and discuss the flaws and potential negative impacts of the allocation methods under Protocol Revision Request (“PRR”) 676 which relates to procurement costs for Replacement Reserve Service (“RPRS”) and Out of Merit Capacity, November 22, 2006.

Before the American Arbitration Association, Case No. GIC 789291, Prepared Rebuttal Report on Behalf of California Department of Water Resources vs. Semptra Energy Resources, July 11, 2006.

Before the State Office of Administrative Hearings, Prepared Expert Report on Behalf of TXU Energy Solutions, regarding their demand-side management program and the difference between the actual and projected savings in the energy bill of University of Texas, July 7, 2006.

Before the Missouri Public Service Commission, Case No. ER-2007-0002, Prepared Direct Testimony on Behalf of Union Electric Company with regard to Ameren UE’s rate design proposals, July 5, 2006.

Before the American Arbitration Association, Case No. GIC 789291, Prepared Expert Report on Behalf of California Department of Water Resources vs. Semptra Energy Resources, June 9, 2006.

Before the Superior Court of the State of California, J.C.C.P. Nos. 4221, 4224, 4226 and 4228, Prepared Declaration in support of California State Agencies’ opposition to motion on shortened time and motion in support of preliminary approval of class action settlement, June 8, 2006.

Before the Superior Court of the State of California, J.C.C.P. Nos. 4221, 4224, 4226 and 4228, Prepared Declaration in support of California State Agencies’ opposition to proposed publication notice, January 13, 2006.

Before the United States Bankruptcy Court, Case No. 05-60200 (BRL), Prepared Declaration on Behalf of Calpine Corporation with regard to the public interest standard for the rejection of the contract, December 30, 2005.

Before the FERC, Docket No. EL05-76-001, Prepared Direct Testimony on Behalf of Dominion Energy Marketing, Inc. (DEMI), regarding a dispute between DEMI and The United Illuminating Company as to which party is responsible for paying certain costs associated with Reliability Must-Ran agreements under a December 28, 2001 Power Supply Agreement between the two parties, December 5, 2005.

Before the American Arbitration Association, Case No. 74Y1980019304VSS, Prepared Expert Report on Behalf of California Department of Water Resources vs. Sempra Energy Resources with regard to damages from multiple contract breaches, May 2005.

Before the FERC, Docket No. EL03-180-000, Prepared Supplemental Testimony on Behalf of the California Parties with regard to Enron's circular scheduling and paper trading gaming practices, January 31, 2005.

Before the FERC, Docket No. ER96-496-010, *et al.*, Prepared Affidavit on Behalf of Northeast Utilities Service Company and affiliated companies market-based rate authorization, September 27, 2004, Revised December 9, 2004.

Before the Connecticut Siting Board, Docket 217, Prepared Testimony on Behalf of Connecticut Light and Power in support of its application for a Certificate of Environmental Compatibility and Public Need for the construction of a 345-kV electric transmission line and reconstruction of an existing 115-kV electric transmission line between Connecticut Light and Power Company's Plumtree Substation in Bethel, through the Towns of Redding, Weston, and Wilton, and to Norwalk Substation in Norwalk, Connecticut, November, 2004.

Before the FERC, Docket No. ER04-691-000, Prepared Affidavit on Behalf of Otter Tail Power Company (OTP) regarding problems that may result from the implementation of MISO's markets tariff in OTP's region, May 7, 2004.

Before the FERC, Docket No. ER03-563-030, Prepared Joint Affidavit with Judy W. Chang on Behalf of Devon Power LLC, *et al.*, March 24, 2004.

Before the FERC, Docket No. EL03-180-000, Prepared Direct Testimony on Behalf of the California Parties with regard to Enron's circular scheduling and paper trading gaming practices, February 27, 2004

Before the Commonwealth of Massachusetts, Case No. 99-6016, Prepared Expert Report on Behalf of Alstom Corporation and Black and Veatch vs. Meriden Corporation, LLC, Review of "*Value of the Meriden Power Project*", January 9, 2004

Before the FERC, Docket No. EL03-159-000, Prepared Declaration on Behalf of The California Parties, Re: Gaming Activities Of Modesto Irrigation District, October, 2003.

Before the FERC, Docket No. ER03-118-000, Prepared Affidavit on Behalf of Otter Tail Power Company For Otter Tail Power Company, assessing how the Midwest ISO's proposed Transmission and Energy Market Tariff will affect Otter Tail Power both operationally and financially, September 15, 2003.

Before the Pennsylvania Environmental Hearing Board, New Jersey Department of Environmental Protection vs. Pennsylvania Department of Environmental Protection and Lower Mount Bethel Energy, LLC, Docket No. 2001-280-C, Prepared Expert Report on Behalf of Pennsylvania Power and Light, May 2, 2003.

Before the FERC, Docket No. EL00-95-069, Prepared Rebuttal Testimony on Behalf of Southern California Edison for the California Parties regarding manipulation of energy and ancillary service market prices and the outage behavior of gas fired power plants, March 20, 2003.

Before the FERC, Docket No. EL00-95-069, Prepared Testimony on Behalf of Southern California Edison for the California Parties regarding manipulation of energy and ancillary service market prices and the outage behavior of gas fired power plants, February 24, 2003.

Before Southern District Court of Illinois, Docket No.99-833-MBR, Prepared Expert Report for Department of Justice, Environmental Protection Agency vs. Illinois Power Company and Dynegy Midwest Generation regarding the likely rate treatment of, July 29, 2002.

Before the FERC, Docket No. ER99-3693-000, Prepared Direct Testimony on Behalf of Edison Mission Energy and Edison Mission Marketing and Trading, Inc. on behalf of Midwest Generation's application for market-based rate authority, April 1, 2002.

Before the FERC, Docket No. ER01-890-000, Prepared Rebuttal Testimony on Behalf of NSTAR on the appropriate rates for generators during transmission upgrades or enhancements requiring substantial and sustained reduction in transfer capability, September 21, 2001.

Before the FERC, Docket No. EL01-79-000, Prepared affidavit on Behalf of NSTAR, in their intervention of the granting of market-based rate authority to Sithe, May 2001.

Before the FERC and the Public Utilities Commission of Nevada, Docket No. EC0-173-000, Prepared Affidavit on Behalf of Sierra Pacific Resources Company, regarding the market power implication of generation asset divestiture required for the merger of Sierra Pacific Power and Nevada Power Company, February 23, 2001.

Before the California Energy Commission, Prepared Expert Report on Behalf of Calpine Corporation; Socioeconomic Resources: Economic Benefits of the Metcalf Energy Center, October 27, 2000.

Before the FERC, Docket No. EL00-83-000, Prepared Affidavit on Behalf of NSTAR with regard to the necessity of imposing bid caps on the New England electricity market, June 23, 2000.

Before the FERC, Docket No. ER99-2338-001, Prepared Direct Testimony on Behalf of Nevada Power Company in support of the divestiture of its generation assets, June 24, 1999.

Before the FERC, Docket No. ER99-2338-001, Prepared Direct Testimony on Behalf of Nevada Power Company in support of the divestiture of its generation assets, March 30, 1999.

Before the Vermont Public Service Board, Docket No. 6018, Prepared Rebuttal Testimony on Behalf of Central Vermont Public Service Corporation on the impact of its demand-side management programs, April 10, 1998.

Before the New Mexico Public Utility Commission, Case No. 2769, Prepared Direct Testimony prepared on Behalf of the Public Service Company of New Mexico regarding forecasted growth of the El Paso and Juarez, Mexico markets, 1997.

Before the Public Service Commission of Wisconsin, Docket No. 05-EP-7, Prepared Direct Testimony on Behalf of investor-owned utilities of Wisconsin on the utilities cost of capital, May 8, 1995.

Before the FERC, Docket No. RP95-363-015, Prepared Affidavit on Behalf of Southern California Edison describing the implications for the electricity market of the manipulation of gas market prices.

## ACADEMIC HISTORY

Guest Lecturer, Energy Laboratory Short Courses, Massachusetts Institute of Technology, Cambridge, MA	1997-1998
Visiting Lecturer, Department of Economics, University of California, Davis; Davis, CA	1981-1982
Assistant Professor, Departments of Economics and Mathematics, University of the Pacific, Stockton, CA	1975-1980
Ph.D. Candidacy Requirements Completed, Columbia University, NY	1975
Phil.M. (Economics and Mathematical Statistics) Columbia University	1975
A.B. (Economics and Mathematics) The Florida State University, FL	1971
Time Series and Econometric Forecasting, University of California at Berkeley Engineering Extension Course	September 1979
Data Analysis and Regression, American Statistical Association Short Course, San Diego, CA	August 1978

## PROFESSIONAL RELATIONSHIPS

<i>American Statistical Association</i>	1974-current
Member of Committee on Energy Statistics	1993-1999
<i>Institute of Electrical and Electronics Engineer</i>	1986-current
<i>Association of Energy Service Professionals</i> , Board Member	1991-1995
<i>Journal of ADSMP</i> , Editor	1995
<i>American Economic Association</i>	Present

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<i>Northeast Energy and Commerce Association</i>	Present
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<i>National Association of Regulatory Commissioners</i>	Present
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## HONORS

Teaching Incentive Award, University of the Pacific	1979
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Teaching Assistantship in Econometrics, Columbia University	1974
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National Science Foundation Research Traineeship	1972 – 1974
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Undergraduate and Graduate Research Assistantships, Florida State University	1968 – 1972
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Omicron Delta Epsilon, Economics Honor Society	1971
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## PUBLICATIONS AND PRESENTED PAPERS

“Utility Supply Portfolio Diversity Requirements” (with Frank Graves), *The Electricity Journal*, Vol. 20, Issue 5, June 2007.

“Electric Utility Automatic Adjustment Clauses Revisited: Why They Are Needed More Than Ever” (with Frank Graves and Greg Basheda), *The Electricity Journal*, Vol. 20, Issue 5, June 2007.

“Rate Shock Relief” (with Frank Graves and Greg Basheda), *Electric Perspectives*, May/June 2007.

“Rate Shock Mitigation” (with Frank Graves and Greg Basheda), prepared for Edison Electric Institute, May 2007.

“Wire We Here? Coal in the West,” Law Seminars International, Coal in the West Conference, Denver, Colorado, March 30, 2007.

“Electric Utility Automatic Adjustment Clauses: Benefits and Design Considerations” (with Frank Graves and Greg Basheda), Edison Electric Institute, August 2006.

“Can Wind Work In An LMP Market?” (with Serena Hesmondhalgh and Dan Harris), *Natural Gas & Electricity*, November 2005.

“The CAISO’S Physical Validation Settlement Service: A Useful Tool for All LMP-Based Markets” (with Jared S. des Rosiers, Metin Celebi, Joseph B. Wharton), *The Electricity Journal*, September 2005.

“Does SMD Need a New Generation of Market Models? Or How I Learned to Stop Worrying and Enjoy Carrying a Pocket Protector,” SMD Conference, Washington, D.C., December 5, 2002.

“A Summary of FERC’s Standard Market Design NOPR,” Edison Electric Institute, August 2002.

“Standard Market Design in the Electric Market: Some Cautionary Thoughts,” SMD Conference, May 10, 2002, Chicago, Illinois.

“The Design of Tests for Horizontal Market Power in Market-Based Rate Proceedings” (with James Bohn and Metin Celebi), *The Electricity Journal*, May 2002.

“The State of Performance-Based Regulation in the U.S. Electric Industry” (with D.E.M. Sappington, J.P. Pfeifenberger, and G.N. Basheda), *The Electricity Journal*, October 2001.

“Deregulation and Monitoring of Electric Power Markets” (with R.L. Earle and J.D. Reitzes), *The Electricity Journal*, October 2000.

“Shortening the NYISO’s Installed Capacity Procurement Period: Assessment of Reliability Impacts,” NYISO, May 2000.

“PJM Market Competition Evaluation White Paper,” (with Frank C. Graves), prepared for PJM, L.L.C., October 1998.



“Lessons from the First Year of Competition in the California Electricity Market” (with R.L. Earle, W.C. Johnson, and J.D. Reitzes), *The Electricity Journal*, October 1999.

Comments to the FERC concerning Regional Transmission Organizations Notice of Proposed Rule Making, RM99-2, (with Peter Fox-Penner), September 17, 1999.

“In What Shape is Your ISO?” (with J.P. Pfeifenberger, G.M. Basheda and P.S. Fox-Penner), *The Electricity Journal*, Vol. 11, No. 6, July 1998.

“What’s in the Cards for Distributed Resources?” (with J. P. Pfeifenberger and P.R. Ammann), in Special Issue of *The Energy Journal*, *Distributed Resources: Towards a New Paradigm of the Electricity Business*, January 1998.

“One-Part Markets for Electric Power: Ensuring the Benefits of Competition” (with F.C. Graves, E.G. Read, and R.L. Earle), in *Power Systems Restructuring: Engineering and Economics*, ed. M. Ilic, F. Galiana, and L. Fink, (Boston, MA: Kluwer Academic Publishers, 1998)

“Power Market Price Forecasting: Pitfalls and Unresolved Issues” (with R.L. Earle and F.C. Graves), forthcoming in *The Energy Journal*.

Ten EPRI reports and approximately 20 articles in EPRI Reports and Conference Proceedings.

“Insurance Recovery for Manufactured Gas Plant Liabilities” (with G.S. Koch and K.T. Wise), *Public Utilities Fortnightly*, April 1997.

“Real-Time Pricing - Restructuring’s Big Bang?” (with J.B. Wharton and P. Fox-Penner), *Public Utilities Fortnightly*, March 1997.

“Load Impact of Interruptible and Curtailable Rate Programs” (with D.W. Caves, J.A. Herriges, and R.J. Windle), *IEEE Transactions on Power Systems*, Vol. 3, No. 4, November 1988.

“Estimating Hourly Electric Load with Generalized Least Squares Procedures” (With N. Toyama and C.K. Woo.), *The Energy Journal*, April 1986.

“Transfer Function Estimation Using TARIMA,” *SAS User’s Group International, 1982 Proceedings*. Cary, North Carolina: SAS Institute. Inc., 1982.

“Invited Editorial Response to Behavioral Community Psychology: Integrations and Commitments,” by Richard Winett, *The Behavior Therapist* 4(5), Convention, 1981.

*Statistics Through Laboratory Experiences* (with D. Christianson and D. Hughes), Stockton, CA: University of the Pacific 1976-1977.

“Unsolved Advanced Problem,” *American Mathematical Monthly*, May 1975.

“Multiattribute Utility Theory and Earthquake Mitigation Policy” (with T. Munroe), Western Economic Association Conference, June 1978.



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“Introduction to Multivariate Data Analysis Techniques,” Bureau of Applied Social Research, Columbia University, New York, NY, 1973.

September 30, 2009