CAC Exhibit #

CAC Manitoba: Book of Documents
NFAT Review
Subject: Load Forecast & DSM

Tab	Document
1	Clean Environment Commission, *Report on Wuskwatim Generation and Transmission Projects* (September 2004) p. 122
2	Manitoba Hydro, NFAT Filing *Chapter 4: The Need for New Resources* p. 12-15; 29-31 *Chapter 12:Economic Evaluations - 2013 Update On Selected Development Plans* p. 1, 2, 4, 5
3	Manitoba Hydro, *NFAT Filing: Appendix 3.1 Long-Term Price Forecast for Manitoba Hydro's Export Market in MISO - The Brattle Group* p. 10 (slide 8); 28 (slide 26)
4	Manitoba Hydro, *NFAT: Rebuttal Evidence of Manitoba Hydro* (February 28, 2014) p. 4, 5; 18, 19; 28; 31-33; 37; 40; 41
5	Public Utilities Board, *Transcript of NFAT, March 3, 2014* p. 194-197; 293-295
6	Lloyd Kuczek, Load Forecast & Demand Side Management Powerpoint (March 4, 2014) slide 12
7	Manitoba Hydro, *Request for Proposal 035349: Provision of Demand Side Management Market Potential Study* (February 16, 2011) p. 17-25
8	Public Utilities Board, NFAT, Response to Information Request CAC I-39b; CAC I-40a; CAC I-40c CAC-GAC/MH-14; CAC-GACII-001a PUB 1-256
9	Manitoba Hydro, NFAT filing: *Appendix 4.3 Demand Side Management Potential Study* (September 2013) p. 4-4
10	Manitoba Hydro, NFAT filing: *Appendix 4.3 Demand Side Management Potential Study* (November 2013) p. 1-1 to 1-2; 2-4; 2-11 to 2-12; 2-13; 2-15 to 2-16; 2-20; 2-24; 4-1; 4-4; 4-6; 4-7

11	National Action Plan for Energy Efficiency, *Guide for Conducting Energy Efficiency Potential Studies* (November 2007) p. 2-3; 2-4
12	Electric Power Research Institute, *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010-2030),* (January 2009) p. 12-14
13	Global Energy Partners, *Tennessee Valley Authority Potential Study: Volume 1: Executive Summary: Final Report* (December 21, 2011) p. 1-1 to 2-2; 2-5; 2-12 to 2-13; 3-1 to 3-3; 4-2 to 4-3
14	Global Energy Partners, LLC, *AmerenUE Demand Side Management (DSM) Market Potential Study: Volume 1: Executive Summary* (January 2010) p. 1-6; 9-11; 13; 17-21
15	Global Energy Partners, LLC, *Energy Efficiency Potential Study for Consolidated Edison Company of New York, Inc. Volume 1: Executive Summary* (June 2010) p. 2-4
16	EnerNOC Utility Solutions Consulting, *Ameren Illinois Energy Efficiency Market Potential Assessment, Volume 1: Executive Summary* (July 8, 2013) p. 2-9; 15-23
17	BC Hydro, *2008 Long Term Acquisition Plan: Appendix E to BC Hydro's 2008 LTAP: Direct Testimony of Dr. Ren Orans* p. 17; 20; 21; 22
18	La Capra Associates, *NFAT: Proposal for the Keeyask and Conawapa Generating Stations* p. 1-25, 1-26, 1-37
19	Elenchus, *NFAT Review: A Review of Manitoba Hydro's Load Forecast* (January 2014) p. iii, iv; 8, 9; 10; 16, 17; 21
20	Phillippe Dunsky, *The Role and Value of Demand Side management in Manitoba Hydro's Resource Planning Process* (February 2014) p. 31
21	North American Electric Reliability Corporation, *2012 Long-Term Reliability Assessment* (November 2012) p. 60
22	North American Electric Reliability Corporation, *2013 Long-Term Reliability Assessment* (December 2013) p. 8

Tab 1

Report on Public Hearings

Wuskwatim Generation and Transmission Projects

Commissioners Presiding:
Mr. Gerard Lecuyer, Chairperson
Dr. Kathi Avery Kinew
Mr. Robert Mayer
Mr. Harvey Nepinak
Mr. Terry Sargeant

September 2004

Manitoba Clean Environment Commission
305-155 Carlton Street
Winnipeg, Manitoba R3C 3H8

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8. Recommendations

Recommendation 6.1

The Clean Environment Commission recommends that:

Any future Manitoba Hydro "Need for and Alternatives To" filings for major hydroelectric projects be required to include an analysis of all risks, including business risks, and, where possible, the risks should be quantified.

Recommendation 6.2

The Clean Environment Commission recommends that:

The Government of Manitoba grant the Public Utilities Board jurisdiction to review, on an ongoing basis, as part of Manitoba Hydro's future General Rate Applications, the actual revenues and costs of the Projects relative to forecast, along with the impact of the Projects on Manitoba Hydro's financial stability and its domestic rates.

Recommendation 6.3

The Clean Environment Commission recommends that:

Any future Manitoba Hydro "Need for and Alternatives To" filings for major hydroelectric development projects be required to include internal-rate-of-return-analyses of the project that have been conducted from both a Project perspective and Manitoba Hydro's corporate perspective.

Recommendation 6.4

The Clean Environment Commission recommends that:

Any future Manitoba Hydro "Need for and Alternatives To" filings for major hydroelectric development projects be required to employ a portfolio approach for assessing resource options. The portfolios should include consideration of hydroelectric sequencing as well as coordinated implementation of other initiatives such as DSM programs and SSE projects.

Recommendation 6.5

The Clean Environment Commission recommends that:

Manitoba Hydro should be required to review its non-utility generation policy and its rate structure to ensure that all possible steps are being taken to promote economic non-utility generation.

Recommendation 7.1

The Clean Environment Commission recommends that:

A licence under *The Environment Act* for the

Tab 2

Due to the expectation that a larger proportion of customers will continue to choose electricity for space and water heat as well as miscellaneous end-uses, the average energy usage per residential customer is expected to rise by 0.4% /year. Electricity is currently used for space heating by approximately 35% of Residential Basic customers—forecast to grow to approximately 40% by 2031/32 as a progressively higher percentage of new homes and apartments choose electricity for space heating.

Electric water heating is currently used by approximately 47% of Residential Basic customers—forecast to grow to approximately 69% by 2031/32 in the 2012 Load Forecast. The current trend is for new homes to install electric water heaters; in addition, a growing number of existing natural gas water heaters are also being replaced with electric units.

The influence of improved efficiency requirements for natural gas furnaces and resulting impact on the fuel choice for water heating on the average electricity usage per customer will differ from region to region. This difference depends upon the level of saturation of electric space and water heating in a region, building practices, historic and current energy pricing and other market characteristics. These trends in space and water heating in Manitoba are expected to be mitigated through the corporation's planned heating fuel choice initiatives, with the effects reflected in the 2013 Electric Load Forecast as outlined in ***Chapter 12 – Economic Evaluations – 2013 Update on Selected Development Plans***.

The 1.2% annual increase in Residential Basic customers due to population growth combined with the 0.4% annual increase in average electricity use results in an annual growth rate of 1.6% for the Residential Basic sector over the next 20 years.

General Service – Mass Market

The Mass Market sector is made up of commercial and industrial customers, excluding the Top Consumers. This sector had 65,546 customers in 2011/12, whose weather-adjusted energy consumption was 8,270 GWh, or 34% of the total energy consumed in Manitoba. Over the past 10 years, this sector's consumption has grown at a fairly constant rate of 119 GWh (1.6%) per year, and is forecast to grow at a slightly higher rate averaging 161 GWh (1.7%) per year for the next 20 years due to the expected population growth in Manitoba. The number of Mass Market customers themselves is also expected to increase as more commercial entities seek to provide services for the growing population.

This sector is made up of a wide variety of commercial and small-industrial customers, including offices, retail, wholesale, apartment complexes, schools, hospitals, agriculture, and small manufacturing. Their energy use is not as significantly affected by the economy as other sectors as the related facilities continue to use energy between periods of tenancy.

General Service - Top Consumers

The Top Consumers sector is made up of the 17 industrial and commercial companies, which represent the largest energy users in Manitoba. In 2011/12, the Top Consumers used 5,531 GWh, or 23% of the total electricity consumed in Manitoba.

Energy use for Top Consumers is forecast on a per-company basis to include their respective short-term committed plans and expectations—the forecast excludes longer-term plans that are uncommitted or subject to change. The impact of these plans is reflected generally within the first three years of the load forecast.

During the recent economic slow-down, overall sector load declined due to the loss of one customer in the pulp and paper industry; another major reduction is currently projected in 2015 for primary metals. However, growth among other Top Consumers is expected to make up these load losses, primarily in the pipelines and chemical industries. Overall, short-term plans indicate that Top Consumers should grow by 680 GWh (12%) in the next two years, since a number of customers are planning major expansions.

For the longer term, the future energy requirements of individual customers within the Top Consumers sector cannot be reliably forecast: their growth is too dependent on their particular industry, the economy, and their own competitive situation. One company may be in the right industry at the right time and decide to expand; another may be forced, by a number of unforeseen circumstances, to cut back or even shut down.

To estimate the longer-term growth for the Top Consumer sector, the sector is forecast as a whole. The growth for the longer-term is called Potential Large Industrial Loads and includes consideration for company expansions, cutbacks and shutdowns; new startups of 50 GWh a year or more; and the long-term normal incremental growth of all the companies combined. Since short-term customer intentions are known, Potential Large Industrial Loads is not added to the first three years of the forecast.

In the past 20 years, there have been 14 major increases of load of 100 GWh or more, and two major losses of load of 100 GWh or more within the sector. The net effect has been an addition of about 85 GWh per year. Normal company growth among these customers has added another 7 GWh per year. The combined effect is that Top Consumers has grown from 3,783 GWh in 1992/93 to 5,531 GWh in 2011/12, a growth of 92 GWh or 2.0% per year.

Potential Large Industrial Loads are forecast to be 100 GWh per year. By 2031/32, their contribution is forecast to be 1,700 GWh. Including Potential Large Industrial Loads, General Service Top Consumers is forecast to grow from 5,531 GWh in 2011/12 to 7,698 GWh in 2031/32, for an average growth of 108 GWh or 1.7% per year.

In general, the economy continues to have a significant impact on Top Consumers. Their electricity consumption is dependent upon the state of the economy in their specific industries: in robust economic times they expand operations, increasing their electricity consumption;

while in recessionary times, they reduce shifts and cut back production, thereby decreasing consumption.

Manitoba recently went through an economic downturn, and with the loss of a major customer, electricity consumption of the Top Consumers sector still remains below what it was at its peak in 2008/09; however, Manitoba is a growing province in terms of population and gross domestic product. It is therefore not reasonable to expect that the recent experience of no growth in this sector will continue. It would only take one or two large new customers over the next 20 years to provide the entire additional load that is forecast for the Top Consumers sector until 2031/32.

Losses and Station Service

In 2011/12, distribution losses, transmission losses and station service accounted for 3,156 GWh or 13% of the total energy consumed in Manitoba. This percentage is expected to remain generally the same over the duration of the forecast. (The addition of Bipole III will reduce losses but this is captured separately in the Power Resource Plan due to it being a future project at this time.)

Miscellaneous

Miscellaneous sectors—including seasonal, flat rate, diesel and lighting—used a total of 296 GWh, or 1% of the total energy consumption in Manitoba. The growth in these sectors has minimal effect on overall domestic growth.

4.2.1.2 Load Variation and Forecast Accuracy

Load Variation

Uncertainty is an inherent characteristic of forecasting. The load will vary both year to year and in the long-term because of underlying changes in population growth, economic growth, changes in the operations of Top Consumers, and overall use patterns. An economic recession

To complement Manitoba Hydro's ongoing and internal efforts to identify and quantify potential DSM opportunities and energy savings, Manitoba Hydro hired a third-party consultant to undertake a DSM Market Potential Study in Manitoba in concert with the corporation. The study broadly examines, at a conceptual level, the market potential of existing energy-efficient technologies, which are economic in Manitoba and those technologies that may be "on the horizon". A copy of this study is provided in ***Appendix 4.3 – Demand Side Management Potential Study.***

For purposes of the study, DSM potential is defined within four contexts: 1) technical, 2) economic, 3) market and 4) achievable.

1. The absolute level of DSM without regard for cost and other barriers is defined as the technical potential.
2. "Economic potential" represents the adoption of all energy efficient measures that are cost-effective from a resource perspective (MRC > 1). Technical and economic potential both represent theoretical limits to efficiency savings.
3. Estimating market potential involves the inherent uncertainty of predicting human behaviors and responses to market conditions. This recognizes that any estimate of electricity consumption or potential savings that spans a 15-20 year period is necessarily subject to uncertainty. Numerous external factors create this uncertainty underlying the estimate, including varying levels of market barriers to adoption and factors beyond the influence of Manitoba Hydro (e.g., the levels of complementary support for energy efficiency provided by the federal or provincial governments). Market potential represents the absolute level of energy and demand savings that are technically feasible, economically attractive assuming ideal market conditions. These ideal market conditions could be characterized by the presence of a focused and coordinated effort across organizations/governments (federal, provincial and utilities) eliminating all material market barriers to adoption, such as product availability and market capacity, product awareness and knowledge, price differentials, etc. The probability of these ideal

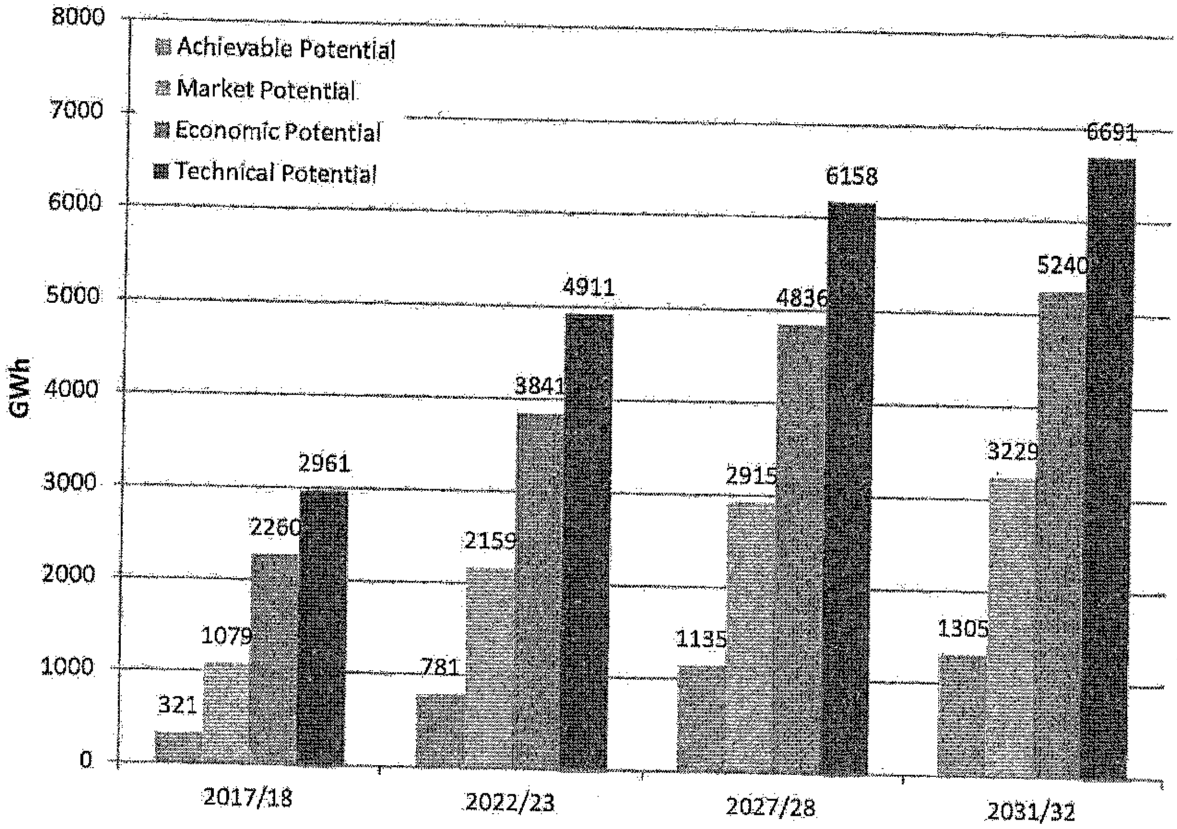
market conditions being present in combination is doubtful and therefore represents a theoretical limit.

4. "Achievable potential" recognizes that market conditions are not ideal and projects energy savings that may be reasonably captured recognizing that there are material market barriers to address.

Caution must be exercised in interpreting the results of a DSM market potential study: the estimates are forecast at a high level and do not account for the investment or the specific strategies required to support the market intervention required to eliminate market barriers, such as education, research and demonstrations, training, capacity-building, incentives, advertising, etc. The setting of specific Power Smart targets involves more detailed and market-specific analysis beyond the scope of the market potential study. The key to developing a sustainable realistic DSM program and overall plan is to recognize the real market constraints and to work within existing market channels (e.g., trade allies, retailers, distributors) to create an effective market change over time.

Figure 4.14 presents the conceptual-level projections of energy efficiency potential in Manitoba.

Figure 4.14 ENERGY EFFICIENCY POTENTIAL PROJECTIONS



The DSM Market Potential Study undertaken for Manitoba Hydro indicated that, across all sectors, the energy savings range from 321 GWh for achievable potential to 1,079 GWh for market potential in 2017/18 and from 1,135 GWh for achievable potential to 2,915 GWh for market potential in 2027/28. Current projected savings under Manitoba Hydro's 2013 - 2016 Power Smart Plan represent approximately 62% of the forecast achievable potential in 2027/28.

For the purposes of this submission, a sensitivity analysis for increased DSM was undertaken, including increasing Manitoba Hydro energy savings through DSM by 1.5 times, and, similarly, a stress test for increased DSM was undertaken at 4 times the current planned DSM. Based on the results of the market potential study and as evidenced in the following graph, the sensitivity analyses capture the potential for increasing Manitoba Hydro's DSM plans to include both reasonable additional and "ideal" market-threshold energy savings through DSM initiatives. As

12 Economic Evaluations – 2013 Update on Selected Development Plans

12.0 Chapter Overview

The NFAT submission has utilized 2012 planning assumptions (with export prices adjusted primarily downward) throughout with the exception of this chapter. Chapter 12 presents an evaluation of the economics of selected development plans using 2013 planning assumptions for load forecast, electricity export prices, natural gas prices, economic parameters and resource timing. A demand side management (DSM) sensitivity and a DSM stress test are also included to demonstrate whether the Preferred Development Plan remains attractive under higher levels of DSM. An economic analysis to evaluate the attractiveness of higher levels of DSM could not be completed in time for this NFAT submission as overall resource costs, including program costs for increased levels of DSM, were not available.

Due to the timing of Manitoba Hydro's annual planning cycle, only a limited scope of development plans and analysis is available to be presented in this chapter.

12.1 2013 Updated Reference Scenario Assumptions

The following updated assumptions have been applied to the reference scenario, i.e. "most likely outcomes", as a basis for the 2013 economic analysis update in this chapter:

- Overall the 2013 Electric Load Forecast has decreased for both energy and peak demand as compared to the 2012 Electric Load Forecast.
- The next generation in-service date requirement for Manitoba load and existing firm commitments has been deferred from 2022/23 to 2023/24.
- With respect to export sales, the Great River Energy (GRE) Diversity Exchange Agreement has been extended, based on the progress of negotiations, to end in 2030/31 as opposed to the end date of 2025/26 used in the 2012 planning assumptions.

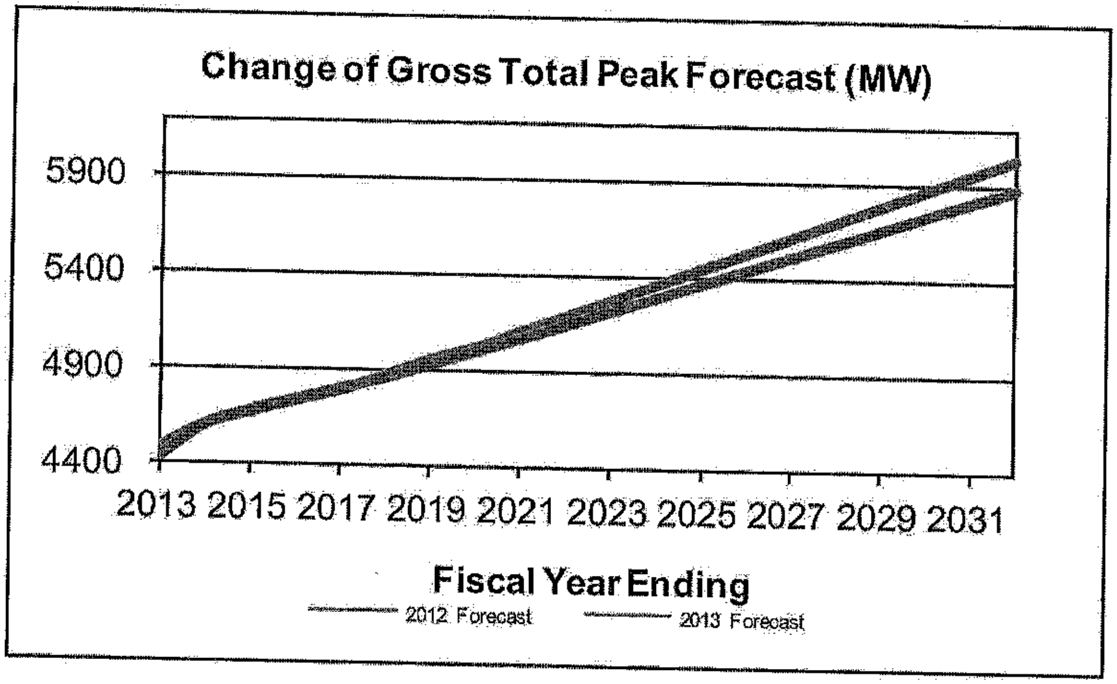
In addition, a new five year 50 MW Term Sheet with Minnesota Power (MP) beginning 2015/16 is included in the 2013 assumptions.

- The 2013 forecast for electricity export prices is higher than the electricity export prices used in the 2012 planning assumptions in the NFAT submission.
- The real discount rate has been increased from 5.05% in the 2012 planning assumptions to 5.40% in the 2013 assumptions.
- The earliest possible in-service date for the Conawapa G.S. is now 2026/27, as opposed to 2025/26 used in the 2012 assumptions.

12.1.1 Changes Between the 2012 and 2013 Electric Load Forecasts

The Gross Firm Energy forecast under the 2013 Electric Load Forecast is 1,159 GWh (3.5%) lower by 2031/32 compared to the 2012 Electric Load Forecast, primarily due to the reduction of the Residential Basic customer forecast and its effect on the Residential and General Service Mass Market forecasts. The reduction in Gross Total Firm Energy in 2022/23 of 717 GWh (2.4%) is equivalent to approximately 1.5 years of load growth (one year = approximately 420 GWh). In 2031/32, the 3.5% decrease in Gross Total Firm Energy is equivalent to a reduction of almost three years of load growth. The 2013 Electric Load forecast for Gross Total Firm Energy compared to 2012 is shown in Figure 12.1 below.

Figure 12.2 GROSS TOTAL PEAK FORECAST – COMPARISON OF 2013 TO 2012



The primary changes between the 2013 Electric Load Forecast and the 2012 Electric Load Forecast are as follows:

- Residential Basic forecast decreased primarily due to the decrease in the forecast growth of Residential Basic customers and to reflect heating fuel choice initiatives being undertaken by Manitoba Hydro.
- General Service Mass Market forecast decreased primarily due to the decrease in the forecast growth of Residential Basic customers.
- General Service Top Consumers forecast decreased, mostly in the Primary Metals sector.

12.1.2 Changes in Demand Side Management Forecast

The update to the 2013-2016 Power Smart Plan (along with the 2013-2016 Power Smart Plan – 15 Year Supplementary Analysis Report) results in a reduction in forecasted DSM savings of

93 GWh and 29 MW by the year 2027/28 based on changes to assumptions related to Manitoba Hydro's Power Smart programs.

12.1.3 Changes in Need for New Resources

Based on the 2013 Electric Load Forecast, new generation to meet Manitoba load and existing firm commitments will be required in 2023/24, which is one year later than the requirement using the 2012 planning assumptions. Similarly new capacity resources are required one year later, in 2026/27, as shown in Figure 12.4. Supply and demand tables for the 2013 update are included in ***Appendix 4.2 – Manitoba Hydro Supply and Demand Tables.***

Figure 12.3 shows the dependable energy balance for the next 20 years (2013/14 to 2032/33) as either a surplus or deficit, assuming no further resource additions to system supply.

Figure 12.3 2013 UPDATE – ENERGY BALANCE-DEPENDABLE ENERGY

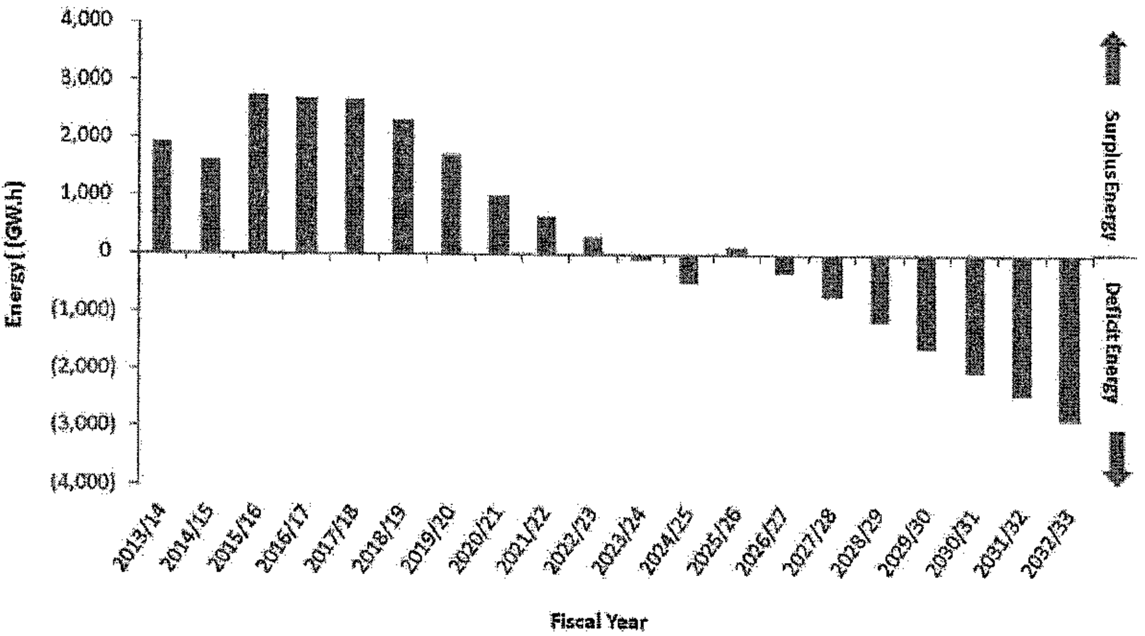


Figure 12.4 shows the capacity balance for the next 20 years (2013/14 to 2032/33) as either a surplus or deficit, assuming no further resource additions to the system.

Tab 3

APPENDIX 3.1

Long-Term Price Forecast for Manitoba Hydro's Export Market in MISO - The Brattle Group

Conceptual Issues: Feedbacks and Interrelationships

Strong negative feedback effects tend to pull prices away from extremes over the long-term, but allow high short-run volatility, and still a broad range of long-term outcomes

- High power prices will reduce demand, encourage efficiency and demand response, spur newer and lower cost supply, and may reduce the political will to impose stringent and costly environmental policies, all of which tend to limit how high prices get
- Lower prices spur demand, reduce incentives for efficiency and demand response, slow entry of new generation, and make stricter environmental policies more politically palatable, limiting further price reductions

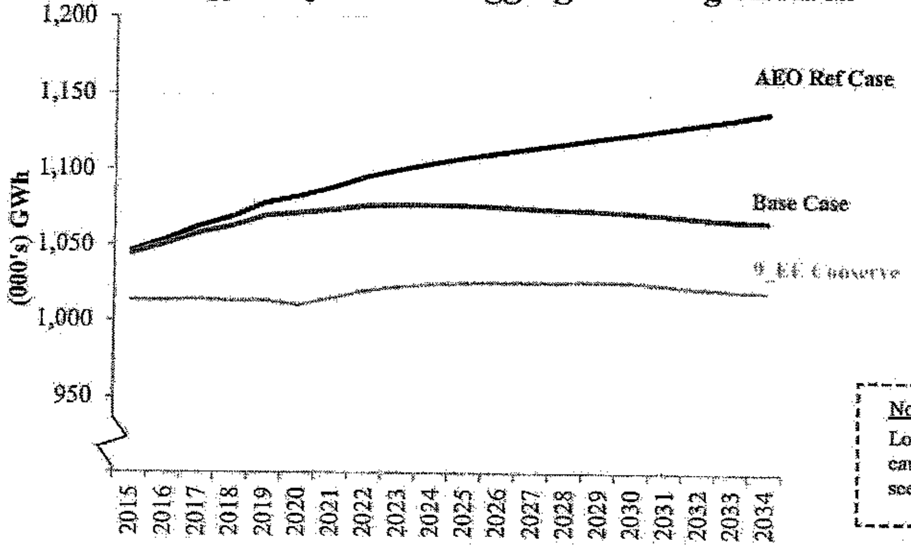
Our forecasting accounts for the long-run price elasticity of demand, as well as market responses regarding the addition of new generation, economic retirement of existing capacity, and system operation

- In the very long run, prices should be closely related to long-run marginal cost (at least in expectation). But since energy infrastructure is very long-lived, the "long run" can be very far in the future, and conditions may change again before we get there.

Load Projections

Reference load from 2013 AEO forecast

- Peak grows at 0.7%, energy at 0.4%, on average (just below AEO 2012 forecast)
- Load responds via price elasticity to retail power price in each scenario
  - Short-run and long-run price elasticity effects (elasticity of -0.1 and -0.4, respectively)
  - CO_2 costs phase in due to declining free allowance allocations over time
  - Base Case load rises slowly over the next 10 years, then flattens and declines slightly post-2020 due to CO_2 cost (peak still grows slightly). MRO-W has slightly higher growth.
- Also examine DSM program effects on load
  - E.g., utility efficiency programs (which can cannibalize price effect)



Annual Energy Projections - Aggregate 6-Region Area

Note:
Load differs in other scenarios. Retail cost differences cause different price elasticity responses. Higher-price scenarios have lower load levels, all else equal.

Tab 4

MANITOBA PUBLIC UTILITIES BOARD

IN THE MATTER OF *Order In Council 128/2013 and attached Terms of Reference Needs For and Alternatives (NFAT) Review*

AND IN THE MATTER OF *Manitoba Hydro's Filing with Respect to the Need For and Alternatives to Manitoba Hydro's Preferred Development Plan*

REBUTTAL EVIDENCE OF MANITOBA HYDRO

WITH RESPECT TO THE WRITTEN EVIDENCE OF:

- **ELENCHUS RESEARCH ASSOCIATES INC., ("Elanchus"); KNIGHT PIESOLD CONSULTING, ("KP"); LA CAPRA ASSOCIATES, INC., ("LCA"); MNP LLP, ("MNP"); MORRISON PARK ADVISORS, ("MPA"); POTOMAC ECONOMICS, LTD., ("POT") and POWER ENGINEERS INC., ("PE"), Independent Expert Consultants ("IECs") retained by the Public Utilities Board ("PUB")**

- **BILL HARPER, ECONALYSIS CONSULTING SERVICES; KYRKE GAUDREAU & ROBERT GIBSON; JILL GUNN & AYODELE OLAGUNJU, DOUGLAS GOTHAM, WAYNE SIMPSON; and WAYNE SIMPSON & DOUGLAS GOTHAM on behalf of Consumers Association of Canada (Manitoba) ("CAC")**

- **PAUL CHERNICK, RESOURCE INSIGHT, INC. and WESLEY STEVENS POWER ADVISORY LLC on behalf of Green Action Centre ("GAC")**

- **PATRICK BOWMAN, INTERGROUP CONSULTANTS LTD. on behalf of Manitoba Industrial Power Users Group ("MIPUG")**

- **WHITFIELD RUSSELL, WHITFIELD RUSSELL ASSOCIATES on behalf of the Manitoba Métis Federation ("MMF")**

- **PHILIPPE U. DUNSKY, DUNSKY ENERGY CONSULTING on behalf of Consumers' Association of Canada (Manitoba) and Green Action Centre ("CAC/GAC")**

February 28, 2014

Manitoba Hydro

2.2 Manitoba Growth Compared to Other Jurisdictions

On page 8 of their evidence, Drs. Simpson and Gotham, on behalf of CAC, express puzzlement as to Manitoba Hydro's projection of 1.6% load growth (1.5% under the 2013 Load Forecast) exceeding the load growth forecast for the U.S. at 0.9%. As noted in response to CAC/MH I-171 the 0.9% US load growth forecast was drawn from the U.S. Energy Information Administration's Annual Energy Outlook 2013 (AEO13) and represents an average for the United States. The AEO13 compares the AEO13 forecast with the forecast of three other agencies with the other agencies are all forecasting electricity sales to have a higher growth rate[1]. National Renewable Energy Laboratory's forecast is 0.2% per year higher, Energy Ventures Analysis' forecast is 0.4% per year higher, and IHS Global Insight's forecast is 0.7% per year higher than AEO13. These three agencies are forecasting U.S. electricity growth rates to be between 1.1% and 1.6% per year. Manitoba Hydro's 20 year forecast average annual growth of 1.4%, including the influence of DSM savings, is within these bounds.

The AEO13 does not give specific details regarding the construct of these forecasts. Such comparisons of load growth rates between jurisdictions cannot be presumed to compare equivalent measures. Definitions of load differ and treatment of losses vary. Recent data may not be available and older data is compared to newer data. Further, when comparing a specific jurisdiction to an overall average, it is important to recall that the average represents an average of the expectations of a number of unique jurisdictions some of which will be projecting higher or lower growth than the average.

A more appropriate comparator is the data assembled from utilities by the North American Electric Reliability Corporation (NERC). Table 3.1 of Chapter 3, is produced below in graphic format for the benefit of the reader, presented in the order given in Table 3.1. The data contained therein is collected by NERC using a specific definition of load (Total Internal Demand) to compare forecasts. What is to be included and excluded is specified, as are time periods, and the data is required to be submitted by all utilities subject to NERC jurisdiction to NERC. So this is the best source of comparing projected growth in relationship to other jurisdictions. NERC reports a Total Internal Demand figure that reports Summer and Winter peak demand excluding Station Service and including DSM programs and specific system improvements. Because of this, NERC reports Manitoba Hydro's Total Internal Demand growth rate for 2012 to 2022 to be 1.14%. This

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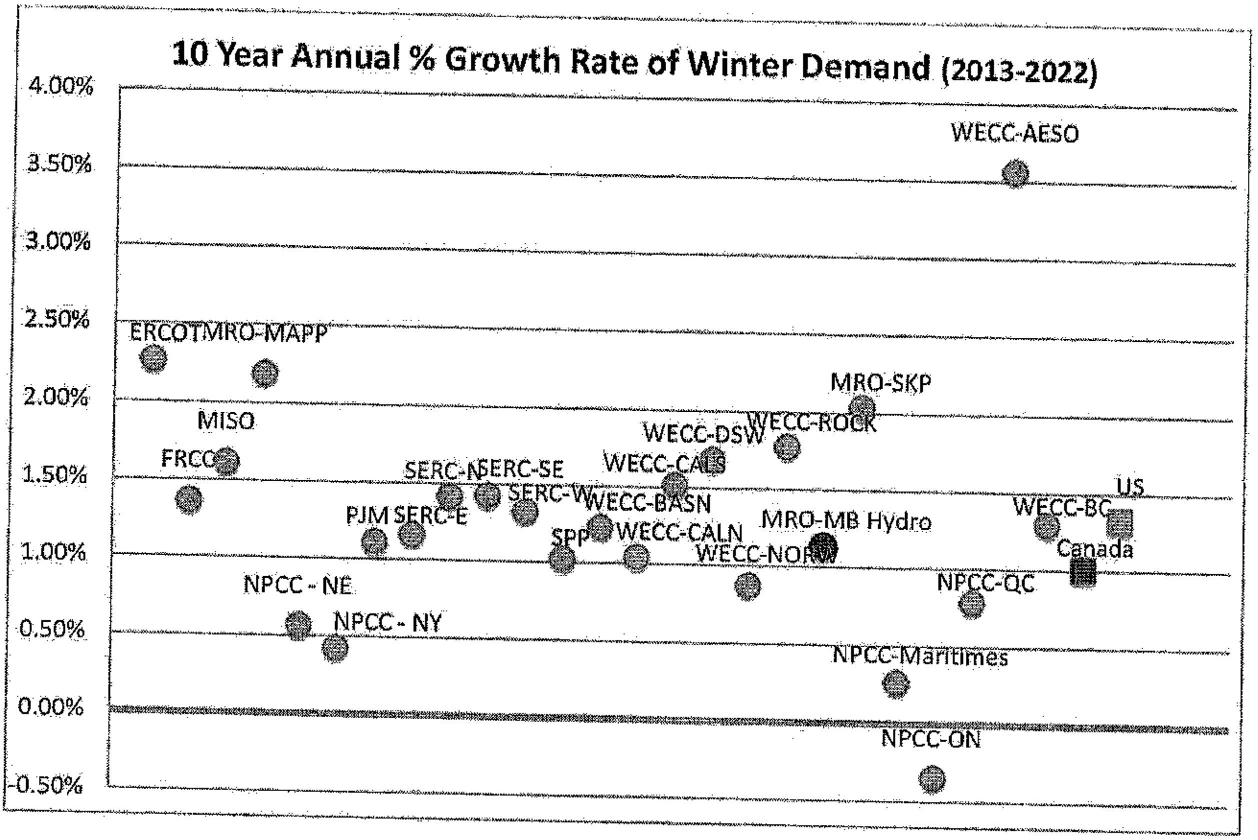
[1] Table 11 page 98 of http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf

corresponds to the 1.7% forecast annual peak growth during the same ten year period noted under Manitoba Hydro's 2012 Load Forecast.



In Mr. Dunsky's response to PUB/CAC-GAC-008a, he highlights four regions projecting flat to limited growth. The above figure demonstrates that Manitoba Hydro's forecast growth rate is only slightly higher than the "Total Canada" growth rate of 1.01%, but lower than the "Total U.S." growth rate of 1.33%. Ontario (NPCC-ON) and the Maritimes (NPCC-Maritimes), noted by Mr. Dunsky, do project flat growth over the next ten years. However, Table 3.1 also demonstrates that there are many jurisdictions with higher projected growth rates than Manitoba, including SaskPower (MRO-SKP) at 2.04%, Alberta (WECC-AESO) at 3.57%, and British Columbia (WECC-BC) at 1.30%. In the United States, the majority of jurisdictions have higher growth rates than Manitoba. Even the nearby MAPP region (MRO-MAPP) projects a higher growth rate at 2.19%. NERC presents all growth rates as including the influence of projected DSM savings.

their customers. As sufficient information was unavailable during the preparation of the 2013 forecast to provide reasonable certainty regarding the energy requirements of those projects, no projections beyond the PLIL were included in the 2013 forecast.

In one of its information requests (MIPUG/MH I-43b) and further outlined in MIPUG's response to MH/MIPUG I-4, Mr. Bowman suggests that Manitoba Hydro should consider an alternate load growth scenario that advances 13 years of PLIL growth (1300 GWh) to 2019/20. Manitoba Hydro considers the impact of this 1300 GWh advancement, combined with the four prior years of PLIL (400 GWh) included in the 2013 forecast, to be a conservative approximation of the anticipated net load growth for projects being considered by the pipeline sector in respect to both timing and magnitude. The analysis of the energy requirements for these projects is still ongoing and therefore subject to change as the proponents move forward with preparation of their regulatory filings. It is important to recognize that this allocation of the PLIL does not preclude considerations for other Top Consumers from moving forward with expansions to existing facilities or additions of new facilities that are included within the scope of the PLIL projection.

Since long term changes to the Top Consumers sector are difficult to predict reasonably on an individual consumer basis, the PLIL attempts not to capture the specific timing of these events, but to include a forecast of the cumulative load likely to be added by any given year – with the expectation, using the average growth experienced in the past 20 years, that there is an equal chance of the forecast being too high as there is of it being too low. The use of a trend line that is based on past periods of economic expansion as well as economic contraction enables Manitoba Hydro to produce a reasonable midpoint projection that is most likely to be unbiased as either high or low.

2.4 Price Elasticity in Manitoba

Elenchus, at page 44 of their evidence, and Drs. Simpson and Gotham, at page 9 of their evidence, have suggested that Manitoba Hydro's forecast ought to specifically recognize the potential demand response which may result from forecast future rate increases. Several Information Requests posed to Manitoba Hydro have also questioned the future effect of Manitoba Hydro's proposed long term price increases of 3.95% each year on demand. The current Manitoba Hydro long term plan forecasts electricity price increases of 3.95% per year for the next 20 years, compared to 2% per year increases in the CPI. This amounts to a real increase in electricity prices of 1.95% annually.

A price elasticity measure is expressed as a number such as -0.1, representing the ratio of the percentage change of the price response to the percentage change of the price. For example, with a price elasticity of -0.1, if the price of a product went up 50%, then the consumption of that product should correspondingly go down 5%.

Manitoba Hydro has among the lowest electricity prices in North America. As outlined in Manitoba Hydro's response to PUB/MH I-256, electricity prices have increased slowly at or close to the rate of inflation. As a result, the effect of price changes on customers' use of electricity would have been largely overwhelmed by the effect of other factors that affect demand for electricity, such as population increases, economic growth, improvements in residential construction, appliance efficiency, and the underlying random year-to-year variation in load.

Manitoba Hydro has previously investigated the possible relationship between energy use and price as noted in Manitoba Hydro's responses to PUB/MH I-256 and more recently in response to an interrogatory by Consumers Association of Canada (CAC) and Green Action Centre (GAC) (GAC-CAC/MH II-001a). These analyses have not provided estimates of elasticity that can be relied upon.

Manitoba Hydro formerly incorporated the effect of electricity and natural gas prices in relation to new homes selecting either electricity or natural gas for space heat into its load forecast. The analysis was based upon natural gas to electricity price ratios, and not electricity price alone. In 2012, the model incorporating the Price of Gas/Price of Electricity ratio predicted a decline in the percentage of New Electric Heat customers to the total number of new customers while the price of natural gas continued to fall. However, the actual market penetration of electric heat billed homes increased in 2011 and 2012. This was indicative that some other factor was being more determinative of the change in the percentage of electric heat billed customers than the price ratio, and the price ratio factor was removed from the model.

The following graph shows how the model built with the 2012 data would predict the historical data, and clearly shows that the model was not performing as expected in 2011 and 2012.

excluded (e.g. LED applications for Roadway lighting, residential and commercial applications; load displacement opportunities, fuel switching opportunities and energy conservation rates). These and other programs are expected to be added in future Power Smart Plans.

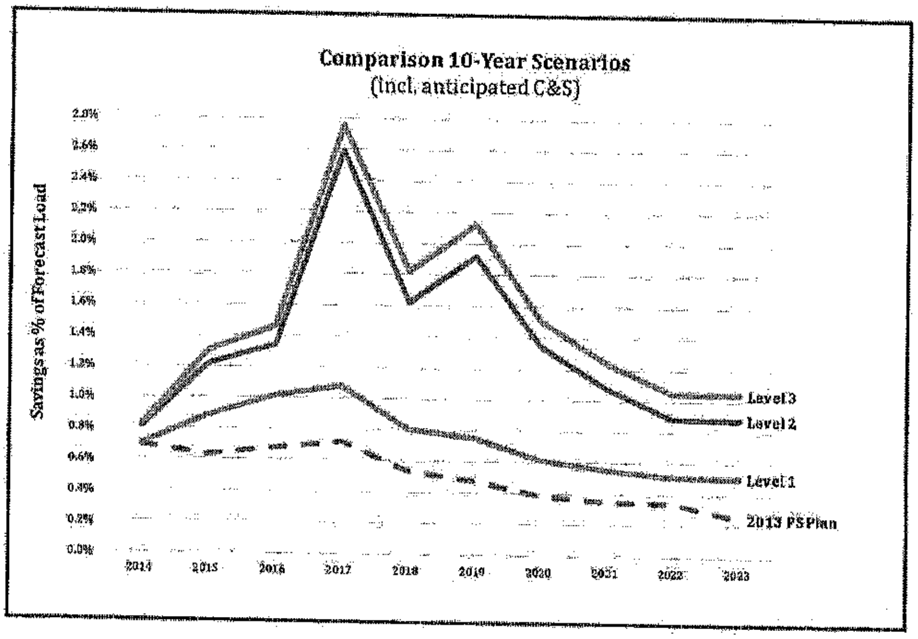
Manitoba Hydro is currently in the process of updating its DSM Plan in accordance with the Energy Savings Act and in consultation with the Minister responsible for Manitoba Hydro. The DSM Plan will likely continue to be a three year plan and Manitoba Hydro will subsequently be developing a longer term DSM Plan to meet the needs of the Corporation's resource planning process and requirements. To reflect DSM targets for resource planning purposes, the Corporation intends to forecast its expectation of DSM savings which will most likely be achieved, and therefore may include energy savings from emerging technologies or other initiatives such as load displacement, energy conservation rates and fuel switching.

For the purposes of undertaking evaluations as part of the NFAT process, Manitoba Hydro developed three levels of DSM. The DSM options were developed at a high level and without in-depth assessment for the purpose of evaluating various levels of DSM, whether economic or not. The three levels of DSM include the following broad categories:

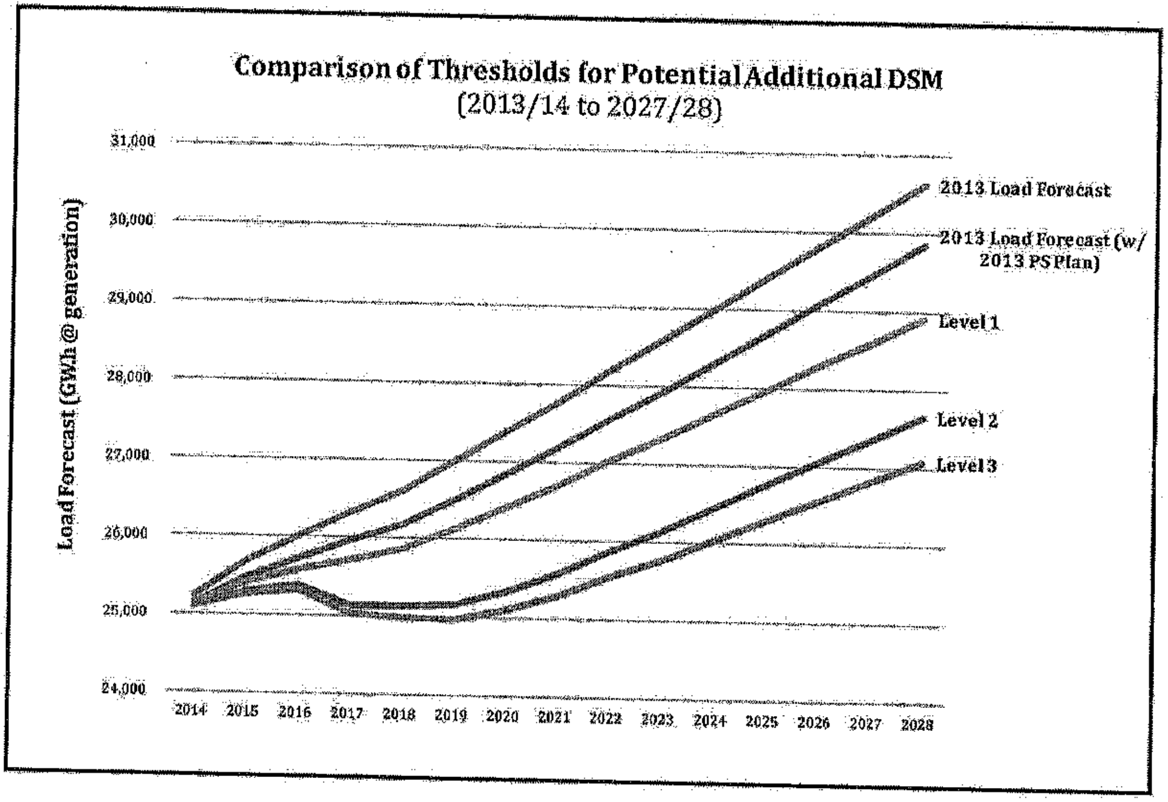
- DSM Level 1 – Energy Efficiency Programming which include extending some existing programs beyond the approval periods (e.g. insulation), emerging technologies which were now economic (e.g. LED applications in roadway, residential and commercial lighting applications), and modifying some existing programs with a more aggressive design and approach. Opportunities included with this option were considered to be generally economic subject to more in-depth analysis and review.
- DSM Level 2 – This option includes additional opportunities which have been and are still under consideration by the Corporation but which are of a different nature than the traditional energy efficiency initiatives. These initiatives include Conservation Rates, Load Displacement opportunities and Fuel Switching. Based on a high level assessment, these opportunities are considered to be economic, however they involve broader considerations beyond simply energy savings objectives.
- Level 3 – This option includes all of the DSM Level 2 initiatives and modifies the energy efficiency programs to achieve greater energy savings, but with a commensurate higher cost. These higher cost programs would be considered uneconomic relative to the Level 2 programs when evaluated against the marginal costs but were included here to test more fully the viability of a higher level of DSM.

		2014	2015	2016	2017	2018	2019	10 YEAR AVG 2014-2023 *(programs only)*	10 -yr Avg. 2014-2023 *(prog's + C&S)*
Level 1 0.5%	%/yr	0.4%	0.6%	0.7%	0.6%	0.5%	0.5%	0.5%	0.7%
	GWh/yr	*110*	*160*	*170*	*167*	*138*	*137*	*1,272 GW.h/yr (cumulative)*	*1,918 GW.h/yr (cumulative)*
Level 2 1.1%	%/yr	0.5%	1.0%	1.0%	2.1%	1.3%	1.6%	1.1%	1.3%
	GWh/yr	*138*	*244*	*255*	*559*	*352*	*445*	*2,459 GW.h/yr (cumulative)*	*3,104 GW.h/yr (cumulative)*
Level 3 1.2%	%/yr	0.6%	1.0%	1.1%	2.3%	1.5%	1.8%	1.2%	1.5%
	GWh/yr	*141*	*266*	*285*	*601*	*403*	*490*	*2,613 GW.h/yr (cumulative)*	*3,478 GW.h/yr (cumulative)*

The following figure illustrates the cumulative savings of the enhanced levels of DSM as a percentage of load reduction compared to Manitoba Hydro's 2013 Power Smart Plan.



The enhanced levels of DSM represent a significant potential reduction to Manitoba Hydro's load forecast. The following figure presents graphically the 2013 Forecast adjusted for the enhanced levels of DSM examined.



Under the 2013 Load Forecast, energy requirements are projected to grow at an average rate of 1.5% per year over 20 years with energy savings projected under the 2013 Power Smart Plan reducing average annual growth to 1.4%. Under the enhanced DSM scenarios, average annual load growth declines to 1.2% under Level 1, 0.9% under Level 2 and 0.8% under Level 3 over the 20 year forecast horizon.

3.3 DSM Planning as a Resource

Mr. Dunsky is concerned that Manitoba Hydro *"risks locking itself into a path of new supply that, as a result, will lock out the much less expensive option of more efficient demand"*. (Dunsky Report, page 16)

Manitoba Hydro has not locked itself into a new supply path. The purpose of this NFAT process is to assess and make recommendations as to which future resources will be developed. The selection of resources and any commitment will depend on the outcome of the NFAT process and subsequent government decisions.

Manitoba Hydro's Power Smart Plan is an integral component of the Corporation's resource plan. Manitoba Hydro's DSM strategy is to pursue all economic DSM opportunities. The Power Smart Plan is developed following this principle, and results in DSM being a preferred option relative to alternative supply side options within the integrated resource planning process. This has been the case for many years and as a result, the Power Smart plan has and continues to be a component of the Corporation's strategy to meet the future electricity needs of Manitoba.

All the NFAT development plans and the pathways include DSM and whichever plan or pathways is pursued will involve expanding DSM.

We concur with Mr. Dunsky that the 1.5x DSM and 4x DSM sensitivity evaluations in Chapter 12 do not provide an integration of DSM and supply which determines the optimum level of DSM. Instead, as stated in the submission, the sensitivities were intended to assess the impact on the supply option selection arising from different levels of DSM which potentially would be developed by Manitoba Hydro.

An integrated evaluation of DSM and supply options to determine the optimum level of DSM could not be provided in the August submission because of the delay in the DSM Potential Study. The DSM options are currently being assessed with the supply options in development plan evaluations and will be provided to the NFAT process as soon as complete.

These evaluations with different levels of DSM will be input into the decisions on:

- DSM expansion
- Selection of development pathway
- Selection of generation options over time (e.g. If Keeyask developed first; would subsequent generation be Conawapa or gas fired generation)
- Timing of these generation options.

The planning for DSM programs and integration with supply options will not stop with the NFAT analysis but carry on in further stages. The DSM program option chosen will evolve in conjunction with supply option planning and not be locked out.

There is a risk when evaluating DSM Option levels, which are packages of programs, that the chosen DSM Option level could include individual programs which are individually not economic. There is also the converse risk that a DSM Option level not chosen contained DSM programs which individually were economic.

At page 20 of his evidence, Mr. Dunsky postulates a series of aspects that limit the DSM Potential Study, which as he characterizes "limiting the estimated savings potential". The first area of concern is possible exclusions from the study. Manitoba Hydro acknowledges that load displacement and fuel switching to natural gas were not included within the scope of this study. Conservation Rates were not explicitly modeled within the study; however the Corporation notes that conservation rates may be a possible program strategy used to pursue the higher level market potential, as contained in DSM Level 2.

The following evidence was prepared in collaboration with EnerNOC Utility Solutions in regards to the other exclusions identified in Mr. Dunsky's report:

- *Individual Measures* – The measure list for this study was developed in late 2011 and represents an extensive list of measures compiled by EnerNOC that underwent a qualitative screening process for relevance to Manitoba and also a thorough review by Manitoba staff. For example, Mr. Dunsky specifically referenced the exclusion of air-source heat pumps. In determining the measures relevant to Manitoba, EnerNOC excluded air-source heat pumps in the qualitative screening process as they are not well-suited to Manitoba's very cold climate. EnerNOC's research at the time indicated that air source heat pumps do not work well in cold climates. There was one manufacturer of a "cold-climate" heat pump, but EnerNOC considered this to be an emerging technology that was not proven. Ductless heat pumps were also excluded as an emerging technology. It should be noted that both of these technologies are load-building technologies since they would add cooling to homes that do not currently have it. Geothermal heat pumps were assessed at Manitoba Hydro's request. Air source heat pumps are an electric heat technology which compete with ground source heat pumps. In cold climates, such as Manitoba, the seasonal coefficient of performance (SCOP) of an air source heat pump is lower than a ground source heat pump as the earth retains a larger quantity of heat throughout the winter compared to the air. Pages 6-8 of the Demand Side Management Potential Study note that for the residential market sector, "Heating offers the highest technical potential, which reflects the across the board-installation of geothermal heat pumps". With air source heat pumps having a lower SCOP than ground source heat pumps, including the technology in the Study at the technical level would not have increased the technical potential. The approximate installed cost of a whole home air source heat pump that can operate in Manitoba's cold climate is $14,000 to $16,000 installed, with an approximate SCOP of 1.5.

program administration costs were included, keeping the costs to a minimum and producing a higher B/C ratio.

Under the LoadMap model used for determining cost effective measures, each measure is assessed each year within the study horizon such that a measure that is not cost effective in years 1 or 2 may become cost effective in year 3 and is accounted for in the potential.

- *Non-energy benefits* - As Mr. Dunsky notes at page 53 of his report, it is difficult to assess the value of non-energy benefits (NEBs) and, for this reason, EnerNOC states that most of their clients do not require the analysis to consider NEBs. The only NEBs EnerNOC has considered are water savings from low-flow showerheads and horizontal-axis washers. If these measures do not pass the economic screen (B/C ratio < 1.0) on energy savings alone, EnerNOC looks at the B/C ratio. If it is close to 1.0, then the client may direct EnerNOC to include the measure in economic potential. EnerNOC's LoadMap model has a "B/C kicker" variable that allows them to augment the B/C ratio so it is greater than 1.0. EnerNOC has not considered other NEBs such as productivity in their potential studies.

- *Measure bundling* – Measures in the DSM potential study were screened on an individual basis. However, when designing programs, Manitoba Hydro does bundle measures where it makes sense to do so such as with insulation measures or under its Affordable Energy Program targeted to lower income customers.

The third area of concern noted by Mr. Dunsky is related to the approach to determining the baseline projection and achievable market adoption rates.

- Mr. Dunsky states concern that the baseline projection in the study is lower than the load forecast used by Hydro for its overall energy planning. The EnerNOC baseline projection in the Manitoba potential study is lower than the corporate load forecast because EnerNOC uses an end-use forecasting approach that focuses on describing end-use energy for purposes of estimating potential energy efficiency savings. This approach explicitly accounts for numerous factors, including appliance standards, building codes, and customer response to energy prices, some of which are not included in the same way in utility forecasts. In addition, EnerNOC's modeling of growth in the commercial sector is driven by floor space and in the industrial sector is driven by employment and this approach for modeling growth is also different than what utilities typically use to develop their load forecasts and is better for DSM analysis. The purpose of EnerNOC's projection is to identify and quantify the likely projection for each technology included in the study so that the analysis of potential savings through energy-efficiency programs start in an appropriate place. The baseline projection is a stepping stone rather than a key deliverable of the potential study.

In most of EnerNOC's potential studies, the baseline projection is lower than the official utility forecast. This is not of great concern to EnerNOC or to many of their clients as the development of the baseline projection is separate and distinct from the process utilities use to develop their load forecast. Different methods produce different results. In cases where EnerNOC's clients have wanted the baseline projection to align with the utility load forecast, the difference between the baseline projection and the utility forecast is allocated to the miscellaneous-miscellaneous category which does not have any energy-efficiency savings associated with it; either approach results in the same outcome.

- *Adoption Rates* – Mr. Dunsky states that the adoption rates appear far lower than is found in many other regions, including those that served as the basis for the study. EnerNOC routinely adjusts the adoption rates used as a starting point to reflect local results and circumstances (in this case the starting rates are from the Pacific Northwest U.S and adjusted for Manitoba). This information is incorporated into estimates of Market and Achievable Potential. The Market Potential estimates provide an upper bound of potential. Achievable Potential and Market Potential provide a range of potential that could be reached through increased funding, program design, and other actions.

3.6 Solar and Grid Parity

The evidence of both Manitoba Hydro and Mr. Dunsky points to considerable long-term uncertainty over the future costs of solar PV. Such uncertainty provides a challenging framework within which to establish the timing of solar PV as a cost-effective supply option in Manitoba.

In his evidence supporting the near-term grid parity of solar PV installations, Mr. Dunsky provides an estimated time frame for grid parity based on high and low price considerations, using Manitoba Hydro's information as the low price scenario. The estimates for grid parity are based upon solar installations across a number of jurisdictions, not only Manitoba. Costs in each jurisdiction will be impacted by a number of factors including variations in retail rates, incentives, rebates, tax credits, and installations costs.

Tab 5

ask you to put -- to move the microphone to the other side of your -- your left-hand side. That'll probably be easier.

Yeah. That'll be -- I think we'll get a -- we'll get a better reception if you're speaking to that one.

MR. SCOTT THOMSON: Okay.

THE CHAIRPERSON: Thank you.

MR. SCOTT THOMSON: Is that better?

THE CHAIRPERSON: Yeah

CONTINUED BY MR. BYRON WILLIAMS:

MR. BYRON WILLIAMS: I was trying to take tactical advantage of you having to twist your head, Mr. Thomson, so.

Despite your recent start with the Corporation, I take you -- take it that, at a high level, you're familiar with the NFAT business case?

MR. SCOTT THOMSON: Yes, I am.

MR. BYRON WILLIAMS: And at a high level you're aware of the screening process and the alternatives analysis?

MR. SCOTT THOMSON: Yes.

MR. BYRON WILLIAMS: And I know you've been really busy since you got here, but would I be correct in assuming that prior to pro -- partaking in -- in this NFAT you would have taken the time to review the report and recommendations of the joint panel into the Wuskwatim NFAT?

Would you have done that, sir?

MR. SCOTT THOMSON: I haven't seen that in detail.

MR. BYRON WILLIAMS: Okay. Coming back to 2013, can we agree that at the time the Hydro business case was filed in August of 2013 that an economic analysis to evaluate the attractiveness of higher levels of DSM was not able to be completed at that time, sir?

MR. SCOTT THOMSON: Yes, that's true.

MR. BYRON WILLIAMS: And we can agree -- or you will agree with me, that the Hydro business case filed in August of 2013, in the business case, the Corporation was unable to provide an integrated evaluation of DSM and supply options which would have allowed for the assessment at the optimum level of DSM, correct?

MR. SCOTT THOMSON: I think that's true. I think that sensitivity information had been filed at that point, and -- and we were waiting for the -- the DSM potential study results to come out to -- to have a better understanding of what was -- what was possible.

MR. BYRON WILLIAMS: Okay. And, sir, again recognizing that you haven't memorized the report from Wuskwatim into the NFAT, but going back to that report, would you be aware that in that proceeding it was recommended that in any future Manitoba Hydro -- Hydro NFATs, that portfolios should include consideration of hydro electric sequencing as well as coordinated implementation of other initiatives, such as DSM programs and SSE programs?

Were you aware of that, sir?

MR. SCOTT THOMSON: Not the explicit details, but -- but I'll accept that.

MR. BYRON WILLIAMS: Okay. And you'll be aware -- or you'll accept, subject to check, that the Wuskwatim recommendations were made in September of 2004?

MR. SCOTT THOMSON: Subject to check.

MR. BYRON WILLIAMS: Roughly nine (9) years before this NFAT filing, agreed?

MR. SCOTT THOMSON: Agreed.

MR. BYRON WILLIAMS: And would you agree that nine (9) years would be sufficient time to integrate DSM into hydro resource planning in such a way as to provide alternatives for examining an optimized DSM por -- portfolio, sir?

MR. SCOTT THOMSON: Well, I think that work had been done. A consultant had been hired. And as I understand it, the -- the Corporation anticipated the -- the DSM potential study about a year before it was delivered. It was -- it was quite late.

And so the -- the work plan had -- had anticipated that -- that we would have had that and we would have been able to integrate that sooner. The analysis is -- has been done subsequent, and -- and the -- the DSM load forecasting panel, which is next, tomor -- I believe, starting tomorrow, will be addressing questions around that.

MR. BYRON WILLIAMS: And, Mr. Thomson -- and if this is an unfair question, your counsel will -- will chip in -- but, to your knowledge, has the detailed analysis supporting this DSM analysis been -- been filed on the public record or is it just the reference to the -- in rebuttal evidence?

(BRIEF PAUSE)

MR. SCOTT THOMSON: It's -- it will be filed. Mr. Kuczek, tomorrow, will be in a position to mention, 'cause I was trying to save some time, but I'll mention it now, is that the transmission planning authorities in Minnesota have strongly indicated that transmission lines should be optimized in terms of use of the right-of-ways. There's a lot of opposition to expanding transmission lines. We've seen it in Manitoba. It's -- certainly see it in Minnesota.

And what they have told all the developers is -- and a goal is to use the available right-of-ways to the max amount out possible. So if Minnesota Power now went back and withdrew the 750 megawatt option and put the 250 megawatt, the smaller option, on the table, which has much less ability and -- and less potential to expand later, the transmission approval people would -- would look probably not very kindly on that.

THE CHAIRPERSON: Now, just since you've raised the issue of DSM -- and I -- I know you're not the expert on DSM -- but there -- there is a strategic element to this because one (1) of the -- one of the experts acting on behalf of GAC and CAC has suggested that DSM should be addressed via integrated resource planning, specifically, that it's not considered an add-on but you -- you use that as one (1) of the potential sources of -- of supply, in essence,

3

in your decisions around which options should you pursue.

So I guess the question is: Longer term, are you considering integrating DSM into your resource planning given the significance of DSM more generally in North American and in Canada?

MR. ED WOJCZYNSKI: I -- well, thank you for the question. And I was going to touch on that, but I'll -- I'll do that now.

Manitoba Hydro agrees that for us to have a -- a good evaluation and comparison and decision on -- on which pathway we should follow, which -- which of these decisions we should take, we should have a good sense of what would the different DSM options -- how they combine with the different plans, and would your choices change with the -- the different DSM levels or sets of options, and that we should integrate those.

Manitoba Hydro has been looking at DSM on an ongoing basis. There are two (2) ways to do it. You can use what are called the marginal values of how much extra DSM is worth with the current plan you have. And if you're not looking -- and that's what we have been doing for a number of years, and that's because we weren't looking at radically different plans. The plans were more or less similar, and so the -- the value of additional DSM wouldn't change that much.

But now when we're looking at radically different plans for going forward, then the -- the value of the -- the incremental DSM could be different in those plans and could complement them in different ways. And they should be integrated into that analysis, and that is what we are doing.

And, unfortunately, as was mentioned earlier, we had intended to have that available well before our submission in August last year. The DSM potential study, which is a -- a first step in doing that, took a lot longer, a year and a half longer, than was -- was supposed to happen, and so we weren't able to do that integrated evaluation in our submission. We did a sensitivity to try and see what impacts there may be, but that isn't a -- a full integration.

What you will be getting in the course of the next few weeks will be that integrated evaluation. And we are -- it's still actually a work in progress. We're just doing the final work on that. And -- and it's not even quite ready yet, although we have some preliminary indications, and I was going to talk about that.

Refer to these choices, and in -- in

Tab 6

LOAD FORECAST

&

DEMAND SIDE MANAGEMENT

Lloyd Kuczek – VP, Customer Care & Energy Conservation

Date: March 4, 2014

Manitoba Hydro

Load Forecast – Potential Adjustments

Change Item	Impact – GW.h	Date
Pipeline Sector	1700 GW.h*	2019/20
Codes and Standards	(300) GW.h	2027/28
Price Elasticity	(500-600) GW.h	2027/28
Fuel Choice	(100) GW.h	2027/28

- Concurrently, The Potential Large Industrial Load (PLIL) Value To Be Used For The 2014 Forecast Will Need To Be Assessed

<u>Caution</u>: information is subject to further analysis/confirmation

Tab 7

MH Exhibit #65
Undertaking # 56
Transcript Page # 2747
Page 1 of 1

MANITOBA HYDRO

2012/13 & 2013/14 ELECTRIC GENERAL RATE APPLICATION

UNDERTAKING PROVIDED BY: L. MORRISON

Manitoba Hydro Undertaking #56

Manitoba Hydro to provide the request for proposals that was submitted to the marketplace for the DSM Market Potential Study.

Response:

Please see the attachment to this response.

2013 01 10

3

Manitoba
Hydro

REQUEST FOR PROPOSAL 035349

PROVISION OF DEMAND SIDE MANAGEMENT MARKET POTENTIAL STUDY

IMPORTANT

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FEBRUARY 16, 2011

41

Manitoba
Hydro

GENERAL REQUIREMENTS

4

PROVISION OF DEMAND SIDE MANAGEMENT MARKET POTENTIAL STUDY REQUEST FOR PROPOSAL 035349

GENERAL REQUIREMENTS

1 BACKGROUND

Manitoba Hydro, a provincial Crown Corporation, provides electric service to over 532,000 customers throughout Manitoba and natural gas service to over 264,000 customers in various communities in Manitoba. Manitoba Hydro generates, transmits, distributes and provides retail electric services, and provides distribution and retail natural gas services within the province of Manitoba. Manitoba Hydro also exports and imports electricity within three wholesale markets in Canada and the Midwestern United States.

Manitoba Hydro, a leader in energy efficiency, was recently recognized when Manitoba received an A-plus on the 2009 Canadian Energy Efficiency Alliance's (CEEA) National Energy Efficiency Report Card. This was the fourth consecutive report card where Manitoba either led or was tied for first place in the national rating. Manitoba Hydro's Power Smart DSM initiative is designed to aggressively promote the efficient use of energy in the residential, commercial, institutional, agricultural and industrial customer sectors. More than 40 programs and initiatives have been offered over the last 19 years with 36 offerings included within our current portfolio.

As part of Manitoba Hydro's overall strategy to transform the Manitoba market, its staff sit on a number of provincial and national bodies to ensure that energy efficiency is incorporated into codes and regulations. Manitoba Hydro also sits on the CSA Strategic Steering Committee on Performance, Energy Efficiency and Renewables (SCOPEER) and funds the development of standards that improve the energy performance of equipment and serves as the basis for provincial and national codes and regulations.

1.1 ELECTRIC SERVICES

In 1991, Manitoba Hydro established its Power Smart Demand Side Management (DSM) initiative and created its first long range DSM plan. In the long range planning process, Power Smart DSM resource options are developed and included in the Corporation's Integrated Resource Planning process. The DSM resource options are designed to provide alternative cost-effective methods of power supply, to minimize the total cost of energy services to customers and to provide value-added services for customers.

4

In order to develop aggressive MW and GW.h savings projections, Manitoba Hydro undertook a summary review of the DSM market potential within its service territory in late 1999. In 2003, a second market potential study was undertaken that provided quantitative information about the maximum attainable DSM potential for electricity within the Manitoba Hydro service territory.

1.2 NATURAL GAS SERVICES

Manitoba Hydro acquired Centra Gas in 1999. In 2001, Manitoba Hydro introduced its first natural gas Power Smart offering to customers; and in 2004, the Power Smart Plan was adjusted to include natural gas savings projections.

Following the completion of the electric DSM market potential study in 2004, Manitoba Hydro undertook an internal study to identify the achievable natural gas conservation potential in Manitoba. The report was finalized in 2005 and used to develop targets for the 2005 Natural Gas Supplement to the 2004 Power Smart Plan. All Power Smart Plans now include integrated electric and natural gas DSM energy savings forecasts.

1.3 POWER SMART DSM PORTFOLIO

Manitoba Hydro reviews and prepares an integrated electric and natural gas Power Smart Plan on an annual basis. This allows Manitoba Hydro to adjust its strategies, increasing or decreasing its involvement in DSM to reflect corporate, economic and market situation changes. On an annual basis impact evaluations of DSM initiatives are also prepared to determine the energy savings and cost-effectiveness of the programs being offered.

The following table outlines Manitoba Hydro's current portfolio and the projected savings for each program in 2010/11, 2011/12 and 2012/13 from the 2010 Power Smart Plan. Internal Manitoba Hydro staff have been involved in the analysis, design and delivery of these programs and initiatives, thus extensive market information has been acquired and is available on the majority of these programs.

	Launched	GW.h			m3 (000,000's)		
		2010/11	2011/12	2012/13	2010/11	2011/12	2012/13
RESIDENTIAL							
New Home Program	Feb-04	0.50	6.00	11.61	0.07	0.98	1.91
Home Insulation Program	May-04	4.73	9.00	12.81	1.25	2.46	3.63
Water and Energy Saver Program	Sep-10	4.30	9.87	16.78	0.36	0.80	1.32
Residential CFL Program	Sep-04	19.19	40.07	40.07	0.00	0.00	0.00
Lower Income Energy Efficiency Program	Dec-07	1.67	4.24	6.80	1.10	2.78	4.47
EE Light Fixtures	Oct-08	0.23	0.47	0.47	-	-	-
Fridge Recycling Program*	Spring-11	3.33	16.62	29.92	-	-	-
Residential Appliance Program (market effects)	Jun-06	1.10	2.09	3.19	0.03	0.06	0.09
Power Smart Residential Loan Program	Feb-01	0.64	1.28	1.92	0.50	1.00	1.50
Wisdom in Saving Energy (WISE) Home Program	Jun-01	-	-	-	-	-	-
Energy Saver Presentations	Jan-02	-	-	-	-	-	-
New Home Program Workshop	Jan-02	-	-	-	-	-	-
ecoEnergy	Mar-01	-	-	-	-	-	-
Residential Earth Power Program	Apr-02	1.64	3.40	5.30	0.22	0.45	0.70
Solar Water Heaters	Nov-08	0.05	0.05	0.05	n/a	n/a	n/a
COMMERCIAL							
Commercial Lighting Program	Apr-92	28.65	52.42	73.48	-	-	-
Commercial Custom Measures Program	Dec-95	0.57	1.14	1.71	0.06	0.12	0.19
Commercial Windows Program	Dec-95	2.49	4.21	5.92	0.35	0.60	0.85
Commercial HVAC Program - Chiller	Sep-03	0.97	1.91	2.81	-	-	-
Commercial Parking Lot Controller Program	Dec-95	0.38	0.38	0.38	-	-	-
City of Winnipeg Power Smart Agreement	Sep-02	0.23	0.46	0.46	-	-	-
Commercial Refrigeration Program	Apr-06	1.35	2.84	4.53	-	-	-
Commercial Insulation Program	Dec-95	3.23	6.43	9.61	1.40	2.80	4.21
Commercial Earth Power Program	Dec-95	2.24	4.49	6.82	n/a	n/a	n/a
Commercial New Construction Program	Apr-09	3.34	7.24	13.37	0.22	0.47	0.87
Commercial Building Optimization Program	Apr-06	0.66	1.42	2.73	0.14	0.31	0.60
Internal Retrofit Program	Jul-95	4.49	19.11	22.20	-	-	-
Agricultural Heat Pad Program	Apr-98	0.70	1.01	1.15	-	-	-
Power Smart Energy Manager Program	Nov-08	0.00	0.72	1.44	0.00	0.04	0.09
Commercial Kitchen Appliance Program	Jan-08	0.20	0.44	0.73	0.03	0.07	0.12
Commercial Clothes Washers Program	Jul-08	0.13	0.26	0.41	0.01	0.02	0.03
Network Energy Management Program	May-08	3.12	6.31	9.53	-	-	-
Power Smart Shops	Feb-09	0.35	0.72	1.10	0.02	0.04	0.06
CO2 Sensors	Apr-09	0.03	0.07	0.12	0.04	0.09	0.15
Commercial Boiler Program	Sep-08	-	-	-	0.96	2.27	3.55
Commercial Rinse & Save Program (market effects)	Jul-06	0.18	0.37	0.55	0.08	0.16	0.24
Religious Buildings Initiative	May-01	-	-	-	-	-	-
Power Smart Recreation Facility Survey	May-98	-	-	-	-	-	-
Power Smart Design Standards	Sep-08	-	-	-	-	-	-
INDUSTRIAL							
Performance Optimization Program	Jun-93	12.90	25.80	38.70	-	-	-
Emergency Preparedness Program*	TBD	0.00	1.50	6.00	-	-	-
Industrial Natural Gas Optimization Program	Sep-06	-	-	-	1.60	3.20	4.80
Curtailable Rate Program	Nov-93	-	-	-	-	-	-
Bioenergy Optimization Program	Mar-06	69.56	73.38	87.94	0.03	0.03	1.75
GRAND TOTAL		173.16	305.70	420.61	8.45	18.77	31.12

*Not yet launched

The following table outlines the programs that Manitoba Hydro previously offered in its portfolio which have now been completed. Programs ended for a variety of reasons such as the enactment of codes and regulations, transformation of the market, or complete conversion of the market (e.g. streetlight conversion).

COMPLETED PROGRAMS	Launch Date	End Date
RESIDENTIAL		
Outdoor Timer	Oct-89	Mar-94
Refrigerator/Freezer Buy-Back Pilot	1991/92	1991/92
Residential Showerhead Pilot	1991/92	1995/96
EE Water Tank 'No Worry Plan'	Nov-96	1999/00
Seasonal LED Lighting	Nov-05	Nov-08
Programmable Thermostat Pilot	Oct-06	Mar-08
Energy Efficient Appliances	Jun-06	Mar-09
HE Furnace/Boiler	Nov-05	Dec-09
R-2000 Home Program*	Feb-02	2003/04
ecoENERGY (formerly EnerGuide)	Mar-01	Mar-10
COMMERCIAL		
Roadway Lighting	Apr-91	1994/95
Sentinel Lighting Conversion	Apr-91	1993/94
Commercial Showerhead Pilot	1991/92	1991/92
Infrared Heat Lamps	1991/92	1991/92
Agricultural Demand Controller	Jul-92	1993/94
Livestock Waterer	Oct-94	1996/97
Commercial Construction- Air Barrier Component	Dec-95	2005/06
Commercial Construction- Air Conditioning Component	Dec-95	2005/06
Agricultural Heat Pads	Apr-98	Mar-10
Parking Lot Controllers	Dec-95	Mar-10
Rinse & Save	Jul-96	Feb-10
Power Smart Energy Manager - Pilot	Sep-01	2004/05
INDUSTRIAL		
High Efficiency Motor	Sep-91	1997/98

Since the completion of both the 2004 electric and 2005 natural gas studies, Manitoba Hydro has continued with an aggressive DSM market intervention strategy. As such, it is now an appropriate time to revisit the Corporation's understanding of the achievable DSM opportunities remaining within the Manitoba market and realign its focus and efforts to ensure continued DSM success.

2 STUDY OBJECTIVE

In October 2011, Manitoba Hydro will begin the process of creating the Corporation's 2012 Power Smart Plan. To aid in the development of the DSM targets, Manitoba Hydro wishes to update its estimates of technical, economic and market attainable savings potential by performing a quantitative assessment of existing technologies and the potential for energy efficient technologies (existing and emerging). Manitoba Hydro is seeking a consultant to undertake a comprehensive and quantitative review of the Manitoba Hydro service territory to determine the maximum market attainable DSM potential for electricity and natural gas for the period of 2012 to 2031, using 2011 as the reference year. This potential will be based on Manitoba Hydro's extensive and detailed information available on the Manitoba market and each program and/or technology.

54

Manitoba Hydro has an established system in place for evaluating the cost effectiveness of DSM technologies and initiatives based upon:
(a) Marginal Resource Cost (MRC) Test,
(b) Total Resource Cost (TRC) Test,
(c) Levelized Utility Cost (LUC),
(d) Rate Impact Measure (RIM) Test,
(e) Participating Customer (PC) Test, and
(f) Customer Payback.

Maximum achievable energy savings estimates for the next 20 years are required for all markets; residential, commercial, institutional, agricultural and industrial. In order to determine estimates of maximum attainable potential, economic and market opportunities and barriers should be considered (including Federal Government initiatives) and the utility involvement that would be required to achieve this maximum attainable potential should be specifically defined.

Based upon the introduction of new and emerging technologies, the market review should include an examination of existing energy efficient technologies and those technologies that may be "on the horizon" and potentially viable for Manitoba Hydro customers when determining the maximum market attainable potential.

The outcome of this project will be the design, delivery and reporting of a maximum market attainable potential study for Manitoba Hydro's service area for the period of 2012 to 2031, using 2011 as the reference year. Under this study, three distinct questions must be addressed:

i) What is the technical potential for reducing electricity and natural gas use for the years 2012 to 2031 for the Manitoba Hydro service area, highlighting activity for 2012 and each subsequent 5 year period?
ii) What is the economic potential for reducing electricity and natural gas use for the years 2012 to 2031 based upon various Levelized Utility Cost thresholds for the Manitoba Hydro service area, highlighting activity for 2012 and each subsequent 5 year period?
iii) What is the maximum market attainable DSM potential for electricity for Manitoba Hydro for the years 2012 to 2031, highlighting activity for 2012 and each subsequent 5 year period?

3 SCOPE OF WORK

As directed by Manitoba Hydro's Power Smart Planning, Evaluation and Research Department and with the support of Manitoba Hydro's human and database resources, the Consultant is to provide qualified technical and market consulting expertise to develop and define the maximum attainable market

96

potential for energy efficient technologies in Manitoba, for the period of 2012 to 2031, using 2011 as the reference year.

The following tasks are expected, along with a preliminary report and a final report of its findings and recommendations.

(a) Using Manitoba Hydro's extensive knowledge of the market, undertake a comprehensive review and study of the DSM market in Manitoba Hydro's service territory to determine the technical potential in all market segments (residential, commercial, agricultural, and industrial) for the period of 2012 to 2031.

(b) Using four Levelized Utility Cost thresholds for electric DSM (two distinct levels each with a separate summer and winter value) and one Levelized Utility Cost threshold for natural gas DSM, assess the economic DSM potential for electricity and natural gas within Manitoba Hydro's service territory for all customer sectors. The Total Resource Cost Test, Rate Impact Measure Test and Customer Payback will be used as secondary economic indicators in the analysis.

(c) Estimate the maximum attainable DSM market potential for electricity and natural gas for a utility program offered within Manitoba Hydro's service territory. This estimate shall be developed working within market constraints and recognizing the role of trade allies, retailers, distributors, customer acceptance and adoption curves. This scenario assumes a high level of utility commitment and involvement in the Manitoba marketplace through the aggressive pursuit of DSM savings by Manitoba Hydro.

For electricity, the attainable potential outlined should identify potential kW.h savings/year and kW savings at Manitoba Hydro's system peak by market segment (residential, commercial, agricultural and industrial). For natural gas, the attainable potential should identify potential cubic metre savings/year by market segment.

The study should also outline the potential savings for the various technology opportunities and sectors within each segment, prioritized based upon the greatest maximum attainable market potential. For example, technology opportunities would include lighting, HVAC, equipment, etc.; sectors in the commercial segment may include hotels, grocery stores, offices, etc.; sectors in the industrial segment may include mining, manufacturing, etc.; sectors within the agricultural segment may include hog production, grain production, etc.; and sectors within the residential segment may be based upon geographic location, target communities, etc..

47

(d) Create a reference case for all market intervention to estimate what is attainable under a "Basic Customer Services & Standards" scenario for the period of 2012 to 2031. This scenario incorporates foreseeable energy efficiency improvements as a result of efficiency standards and codes in Manitoba's marketplace without any active promotion or involvement by Manitoba Hydro. Under this scenario, no further DSM program activity (e.g. incentives) would be carried out, but there would be a continuation of customer information and service offerings, and continued development and guidance of energy efficiency standards in Manitoba and Canada.

(e) The Consultant should provide two estimates; one for an electric DSM potential study only and one for an electric and natural gas DSM potential study. Under both study options, energy interactive effects must be recognized.

Since Manitoba Hydro has been involved in DSM and energy efficiency in Manitoba since 1991, program staff are very knowledgeable about the state of the market and thus will be able to provide insight and assistance in determining the market potential in Manitoba. Manitoba Hydro also has existing information sources that are available for review by the Consultant which will dramatically reduce the amount of work required in undertaking this project. The following outlines some examples of information and reports that are available. Manitoba Hydro's DSM Long Range Plans for the years of 1992/93 through to and including 2010/11 outline the DSM strategies undertaken and the forecasted energy and savings for DSM programs and initiatives. Results from the 2009 Residential Customer Energy Use Survey provides detailed information about electricity and natural gas usage in Manitoba. The Manitoba Hydro End Use Load Forecast provides a forecast of the domestic natural gas and electric energy and demand usage. The Manitoba Hydro Customer Information Database provides historical natural gas and electrical energy and demand consumption. Program impact evaluation reports and memos for current and past Power Smart programs and the Power Smart Annual Reviews for the years 1991/92 through to and including 2009/10 fiscal year outline the energy and demand savings achieved by Manitoba Hydro's programs and initiatives.

NOTE: The Consultant may be required to formally present its findings to Manitoba Hydro's senior management and Executive Committee.

The Work may be subject to review by the Public Utilities Board and/or other parties. Manitoba Hydro may request that the Consultant testify at a Public Utilities Board hearing regarding the results of the Work. The Consultant should provide an hourly rate to testify before the Public Utility Board.

48

4 WORK SCHEDULE

Manitoba Hydro expects the Work will be completed before December 1, 2011.

In carrying out the Work, the Contractor shall have reasonable latitude to organize the sequence of the Work, provided that the various stages of the Work are completed by the specified date(s) or the date(s) proposed by the Successful Proponent and accepted by Manitoba Hydro.

Tab 8

REFERENCE: Appendix D 2013 Electric Load Forecast; Page No.: 55

QUESTION:

Please outline the impact this change in assumptions regarding future electricity prices had on the 2013 (versus 2012) Load Forecast for the Residential, General Service Mass Market and General Service Top Consumers sectors.

RESPONSE:

The 2012 Load Forecast used the electricity to natural gas price ratio to estimate the number of new homes in gas available areas choosing electric or natural gas heating. Although the electricity price forecast was listed as an economic assumption at page 55 of the 2013 Load Forecast, under the 2013 Load Forecast the electricity to natural gas price ratio is no longer used as the impact of the ratio was determined to have a limited effect.

REFERENCE: Appendix D 2013 Electric Load Forecast; Page No.: 55

PREAMBLE: During the 2008/09 GRA Manitoba Hydro provided information on own price elasticities of demand by customer class

QUESTION:

Please provide the own price elasticities by customer class filed in the 2008/09 GRA and update the values for each customer class if the estimates have been revised.

RESPONSE:

Please see the attachment to this response. These estimates were prepared by NERA Economic Consulting as part of the "Review of Time of Use and Inverted Electric Rate Structures for Application in Manitoba". The report was prepared for Manitoba Hydro in 2005 and the estimates were based on studies involving other jurisdictions.

5

PUB/MH I-83

Reference: Marginal Costing

a) **Please explain how marginal costing at current levels would reduce domestic loads in each of the various customer classes:**

- **Residential**
- **GSS**
- **GSM**
- **GSL <60**
- **GSL 60-100**
- **GSL >100**

ANSWER:

At a very high level, if marginal cost pricing for domestic customer classes were adopted, the long term load reduction, relative to a regime in which current pricing methodology is maintained would be as follows.

Residential, General Service Small Non-Demand	7%
General Service Small Demand, General Service Medium,	9%
General Service Large < 30 kV	11%
General Service Large > 30 kV	26%

These approximate impacts were derived on the basis of the following:

Current rates:

Residential, General Service Small Non-Demand, runoff	6.0 cents/kW.h
General Service Small Demand, General Service Medium, average	5.1 cents/kW.h
General Service Large < 30 kV	4.1 cents/kW.h
General Service Large > 30 kV	3.2 cents/ kW.h

Marginal Cost based rates (Generation, Transmission expansion, Distribution expansion):

Residential, General Service Small Non-Demand	7.6 cents/kW.h
General Service Small Demand, General Service Medium	7.6 cents/kW.h
General Service Large < 30 kV	7.6 cents/kW.h
General Service Large > 30 kV	6.8 cents/kW.h

Own Price Elasticity of Demand

Residential, General Service Small Non-Demand, runoff	-.056
General Service Small Demand, General Service Medium, average	-.06
General Service Large < 30 kV	-.06
General Service Large > 30 kV	-.125

REFERENCE: Appendix D 2013 Electric Load Forecast; Page No.: 55

QUESTION:

Please explain and demonstrate how own price elasticity are incorporated into the load forecast by each customer class. If own price elasticities are not employed in the load forecast for any particular class, please explain why not.

RESPONSE:

Price elasticity is not a variable that is explicitly incorporated into Manitoba Hydro's load forecast. Please see Manitoba Hydro's response to PUB/MH I-256.

REFERENCE: Appendix 4.3 Demand Side Management Potential Study.

PREAMBLE: EnerNOC's potential study

QUESTION:

On or around what date was the contract provided to EnerNOC?

RESPONSE:

The agreement between Manitoba Hydro and EnerNOC was signed on or around June 15, 2011.

REFERENCE: Appendix 4.3 Demand Side Management Potential Study.

QUESTION:

On or around what date were the first draft results provided to Manitoba Hydro?

RESPONSE:

Manitoba Hydro received the results of the first model iterations in December 2012.

REFERENCE: Appendix 4.3 Demand Side Management Potential Study

QUESTION:

On or around what date were the final draft results accepted by Manitoba Hydro?

RESPONSE:

The results received in the draft report dated July 11, 2013 were accepted by Manitoba Hydro. EnerNOC identified errors in some of the tables of this report and issued a revised report on August 31, 2013.

SUBJECT: **Price elasticity**

REFERENCE: **017a to 017c, PUB/MH I-0256**

PREAMBLE: We conducted a regression analysis using the % change of weather adjusted average consumption (kWh) per customer as the dependant variable, and the % change of real average price ($/kWh) the year before (t-1) as the independent variable (data provided by MH for PUB/MH 1-0256). The resulting coefficient of -0.24 for the X variable is consistent with a short term price elasticity of -0.20. The regression statistics could potentially be greatly improved by using more precise data, notably monthly price and consumption data for a specific set of customers, as it is commonly done for price elasticity analyses elsewhere. Our graph also seems to show a correlation between the average price of electricity and the average consumption. In the case of PUB/MH 1-0256, the aggregation of price and consumption information across all customers by Manitoba Hydro can lead to misleading data and imprecision, for example swings in prices or consumption levels that are not caused by rate increases but by other factors (number of customers by market segment, average consumption by market segment, etc.). This imprecision of data could also explain some outliers in our analysis (notably the year 2010/11).

ORIGINAL DATA (from PUB/MH 1-0256)

REGRESSION ANALYSIS

	% Delta Real $/kWh	% Delta kWh/Customer (weather adjusted)	Y kWh/Customer (t)	X Real $/kWh (t-1)
1990/91				
1991/92	0.10%	0.96%		
1992/93	-0.30%	-0.31%	-0.31%	0.10%
1993/94	-3.02%	0.95%	0.95%	-0.30%
1994/95	-0.28%	3.05%	3.05%	-3.02%
1995/96	-2.51%	-1.13%	-1.13%	-0.28%
1996/97	-1.29%	1.84%	1.84%	-2.51%
1997/98	-0.40%	2.25%	2.25%	-1.29%
1998/99	-1.60%	1.35%	1.35%	-0.40%
1999/00	-2.08%	2.28%	2.28%	-1.60%
2000/01	-3.04%	1.44%	1.44%	-2.08%
2001/02	-1.86%	-0.27%	-0.27%	-3.04%
2002/03	-3.57%	2.42%	2.42%	-1.86%
2003/04	-1.47%	0.86%	0.86%	-3.57%
2004/05	0.51%	1.10%	1.10%	-1.47%
2005/06	1.23%	1.00%	1.00%	0.51%
2006/07	-2.69%	-2.09%	-2.09%	1.23%
2007/08	0.68%	1.62%	1.62%	-2.69%
2008/09	1.16%	0.12%	0.12%	0.68%
2009/10	4.43%	0.23%	0.23%	1.16%
2010/11	1.01%	2.04%	2.04%	4.43%
2011/12	-0.10%	-1.16%	-1.16%	1.01%

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.343871200453598
R Square	0.118247402501399
Adjusted R Square	0.0692611470848099
Standard Error	0.0131119269132911
Observations	20

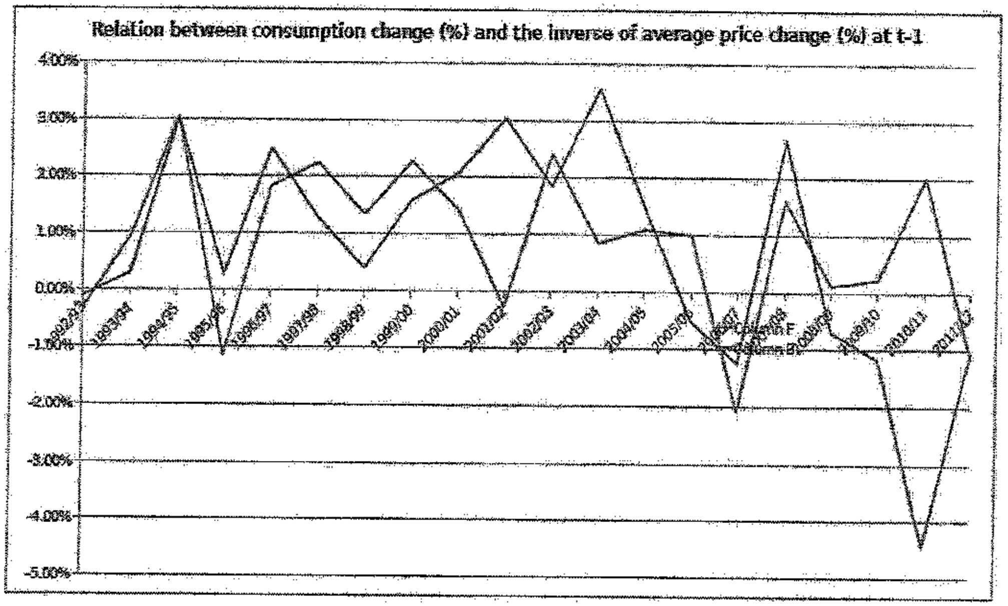
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000415002207	0.000415002207	2.413889396632	0.137669052691
Residual	18	0.003094607293	0.000171922627		
Total	19	0.0035096095			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00599737850931675	0.003151954734	2.220012373078	0.039498893695	0.000375367338	0.0136193389680
X Variable 1	-0.239842760598166	0.154371786736	-1.55366965473	0.137669052691	-0.56416584974	0.084480328547

INVERSE OF % DELTA PRICE (for graph)

-0.10%
0.30%
3.02%
0.28%
2.51%
1.29%
0.40%
1.60%
2.08%
3.04%
1.86%
3.57%
1.47%
-0.51%
-1.23%
2.69%
-0.68%
-1.16%
-4.43%
-1.01%


Relation between consumption change (%) and the inverse of average price change (%) at t-1

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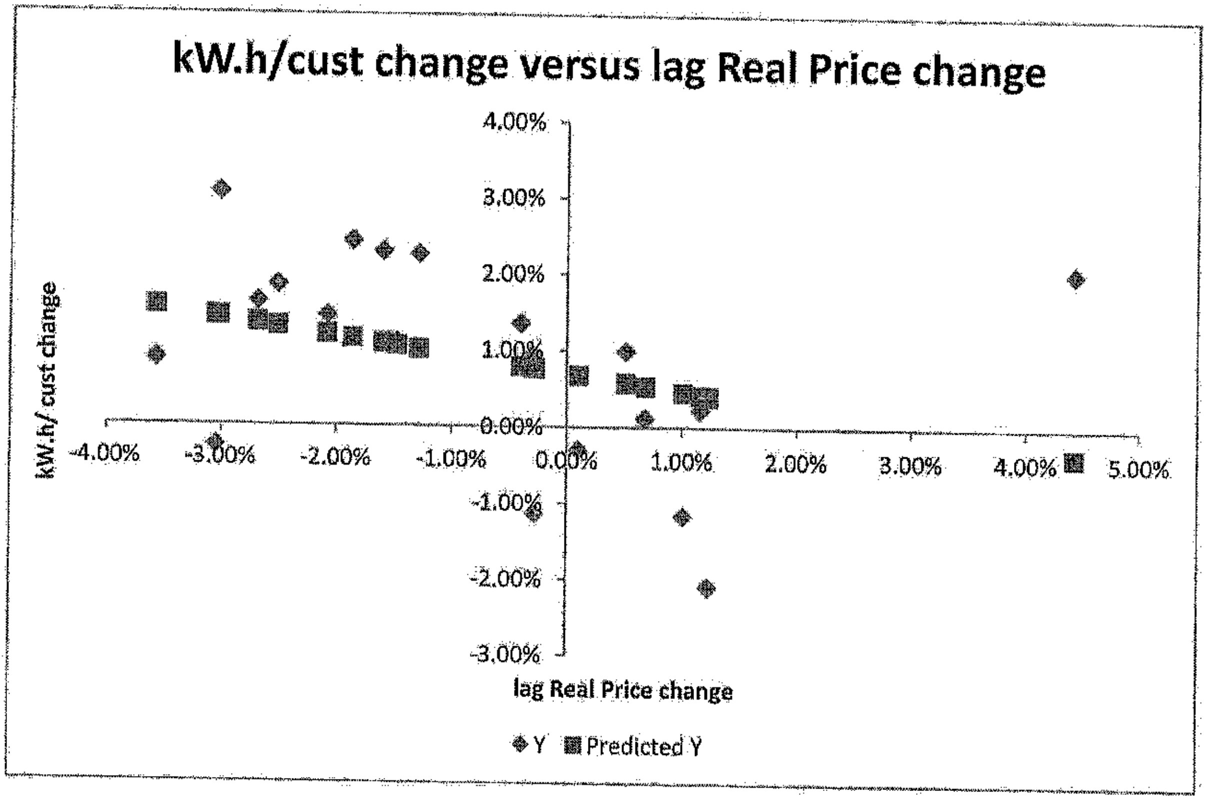
58

QUESTION:

Please compute the price elasticity using Manitoba Hydro's historic data, found on page 2 of this document, ideally based on monthly data at the customer (household and/or business) level, and broken out by market segment.

RESPONSE:

Based upon the above request, Manitoba Hydro reproduced the supplied regression result with the data to obtain the -0.24 coefficient value. The regression has an adjusted R^2 of just 7%, the t-ratio is not significant at -1.6, and the estimate has low accuracy with its 95% confidence interval covering -0.56 to +0.08. The plot of the Y to X values shows this regression to be a poor predictor:



There are many difficulties involved in estimating price elasticity that require more than a simplistic analysis:

60

1. When using a small number of annual data points, there are many factors other than price that could be contributing to the observed changes in annual use. It is difficult to determine what factors need to be included without detailed assessment.
2. Using just annual data is often very dependent on the specific data points available. For example, in the above data set, the estimated price coefficient can vary greatly if only a single year of data is missing, e.g. if the year the average use went down over 2% was missing, then the price coefficient result would become -0.16. If the year the price grew over 4% was missing, then the result would become -0.54.
3. Autocorrelation of the residuals needs to be addressed and removed from this result for it to be considered valid. Correcting for autocorrelation improves the R^2 of the analysis based on annual data points significantly to 95% and the price coefficient lowers to -0.19 but still has a t-ratio of -1.09 indicating that it is still not significantly different from zero; its 95% confidence interval covers -0.54 to +0.15.

Manitoba Hydro then used monthly data rather than annual data, as requested above. Doing this does not necessarily add significant precision to an analysis. Average monthly prices are computed as total revenue for the sector each month divided by the kW.h for each month. However, the underlying rates per unit consumption only change when new rates are approved, approximately annually. Usage has an annual cycle and growth will only be noticed between years, not between months. Monthly data simply preserves the yearly relationships and replicates them twelve times. This results in better statistics, but in reality the annual relationship is still the driver. Running the same regression with monthly data for the GS Mass Market sector and correcting for autocorrelation at lags of 1 and 12 months gives an R^2 of 94%, a price coefficient of -0.29 and a t-ratio of -4.17 that now appears to be significant solely due to the use of 264 observations rather than 22. However, its 95% confidence interval is still wide, covering -0.43 to –0.15.

In addition, the residuals under the analysis based on monthly data need to be checked to ensure they are not still correlated to the price. If there is correlation, then the price effect will be inflated and additional work will likely be required to remove the supply-side price effect. This would include determining price relationships with such factors as the cost of service for the sector, the export price and Manitoba Hydro's profit or loss, each of which can affect the price.

It is questionable as to whether this general procedure is valid and usable for all average use data. If it were valid, then it would also be expected to work for other sectors. Attempting to use this same procedure to regress average use monthly data for Residential customers against real price gives a price coefficient of +0.05. A positive elasticity is of course, not realistic. Using the standard error of the estimate indicates the value may range between -0.18 and +0.27. The same analysis for General Service Top Consumers gives a price coefficient of -1.66 with a 95% confidence interval that ranges from -1.42 to -1.89.

A major difficulty in this type of analysis is the use of price as the only predictor variable. The assumption that price is the only influencing variable will allow any coincidental growth pattern to be associated to the price effect, regardless of whether or not the changes were actually caused by the changes in price. To properly identify a price effect, all other major factors must be removed. A model of this sort must be formulated properly before it can produce results that can be trusted. For example, for General Service Mass Market, the load is likely affected not only by price but also by:

1. Market drivers, such as: GDP, company earnings, salaries,
2. The increase of average building size over time, i.e., the average use should be divided into its components: (square footage / customer) * (average use / square foot) with the latter being analyzed for price elasticity.

3. Analysis by building type, e.g. schools may have different price elasticities than offices or restaurants.
4. Demand Side Management (DSM) initiatives in the past may have contributed to helping people adjust to price changes. The proportion of this contribution should be determined so that a price-only effect can be obtained.

Removing these exogenous effects would result in more accuracy in estimating the price effect, but only if accurate data for these effects was available. Considerable work and expertise is required in determining price elasticity.

The question asks to compute the price elasticity using Manitoba Hydro's historic data based on monthly data at the customer (household and/or business) level broken out by market segment. This method produces results of -0.29 for General Service Mass Market, +0.05 for Residential Basic and -1.66 for General Service Top Consumer where the outcomes for the Residential Basic and General Service Top Consumer sectors are not reasonable. It would not be appropriate to accept this methodology for the General Service Mass Market sector, while considering it not acceptable for the other two sectors. A method for computing price elasticities should only be used if the predictor variables included are appropriate and if the results are reasonable.

REFERENCE: **September 5, 2013 Technical Conference; Transcript and PowerPoint**

QUESTION:

Please produce any studies Manitoba Hydro has on energy price elasticity. Does energy price elasticity factor into Manitoba Hydro's load forecast?

RESPONSE:

Manitoba Hydro has not undertaken any studies that specifically explore the relationship between Manitoba domestic prices and Manitoba Load. However, an analysis of the relationship between price changes and general service mass market customers' electricity demand was filed during the 2012/13 & 2013/14 General Rate Application, as Manitoba Hydro's response to Undertaking #67. Please see the attachment to this response.

Energy price elasticity is not a variable that is explicitly incorporated into Manitoba Hydro's load forecast. Manitoba Hydro's historical pattern of rate increases have been in small annual increments, so electricity prices have increased slowly at or close to the rate of inflation. Any effects of price changes would have been largely overwhelmed by the effect of other factors that affect demand for electricity, such as population increases, economic growth, improvements in residential construction, appliance efficiency, among others. The relatively low and stable prices that have been experienced limit the ability to estimate meaningful price elasticities for the Manitoba market.

Tab 9

Commercial Sector

Electricity use in the commercial sector remains essentially flat during the forecast horizon, an average of -0.03% per year. Usage starts at 5,685 GWh in 2010/11, decreases until 2016/17 and then increases to 5,655 GWh in 2031/32. Figure 4-3 and Table 4-2 present the baseline forecast at the end-use level for the commercial sector as a whole. Most end uses show modest growth over the forecast period. The exceptions are interior lighting, which declines due to the lighting standards, and refrigeration, which is affected by the standards for refrigeration.

Figure 4-3 Commercial Baseline Electricity Forecast by End Use

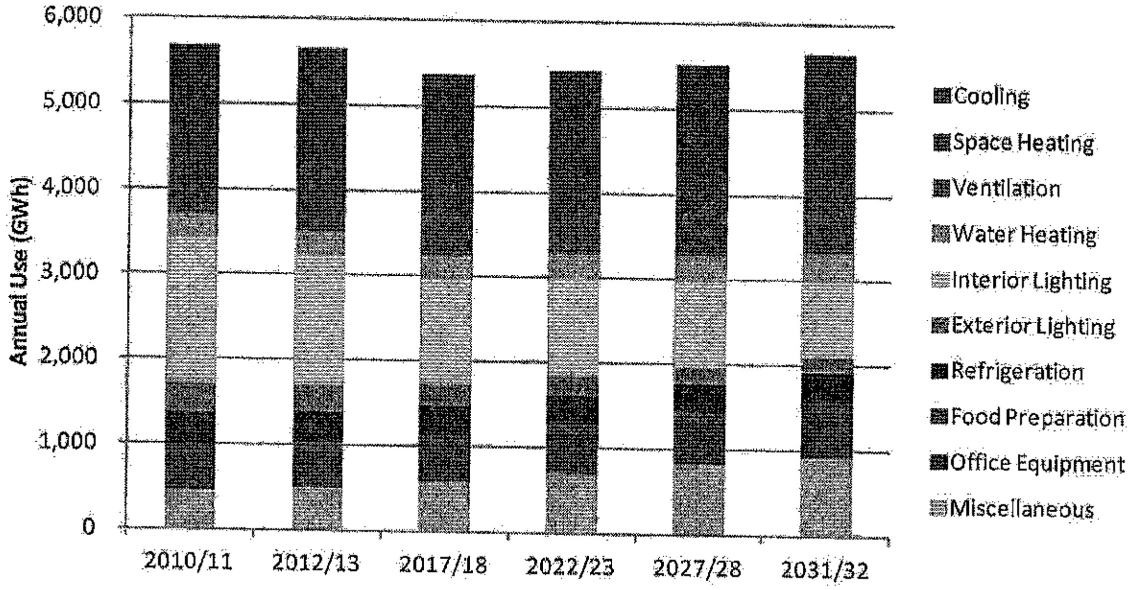


Table 4-2 Commercial Electricity Consumption by End Use (GWh)

End Use	2010/ 11	2012/ 13	2017/ 18	2022/ 23	2027/ 28	2031/ 32	% Change	Avg. Growth Rate
Cooling	1,212	1,324	1,273	1,278	1,314	1,370	13%	0.6%
Space Heating	362	368	385	401	419	431	19%	0.8%
Ventilation	429	441	462	479	502	529	23%	1.0%
Water Heating	252	258	275	294	313	328	30%	1.2%
Interior Lighting	1,734	1,558	1,238	1,149	1,006	893	-48%	-3.2%
Exterior Lighting	337	297	240	228	198	174	-48%	-3.1%
Refrigeration	375	372	349	339	341	355	-5%	-0.3%
Food Preparation	111	110	110	114	120	125	12%	0.6%
Office Equipment	416	424	434	453	486	520	25%	1.1%
Miscellaneous	457	493	595	707	828	929	104%	3.4%
Total	**5,685**	**5,646**	**5,361**	**5,441**	**5,527**	**5,655**	-1%	0.0%

Table 4-3 presents the commercial sector forecast by technology. Interior screw-in lighting decreases significantly over the forecast period as a result of the lighting standard.

Tab 10

65

CHAPTER | 1

INTRODUCTION

Background

Manitoba Hydro engaged EnerNOC (formerly Global Energy Partners) to conduct an assessment of 20-year potentials of energy efficiency (EE) for electricity and natural gas to assist Manitoba Hydro in refining their Power Smart program portfolio. Toward this end, EnerNOC conducted a detailed, bottom-up assessment of the Manitoba Hydro market to deliver forecasts of energy use and peak demand, as well as forecasts of energy and peak-demand savings achievable through energy efficiency programs. The 20-year potentials study addresses the residential, commercial and industrial sectors.

Definitions of Potential

In this study, we estimate the potential for energy efficiency savings. The savings estimates represent four types of potential: technical potential, economic potential, market potential and achievable potential. Technical and economic potential are both theoretical limits to efficiency savings. Market and achievable potential estimates embody assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. Estimating market and achievable potential involves the inherent uncertainty of predicting human behaviors and responses to market conditions. These four levels of potential are described in more detail below.

- **Technical potential** is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option that is available. Examples of measures that make up technical potential in the residential sector include geothermal heat pumps and LED lighting.

  Technical potential also assumes the adoption of every available, applicable measure. For example, it includes installation of high-efficiency windows in all new construction opportunities and heating system maintenance in all existing buildings. The retrofit measures are phased in over a number of years, which is longer for higher-cost and complex measures.

- **Economic potential** represents the adoption of all **cost-effective** energy efficiency measures. In this analysis, the cost effectiveness is measured based upon a simplified total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. It reflects cost effectiveness from a resource perspective independent of who pays for implementing the measure. If the benefits equal or outweigh the costs (that is, if the TRC ratio is equal to or greater than 1.0), then a given measure is included in economic potential. As with technical potential, all customers, to whom the measure applies, purchase the most efficient option with a B/C ratio of 1.0 or higher.

- **Market potential** is the subset of economic potential that can be obtained through market intervention under ideal market, implementation, regulatory and customer preference conditions; efforts are supported by focused and coordinated efforts across governments, utilities and industry to eliminate all material market barriers. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. The only barrier is customer preferences for the technology or measure (e.g., some customers don't like CFL lamps in some applications and won't install them). Market potential establishes a theoretical maximum threshold for the EE savings that are available in the market but does not take into account the wide range of more specific market barriers that will prevent a willing customer from pursuing the EE option (e.g., even in the presence of a program, the customer does not currently prioritize EE and will not participate).

- **Achievable potential** recognizes that market conditions are not ideal and reflects expected program participation given significant barriers to customer acceptance, and non-ideal implementation conditions such as lack of availability and imperfect marketing. It should be emphasized that the estimation of achievable potential is not synonymous with either the setting of specific DSM targets or with program design. While both are closely linked to achievable potential, they involve detailed analysis that is beyond the scope of this study.

Abbreviations and Acronyms

Throughout the report we use several abbreviations and acronyms. Table 1-1 shows the abbreviation or acronym, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
AC	Air conditioning
AEO	Annual Energy Outlook
B/C Ratio	Benefit to Cost Ratio
BEST	EnerNOC's Building Energy Simulation Tool
C&I	Commercial and Industrial
CFL	Compact Fluorescent Lamp
DEEM	Database of Energy Efficiency Measures
DEER	Database for Energy-Efficient Resources
DSM	Demand side management
DR	Demand Response
EE	Energy Efficiency
EIA	Energy Information Administration
EPRI	Electric Power Research Institute
EUI	Energy-use Index
HH	Household
HID	High Intensity Discharge lighting
IC	Industry Canada
LED	Light Emitting Diode lamp
LoadMAP	EnerNOC's Load Management Analysis and Planning^{TM} tool
MAR	Market Acceptance Rate
NRCAN	Natural Resources Canada
NWPCC	Northwest Power and Conservation Council
PIF	Program Implementation Factors
RTU	Roof top unit
Sq. ft.	Square feet
STATCAN	Statistics Canada
TRC	Total Resource Cost
UEC	Unit Energy Consumption

Program Year 2010/11 since that was the most recent year for which a complete set of utility data were available at the start of the analysis.

Segmentation for Modeling Purposes

The market assessment began by defining the market segments (building types, end uses, and other dimensions) that are relevant for Manitoba Hydro. The analysis segmentation used for this project is presented in Table 2-1.

Table 2-1 Overview of Analysis Segmentation for Potentials Modeling

Segmentation Variable	Market Dimension	Dimension Examples
Sector	1	Residential, commercial, industrial
Building type	2	Residential (Single family, Multi family, and Apartments, further segmented by heating fuel, geographical location, building vintage and income level.) Commercial (Office, Restaurant, Retail, etc.) Industrial (Mining, Food and Beverage, Pulp and Paper, Chemical, Petroleum, Primary Metals, Miscellaneous Industrial, Other Agriculture, and Other industrial)
Vintage	3	Existing and new construction
End uses	4	Cooling, space heating, lighting, water heat, motors, etc. (as appropriate by sector)
Fuel	5	Electric and Natural Gas
Appliances/end uses and technologies	6	Technologies such as lamp type, air conditioning and heating equipment, motors by size, etc.
Equipment efficiency levels for new purchases	7	Baseline and higher-efficiency options as appropriate for each technology

Following this scheme, the residential sector was segmented into twenty-nine residential segments as shown in Table 2-2 below. The twenty-nine segments are determined by the following:

- **Home type** — Single-family homes, multifamily homes, or apartments
- **Heating fuel** — Natural gas heat, electric heat, or other fuel
- **Geographic location** — Natural gas available, South-no gas available, North-no gas available, reserve-no gas available, or all
- **Building vintage** — homes built before 2000, 2000 to present, or all
- **Income level** — Non-low income, low income, or all income levels

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. A market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, it is number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, we use energy use as the definition of market size. (However, in the LoadMAP model we unitize industrial use on a per-employee basis.)
- **Saturations** define the fraction of homes/buildings and square feet with the electric or natural gas technologies. (e.g., homes with electric or natural gas space heating, commercial floor space with space cooling). The saturation values are based on Manitoba Hydro's 2009 residential customer survey, 2005 and 1993 Commercial surveys, Manitoba Hydro's internal natural gas potential study, EnerNOC's Energy Market Profiles[2], Natural Resources Canada's Commercial and Institutional Building Energy Use Survey (CIBEUS), and other potential studies including the previous DSM potential study for Manitoba Hydro.
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of electricity or natural gas consumed in 2010/11 by a specific technology in buildings that have the technology. For the residential sector, we started with the UECs available from Manitoba Hydro's conditional demand model, where available. To fill in holes, we used our databases from previous studies, the previous energy efficiency potential study, the Annual Energy Outlook (AEO), and EnerNOC's BEST simulation tool to develop these values. For the commercial and industrial sectors, we developed the technology-level EUIs using our engineering model, BEST, EnerNOC's Energy Market Profiles database, and other secondary sources. Finally, we adjusted the UECs or EUIs to calibrate to overall building type intensity.

  For electricity, we use UECs expressed in kWh/household for the residential sector, and EUIs expressed in kWh/square foot for the commercial sector. For natural gas, the UECs are expressed in m^3/unit.
- **Intensity** for the residential sector represents the average energy use for the technology across all homes in 2010. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity or m^3/household for natural gas. For the commercial sector, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space in 2010/11.
- **Usage** is the annual electricity or natural gas use by a technology/end use in the segment. It is the product of the market size and intensity and is quantified in GWh for electricity or MMm^3 for gas.

The market assessment results and the market profiles are presented in Chapter 3.

Baseline Projection

The next step was to develop the baseline projection of annual electricity and natural gas usage and peak demand for 2010/11 through 2031/32 by customer segment and end use without new utility programs or naturally occurring efficiency scenario. The end-use projection does include the relatively certain impacts of codes and standards that will unfold over the study timeframe. All such mandates that were defined as of January 2011 are included in the baseline. The baseline projection is the foundation for the analysis of savings from future EE efforts as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

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[2] The Energy Market Profiles provide commercial sector energy-use data, by end use and fuel, for 15 building types, based on U.S. DOE's Energy Information Agency's Commercial Building Energy Consumption Survey (CBECS) as well as other secondary data sources. For this analysis, we used Energy Market Profile data for the West North Central region, which includes Minnesota and North Dakota.

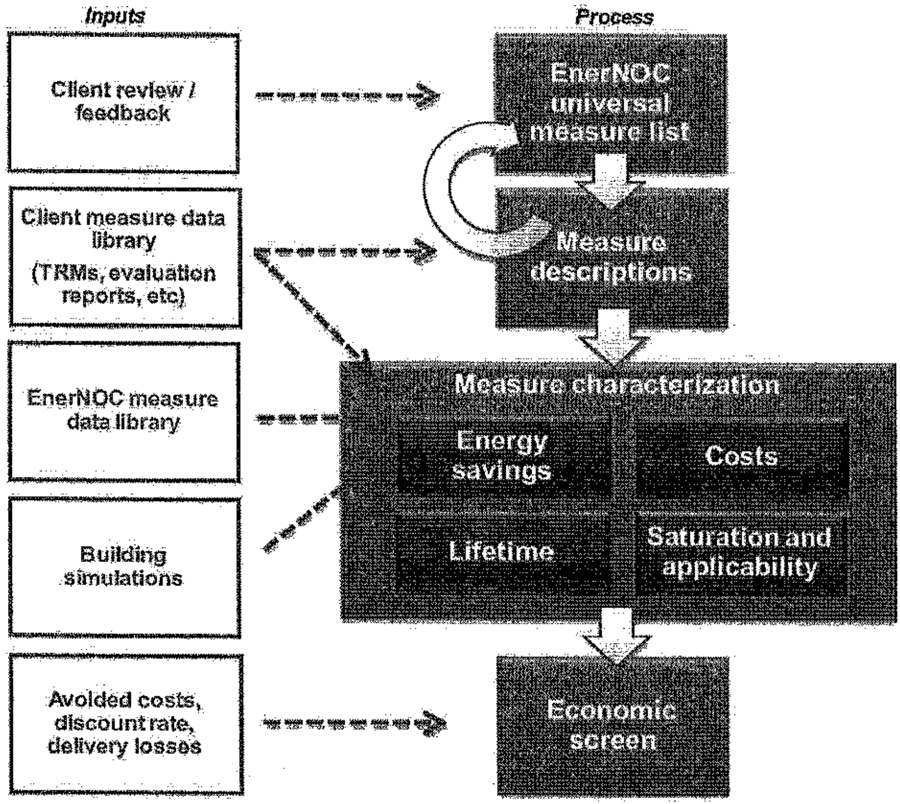
- Current economic growth forecasts (i.e., customer growth, income growth)
- Electricity and natural gas price forecasts
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards
- Equipment purchase decisions
- Heating and cooling degree days
- Manitoba Hydro's internally developed forecasts for electricity and natural gas sales

We present the results of the baseline projection development in Chapter 4.

Energy Efficiency Measure Analysis

This section describes the framework used to assess the savings, costs, and other attributes of energy-efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, EnerNOC assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information, along with Manitoba Hydro's avoided costs data, in the economic screen to determine economically feasible measures. Figure 2-3 outlines the framework for measure analysis.

Figure 2-3 Approach for Measure Assessment



The framework for assessing savings, costs, and other attributes of energy efficiency measures involves identifying the list of energy efficiency measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Potential measures include the replacement of a unit that has failed or is at the end of its useful life with an efficient unit, retrofit/early replacement of equipment, improvements to the building envelope, the application of controls to optimize energy use, and other actions resulting in improved energy efficiency.

We compiled a robust list of energy efficiency measures for each customer sector, drawing upon a variety of sources including Manitoba Hydro's measure database, EnerNOC databases, and secondary sources. This universal list of EE measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens initially, but may pass in future years as a result of lower projected equipment costs or higher avoided costs in the future.

The selected measures are categorized into two types: equipment measures and non-equipment measures, according to the LoadMAP taxonomy:

- **Equipment measures,** or efficient energy-consuming pieces of equipment, save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels are available for a specific technology ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of residential natural gas water heater, this list begins with the federal standard EF 0.57 unit and spans a broad spectrum of efficiency, with the highest efficiency level represented by a EF 0.86 unit.
- **Non-equipment measures** save energy by reducing the need for delivered energy but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be an insulation upgrade that reduces the heating requirements of the heating system due to reduced thermal losses. Non-equipment measures fall into one of the following categories:
  - Building shell (windows, insulation, roofing material)
  - Equipment controls (thermostat, occupancy sensors)
  - Equipment maintenance (cleaning filters, changing setpoints)
  - Whole-building design (natural ventilation, passive solar lighting)
  - Displacement measures (ceiling fan to reduce use of central air conditioners)
  - Commissioning and retrocommissioning

We developed a preliminary list of EE measures for Manitoba Hydro's review. The final list included in the study, which excluded technologies that are not applicable in Manitoba's climate, is presented in Chapter 5. Note that non-equipment measures can apply to more than one end use. For example, insulation levels will affect the energy use of both cooling and space heating.

Once we assembled the list of EE measures, the project team assessed their energy-saving characteristics. For each measure we characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic potential.

Representative Measure Data Inputs

To provide an example of the measure data, Table 2-9 and Table 2-10 present samples of the detailed data inputs behind both equipment and non-equipment measures, respectively. Table 2-9 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, energy usage, and cost estimates. The columns labeled On Market and Off Market reflect equipment availability due to codes and standards or the entry of new products to the market. The on-market of 2010 indicates that the technology is currently commercially available. In Manitoba, the minimum efficiency for natural gas boiler is 0.80. In 2013, the standard becomes EF 0.82. Therefore, the off-market date for EF 0.80 is 2012.

- The lifetime benefits are calculated by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. The analysis uses each measure's values for savings, costs, and lifetimes that were developed as part of the measure characterization process described above. For economic screening of measures, incentives are not included because they represent a simple transfer from one party to another, but have no effect on the overall measure cost.

The LoadMAP model performs this screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the forecast (see Table 2-11).

It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen.

Table 2-11 shows the results of the economic screen for a natural gas furnace for selected years, as well as results for two interior lighting technologies in the residential sector. In 2012/13, the most cost-effective option is AFUE 92%. The table also shows how the economic choice for two of the lighting technology options varies over the study period. For the interior screw-in lighting CFLs are the cost effective technology until 2020/21, when LED lamps become cost effective. If the measure passes the screen (has a benefit-to-cost (B/C) ratio greater than or equal to 1.0), the measure is included in economic potential. Otherwise, it is screened out for that year. If multiple equipment measures have B/C ratios greater than or equal to 1.0, the most efficient technology of that measure is selected by the economic screen.

Table 2-11 Economic Screen Results for Selected Residential Equipment Measures

Technology	2012/13	2017/18	2022/23	2027/28	2031/32
Natural Gas Furnace	AFUE 92%	AFUE 92%	AFUE 92%	AFUE 92%	AFUE 92%
Interior Lighting Screw-in	CFL	CFL	LED	LED	LED
Interior Lighting Linear Fluorescent	T5	T5	T5	T5	T5

Energy-Efficiency Potential

The approach we used for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[5] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy-efficiency potential. As described in Chapter 1, four types of potentials were developed as part of this effort: technical potential, economic potential, market potential and achievable potential.

The calculation of Technical and Economic potential is a straightforward algorithm. To develop estimates for **market potential,** we develop market adoption rates for each measure that specify the percentage of customers that will select the highest-efficiency economic option under ideal

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[5] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025: Developing a Framework for Change.* www.epa.gov/eeactionplan.

market conditions. The market potential adoption rates are based on the ramp rates from the Northwest Power & Conservation Council's Sixth Plan as a starting point. The NWPCC has been running programs in the Pacific Northwest for many years, and the portfolio of programs reflects a similar profile of market maturity. The Council's ramp rates were adjusted in consultation with Manitoba Hydro program staff to reflect best-case participation by their customers in Hydro programs.

The **achievable potential** adoption rates start with the market potential adoption rates and adjust them to reflect recent program experience at Manitoba Hydro and results from other utilities as captured in EnerNOC potential studies from similarly-situated utilities.

The overall energy efficiency potential results are available in Chapter 6, and the results by sector are given in Chapter 7.

Data Development

This section details the data sources used in this study, followed by a discussion of how these sources were applied.

Data Sources

The data sources are organized into the following categories:

- Utility-provided data
- EnerNOC' databases and analysis tools
- Energy efficiency measure data
- Other secondary data and reports

Utility-provided Data

In order to appropriately characterize the market in Manitoba Hydro, we asked Manitoba Hydro to provide the following:

- Utility 2010/11 billing data — customers, usage, revenue
- Number of customers and electricity sales by sector and segment (residential, commercial, industrial)
- Coincident peak demand by rate class
- Energy and peak demand forecasts, at the sector level
- Number of customers and natural gas sales by sector and segment (residential, commercial, industrial)
- Customer growth forecast
- Price forecast
- Cooling and heating degree day history and forecasts
- Recent saturation surveys for residential and commercial customers
- Avoided cost benefit values for electricity and natural gas
- Discount rate
- T&D line loss factors
- Program data
    - Description of existing energy efficiency programs

Data Application for Baseline Projection

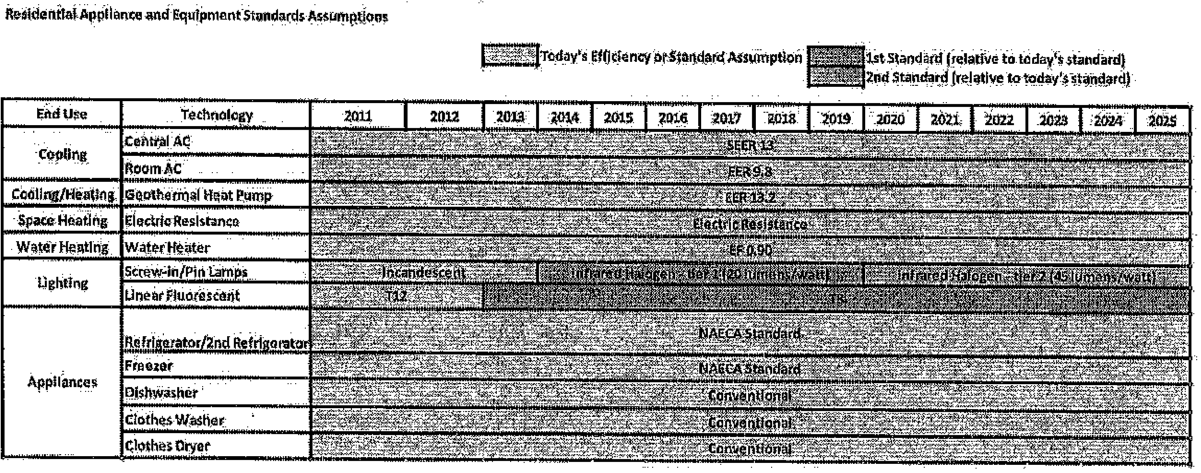
Table 2-13 summarizes the LoadMAP model inputs required for the baseline projection. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-13 Data Needs for the Baseline Projection and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Manitoba Hydro customer growth forecast AEO 2011 growth forecast Industry Canada
Equipment purchase shares for baseline forecast	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO AEO 2011 forecast assumptions[6] Appliance/efficiency standards analysis
Electricity and gas prices	Forecast of average electricity and gas prices	Manitoba Hydro price forecasts
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models Manitoba Hydro forecasting data Environment Canada AEO 2011

In addition, we implemented assumptions for known future equipment standards as of January, 2011, as shown in Table 2-14 through Table 2-17.

Table 2-14 Residential Electric Equipment Standards



Residential Appliance and Equipment Standards Assumptions

▨ Today's Efficiency or Standard Assumption
▨ 1st Standard (relative to today's standard)
▨ 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13														
	Room AC	EER 9.8														
Cooling/Heating	Geothermal Heat Pump	EER 13.2														
Space Heating	Electric Resistance	Electric Resistance														
Water Heating	Water Heater	EF 0.90														
Lighting	Screw-in/Pin Lamps	Incandescent			Infrared Halogen - tier 1 (20 lumens/watt)						Infrared Halogen - tier 2 (45 lumens/watt)					
	Linear Fluorescent	T12		T8												
Appliances	Refrigerator/2nd Refrigerator	NAECA Standard														
	Freezer	NAECA Standard														
	Dishwasher	Conventional														
	Clothes Washer	Conventional														
	Clothes Dryer	Conventional														

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[6] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2011), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match manufacturer shipment data for recent years and then held values constant for the study period. This removes any effects of naturally occurring conservation or effects of future DSM programs that may be embedded in the AEO forecasts.

1.86%. Discount rates, line loss factors, avoided capacity, and avoided energy costs were provided by Manitoba Hydro.

Market and Achievable Potential Estimation

To estimate potentials, three sets of parameters were required to account for the decision making behavior of customers in the efficiency marketplace.

- **Adoption rates for non-equipment measures.** Equipment measures are installed when existing units fail. Non-equipment measures do not have this natural periodicity, so rather than installing all available non-equipment measures in the first year of the forecast (instantaneous potential), they are phased in according to adoption schedules that vary based on cost and complexity. Typically, measures that cause disruption to the building, such as wall insulation in existing buildings, receive longer adoption curves, while those with drop-in installations, such as programmable thermostats in new buildings, receive shorter ones. High capital cost measures will also receive longer adoption curves than ones with low capital cost. These adoption rates are used within LoadMAP to generate the technical and economic potentials. In general, the rates align with the diffusion of similar equipment measures.
- **Adoption rates for Market potential (MARs).** These factors are applied to economic potential to estimate the upper bound: market potential. These estimate customer adoption of economic measures through market intervention under ideal market, implementation, regulatory, and customer preference conditions. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. The only barrier is customer preferences for the technology or measure.

  The market potential adoption rates are based on the ramp rates from the Northwest Power & Conservation Council's Sixth Plan, as a starting point. The NWPCC has been running programs in the Pacific Northwest for many years, and the portfolio of programs reflects a similar profile of market maturity. Market potential establishes a theoretical maximum threshold for the EE savings that are available in the market but does not take into account the wide range of more specific market barriers that will prevent a willing customer from pursuing the EE option (e.g., even in the presence of a program, the customer does not currently prioritize EE and will not participate).

  Adoption rates for Achievable potential (PIFs). These factors are applied to Market potential to calculate achievable potential, decrementing them by a range of 40% to 90% based on where measures lie in the time horizon of the study or whether they are already familiar inclusions in existing programs. These rates reflect expected program participation given significant barriers to customer acceptance and non-ideal implementation conditions such as lack of availability and market capacity, price differentials, etc.

  It should be emphasized that the estimation of achievable Potential is not synonymous with either the setting of specific DSM targets or with program design. While both are closely linked to the discussion of achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

MARs and PIFs are presented in Appendix E.

CHAPTER | 4

BASELINE PROJECTION

Prior to developing estimates of energy-efficiency potential, a baseline end-use projection was developed to quantify how electricity and natural gas are used by end use in the base year and what the consumption is likely to be in the future in absence of new utility programs. This is not a sales forecast per se, but instead a projection into the future of the base-year market profiles described in the previous chapter. It is intended to capture the key variables that would impact the estimation of savings potential. The baseline projection includes the expected impact of appliance standards, building codes and naturally occurring efficiency. It serves as the metric against which energy efficiency potentials. The first part of this section focuses on electricity, followed by the projections for natural gas.

Baseline Projection for Electricity

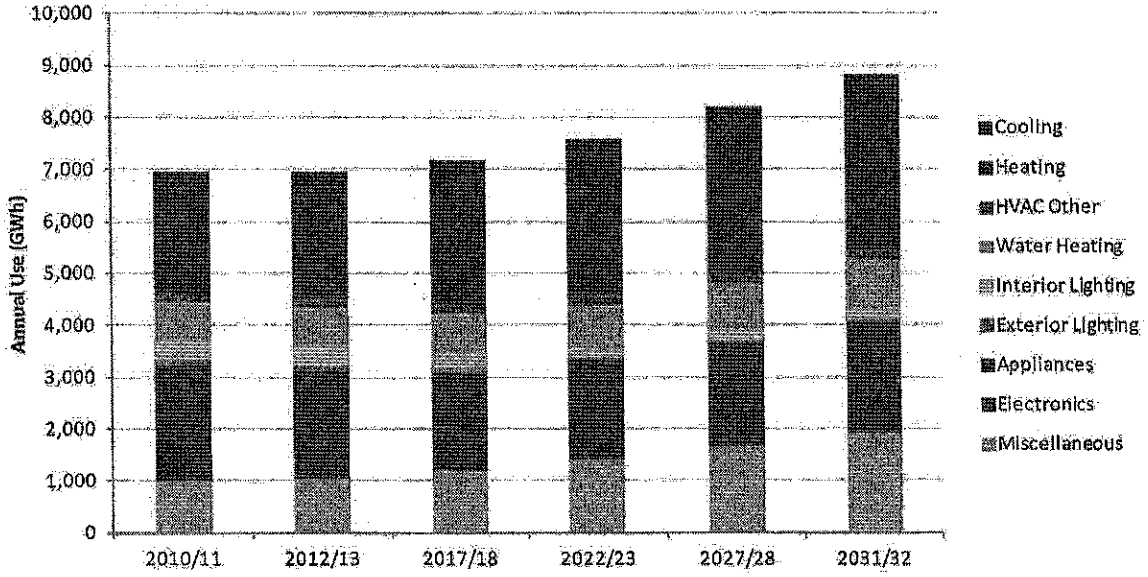
In this section, the baseline end-use projections for the residential, commercial and industrial sectors are presented. This is followed by the combined projection across all sectors.

Residential Sector

The baseline projection incorporates assumptions about economic growth, electricity prices, and appliance/equipment standards and building codes that are already mandated.

Figure 4-1 presents the baseline projection at the end-use level for the residential sector as a whole. Overall, residential use increases from 6,952 GWh in 2010/11 to 8,831 GWh in 2031/32, an increase of 27%, or an average growth of 1.1% per year.

Figure 4-1 Residential Baseline Projection by End Use



Commercial Sector

Electricity use in the commercial sector increases by nearly 16% during the forecast horizon, an average of 0.7% per year. Usage starts at 5,685 GWh in 2010/11, dips in 2016/17 and then increases to 6,581 GWh in 2031/32. Figure 4-3 and Table 4-2 present the baseline projection at the end-use level for the commercial sector as a whole. Most end uses show modest growth over the forecast period. The exceptions are interior lighting, which declines due to the lighting standards, and refrigeration, which is affected by the standards for refrigeration.

Figure 4-3 Commercial Baseline Electricity Projection by End Use

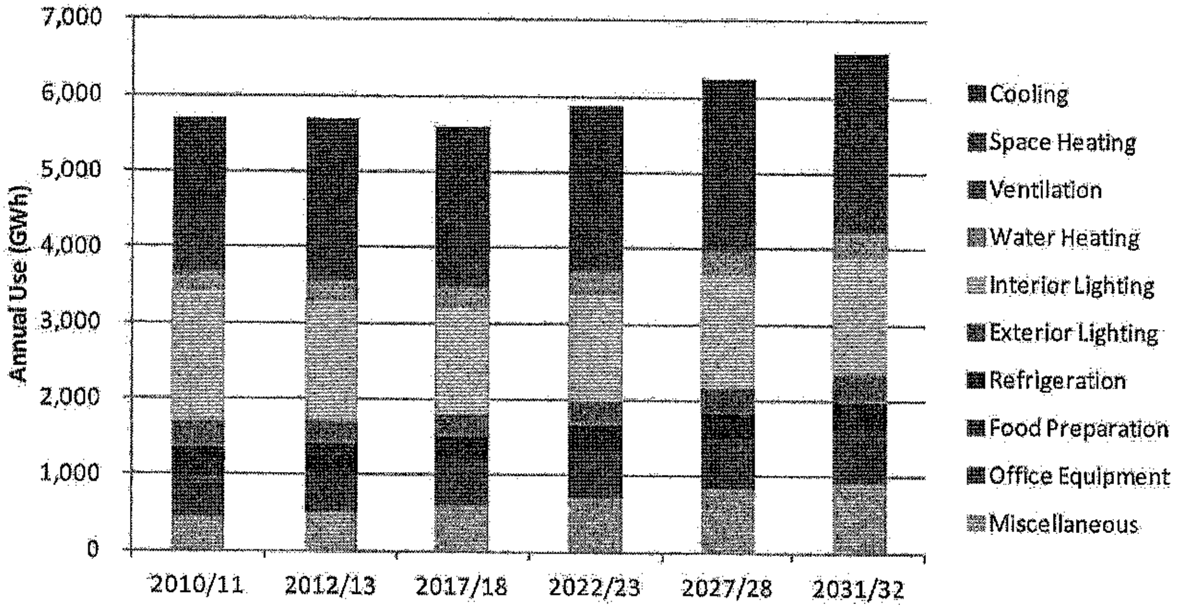


Table 4-2 Commercial Electricity Consumption by End Use (GWh)

End Use	2010/11	2012/13	2017/18	2022/23	2027/28	2031/32	% Change	Avg. Growth Rate
Cooling	1,212	1,324	1,239	1,250	1,293	1,352	11.6%	0.5%
Space Heating	362	368	385	398	413	423	16.9%	0.7%
Ventilation	429	441	477	517	556	587	36.8%	1.5%
Water Heating	252	258	275	294	313	328	30.0%	1.2%
Interior Lighting	1,734	1,591	1,404	1,418	1,487	1,545	-10.9%	-0.5%
Exterior Lighting	337	301	292	311	333	349	3.8%	0.2%
Refrigeration	375	372	350	345	355	376	0.1%	0.0%
Food Preparation	111	110	110	115	121	128	14.5%	0.6%
Office Equipment	416	429	463	503	536	563	35.4%	1.4%
Miscellaneous	457	493	595	707	828	929	103.5%	3.4%
Total	**5,685**	**5,688**	**5,590**	**5,858**	**6,236**	**6,581**	**15.8%**	**0.7%**

Table 4-3 presents the commercial sector projection by technology. Interior screw-in lighting decreases significantly over the forecast period as a result of the lighting standard.

Industrial Sector

Figure 4-4 and Table 4-4 present the baseline projection at the end-use level for the industrial sector as a whole. Overall, industrial annual energy use increases from 7,576 GWh in 2010/11 to 9,304 GWh in 2031/32, a 23% increase, or 1.0% average growth per year.

Figure 4-4 Industrial Baseline Electricity Projection by End Use

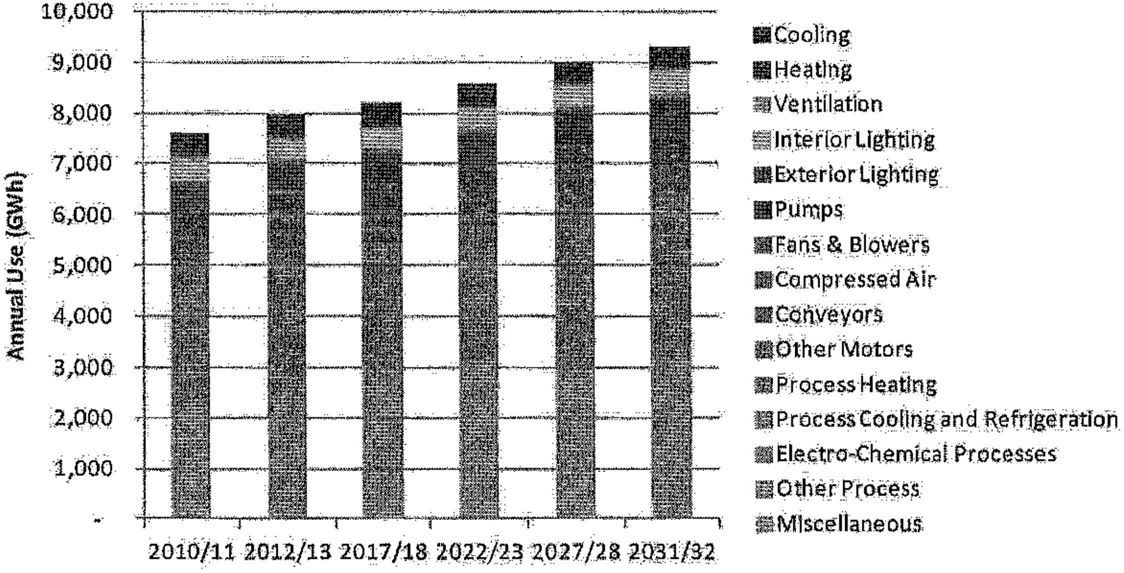


Table 4-4 Industrial Electricity Consumption by End Use (GWh)

End Use	2010/ 11	2012/ 13	2017/ 18	2022/ 23	2027/ 28	2031/ 32	% Change	Avg. Growth Rate
Cooling	349	400	380	366	361	363	4%	0.2%
Heating	78	75	77	80	83	84	9%	0.4%
Ventilation	30	29	25	25	26	26	-14%	-0.7%
Interior Lighting	448	420	413	427	445	454	1%	0.1%
Exterior Lighting	84	64	58	61	63	64	-23%	-1.2%
Pumps	524	515	611	641	684	711	36%	1.4%
Fans & Blowers	481	484	504	519	542	557	16%	0.7%
Compressed Air	333	330	348	365	388	402	21%	0.9%
Conveyors	296	303	272	276	284	289	-3%	-0.1%
Other Motors	1,089	1,096	1,179	1,224	1,289	1,331	22%	1.0%
Process Heating	1,288	1,421	1,322	1,393	1,468	1,513	18%	0.8%
Process Cooling & Refrig.	361	384	419	440	462	476	32%	1.3%
Electro-chemical Process	1,861	2,089	2,192	2,350	2,519	2,623	41%	1.6%
Other Process	116	118	121	124	127	129	11%	0.5%
Miscellaneous	238	250	256	265	275	281	18%	0.8%
Total	**7,576**	**7,978**	**8,177**	**8,556**	**9,016**	**9,304**	**23%**	**1.0%**

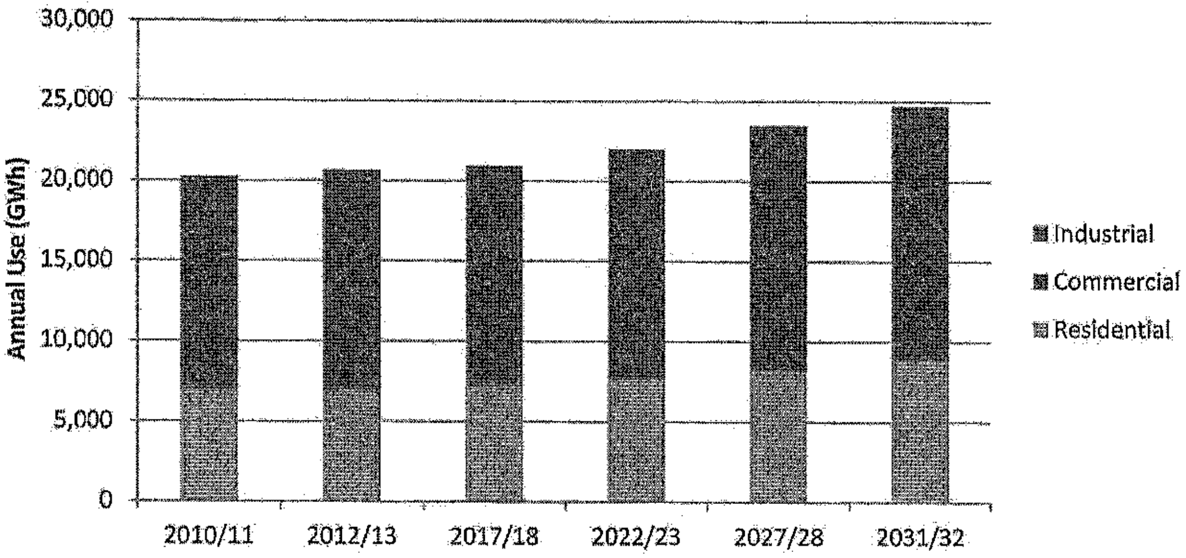
Electric Baseline Projection Summary

Table 4-5 and Figure 4-5 provide a summary of the baseline projection by sector and for Manitoba Hydro as a whole.

Table 4-5 Baseline Projection Summary (GWh)

Sector	2010/11	2012/13	2017/18	2022/23	2027/28	2031/32	% Change	Avg. Growth Rate
Residential	6,952	6,955	7,168	7,592	8,215	8,831	27.0%	1.3%
Commercial	5,685	5,688	5,590	5,858	6,236	6,581	15.8%	0.7%
Industrial	7,576	7,978	8,177	8,556	9,016	9,304	22.8%	1.0%
Total	**20,213**	**20,621**	**20,935**	**22,006**	**23,467**	**24,716**	**22.3%**	**1.1%**

Figure 4-5 Baseline Projection Summary (GWh)



Baseline Projection for Natural Gas

In this section, the baseline natural gas projections for the residential, commercial and industrial sectors are presented. This is followed by the combined projection across all sectors.

Residential Sector

The baseline projection incorporates assumptions about economic growth, natural gas prices, and appliance/equipment standards and building codes that are already mandated.

Figure 4-6 presents the baseline projection at the end-use level for the residential sector as a whole. Overall, residential use increases from 590 MMm^3 in 2010/11 to 551 MMm^3 in 2031/32, a decrease of 7%, or an average growth of -0.3% per year.

Tab 11

79

Guide for Conducting Energy Efficiency Potential Studies

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how much to invest.[3] To support this objective, decision-makers need to understand the overall magnitude of the efficiency resource and the associated costs and benefits. The analysis in this case focuses on providing a reasonable estimate of efficiency potential at a high level[4] of aggregation. Results from these studies are typically used to establish the magnitude of efficiency opportunities and to support high-level decisions on funding levels for efficiency portfolios. While the level of funding allocated to efficiency programs is ultimately a political decision, a potential study can help all stakeholders to clearly see the possibilities.

In many cases, needlessly detailed and expensive studies are performed where simpler analyses would suffice. For example, if available program funding (whether proposed or currently available) will only support a modest level of efficiency investment, a high-level study conducted for a relatively modest budget will typically provide the necessary information to support policy decisions (see Section 3.4). In cases where jurisdictions are beginning to pursue a high percentage of efficiency opportunities, more detailed studies may be necessary to refine estimates of cost-effective spending levels as well as to provide information on the remaining efficiency opportunities.

2.3.2 Identifying Alternatives to Supply-Side Investments

Energy efficiency is increasingly being considered as an alternative to supply-side investment in generation or transmission resources, especially in the context of reliability constraints. In cases where parties wish to understand the relative magnitude of the efficiency potential and whether it can defer alternative investments, a potential study can answer the question: Can efficiency displace needed investments in supply-side or transmission resources? Investment decisions, especially those regarding investments to meet future reliability, may require a more detailed potential study than under the previous scenario. These studies typically focus on a specific set of conditions (e.g., geographic area, customer loads) to facilitate comparison with alternative solutions. Ideally, the methodology is based on detailed, site-specific data to support investment-grade analysis. Such a potential study is designed to produce estimates of what can be accomplished from a specific program design, rather than on generally aggressive efficiency investments.

2.3.3 Detailed Planning and Program Design

In some cases, policy-makers have decided to invest in efficiency and need guidance on which market sectors, targeted geographic areas, end uses, measures, and programs should be tapped to realize the efficiency potential in their regions of interest. For example, when dealing with equity issues, a policy-maker may wish to fully understand the level of cost-effective efficiency investment that can be achieved in the low-income sector. It may also be desirable to establish specific savings, spending, or net benefits goals for one or more market segments (e.g., new construction). For this purpose, detailed potential studies are needed to describe the efficiency potential by specific characteristics or to analyze various program options for the purpose of understanding additional opportunities for efficiency. Very detailed studies may be warranted to determine the magnitude and economics of specific measures, market segments, or detailed program designs. A greater level of segmentation generally requires a more detailed and expensive study. The effort required for a greater level of detail may be offset by limiting the analysis to one or a few program concepts or market sectors, rather than addressing all efficiency opportunities.

2.4 Types of Efficiency Potential

Energy efficiency practitioners often distinguish between four different types of efficiency potential analysis: technical, economic, achievable, and program. Still, there are often important definitional issues between studies, and terms are used in different ways by different people. Therefore, it is important when reviewing studies to fully understand the definition and scope that applies to any given estimate. Below are typical definitions of these terms. The first two types of studies—technical and economic—provide a theoretical upper bound of existing efficiency resources. Even the best-designed portfolio of programs, with unlimited funding, will not capture 100 percent of the technical or economic potential. The latter two types—achievable and program—tend to be more useful in that they estimate what can actually be achieved, when it can be captured, and how much it will cost to do so.

- **Technical potential** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.
- **Economic potential** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.
- **Achievable potential** is the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficiency equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[5]
- **Program potential** refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding. Program potential studies can consider scenarios ranging from a single program to a full portfolio of programs. A typical potential study may report a range of results based on different program funding levels.

Variations exist on the above definitions. For example, most studies consider achievable potential as a subset of economic potential, but some studies consider it as a subset of technical potential. The rationale for this is that as avoided costs and measure costs change over time, non-cost-effective measures may become economical. *Maximum technically achievable* would be a more informative term for such a view. This is especially true when considering efficiency resources as an alternative to defer or replace substantial new supply-side investment. In this case, what is economical may not be known until the magnitude of efficiency is established and components or new supply-side investments can be analyzed to determine the potential cost and benefits of deferral. Finally, we note that in reality, potential exists along a continuum rather than in discrete steps. While the terms defined above facilitate discussion and comparison of different studies, it is important to understand the scope of the particular definition of potential in use for any given study.

2.5 Review of Results from Previous Potential Studies

There have been numerous potential studies released in the past decade covering regions throughout the United States and Canada. The tables below summarize the technical, economic, and achievable potential found in 21 studies, 19 of which are from the United States.[6] It is important to note that the studies vary in their scope, objectives, methodology, time horizon, and definitions. This is especially true in regard to achievable potential. Some studies define this as the maximum potential that could be captured assuming infinite budget (i.e., 100 percent of incremental efficiency costs covered by incentives, as well as aggressive marketing and other supporting initiatives). Other studies define achievable potential as that which could reasonably be captured through likely policies or specific funding constraints.

Tab 12

ELECTRIC POWER
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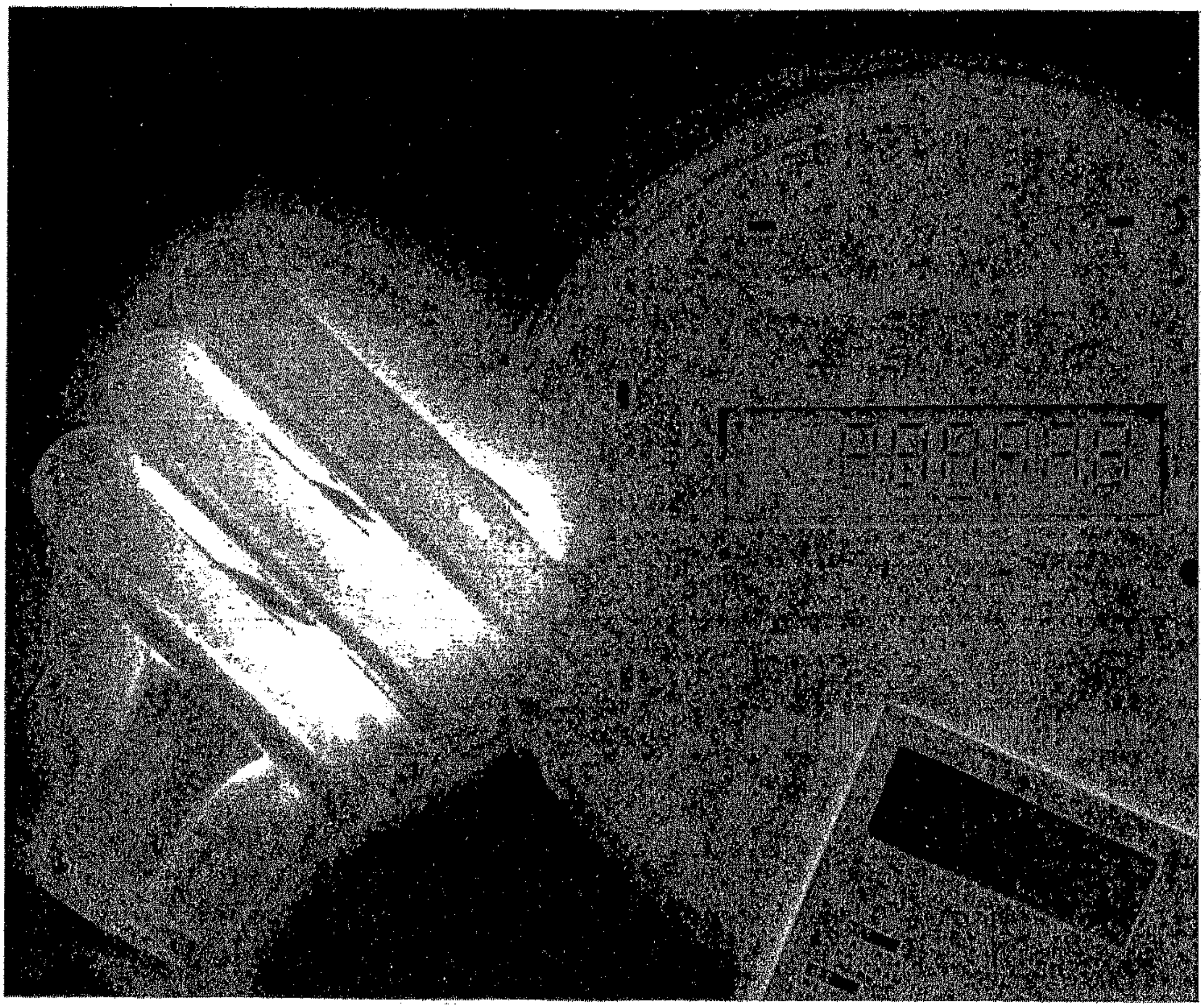
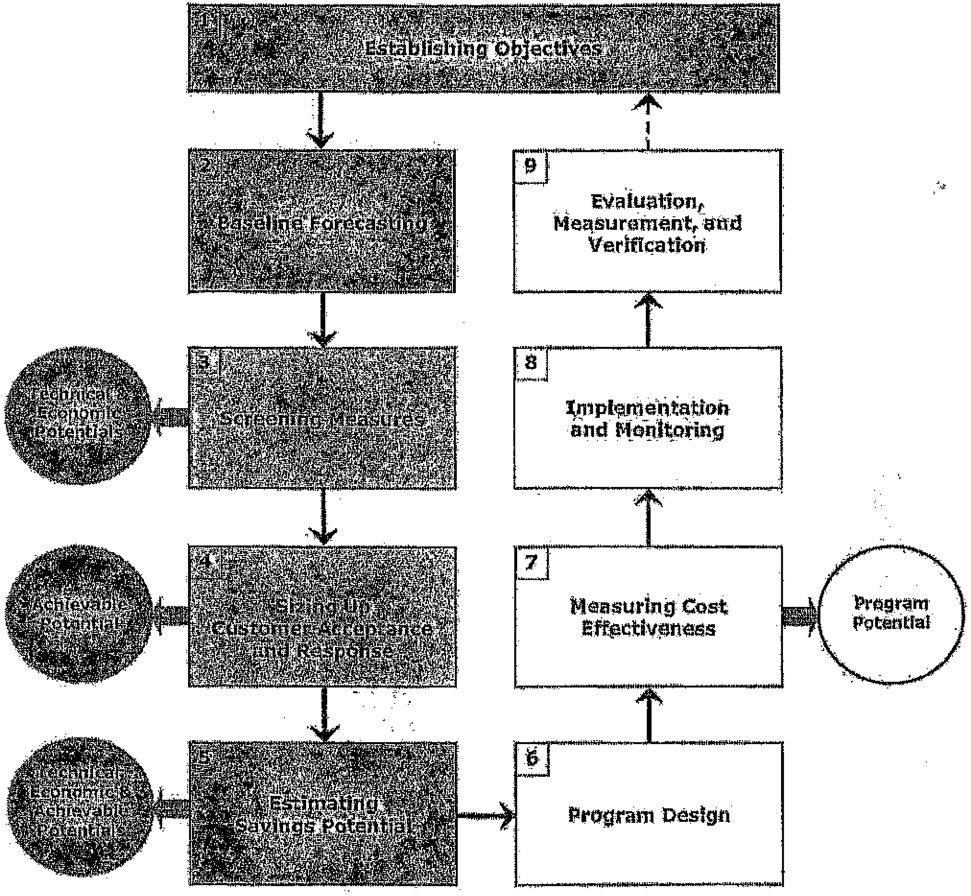
Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.

(2010–2030)





Source: Energy Efficiency Planning Guidebook, EPRI 1016273, June 2008

Figure ES-1
Energy Efficiency Analysis Framework

The savings potential of an individual energy-efficiency measure is a function of its unit energy savings relative to a baseline technology and its technical applicability, economic feasibility, the turnover rate of installed equipment, and market penetration. For a given end-use, a baseline technology represents a discrete technology choice that complies with minimum existing efficiency standards (to the extent such standards exist) and is generally the most affordable and prevalent technology option in its end-use category. For each end use category, several grades of higher-efficiency technology options are available beyond the baseline technology.

For example, for residential central air conditioning (CAC), the baseline technology is a unit with a seasonal energy efficiency ratio (SEER) of 13. In our modeling approach, the baseline SEER 13 unit, along with more efficient, and expensive, technology options (e.g., SEER 14, SEER 15, SEER 17, ductless inverter-driven mini-split heat pumps, etc.) are applicable in existing homes as replacements for CACs *that have reached the end of their expected useful life.* They are also applicable to new homes that are being built with CAC. In our modeling approach, they are not applicable to either existing or new homes with room air conditioners.

The study utilized a modeling tool for forecasting energy use, peak demand, and energy efficiency and demand response savings[5]. The modeling approach is consistent with EPRI's end-use econometric forecasting models, including Residential End-Use Econometric Planning System (REEPS) and the Commercial End-Use Planning System (COMMEND), which are detailed microeconomic models that forecast energy and peak demand at the sector, segment, and end-use levels. The modeling tool used in this study represents a simplification of these legacy EPRI models customized for the analytical task of estimating energy efficiency potential. The study incorporates a comprehensive technology database that includes the latest findings from EPRI energy efficiency research. Energy efficiency savings potentials are developed using a bottom-up approach, aggregating the impact of discrete technology options within end uses across sectors and regions. This approach follows industry best practices and has been applied successfully in numerous forecasting and potential studies for utilities.

Defining "Potential"

The primary focus of this study was to develop a range of **achievable** energy efficiency and demand response potentials. The approach for deriving *achievable potential* is predicated on first establishing the theoretical constructs of *technical potential* and *economic potential* and then discounting them to reflect market and institutional constraints. This study applies the condition that new equipment does not replace existing equipment instantaneously or prematurely, but rather is "phased-in" over time as existing equipment reaches the end of its useful life. All categories of potentials in this study conform to this condition, and may be termed "phase-in" potentials.[6]

This study employs the following categories of potential.

- **Technical Potential** represents the savings due to energy efficiency and demand response programs that would result if all homes and businesses adopted the most efficient, commercially available technologies and measures, *regardless of cost*. Technical potential provides the broadest and largest definition of savings since it quantifies the savings that would result if all current equipment, processes, and practices in all sectors of the market were replaced at the end of their useful lives by the most efficient available options. Technical potential does not take into account the cost-effectiveness of the measures or the rate of market acceptance of those measures (i.e. 100% customer acceptance assumed).

  Using the residential central air conditioning example from above, technical potential assumes that, each year, every home with a residential central AC unit that has reached the end of its useful life purchases and installs the most efficient technology as a replacement (i.e. ductless inverter-driven mini-split heat pumps), regardless of cost.

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[5] The modeling tool employed was Global Energy Partners' Load Management Analysis and Planning (LoadMAP)

[6] For the purposes of this study, no "mid-life" replacements of existing equipment for more efficient equipment are assumed, even though in some instances such replacements may be economically justifiable. Consumers or firms that initiate such replacements could be considered predisposed to efficiency or conservation, and their actions may be grouped in the category or market-driven or "naturally-occurring" savings if they would occur independent of an energy efficiency program.

- **Economic Potential** represents the savings due to programs that would result if all homes and business adopted the most efficient, commercially available *cost-effective* measures. It is a subset of the Technical Potential and is quantified only over those measures that pass a widely recognized economic cost-effectiveness screen. The cost-effectiveness screen applied in this study is a variation of the *Participant Test*, which compares the incremental cost to a consumer of an efficient technology relative to its baseline option, and the bill savings expected from that technology over its useful life. Only those technologies for which the net present value of benefits exceeds its incremental cost to consumers pass the test. Economic potential does not take into account the rate of market acceptance of those measures (i.e. 100% customer acceptance assumed).

  Economic potential assumes that, each year, every home with a residential central AC unit that has reached the end of its useful life purchases and installs the most efficient technology that passes a basic economic cost-effectiveness test as a replacement (e.g. SEER 14 – 17 depending upon the region).

- **Achievable Potential** refines economic potential by taking into account various barriers to customer adoption.
  - **Maximum Achievable Potential (MAP)** takes into account those barriers that limit customer participation under a scenario of perfect information and utility programs. MAP involves incentives that represent 100% of the incremental cost of energy efficient measures above baseline measures, combined with high administrative and marketing costs. These barriers could reflect customers' resistance to doing more than the absolute minimum required or a dislike of the technology option. For example, some customers might choose not to buy compact fluorescent lamps (CFLs) because they don't like the color or don't believe they work as well as incandescent lamps. When considering the purchase of major appliances, many customers consider price, aesthetics, and functional attributes before turning to energy efficiency and operational costs. Similarly, even though a financial incentive such as a rebate afforded by a program would bring the up-front cost of an energy-efficient product at parity with a standard product, some segment of customers are not be willing to go through the perceived hassle of a rebate application. This despite the clear economic benefits that would accrue from the monthly bill savings that result from a more efficient device. MAP is estimated by applying market acceptance rates (MARs) to the economic potential savings from each measure.
  - **Realistic Achievable Potential (RAP)**, unlike the other potential estimates, represents a forecast of likely customer behavior. It takes into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy-efficiency and demand-response programs. For example, utilities do not have unlimited budgets for energy efficiency and demand response programs. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. Market barriers reflect imperfect information. RAP also takes into account recent utility experience and reported savings. RAP is calculated by applying a program implementation factor (PIF) to MAP for each measure