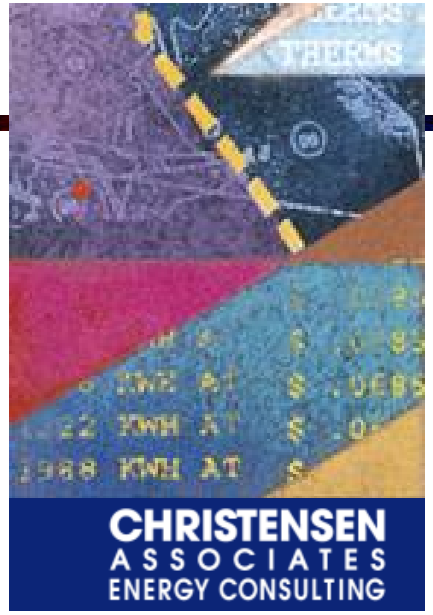

REVIEW OF COST-OF-SERVICE METHODS OF MANITOBA HYDRO

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September 2016

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- Outline of Presentation
  - CAEC's Role in this cost-of-service proceeding
  - PCOSS Treatment of Exports Including Number of Export Classes and cost allocation
  - Treatment of Net Export Revenues (NER)

Review of Cost-of-Service Methods of Manitoba Hydro

- Project Purpose: Christensen Associates Energy Consulting (CAEC) was retained to provide an independent assessment of Manitoba Hydro's (MH) cost allocation methods as presented within the Prospective Cost of Service Study (PCOSS). This review was conducted using accepted costing theory and North American utility industry practices.

- Deliverables:
  - June 8, 2012 report: CAEC provided comments and recommendations some of which MH agreed with and some they did not. The report also provided an overall assessment concluding that the methods were well within acceptable industry norms and reasonably determined the cost of providing service to rate classes.
  - August 10, 2015 Supplemental Report: further address three major, evolving, and provocative issues:
    - Export sales
    - Transmission cost allocation
    - Generation cost allocation
  - Participation in related stakeholder workshops and the current hearing

Treatment of Exports in Terms of Number of Classes (types of sales) and Cost Allocation within PCOSS

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- Two Types of Export Sales:
  - Opportunity Sales:
    - Short notice and short duration
    - When water conditions permit in excess of Dependable energy sales
    - *Non-firm* sales and not backed up by MH resources
  - Dependable Sales:
    - Long notice and duration
    - Served under low flow conditions
    - *Firm* sales and originate from MH resources
    - Can enable advancements of new generation to take advantage of markets for Dependable Sales

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- The reason that this Export issue of number of classes and allocation matters is that it can impact RCC differently
- Three possible ways to allocate costs to Exports:
  - Treat the two types of sales separately:
    - Opportunity sales receive variable cost allocation
    - Dependable sales receive variable cost and fixed cost allocation
  - Allocate variable cost and fixed cost to both Opportunity and Dependable sales
  - Allocate variable cost only to both Opportunity and Dependable sales

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RCC Comparisons for various treatments in PCOSS			
Customer Class	Embedded Fixed and Variable G&T to Dependable, Variable Costs Only to Opportunity	Embedded Fixed and Variable G&T to both Dependable and Opportunity	Variable G&T Costs only to both Dependable and Opportunity
Residential	99.90%	98.30%	101.7%
GSS – ND	108.00%	107.50%	108.5%
GSS – D	104.50%	105.10%	103.7%
GSM	99.30%	100.10%	98.6%
GSL <30	91.10%	91.70%	90.8%
GSL 30-100	99.80%	102.50%	97.1%
GSL >100	98.50%	102.10%	94.9%
ARL	100.20%	99.60%	101.1%

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- Some factors to consider in deciding PCOSS Treatment of Exports

- Exports influence MH cost
  a. Cause variable cost to be incurred
  b. Can cause some fixed cost impacts
     i. For instance Dependable sales can advance in-service dates
  - Many utilities have these type wholesale transactions
    a. Opportunity Sales are often referred to as Economy Sales
    b. Dependable Sales are often referred to as Wholesale Sales
  - Utilities often base their cost-of-service treatment on the non-firm or firm nature of the product

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GEORGIA POWER COMPANY
COST OF SERVICE STUDY FOR HISTORIC YEAR ENDED DECEMBER 31, 2012
SCHEDULE 1.00 - PRESENT RATE SUMMARY (AMOUNTS IN THOUSANDS)

LINE NO.	LINE DESCRIPTION	TOTAL ELECTRIC SYSTEM	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	STREET & OUTDOOR LIGHTING	TOTAL RETAIL SERVICE	WHOLESALE SERVICE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	--- RATE BASE ---							
35	TOTAL INVESTMENT	15,810,842	7,585,750	5,574,142	1,943,140	138,371	15,241,403	569,438
	--- REVENUES ---							
36	REVENUE FROM SALES	7,415,597	2,877,359	2,824,487	1,309,785	159,718	7,171,350	244,247
37	OTHER OPERATING REVENUES	255,311	138,784	69,675	21,710	2,513	232,682	22,629
38	TOTAL REVENUES	7,670,908	3,016,143	2,894,162	1,331,495	162,231	7,404,032	266,876
	--- EXPENSES ---							
39	OPERATIONS & MAINTENANCE	4,676,345	1,796,260	1,700,070	973,476	90,473	4,560,279	116,066
40	DEPRECIATION	774,869	358,467	265,982	92,152	23,337	739,938	34,931
41	NUCLEAR DECOMMISSIONING	1,686	738	671	270	6	1,685	1
42	TAXES OTHER THAN INCOME TAXES	370,249	166,249	139,513	56,298	3,620	365,680	4,569
43	AMORT. OF INV. TAX CREDITS	(12,843)	(5,996)	(4,455)	(1,552)	(235)	(12,238)	(605)
44	AMORT. OF COR REG. LIAB.	(30,824)	(16,584)	(10,227)	(2,860)	(1,143)	(30,814)	(10)
45	AMORT. OF PORT TAX CREDIT	(26,678)	(11,674)	(10,623)	(4,274)	(95)	(26,666)	(12)
46	AMORT. OF MCDONOUGH MATERIALS	1,458	637	581	234	5	1,457	1
47	AMORT. OF DEF. HEALTHCARE COSTS	4,256	2,318	1,328	485	124	4,255	1
48	SUBTOTAL EXPENSES	5,758,518	2,290,415	2,082,840	1,114,229	116,092	5,603,576	154,942
49	INCOME TAXES	598,093	212,811	263,929	66,648	16,554	559,942	38,151
50	TOTAL EXPENSES	6,356,611	2,503,226	2,346,769	1,180,877	132,646	6,163,518	193,093
	--- RETURN ---							
51	OPERATING INCOME	1,314,296	512,917	547,393	150,618	29,585	1,240,513	73,783
52	INTEREST ON CUSTOMER DEPOSITS	(4,308)	(1,823)	(1,665)	(820)	0	(4,308)	0
53	NET INCOME	1,309,988	511,094	545,728	149,798	29,585	1,236,205	73,783
54	RETURN ON INVESTMENT	8.29%	6.74%	9.79%	7.71%	21.38%	8.11%	12.96%

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GEORGIA POWER COMPANY
COST OF SERVICE STUDY FOR HISTORIC YEAR ENDED DECEMBER 31, 2012
SCHEDULE 2.10 - ANALYSIS OF REVENUES (AMOUNTS IN THOUSANDS)

LINE NO.	OPERATING REVENUE	TOTAL ELECTRIC SYSTEM	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	STREET & OUTDOOR LIGHTING	TOTAL RETAIL SERVICE	WHOLESALE SERVICE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	SALES OF ELECTRICITY							
1	RETAIL BASE REVENUE	4,529,720	2,022,508	1,782,873	605,678	118,661	4,529,720	0
2	RETAIL FUEL REVENUE	2,584,862	833,458	1,018,726	692,527	40,151	2,584,862	0
3	TOTAL RETAIL REVENUE FROM SALES	7,114,582	2,855,965	2,801,599	1,298,205	158,812	7,114,582	0
4	SCG FUEL REVENUE	10,598	3,969	4,273	2,177	174	10,593	5
5	SCG VOM REVENUE	792	297	319	163	13	792	0
6	SCG CAPACITY REV. CREDIT	716	313	285	115	3	716	0
7	SCG REVENUE TO ALL OTHER	179	67	72	37	3	179	0
8	GENERATOR IMBALANCE SVC	313	118	126	64	5	313	0
9	ECONOMY ENERGY FUEL REVENUE	16,153	6,049	6,513	3,319	265	16,146	7
10	ECONOMY ENERGY OTHER REVENUE	5,505	2,062	2,220	1,131	90	5,503	2
11	ECONOMY ENERGY RETAIL REVENUE	2,882	1,080	1,162	592	47	2,881	1
12	WHOLESALE BLOCK FUEL REVENUE	49,954	0	0	0	0	0	49,954
13	WHOLESALE BLOCK VOM REVENUE	4,230	0	0	0	0	0	4,230
14	WHOLESALE BLOCK CAPACITY REVENU	159,252	0	0	0	0	0	159,252
21	POWER POOL FUEL REVENUE	16,887	6,324	6,809	3,469	277	16,879	8
22	PUR. POWER VOM REVENUE	1,548	580	624	318	25	1,547	1
23	PUR. POWER CAPACITY REVENUE	1,106	484	440	177	4	1,105	1
24	UPS CAPACITY REVENUE	234	0	0	0	0	0	234
25	RETAIL OPTIONS STRUCK CAPACITY	114	51	45	18	0	114	0
26	TOTAL FUEL REVENUE	2,691,052	849,800	1,036,321	701,492	40,867	2,628,480	62,572
27	TOTAL OTHER REVENUE	4,724,545	2,027,560	1,788,166	608,293	118,851	4,542,870	181,675
28	TOTAL SALES OF ELECTRICITY	7,415,597	2,877,359	2,824,487	1,309,785	159,718	7,171,350	244,247

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- CAEC recommends separate class status
  - Sheer magnitude of Export sales
  - Reveals importance to MH system
  - Exports influence resources and costs

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- CAEC recommends separate cost allocation for the two sales types
  - Opportunity sales receive variable cost allocation only:
    - Sales of short notice and duration
    - Non-firm sale and not backed-up by MH resources
    - Occurs only after Dependable sales have been satisfied
    - These sales have a history and likely to continue, but this does not change the nature of the product and each Opportunity sale contract
    - Lower quality and status than a Dependable sale

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- Dependable sales receive variable cost and fixed cost allocation
  - Sales of much longer notice and duration
  - Revenues for Dependable sales are based upon long term contracts and of more certainty than short term non-firm sales
  - Firm sale and provided by MH hydro resources (and this condition should be considered in the buy/sale market price transaction)
  - Higher quality and status than an Opportunity sale

Treatment of Net Export Revenues (NER)

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- What is NER:
  - NER is the residual of all Export Sales revenue after subtracting assigned and allocated embedded cost to Exports in PCOSS
  - NER is traditionally allocated back to Domestic rate classes
  - There is no cost foundation for NER:
    - Export Sales revenue is based upon competitive market transactions without direct consideration of PCOSS
    - Embedded cost allocated to Export Sales have been subtracted in order to compute a NER residual value

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- Recommendation for Treatment of NER

  Various reasonable allocators for NER were provided in the CAEC reports. However since there is no cost foundation for NER and PCOSS has an objective of cost-determination and revenue coverage, CAEC sees no compelling reason to change from the current allocation of NER

Topics

- Foundations: Nature of power systems; Financial and economic costs
- Selected COS Issues, Generation Services
  - Weighted Energy
    - Inclusion of Capacity Costs
  - Bipole III
  - Converter Facilities
- U.S. Interface
- DSM

Foundations

- Overarching objectives
  - Cost coverage: incurred costs of resources used in the provision of services – *financial cost basis*
  - Efficiency: set prices at levels which contribute to value-maximizing use of resources – *economic cost basis*
  - Sustainable fairness: implicit in COS result, across consumer classes
- Common use resources; multiple services provided simultaneously
  - As a consequence, provision of electricity services is laced with inherently common and joint costs
  - Hence…the necessity of cost allocation

Foundations…2

- Physical properties of power systems remarkably exacting
  - Demand (load) balanced by supply in real time, exactly
  - Non-storability: cannot readily arbitrage supply costs across timeframes
    - Thus, the storage value of major hydro facilities
  - RT operations carried out under highly strict protocols, a must
- As a consequence…
  - Economic (marginal) costs/market prices specific to time, space
  - High granularity…loads, costs, prices in hourly frequency
  - Because of limited storability, considerable variation in cost and value across peak and off-peak timeframes

Foundations…3

- Cost dimensions/structure…
  - Financial costs…largely fixed and non-varying in output, over the relevant time domain
  - Economic costs vary greatly with respect to time, space, and near-term supply/demand conditions – *driven by physical properties*
    - Peak periods: *energy, capacity costs*; Off-Peak periods: *energy costs*

- Thus, the utility pricing problem
  - Recovery of financial costs…cost coverage
  - Reflect resource value (economic costs) in allocation process and prices…efficiency

Generation Services…Weighted Energy

- MH's weighted energy approach
  - Integrates financial and economic costs
    - Jointly satisfies cost recovery and efficiency criteria
      - Covers financial costs
      - Adheres, in significant ways, to *First-Best Pricing*: marginal cost basis
  - *Touch up* necessary: incorporate capacity costs during peak periods, in lieu of implicit scarcity rents
    - Approach options: *scarcity rent content*, implicit in observed prices; MISO capacity *auction prices*; MH *capacity costs*
    - Recommendation: capacity cost internal to MH, used for determining the worth of interruptible services (CRP)

Weighted Energy…2

- Reasoning
  - Scarcity rent content within energy prices a small fraction of all-in capacity costs, over recent years
    - A consequence of *capacity-long* market condition
  - MISO capacity auction prices understate/overstate capacity costs
    - Continuing market design
  - CRP capacity prices, internal to MH, highly plausible
    - Appropriately attenuated from all-in cost of capacity, thus capturing current market conditions
- Outstanding issue
  - How best to assign capacity costs across loads, hours

Generation Services…Bipole III

- Bipole III Integral to generation, like Bipole I and II
  - *Reliability benefits:* necessary for MH to fortify transfer capability of Bipole I and II; Bipole III fulfills secures overall system integrity
  - *Operational features:* one-way flows; utilization varies lock-step with that of northern fleet; no counter-flows or load sinks
  - Northern fleet, *w/HVDC facilities*, serve as highly viable substitute for thermal generation sited close to load center(s).
- COS approach:
  - Functionalize as generation
  - Classify/allocate with weighted energy

Bipole III…2

- Reasoning underlying proposed COS approach
  - Improved reliability from Bipole III: avoided power outage events
    - probability of events likely to be distributed uniformly over time
    - events may have considerable duration
  - Value…worth of improved reliability, measured in dollars
    - distribution approximated by marginal costs (energy, capacity)
  - In short: worth of reliability as a consequence of Bipole III is captured within MH's weighted energy allocation

  - In addition: proposed approach fully consistent with:
    - modern features of restructured wholesale markets
    - methodology assumed by other incumbent utilities

Generation Services…Inverter Facilities

- Inverters reside at Dorsey and Riel stations
  - Costly, when sized to handle flow levels (MW) common to hVDC
  - Integral to HVDC and MH's northern generation
    - thus, weighted energy a compelling COS approach

- Not the full story…
  - MH inverters equipped with special protection systems (SPS)
    - facilitates fast responding controls of HVDC: vast improvement in reliability on AC meshed network
    - *Net Result:* approximately twofold increase in flow capability on AC network, *without breach of stability limits*
      - additional network investment is avoided

Inverter Facilities…2

- Proposed COS approach
  - Assign/functionalize 50% of inverter facilities to generation
    - *reasoning:* fast responding controls not necessary for approximately one-half loading on lines: transients can be managed absent controls, providing load levels are moderate
  - Attribute 50% jointly to generation and transmission
    - With generation to be apportioned no less than 25% of total
  - Summary:
    - Generation assigned 75-100% of total costs of inverter facilities
    - Transmission assigned the remaining share of costs: 0 – 25% of total

U.S. Interface

- Proposed COS approach:
  - Function: assign U.S. Interface facilities to transmission services
  - Allocate costs of such facilities according to weighted energy
- Reasoning…
  - Reliability events can arise from high demand and short supply, compared to expected conditions
    - demand–induced events often local and short…a few high-load hours
    - supply-side induced events can be system-wide, occur randomly, and have considerable depth and duration
  - MH's U.S. Interface mitigates, significantly, supply-side shortfalls
    - because of randomness, and potentially long duration, the pattern of reliability benefits is approximated by MH's weighted energy in COS
    -

U.S. Interface…2

- Key Charateristics of transmission – and hydro – facilities
  - long lead times…difficult to get the timing correct in view of inherent forecast error
  - large scale economies…makes little sense to build for immediate needs, only to further expand capability soon thereafter at considerably higher cost, in total

DSM

- DSM is not driven by export sales,
  - Reverse causality clearly present: DSM makes larger export sales possible, given available supply
  - Plausible approach options are available, and well known
    - match class-specific DSM costs to class participation
    - system benefits approach