BC hydro

Integrated Resource Plan

Appendix 6B-2

Addendum to the Greenhouse Gas Reduction Scenarios of the Western interconnection: (2010-2050)

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Greenhouse Gas Reduction Scenarios for the Western Interconnection: (2010 – 2050)

Scenario Development and Methodology Report for BC Hydro 2011 Integrated Resource Plan

March 2011

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1 Introduction

BC Hydro engaged Energy and Environmental Economic Inc. (E3) to assist with the preparation of Greenhouse Gas (GHG) Reduction scenarios for the 2011 Integrated Resource Plan (IRP). This work is described in the E3 report (the Report) "Greenhouse Gas Reduction Scenarios for the Western Interconnection: (2010-2050). Two scenarios of GHG reduction are presented, a low GHG reduction scenario, reflecting a 30% reduction in GHG emissions by 2050 across the Western Interconnection and a high GHG reduction scenario, reflecting an 80% reduction in GHG emissions by 2050 across the Western Interconnection.

One of the strategies for GHG reduction included in the E3 report is electrification. Electrification is the process of switching specific end uses in the residential, commercial, industrial and transportation sectors from the utilization of fossil based fuels to using clean electricity.

The purpose of this Addendum is to describe additional work that BC Hydro has undertaken on the electrification impacts of the work presented in the E3 report.

The incremental electricity demand due to electrification in British Columbia associated with the low and high scenarios are contained in Table 10 and Table 14 of the E3 report.

2 Additional Analysis

The areas of additional analysis that BC Hydro has undertaken on the GHG reduction scenarios are:

1. Identifying the BC Hydro electrification impacts by removing the Fortis BC service territory electrification impacts;

2. Incorporation of the capacity impacts of electrification;

3. Incorporation of Demand Side Management (DSM) to reduce the incremental electricity load associated with the electrification contained within the scenarios; and

4. The inclusion of transmission and distribution system losses and rate impacts to determined the resulting impact on BC Hydro generation requirements.

2.1 Fortis BC Electrification Impacts

The starting point for the additional analysis that BC Hydro undertook on the electrification scenarios was to remove the electrification associated with the Fortis BC service territory, which is included in the values shown in the Report in tables 10 and 14 for Scenarios 2 and 3, respectively. Tables 1 and 2 show the incremental BC Hydro electricity demand due to electrification.

Table 1 – Incremental BC Hydro Electricity Demand Due to Electrification – Scenario 2

(Before Electrification DSM, Rates & Losses)	2020	2030	2040	2050
Residential (GWh)	148	911	2,709	3,604
Commercial (GWh)	149	1,014	3,408	5.,119
Industrial (GWh)	167	1,090	3,738	5,512
Transportation (GWh)	369	2,529	8,713	12,963
Total (GWh)	**832**	**5,544**	**18,568**	**27,199**

Table 2 – Incremental BC Hydro Electricity Demand Due to Electrification – Scenario 3

(Before Electrification DSM, Rates & Losses)	2020	2030	2040	2050
Residential (GWh)	246	1,518	4,483	5,898
Commercial (GWh)	248	1,689	5,641	8,379
Industrial (GWh)	333	2,178	7,425	10,826
Transportation (GWh)	521	3,565	11,899	16,608
Total (GWh)	**1,349**	**8,950**	**29,449**	**41,711**

2.2 Capacity Impacts of Electrification

Load factors were applied to the incremental electrification impact at the end use or sub-sector level in order to estimate the capacity impact of incremental electrification load. The load factors applied were:

Table 3 – Load Factors Applied to Estimate Electrification Capacity Impacts

	Load Factor
Residential	
Electric Space Heating	31%
Electric Water Heating	29%
Appliances	24%
Other residential loads	33%
Commercial	
Electric Space Heating	31%
Electric Water Heating	29%
Electric Space Cooling	5%
Other commercial loads	59%
Industrial	

	Load Factor
All Sectors	82%
Transportation	40%

The resulting impacts on BC Hydro capacity requirements are shown in Table 4 and Table 5 for scenario 2 and scenario 3 respectively.

Table 4 – Incremental BC Hydro Capacity Requirements –Scenario 2 Electrification

(Before Electrification DSM, Rates & Losses)	2020	2030	2040	2050
Residential (MW)	54	331	987	1,315
Commercial (MW)	50	340	1,138	1,701
Industrial (MW)	23	153	527	778
Transportation (MW)	106	727	2513	3,743
Total (MW)	**233**	**1,552**	**5,165**	**7,537**

Table 5 – Incremental BC Hydro Capacity Requirements – Scenario 3 Electrification

(Before Electrification DSM, Rates & Losses)	2020	2030	2040	2050
Residential (MW)	89	551	1,664	2,151
Commercial (MW)	84	566	1,884	2,785
Industrial (MW)	47	307	1,047	1,528
Transportation (MW)	150	1,025	3,432	4,795
Total (MW)	**369**	**2,449**	**7,997**	**11,259**

2.3 Demand Side Management of Electrification Load

BC Hydro assessed the potential to reduce both the energy and capacity impacts associated with the electrification scenarios through DSM efforts. Separate processes were used for:

- Energy (and associated capacity savings);
- Capacity associated with transportation / electric vehicles; and
- Capacity from Capacity Focused (CF) DSM options.

Each of these processes is described below.

2.3.1 ELECTRIFICATION ENERGY SAVINGS ASSOCIATED WITH DSM OPTION 2

The overall process of determining the potential electrification energy savings (and associated capacity) assumed the same level of DSM effort as the 2011 IRP Option 2. The specific process follows was as follows:

a. Incremental energy and capacity levels due to electrification were identified by end-use (residential and commercial) or sub-sector (industrial). No energy savings were assumed for the transportation sector.

b. The level of DSM Program and Codes and Standards savings associated with the end-uses or sub-sectors in a. for the 2011 DSM Option 2 was estimated and applied proportionally to the incremental electrification load for the same end-uses or sub-sectors over the 30 year IRP planning time frame.

c. Savings from conservation rates at an equivalent level as the 2011 DSM Option 2 for each sector was applied to the incremental electrification load by sector over the initial 30 year IRP planning time frame.

d. DSM savings after the 30 year IRP planning period was extrapolated based on the proportion of DSM savings to electrification load in the last year by sector.

2.3.2 ELECTRIFICATION CAPACITY SAVINGS ASSOCIATED WITH TRANSPORTATION / ELECTRIC VEHICLES

Based on the relative load factor provided in the electrification scenarios, a significant portion of the vehicles are assumed to be charging in the evening hours to replenish batteries. Users are assumed to be plugging their electric vehicle into the charging outlet after work so that the vehicle will be ready for use the next day.

To limit the impact of charging at the time of system peak, BC Hydro would implement a time-based rate and / or a Power Smart program to encourage the installation of a timer which prevents the charging of vehicles during the system peak hours in the evening. Assuming that the charging cycle of the batteries is a few hours, there should be sufficient time to re-charge the batteries over-night (outside of the system peak hours). As such, the implementation of the timer is essentially transparent to the users.

A conservative estimate is that half of the peak capacity impact due to transportation / EVs would be reduced as a result of the use of these timers.

2.3.3 ELECTRIFICATION CAPACITY SAVINGS ASSOCIATED WITH CAPACITY FOCUSED DSM

The process to estimate the incremental capacity savings from CF-DSM is the same proportionally as that for DSM Option 2. The proportion of CF-DSM savings in a given year by sector is applied to the incremental electrification capacity for the same year.

2.3.4 SUMMARY OF DSM ENERGY AND CAPACITY IMPACTS

Table 6 and Table 7 provide a summary of the potential impacts of DSM on incremental electrification energy and capacity for scenarios 2 and 3 respectively. These estimates include losses.

Table 6 – Potential DSM Energy and Capacity Savings on Incremental Electrification Load – Scenario 2

(Before Rates and Losses)	2020	2030	2040	2050
Energy Acquired P50 (GWh)				
Residential	9.8	110.2	368.9	487.6
Commercial	15.6	128.6	499.0	749.1
Industrial	14.5	105.6	392.9	576.0
Transportation	0.0	0.0	0.0	0.0
Total	**39.9**	**344.4**	**1,260.8**	**1,812.7**
Capacity P50 (MW)				
Residential	3.0	28.1	77.7	102.9
Commercial	2.7	22.5	74.5	111.6
Industrial	2.3	15.2	48.6	71.3
Sub-total: Energy Related Capacity Reduction	***8.0***	***65.8***	***200.8***	***285.8***
Transportation	65.0	429.4	1,345.3	1,986.0
TOU / CPP – Res	0.6	6.3	18.1	24.0
TOU / CPP – Comm	0.5	7.0	20.6	30.4
TOU / CPP – Ind-D	0.2	2.3	6.9	10.0
Load Curtailment – Ind – Tx	1.2	7.4	23.2	33.9
Demand Response – Res	2.5	12.8	34.6	45.7
Demand Response – Comm	1.4	7.9	24.1	35.7
Demand Response – Ind-D	0.4	2.1	6.5	9.5
Total	**79.9**	**541.0**	**1,680.0**	**2,461.0**

Table 7 – Potential DSM Energy and Capacity Savings on Incremental Electrification Load – Scenario 3

(Before Rates and Losses)	2020	2030	2040	2050
Energy Acquired P50 (GWh)				
Residential	16.4	183.6	609.9	761.6
Commercial	25.9	214.2	824.9	1,055.5
Industrial	27.8	202.2	744.4	891.9
Transportation	0.0	0.0	0.0	0.0
Total	**70.1**	**600.0**	**2,179.1**	**2,709.0**
Capacity P50 (MW)				
Residential	4.9	46.9	128.4	168.2
Commercial	4.6	37.5	123.1	182.4
Industrial	4.5	29.1	92.1	133.5
Sub-total: Energy Related Capacity Reduction	***14.0***	***113.4***	***343.7***	***484.1***
Transportation	91.9	604.7	1,824.9	2,526.1
TOU / CPP – Res	1.0	10.6	29.9	39.2
TOU / CPP – Comm	0.9	11.6	34.1	49.7
TOU / CPP – Ind-D	0.3	3.9	11.4	16.3
Load Curtailment – Ind – Tx	2.5	14.8	45.9	66.4
Demand Response – Res	4.1	21.2	57.2	74.7
Demand Response - Comm	2.3	13.2	39.8	58.4
Demand Response – Ind-D	0.7	4.2	12.9	18.7
Total	**117.7**	**797.5**	**2,399.7**	**3.333.6**

2.4 Other Adjustments to Determine the Impact of Electrification on BC Hydro Generation Requirements

The focus of the E3 scenario impacts were the Western Interconnection and the associated provinces and states. This provided a view for the impacts of electrification for the province of British Columbia at the customer meter. In order to determine the impacts of electrification on BC Hydro (only) system generation requirements the following adjustments were made:

- Transmission and distribution system line losses were added to the electrification impacts; and
- A rate elasticity impact estimate was included on the incremental electrification load based on the December 2010 Long Term Rate Forecast.

Table 1 and Table 2 summarize the resulting incremental energy requirements associated with the electrification scenarios on BC Hydro.

Table 8 – Incremental BC Hydro Energy Requirements – Scenario 2 Electrification

(Including DSM, Losses and Rates)	2020	2030	2040	2050
Residential (GWh)	146	840	2,520	3,355
Commercial (GWh)	141	931	3,134	4,706
Industrial (GWh)	156	1,013	3,493	5,152
Transportation (GWh)	410	2,736	9,385	13,958
Total (GWh)	**844**	**5,521**	**18,532**	**27,170**

Table 9 – Incremental BC Hydro Energy Requirements – Scenario 3 Electrification

(Including DSM, Losses and Rates)	2020	2030	2040	2050
Residential (GWh)	244	1,400	4,172	5,530
Commercial (GWh)	236	1,550	5,188	7,885
Industrial (GWh)	313	2,037	6,975	10,367
Transportation (GWh)	566	3,857	12,817	17,882
Total (GWh)	**1,359**	**8,844**	**29,153**	**41,665**

Table 10 – Incremental BC Hydro Capacity Requirements – Scenario 2 Electrification

(Including DSM, Losses and Rates)	2020	2030	2040	2050
Residential (MW)	57	334	980	1,303
Commercial (MW)	53	350	1,146	1,709
Industrial (MW)	23	148	500	737
Transportation (MW)	119	802	2,707	4,024
Total (MW)	**252**	**1,632**	**5,332**	**7,773**

Table 11 – Incremental BC Hydro Capacity Requirements – Scenario 3 Electrification

(Including DSM, Losses and Rates)	2020	2030	2040	2050
Residential (MW)	98	574	1,676	2,205
Commercial (MW)	91	601	1,960	2,893
Industrial (MW)	48	306	1,031	1,502
Transportation (MW)	173	1,166	3,821	5,330
Total (MW)	**410**	**2,647**	**8,488**	**11,930**

3 Summary of Additional Analysis Impacts

Figure 1 and Figure 2 show the gross system requirements for the energy and peak load reference forecasts and the two electrification scenarios. The reference forecasts were extrapolated beyond the 30 year IRP planning horizon based on the annual compound growth rate in the last 10 years of the 30 year horizon.

Figure 1 – Reference Load Forecast and Electrification Scenarios 2 and 3

(Including DSM, Rates and Line Losses)

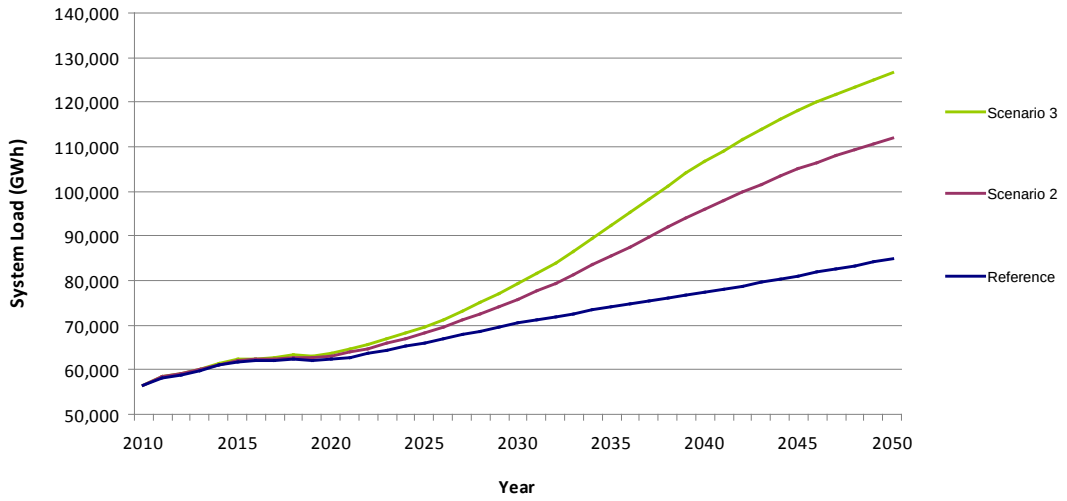
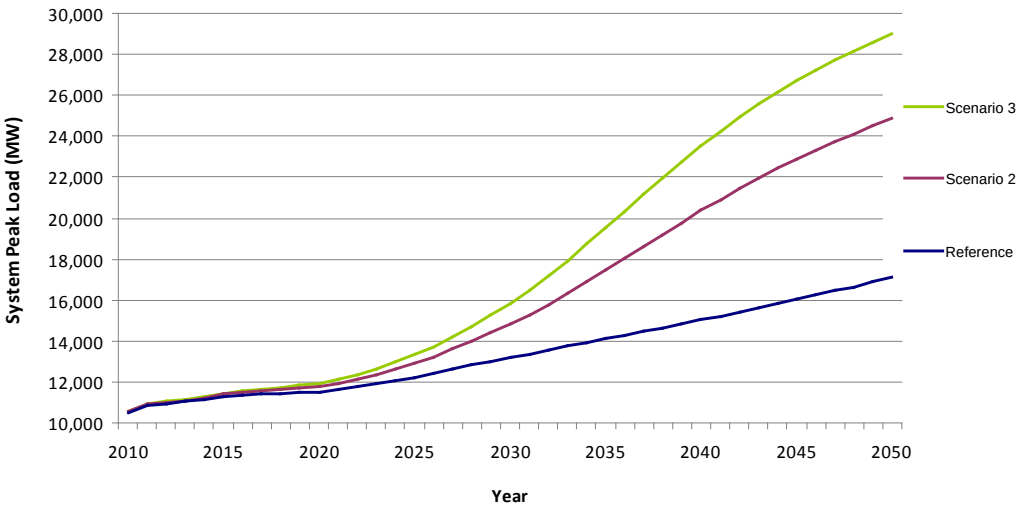


Figure 2 – Reference Peak Load Forecast and Electrification Scenarios 2 and 3 (Including DSM, Rates and Line Losses)



In Figure 2, only the capacity associated with the DSM energy savings is netted from the reference peak system load forecast, as the capacity savings associated with transportation and capacity focused DSM programs will be incorporated into a separate capacity analysis within the IRP.