2008 Long-Term Acquisition Plan

Intervenor Workshop #2
Inputs to the 2008 LTAP Analysis, Risk Assessment & Mitigation

April 25, 2008
The Sutton Place Hotel
## Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda Item</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 - 9:00</td>
<td>Coffee available</td>
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<tr>
<td>9:00 - 9:10</td>
<td>Welcome and Introduction</td>
<td>Anne Wilson [Facilitator] BCH Energy Planning Engagement Coordinator</td>
</tr>
<tr>
<td>9:10 - 9:15</td>
<td>Legislative Context</td>
<td>Craig Godsoe BCH General Counsel Senior Solicitor</td>
</tr>
<tr>
<td>9:15 - 10:15</td>
<td>Load Forecast</td>
<td>David Ince BCH Energy Planning Market Forecast Manager</td>
</tr>
<tr>
<td>10:15 - 10:30</td>
<td>Break</td>
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<tr>
<td>11:15 - 12:00</td>
<td>Risk Framework</td>
<td>Basil Stumborg BCH Enterprise, Strategy &amp; Investment Senior Advisor</td>
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<tr>
<td>12:00 - 12:45</td>
<td>Lunch</td>
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<tr>
<td>12:45 - 1:45</td>
<td>Risk Framework - continued</td>
<td>Basil Stumborg</td>
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<td>1:45 - 2:00</td>
<td>Break</td>
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<tr>
<td>2:00 - 4:00</td>
<td>Portfolio Analysis</td>
<td>Randy Reimann</td>
</tr>
<tr>
<td>4:00</td>
<td>Close</td>
<td>Randy Reimann</td>
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</table>

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Intervenor Sessions - Summary

Nov 14, 2007

**PRELIMINARY SESSION**
- Provided LTAP Context
  - 2007 Energy Plan *(recent Legislative changes summarized)*
  - BCUC 2006 IEP/LTAP Decision
  - New approach to Risk Assessment
- Reviewed LTAP Components
- Feedback on Intervenor Engagement
  - Two upfront workshops on inputs
  - Review draft application

Mar 5, 2008

**INPUTS WORKSHOP #1**
- Resource options
  - DSM, Site C
- Electricity and Gas Price Forecast
- GHG Offset Price Forecast
- Risk Framework Introduction

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*Reliable power, at low cost, for generations.*
Materials Summary

Available on-line:

- GHG price forecast and probability assessment (Natsource)

- Natural gas price forecast with probability assessment (Global Energy)*

- Resource Options Related Reports (post-Dec 4 results session)
  - Assessment of the Energy Potential and Estimated Costs of Wind Energy in British Columbia (Garrad Hassan)
  - Technology Summary: Clean Coal Power Generation by CO2 Sequestration (Powertech Labs Inc.)
  - Run-of-River Hydroelectric Resource Assessment for British Columbia (Kerr Wood Leidal)
  - Jordan River Pumped Storage (BC Hydro Engineering Memo)*

- Intervenor meeting materials: presentations and summary notes

*Will be available on-line: Monday, April 28th.
Intervenor Sessions - Summary

April 25, 2008  |  INPUTS WORKSHOP #2

| Step 1 - Establish Objectives | Step 2 - Load Resource Balance | (REVIEW TODAY) |
|                              | Key Risks and Uncertainties    | (REVIEW TODAY) |
| No Update                    | Load Forecast                  | (REVIEW TODAY) |
|                              | Step 4 – Develop & Evaluate Portfolios | (REVIEW TODAY) |
|                              | Step 5 – Portfolio Trade-Off Analysis | |
|                              | Step 6 – Long-Term Acquisition Plan | |
|                              | Attributes                     | (REVIEW TODAY) |
| No Update                    | Step 3 – Resource Options Inventory | |

May 2008  |  REVIEW DRAFT APPLICATION

 Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Legislative Context

◆ B.C. Government is implementing the 2007 Energy Plan through legislation and regulations

◆ Special Direction No. 10
  ■ In force; Directs the BCUC in regulating BC Hydro to use the criterion that BC Hydro is to achieve electricity self-sufficiency by 2016 and each year thereafter
  ■ To become self-sufficient, BC Hydro will need to be able to acquire sufficient energy and capacity solely from electricity generating facilities within B.C. to allow it to meet all of its electricity supply obligations
  ■ For purposes of evaluating BC Hydro’s supply portfolio, the BCUC is to assume the most adverse critical water conditions, meaning BC Hydro’s fleet of hydroelectric generating facilities will contribute, for planning purposes, about 42,600 GWh/year

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Bill 15, *Utilities Commission Amendment Act, 2008*

- Given Third Reading on 8 April 2008, and comes into force on Royal Assent.
- Test for long-term resource plan acceptance is now “public interest” as opposed to “in the interests of persons in British Columbia who receive, or who may receive, service”.
- In reviewing long-term resource plans under section 44.1, BCUC must consider:
- The “government’s energy objectives” - Encourage Public Utilities to:
  - reduce greenhouse gas emissions
  - take demand-side measures (DSM)
  - produce, generate and acquire electricity from clean or renewable sources
  - develop adequate energy transmission infrastructure and capacity in the time required to serve persons who receive or who may receive service
  - use innovative energy technologies
- How the utility intends to reduce the demand for electricity by pursuing cost-effective [DSM] measures.
- The interests of persons in B.C. who receive, or who may receive, service from BC Hydro.
- Bill 15 provides regulating power to the Minister to
  - Make exceptions from sections of the act
  - Define terms
  - Prescribe targets, criteria, and rules.
- 2008 LTAP is consistent with Bill 15 requirements.
Bill 31, *Greenhouse Gas Reduction (Emission Standards) Statutes Amendment Act*

- Given First Reading on 17 April 2008; Part 6.1 of Bill 31 comes into force by regulation

- New Part 6.1 of the *Environmental Management Act* requires prescribed coal-fired generation facilities to capture and store GHG emissions from the combustion of coal

- New Part 6.1 also requires new natural gas-fired generation facilities to have net zero GHG emissions, as soon as Bill 31 comes into force

- Existing natural gas-fired generation facilities will be given until 2016 to become net zero
Questions?
Load Forecast

Dave Ince
Introduction to load forecast and methodology
Total energy and sector sales forecast comparison: 2007 vs. 2006 forecast
Peak demand comparison
Future updates
Introduction to the Load Forecasts

2 MAIN PRODUCTS:

- Annual Peak Forecast
  - Distribution substations
  - Transmission substations

- Annual Energy Forecast
  - Total Sales forecast includes:
    - Residential
    - Commercial
    - Industrial

3 PRIMARY APPLICATIONS:

- Generation operations capital planning
- Revenue Forecast
- Supply and demand balance for system planning

- Load Forecasts reflect economic forecasts, impacts of general rate increases, information from BC Hydro Key Account Managers and industry reports.

- Forecasts are prepared before and with incremental DSM.

- Current Forecasts are before DSM. DSM projections are to be provided by Power Smart. In the LTAP DSM is treated as a supply option and different combinations of DSM are to be tested.
Creating Annual Forecasts

**Energy**

**Residential Forecast (32% of firm sales)**
Average Energy Use * Number of Accounts
Drivers: end use for each appliance type, end-use saturation and housing starts forecasts.

**Commercial Forecast (30% of firm sales)**
Drivers: end use efficiency, saturation and employment, retail sales, and commercial GDP forecasts.

**Industrial Forecast (37% of firm sales)**
Bottom-up approach focused on largest consuming sectors (pulp and paper, mining, chemical, and wood products).
The 30 largest industrial sites account for about 67% of BC Hydro's industrial sales.
Forecast reflects market intelligence from BC Hydro Key Account Managers and industry experts.

**Peak**

First 11 years driven by a bottom up approach:
- Forecast is developed for each of the distribution and transmission voltage substations.
- Peak forecast is calibrated to the coldest temperatures over a rolling 30 year period.
- Drivers: housing starts, employment, and economic conditions Market information and industry reports

Long term (> year 11) of forecast driven by the rate of growth of the energy forecast.
Most of the decline comes from the industrial sector. Forestry sector, which is 50% of total industrial sales, is lower in the 2007 forecast reflecting diminishing long-term wood supply and fiber supply. Projection is consistent with recent forestry studies. Recent announcements on sawmill closures are reflected in the industrial forecast. Residential and commercial forecasts are above the 2006 forecast in the long-term.
BC Hydro Firm Sales Comparison
before DSM - 2007 vs. 2006 forecast

<table>
<thead>
<tr>
<th></th>
<th>2007 (GWh)</th>
<th>2006 (GWh)</th>
<th>Change (GWh) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>53,398</td>
<td>54,937</td>
<td>-1,539 (-2.8%)</td>
</tr>
<tr>
<td>F07/08</td>
<td>56,913</td>
<td>59,914</td>
<td>-3,001 (-5.0%)</td>
</tr>
<tr>
<td>F11/12</td>
<td>62,483</td>
<td>63,986</td>
<td>-1,503 (-2.3%)</td>
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<tr>
<td>F16/17</td>
<td>70,138</td>
<td>72,998</td>
<td>-2,859 (-3.9%)</td>
</tr>
</tbody>
</table>

* Current Forecast as of December 2007

- Firm Sales includes sales other utilities such as Fortis BC and New Westminster
Residential Sector

Sector Characteristics:
- Residential sector is the most stable of the three sectors. Accounts for 32% of total firm sales.
- Weather sensitive due to heating load in winter.

Methodology for Residential: Number of Accounts times Use Per Account
- Use per account comes from SAE model (Statistically Adjusted End use model) and REEPS (Residential End-Use Energy Planning System) model.
- SAE is a regression model and forecast is based on economic drivers, end uses and normal weather (i.e. 10 year rolling average of degree days).

Medium-Term Forecast: Slower Growth
- Annual Growth in actual sales between F06 and F07 was 612 GWh or 3.8%
- Sales growth this year is 234 GWh or 1.4% before DSM.
- Lower forecast over the first five years (i.e. 1.9% in 2007 forecast compare to 2.2% in 2006 forecast) as accounts growth forecast is lower in the medium term.

Long Term Forecast: Consistent Growth
- Lower forecast for housing starts in near term and then strong growth in mid to long term.
- Use per account lower: higher efficiency forecast for appliances by Energy Information Administration, US Department of Energy.
- Overall Trend in Sales: Higher forecast of account additions over the long term, therefore sales are above the 2006 forecast.
Residential Forecast Comparison
Before DSM – 2007 vs. 2006 Forecasts

- In early years, forecast is below the 2006 forecast, reflecting slower growth in use per account and lower residential accounts growth.
- In later years, account growth offsets slower trend in use per account causing sales to increase in the 2007 forecast.

Residential Forecast Comparison
Before DSM – 2007 vs. 2006 Forecasts

<table>
<thead>
<tr>
<th>Year</th>
<th>2007* (GWh)</th>
<th>2006 (GWh)</th>
<th>Change (GWh) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F07/08</td>
<td>17,087</td>
<td>17,238</td>
<td>-151 (-0.9%)</td>
</tr>
<tr>
<td>F11/12</td>
<td>18,517</td>
<td>18,758</td>
<td>-241 (-1.3%)</td>
</tr>
<tr>
<td>F16/17</td>
<td>20,257</td>
<td>20,548</td>
<td>-21 (-0.1%)</td>
</tr>
<tr>
<td>F26/27</td>
<td>24,429</td>
<td>23,824</td>
<td>+605 (2.5%)</td>
</tr>
</tbody>
</table>

* Current Forecast as of December 2007
Commercial Sector

Sector Characteristics:
• About 28% of total firm sales.
• Commercial distribution is about 95% of total commercial sales. Consists of large office, retail, finance, government and education.
• Commercial transmission sales includes ports, universities and government.

Methodology for Commercial:
• SAE (statistically adjusted end use model); regression sales model where forecast is based on economic drivers, end uses and normal weather (i.e. 10 year rolling average of degree days).
• Transmission forecast based on historic trends and information from Key Account Managers.

Medium-Term Forecast: Solid Growth
• Annual Growth in sales between F06 and F07 was 384 GWh or 2.6%.
• Sales growth this year is 516 GWh or 3.4% before DSM.
• Compound growth rate over the first five years is 2.7% in the 2007 forecast compared to 2.9% in the 2006 forecast.

Long-Term Forecast: Stable Growth
• Slight modifications to model structure and drivers to enhance accuracy of over estimation period
• Higher efficiency forecast from EIA for heating and cooling appliances and a slightly lower forecast for other end uses – this puts some downward pressure on the forecast.
• Economic drivers are generally above the 2006 forecast in the near to long term – puts upward pressure on the forecast.
• Commercial transmission forecast continues to be strong. Increase in forecast related to oil and gas and new pipelines.
Commercial Forecast Comparison
Before DSM – 2007 vs. 2006 Forecast

- Forecast is below the 2006 forecast in the near and medium terms. This reflects in impacts of general rate increases, economic drivers and re-estimation of forecasting model.

- Growth in commercial transmission including pipelines and oil and gas sector puts upward pressure on the forecast over the long-term.

<table>
<thead>
<tr>
<th></th>
<th>2007* (GWh)</th>
<th>2006 (GWh)</th>
<th>Change (GWh) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F07/08</td>
<td>15,621</td>
<td>15,634</td>
<td>-13 (-0.1%)</td>
</tr>
<tr>
<td>F11/12</td>
<td>17,260</td>
<td>17,499</td>
<td>-239 (-1.4%)</td>
</tr>
<tr>
<td>F16/17</td>
<td>19,197</td>
<td>19,378</td>
<td>-181 (-0.9%)</td>
</tr>
<tr>
<td>F26/27</td>
<td>23,119</td>
<td>22,722</td>
<td>397 (1.7%)</td>
</tr>
</tbody>
</table>

* Current Forecast as of December 2007
Industrial Sector

Sector Characteristics:
- About 38% of total firm sales and sales concentrated in in a few primary goods producing industries
- Most important are pulp and paper, wood products, chemicals, metal mining and coal mining.

Methodology for Industrial: Modifications to Incorporate Consultant Report on Forestry
- Bottom up approach reflecting expected operations and production for each key account and sector outlook studies.
- BCUC 2006 IEP & LTAP decision: BCH should be enhance methodology to inform industrial forecasts with industry studies.
- GDP-based regression model used for long-term non forestry sales and industrial distribution sales (>10 years).

Medium-Term Forecast: Lower Projection starting from Lower Base Year
- Annual growth in sales between F06 and F07 declined by 467 GWh or 2.3%. Drop in pulp and paper sales is largely a result of declining newsprint demand, a higher Canadian dollar and impact from BC Hydro stepped rates.
- Sales this year are expected to decline by 453 GWh or 2.3% mainly due to the impact of the coastal forestry labor disruption. Declining compound growth rate of 0.2% in 2007 forecast relative to an increase of 1.4% in 2006 forecast. Reflects downward pressures on sales due to $C, low lumber prices and cost pressures in forestry sector.

Long-Term: Slower Growth due to Pine Beetle Impacts
- Revised forecast includes impact of diminishing wood supply and fiber stock.
- Pulp mill production forecasts are relatively flat and declining in the long term. Reflects downward demand trend in North American newsprint.

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Industrial Forecast Comparison
Before DSM – 2007 vs. 2006 Forecast

Lower forecast overall due to:
- Decline in base-year demand
- Slower growth in pulp and paper and wood; forecast reflects wood supply and fiber production forecast from industry consultant report
- Other areas such as mining and oil and gas are expected to have stronger growth but not enough to offset forestry sector

Note: 2007 forecast reflects Highland Valley Copper closure in F2020 as opposed to F2014 closure in 2006 forecast.
Forestry Sector Future Direction: Consensus Among Various Sources

• The BC pulp and paper industry is faced with older assets and low reinvestment rates.

• The industry has achieved a low ROE (4% over last 15 years), which discourages investment and modernization.

• B.C.’s large supply of high quality fibre is at risk. The pine beetle infestation will reduce interior harvest volumes by more than 25% in the next 10 years. Much of this change will occur midway through the next decade, after which economic sources of residual fibre will become less available.

• The recent rise in the value of the Canadian dollar has made the situation worse by reducing margins since products are sold in US dollars.

• The US housing crisis has caused a major reduction in US housing starts, and an increase in the inventory of unsold homes. The crisis is extending to the broader economy in the US, and now the rest of the world.

• This situation is unlike previous economic cycles in the province, due to the lower wood supply situation caused by the pine beetle.
2007 PEAK FORECAST UPDATE
Peak Forecast Overview

- Peak is an extreme event! Maximum amount of power consumed in a single hour. Units are MW.

- BC Hydro System is winter peaking utility and highly responsive to colder temperatures. Peak forecast is prepared for average cold conditions (i.e Design Temperature).

- Design Temperature is the average of the coldest daily average temperatures over the most recent 30 years. Design Temperature for four regions are: LM: -5.3°C, VI:-3.6°C, SI:-16.8°C, NR:-28.5°C.

- The Updated Forecast reflects:
  - Latest estimates of drivers such as number of residential accounts and employment.
  - Expected new load development on the distribution system.
  - Market Intelligence from BC Hydro’s Key Account Managers and forestry studies.
Annual Peak Forecast Method

• Distribution Peak = Substation distribution peak * Coincidence Factor
  • Distribution substation peak forecasts reflects regional economic growth factors
  • Substation forecasts are aggregated from regions and made system coincident

Transmission Peak = Transmission substation peak * Coincidence Factor
  • Transmission customer peak forecasts prepared reflecting expected customer operations
  • Forecasts are aggregated from regions and made system coincidence

System Peak = Distribution + Transmission + Other Utilities + System Transmission Losses

Other Supporting Methods

• Regression and neural network peak models. Weather is main driver for short term forecasts. Annual forecast reflects economic drivers, information from Distribution Planners, and industry sector intelligence.
Consistent with the large industrial energy forecast, transmission peak demand is lower than in the 2006 forecast. This puts downward pressure on the total forecast.

Distribution peak is above what is in the 2006 forecast. This reflects growth in drivers including the number of residential accounts, employment and discrete projects such as Olympic projects/RAV and other infrastructure that impacts substation peak demand.
Distribution peak demand continues to grow reflecting increases in residential accounts and growth in goods and services segment of the economy.
Transmission peak demand is below the 2006 forecast in the near term as less expansion is contemplated from larger sawmills and pulp and paper mills. Some recovery occurs in the medium term as other industry sectors grow. Long-term forecast is flatter growth and consistent with energy sales growth rate.
FORECAST UNCERTAINTIES
BC Hydro Total Integrated Gross Requirements before DSM with Rate Impacts

High vs. Probable vs. Low

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Probable</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>F07/08</td>
<td>58,374</td>
<td>58,366</td>
<td>58,361</td>
</tr>
<tr>
<td>F11/12</td>
<td>63,922</td>
<td>62,187</td>
<td>60,489</td>
</tr>
<tr>
<td>F16/17</td>
<td>71,074</td>
<td>68,289</td>
<td>65,532</td>
</tr>
<tr>
<td>F26/27</td>
<td>81,511</td>
<td>76,778</td>
<td>72,191</td>
</tr>
</tbody>
</table>
BC Hydro Total Integrated System Peak before DSM with Rate Impacts

High vs. Probable vs. Low

<table>
<thead>
<tr>
<th>Year</th>
<th>High</th>
<th>Probable</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>F07/08</td>
<td>10,785</td>
<td>10,783</td>
<td>10,782</td>
</tr>
<tr>
<td>F11/12</td>
<td>11,575</td>
<td>11,261</td>
<td>10,954</td>
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<tr>
<td>F16/17</td>
<td>12,399</td>
<td>11,914</td>
<td>11,432</td>
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<tr>
<td>F26/27</td>
<td>14,261</td>
<td>13,433</td>
<td>12,631</td>
</tr>
</tbody>
</table>

Reliable power, at low cost, for generations.
Future Updates

• Annual Load Forecast document with Forecasts before DSM to be released as an appendix to the LTAP.

• Forecasts with DSM updated in Revenue Requirements and LTAP Applications.
Questions?
Long-Term Electricity & Gas Price Forecast

David Ince
Results: Gas Forecast Scenarios - Henry Hub

Note: No simple average case. A specific weighting will be applied to each of the scenarios.
Results: Mid C Electricity Price Forecast

These are the simulated spot market electricity prices for Mid-Columbia. This is the weighted average of On and Off-peak prices.
Resource Additions in the WECC

The scenarios that BC Hydro ran not only included specific gas prices for each case, but different assumptions as to renewable energy and energy efficiency targets. To the right is a high-level supply and demand balance for the WECC region.

Case 1b is the Mid electricity price scenario. Case 2 is the high case. Case 5b results in the lowest electricity prices.

2009 Dependable Capacity (MW)

<table>
<thead>
<tr>
<th></th>
<th>Initial Base Case (Case 1) - Continuation of current trends</th>
<th>Case 1B - Compliance to Renewable Portfolio Standards</th>
<th>Case 2 - High Gas and Coal Prices</th>
<th>Case 5B - High Energy Efficiency and Renewables (Low Gas)</th>
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</thead>
<tbody>
<tr>
<td>Dependable Load</td>
<td>155,659</td>
<td>155,659</td>
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<td>155,659</td>
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<tr>
<td>Resources:</td>
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</tr>
<tr>
<td>Demand</td>
<td></td>
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<tr>
<td>Demand (EE and PV Solar)</td>
<td>2,812</td>
<td>4,683</td>
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<td>6,365</td>
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<td>Supply-Side Renewables</td>
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<td>9,686</td>
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<td>9,685</td>
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<td>Generic Gas Capacity</td>
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<td>1,880</td>
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<td>Generic Coal Capacity</td>
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<td>Named Capacity Additions*</td>
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<td>Existing Capacity</td>
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<td>183,608</td>
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<td>Total Capacity</td>
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<td>Reserve Margin</td>
<td>34.6%</td>
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<td>36.5%</td>
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2020 Dependable Capacity (MW)

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<th>Load</th>
<th>Dependable Load</th>
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<td>Demand</td>
<td>2,817</td>
<td>191,372</td>
<td>Demand (EE and PV Solar)</td>
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<td>19,853</td>
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<td>Supply-Side Renewables</td>
<td>12,102</td>
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<td>Supply-Side Renewables</td>
<td>15,552</td>
<td>12,347</td>
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<tr>
<td>Generic Gas Capacity</td>
<td>37,665</td>
<td>191,372</td>
<td>Generic Gas Capacity</td>
<td>28,855</td>
<td>23,130</td>
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<tr>
<td>Generic Coal Capacity</td>
<td>6,300</td>
<td>191,372</td>
<td>Generic Coal Capacity</td>
<td>5,800</td>
<td>8,715</td>
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<td>Named Capacity Additions*</td>
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<td>191,372</td>
<td>Named Capacity Additions*</td>
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<td>3,000</td>
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<tr>
<td>Existing Capacity</td>
<td>174,513</td>
<td>191,372</td>
<td>Existing Capacity</td>
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<tr>
<td>Total Capacity</td>
<td>246,307</td>
<td>191,372</td>
<td>Total Capacity</td>
<td>250,615</td>
<td>263,922</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserve Margin</td>
<td>28.7%</td>
<td>191,372</td>
<td>Reserve Margin</td>
<td>31.0%</td>
<td>37.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Scenario Analysis of California Electric System for the 2007 Integrated Electricity Plan - Third Addendum


*Named capacity additions are units that are currently in development or construction, and are deemed to have a high probability of completion. These additions are common to all scenarios. Of the named additions in the Global database, the capacity breakdown is approximately: Gas – 60%, Wind – 15%, Coal: 15%, Hydro – 5%, Other – 5%.

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Load Resource Gap

Randy Reimann
The Load/Resource Balance

Load Resource Balance Inputs → Load/Resource Balance → LTAP will examine options to fill the gap

- Load
- IPP Contracts
- Heritage Hydroelectric and Thermal Contribution
- Resource Smart
- 2,500 GWh non-firm / market allowance
- 400 MW market reliance

Capacity and Energy surplus or deficit

- Examine the attributes of different portfolios to inform decision making.
- Gaps shown are based on existing and committed resources
Changes Since 2006 IEP/LTAP

◆ 2007 Load forecast is lower than 2006 (already discussed)

◆ BC Hydro has modified its planning assumptions
  
  1) The BCUC’s May 2007 decision on the last IEP
     Burrard:
     • Future role uncertain
     • BCH is evaluating options
     • Load/Resource balances plan on Burrard in a range of 0 to 6,100 GWh/year for energy and 0 to 900 MW for capacity.
  
  2) Alcan 2007 EPA and Revelstoke Unit 5 CPCN
     • Now included as committed resources
BC Hydro has modified its planning assumptions (cont’d)

3) 2007 Energy Plan and Special Direction #10 to the BCUC

Self-sufficiency
- Capable by 2016 and 3,000 GWh of insurance by 2026 or as soon as practicable
- Assuming Critical Water (42,600 GWh)
- Using only resources in BC

Impact on the planning supply stack:
- Remove the 400 MW market reliance in F2017
- CE used as contingency resource
- Remove the 2,500 GWh non-firm/market reliance in F2017
Changes Since 2006 IEP/LTAP

2,500 GWh Non-Firm Market Reliance

THREE COMPONENTS:

Non-Firm Heritage Hydroelectric

Market Purchases

Non-Firm IPP

- Removed from the Load/Resource balance in F2017 to comply with self-sufficiency policy and SD 10

- Recent SOP analysis determined current volume of contractually non-firm energy to include in the Load/Resource balance.
Changes Since 2006 IEP/LTAP

Contribution of Intermittent Resources

- Reviewed the capacity and firm energy contributions of intermittent resources in light of updated Resource Options Reports and recent firm energy studies

  - The capacity contribution from small hydro resources is reduced based on actual winter data records of existing small hydro sites
    - ELCC: Effective Load Carrying Capability (MW)
    - 2006 IEP/LTAP: ELCC of 25% for Small Hydro
    - 2008 LTAP: ELCC of ~13% for Small Hydro
  
  - Wind ELCC remains at 21%
  
  - The Firm energy contribution from small hydro resources is largely unchanged
    - Using 85% of average annual output as a proxy for firm energy contribution from existing calls
Changes Since 2006 IEP/LTAP

Contribution of Intermittent Resources (cont’d)

- Some EPAs are Pre-COD
  - Have signed contracts but are not yet delivering
- Three main reasons for attrition
  - Permitting
  - Project Economics
  - Project Complexities
- Reviewed IPP attrition assumptions for pre-COD projects
  - F2006 CFT – about 30% attrition assumed
BCUC expressed concern about BC Hydro’s lack of a request with respect to Burrard

The Commission considered the future role of Burrard to be uncertain

- Directed BC Hydro to plan on a range
  - 0 - 6100 GWh
  - 0 - 900 MW
Burrard Studies

◆ New studies undertaken to examine technical, environmental and social issues with retaining Burrard for the long term (20 years)

◆ Three alternative operating regimes assessed
  - Peaking – 900 MW, 600 GWh/yr
  - Intermediate – 900 MW, 3000 GWh/yr
  - Baseload – 900 MW, 6000 GWh/yr
Energy Load/Resource Balance
(with Burrard at 6,100 GWh after F2014)

2007 Load forecast

Firm Energy Capability (GWh)

Non Firm / Market Allowance
Revelstoke Capacity Addition
Heritage Thermal
2007 Load forecast Before DSM

Heritage Hydro
F2006 Call
Standing Offer (SOP)
Resource Smart
Market Purchases
DSM in the Operating Period

Operating
Planning

Fiscal Year
(year ending March 31)

F2009
F2010
F2011
F2012
F2013
F2014
F2015
F2016
F2017
F2018
F2019
F2020
F2021
F2022
F2023
F2024
F2025
F2026
F2027
F2028

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Energy Load/Resource Balance
(with Burrard removed from the energy stack after F2014)

Fiscal Year
(year ending March 31)


2007 Load forecast

Operating Planning

Firm Energy Capability (GWh)

Non Firm / Market Allowance
Existing Purchase Contracts
Revelstoke Capacity Addition
Standing Offer (SOP)
Heritage Thermal
DSM in the Operating Period
Market Purchases

2007 Load forecast Range
Heritage Hydro
F2006 Call
Resource Smart

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Energy Load/Resource Balance
(with Burrard at 3,050 GWh after F2011)

Fiscal Year (year ending March 31)

2007 Load forecast

2007 Load forecast Before DSM

Operating Planning

Firm Energy Capability (GWh)

- 2007 Load forecast Range
- Heritage Hydro
- Non Firm / Market Allowance
- Existing Purchase Contracts
- F2006 Call
- Revelstoke Capacity Addition
- Standing Offer (SOP)
- Resource Smart
- Heritage Thermal
- DSM in the Operating Period
- Market Purchases

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.

BC hydro
Capacity Load/Resource Balance
(with Burrard after F2014)

Capacity Supply (MW)

Fiscal Year
(year ending March 31)

Operating Planning

2007 Load forecast

Legend:
- 2007 Load Forecast Range
- Heritage Hydro
- Existing Purchase Contracts
- F2006 Call
- Revelstoke Capacity Addition
- Standing Offer (SOP)
- Resource Smart
- Heritage Thermal/Market Purchases
- DSM in the Operating Period
- Canadian Entitlement
- 2007 Load forecast Before DSM

Reliable power, at low cost, for generations.
Capacity Load/Resource Balance
(without Burrard after F2014)

(Fiscal Year: year ending March 31)

- Operating
- Planning

2007 Load forecast

Capacity Supply (MW)

8,000

10,000

12,000

14,000

16,000

2007 Load forecast Before DSM

- 2007 Load Forecast Range
- Heritage Hydro
- Existing Purchase Contracts
- F2006 Call
- Revelstoke Capacity Addition
- Standing Offer (SOP)
- Resource Smart
- DSM in the Operating Period
- Canadian Entitlement
- 2007 Load forecast Before DSM

Reliable power, at low cost, for generations.
Risk Framework and Portfolio Analysis

LTAP Actions

- DSM Plan
- Calls – Size and Type
- Burrard – Future Role
- Mica/Revelstoke

- Site C
- Contingency Resource Plans
- Transmission Contingency Plans

Supported by Analysis

Risk Framework
- Process for comparing risks
- Identify Key Risks
- Scenarios

Uncertainties/Risks

Portfolio Modeling
- Scenario Runs/Portfolios
- PV Costs
- Likelihood of resources being needed, their cost effectiveness
- Ability to meet reliability requirements

Policy Requirements

Resource Options

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Questions?
The Risk Framework

Basil Stumborg
Introduction to Risk Framework

◆ Major Elements of the LTAP
  - Load Resource Gap
  - Contingency Resource Plans

◆ BCH will put also forward spending requests
  - DSM
  - Site C – next stage
  - BGS
  - Columbia capacity projects (Mica, Rev)
  - Call for Power

  - Must demonstrate need/reasonableness of these requests
Risk Framework Introduction

 Goals of the Risk Framework:

- Characterizing risks
  - Using probability distributions and probability trees
- Separating probability judgments from value judgments
- Describing contingency plans
  - Under what scenarios
  - Relative likelihoods
- Describing tradeoffs clearly
- Link analysis clearly to:
  - Near term decisions
  - Future decisions (milestones and offramps)
Introduction to Risk Framework

Key uncertainties

- Size of the gap
  - Load growth uncertainty;
  - IPP attrition risk
  - DSM performance risk;

- Size of the gap affects
  - Site C – next stage
  - Call for Power
  - Columbia capacity projects (Mica, Rev)
  - Contingency Resource Plans
Introduction to Risk Framework

Key Uncertainties – cont’d

- Cost of thermal generation versus clean
  - GHG offset cost uncertainty
  - Future gas prices

- Cost of thermal generation impacts
  - Relative cost of resource options (thermal vs. clean comparisons)
  - Export market prices for electricity
By the end of this section, you should:

- Understand definitions of
  - “The Gap”
  - “Cost of Thermal Generation”
- Understand the simplifications involved
  - Hi / Mid / Low description of the range of outcomes
- Understand probability tree depiction (example below)
- Interpret relative likelihoods of scenarios

![Probability Tree Diagram]

<table>
<thead>
<tr>
<th>Size of Gap</th>
<th>Cost of Thermal Generation</th>
<th>Relative Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Low</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>5.6%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>3.3%</td>
</tr>
<tr>
<td>Mid</td>
<td>LowGas-LowGHG</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>MidGas-MidGHG</td>
<td>24.8%</td>
</tr>
<tr>
<td></td>
<td>MidGas-HighGHG</td>
<td>10.7%</td>
</tr>
<tr>
<td></td>
<td>HighGas-MidGHG</td>
<td>31.0%</td>
</tr>
<tr>
<td></td>
<td>HighGas-HighGHG</td>
<td>13.0%</td>
</tr>
<tr>
<td>Large</td>
<td>Low</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>6.6%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>3.3%</td>
</tr>
</tbody>
</table>
Outline

◆ In the next presentation
  ■ Will present portfolio results
  ■ Tied to each scenario
  ■ With resource additions, timing, and costs
Outline

◆ Uncertainty around the gap
  ■ Load forecasting risk
  ■ IPP attrition risk
  ■ DSM deliverability risk

◆ Cost of thermal generation
  ■ GHG offset costs
  ■ Gas price scenarios
Outline

◆ Probability Tree
  ■ Combination of above uncertainties into one picture
  ■ Show relative likelihood of these scenarios
  ■ Explain role of probability tree

◆ Output of analyses
  ■ Portfolio reporting
  ■ Cost curves
    • Show costs and relative likelihood for each scenario
  ■ Main tools for comparisons among policy options
Gap Uncertainty – Load Growth

- Distribution of load outcomes are uncertain
- Existing models use stochastic, Monte Carlo simulation to capture possible outcomes
Gap Uncertainty – Load Growth

- Full distribution contains too much information
- Simplified to a three-point distribution
- When combined with DSM savings, allowed for a range of Gap sizes to be used in analysis

<table>
<thead>
<tr>
<th>Probability</th>
<th>Hi Load Growth</th>
<th>Mid Load Growth</th>
<th>Low Load Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
</tr>
<tr>
<td>GWh (2020)</td>
<td>74,000</td>
<td>70,000</td>
<td>67,000</td>
</tr>
</tbody>
</table>
Gap Uncertainty - IPP Attrition Risk

- BC Hydro has entered into over 100 EPAs with IPPs
- A significant proportion of our supply stack
- Some EPAs are pre-COD
  - Have signed contracts but are not yet delivering
- Attrition risk
  - Some projects may fail to reach COD
- Main reasons for attrition:
  - Permitting
  - Project Economics
- How to incorporate uncertainty into analysis?
Structured conversation regarding
- Key drivers of uncertainty
- Range of possible outcomes for each project
- Probability assessment for each project

Monte Carlo analysis
- Energy delivered a sum of random variables
- Simulation adds random variables in 10,000 trials
- Results are a spread of outcomes
Gap Uncertainty - IPP Attrition Risk

Expected Firm Energy From Existing IPPs (2020)

- Minimum: 7384
- Maximum: 10868
- Mean: 9245
- Std Dev: 528
- Values: 10000

Firm Energy (Gwh/y, 2020) Values in Thousands

0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08
7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0

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Gap Uncertainty - IPP Attrition Risk

◆ Conclusions
  - Spread of uncertainty is small
  - Fewer unknowns over next two years (to 2010 delivery date)
  - Not a significant driver of uncertainty
  - Used mid-point estimates in LTAP analysis
    - Works out to roughly 30% attrition rate for existing EPAs (pre-COD)
Gap Uncertainty - DSM Performance Risk

- DSM Savings from three strategic elements:
  - Rate Structures
  - Codes and Standards
  - DSM Programs

- Created two levels of effort
  - A “moderate” package
    - Expected to deliver roughly 10,000 GWh/y savings (F2020)
  - A more “advanced” package
    - Expected to deliver roughly 12,000 GWh/y of savings (F2020)

- Forecast savings are subject to uncertainty
- LTAP will show spread of uncertainty around these estimates
Gap Uncertainty - Total DSM Savings

◆ Distribution of DSM outcomes

- Total savings a function of many smaller projects
  - Each with uncertainty impacts
- Monte Carlo simulation analysis
- Summed up many uncertain variables to capture spread of possible outcomes

![Energy Savings (GWh/y, F2020)]

<table>
<thead>
<tr>
<th>Values in Thousands</th>
<th>Total DSM Savings (Moderate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>5964</td>
</tr>
<tr>
<td>Maximum</td>
<td>14406</td>
</tr>
<tr>
<td>Mean</td>
<td>9902</td>
</tr>
<tr>
<td>Std Dev</td>
<td>1247</td>
</tr>
</tbody>
</table>

Mean = 9902
Gap Uncertainty - Total DSM Savings

◆ Distribution of outcomes
  - Too much information
  - Simplified to a three point distribution
  - Used to capture range of the Gap for resource planning

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
</tr>
<tr>
<td>Moderate DSM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWh/y savings, 2020</td>
<td>8,500</td>
<td>10,200</td>
<td>12,000</td>
</tr>
<tr>
<td>Advanced DSM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWh/y savings, 2020</td>
<td>9,900</td>
<td>12,000</td>
<td>14,300</td>
</tr>
</tbody>
</table>
Probability Tree

◆ A probability tree
  - Is a way to combine diverse risk elements
  - Clear about how scenarios are created
  - Attaches a probability to each scenario

◆ Drawbacks
  - A simplified version of underlying risk distributions
    • Simplified to manage modelling efforts
  - Forces users to be clear about how variables are related
    • Sometimes this is difficult
Probability Trees

◆ Size of the Gap

- Load Growth
- DSM Performance (for a given “package” of DSM)
Cost of Thermal Generation

- Thermal Generation Costs
  - Subject to GHG price uncertainty
  - Subject to Gas Price uncertainty
  - Drive electricity market prices
    - Determine export/import opportunities
Cost of Thermal – GHG Offset Cost Uncertainty

- **GHG Offset Cost Scenarios**
  - Three scenarios generated by Natsource
    - Price Cap Scenario (Low Cost, P=15%)
    - Linked Markets Scenario (Mid cost, P=60%)
    - Made in NA Scenario (High Cost, P=25%)
  - Reviewed last workshop
  - Summed up below (using year 2020 as a snapshot)

<table>
<thead>
<tr>
<th></th>
<th>Hi Case</th>
<th>Mid Case</th>
<th>Low Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>25%</td>
<td>60%</td>
<td>15%</td>
</tr>
<tr>
<td>GHG Offset Costs (2020, CDN $2008/t CO2e)</td>
<td>$46</td>
<td>$20</td>
<td>$18</td>
</tr>
</tbody>
</table>
Cost of Thermal – Gas Price Uncertainty

Gas Price Scenarios

- Three scenarios generated by Global Energy
  - Low Gas Case Scenario
  - Base Case Scenario
  - High Gas Case Scenario
- Reviewed last workshop
- Global has assessed the relative likelihoods of each scenario
- Summed up below (using year 2020 as a snapshot)

<table>
<thead>
<tr>
<th></th>
<th>Hi Gas Case</th>
<th>Base Case</th>
<th>Low Gas Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>53%</td>
<td>44%</td>
<td>3%</td>
</tr>
<tr>
<td>Gas Price (2006 USD/MMBtu, 2020)</td>
<td>$11.00</td>
<td>$7.00</td>
<td>$6.00</td>
</tr>
</tbody>
</table>

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Cost of Thermal Generation

- Gas prices
- GHG offset costs

![Probability Trees - Cost of Thermal Generation](image)

- Gas/Electricity Prices
- GHG Offset Costs
- Probability
- Relative Likelihood for Cost of Thermal

<table>
<thead>
<tr>
<th>Gas/Electricity Prices</th>
<th>GHG Offset Costs</th>
<th>Probability</th>
<th>Relative Likelihood for Cost of Thermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>15%</td>
<td>0.5%</td>
<td>Low Case Prob = 1%</td>
</tr>
<tr>
<td>Mid</td>
<td>60%</td>
<td>1.8%</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>25%</td>
<td>0.8%</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>15%</td>
<td>6.6%</td>
<td></td>
</tr>
<tr>
<td>Mid</td>
<td>44%</td>
<td>26.4%</td>
<td>Mid Case Prob = 66%</td>
</tr>
<tr>
<td>High</td>
<td>25%</td>
<td>11.0%</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>15%</td>
<td>8.0%</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>53%</td>
<td>31.8%</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>25%</td>
<td>13.3%</td>
<td>High Case Prob = 33%</td>
</tr>
</tbody>
</table>

Sum 100.0% 100%
Probability Trees – Cost of Thermal Generation

- 5-pt distribution
  - Pulls apart gas/ghg impacts
  - Focus on more likely branches

![Probability Tree Diagram]

- GHG Offset Costs
- Probability
- Relative Likelihood for Cost of Thermal
Risk Framework – Probability Tree

- Full probability tree
  - 11 diverse scenarios
- Questions tested across these scenarios
- Each has a relative likelihood attached
- A simplified look at a complicated subject
  - Additional analysis carried out where needed
Risk Framework – Probability Tree

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Risk Framework – Portfolio Analysis

- How do we test key questions?
  - e.g. Option A vs. Option B?
- Make Option A available and run the 11 scenarios
  - Generates 11 portfolios (timing, resources, costs)
- Make Option B available and run the 11 scenarios
- Compare results (weighted average, extremes)
Risk Framework – Portfolio Analysis

- Following presentation to explain portfolio analysis
- Key points to remember:
  - This analysis is at a high level
  - A rough cut at capturing uncertainty
  - We have tried to be clear that:
    - Simplifications have been made
    - Key elements (not all elements) are included
  - Goal is insight – not answers
- With this in mind
  - What were the modelling methods
  - What are the key assumptions
  - What are some of the high level results
Questions?
Portfolio Analysis

Randy Reimann
2008 LTAP Process

Step 1 - Establish Objectives

Step 2 - Load Resource Balance

Step 3 - Resource Options Inventory

Step 4 - Develop & Evaluate Portfolios

Step 5 - Portfolio Trade-Off Analysis

Step 6 - Long-Term Acquisition Plan

Load Forecast

Key Risks and Uncertainties

Attributes

Limited Update

No Update

Update

Update

Update

Limited Update

No Update

Update

Update

(UPDATE TODAY)

(RULE REVIEW TODAY)
2008 LTAP Objectives

- Objectives based on the 2006 IEP/LTAP
  - Adjusted to reflect the Commission decision
  - Separate Minimum Requirements from Objectives

- Minimum Requirements
  - Meet legal requirements
  - Meet reliability criteria

- Objectives
  - Minimize costs
  - Minimize environmental impact
  - Meet Government policy objectives
    - 2007 Energy Plan
Interpretation of Portfolio Results

◆ Portfolios provide alternative views of possible future worlds
  ■ Are portfolios that would result in a world with perfect foresight
  ■ They can inform the impacts of possible actions/outcomes
  ■ All portfolios intended to meet Minimum Requirements

◆ Portfolio analysis in context of Probability Framework
  ■ Framework shows areas to focus attention through probability of occurrence and financial impact
  ■ Consider impacts of various actions/outcomes and related risks

◆ Risks addressed through specific tests
  ■ Severe consequence even with low risk needs mitigation
  ■ Risk of being wrong
  ■ Contingency Resource Plans
  ■ Transmission contingencies
# Portfolio Modeling

## 2006 IEP/LTAP
- **Portfolios designed based on certain attributes**
  - Manual resource selection and sequencing for portfolios based on attributes
  - No structured optimization process
- **Portfolios tested against different scenario conditions**
  - Gas and electric market prices, GHG

## 2008 LTAP
- **Added System Optimizer**
  - Structured method of selecting portfolios
  - Alternate portfolios developed based on varying input assumptions/restricting resources
- **Linear Optimization model**
  - Selects “optimal portfolio” under single set of scenario conditions
  - Still need to test against alternate worlds/outcomes
- **Early screen of portfolio costs/impacts**
Portfolio Analysis

**Portfolio Inputs and Assumptions**
- Key Input data
  - Existing resources
  - Resource options
  - Transmission options
- Scenarios
  - Gap Size
  - Gas and Electricity prices
  - GHG offset costs
  - Timing of transmission reinforcements
- Planning Assumptions
  - Time frame
  - Reliability criteria
  - Financial assumptions

**Portfolio Evaluation**
- System Optimizer – determines the optimal resource mix (type, location, timing, capacity, minimal cost)
- HYSIM – System Simulation Model
  - Portfolio energy generation under variable inflow conditions
- MAPA
  - Multi-Attribute Portfolio Analysis

**Portfolio Results**
- Portfolio for scenario Xi

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Basic Portfolio Scenarios

◆ Size of Gap is major driver of cost difference
  - Small Gap ~ $7B/Mid Gap ~ 11.5B/Large Gap ~ $18B
  - Generally need to compare like size portfolios

◆ Most gas selected in Low Thermal & Mid-Gas/Mid-GHG Scenarios
  - Note low cost clean resources still picked early
<table>
<thead>
<tr>
<th>Year</th>
<th>Zone</th>
<th>Resource</th>
<th>Installed Capacity (MW)</th>
<th>Firm Energy (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>LM</td>
<td>LM Small Hydro Bundle 1</td>
<td>119</td>
<td>425</td>
</tr>
<tr>
<td>2013</td>
<td>LM</td>
<td>Geothermal LM Bundle</td>
<td>100</td>
<td>800</td>
</tr>
<tr>
<td>2014</td>
<td>VI</td>
<td>MSW VI Bundle 1</td>
<td>51</td>
<td>410</td>
</tr>
<tr>
<td>2016</td>
<td>KLY</td>
<td>Greenfield 500 CCGT KLY</td>
<td>494</td>
<td>2939</td>
</tr>
<tr>
<td>2022</td>
<td>LM</td>
<td>LM Small Hydro Bundle 2</td>
<td>179</td>
<td>637</td>
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<td>CI</td>
<td>CI Small Hydro Bundle 1</td>
<td>35</td>
<td>112</td>
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<td>KLY</td>
<td>KLY Small Hydro Bundle 1</td>
<td>68</td>
<td>192</td>
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<td>2024</td>
<td>KLY</td>
<td>Greenfield 250 CCGT KLY</td>
<td>243</td>
<td>1448</td>
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<tr>
<td>2025</td>
<td>LM</td>
<td>LM Wind Bundle 1</td>
<td>24</td>
<td>66</td>
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<td>2025</td>
<td>VI</td>
<td>250 CCGT VI</td>
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<td>2026</td>
<td>PR</td>
<td>Peace Wind Bundle 2</td>
<td>232</td>
<td>950</td>
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<td>212</td>
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<td>2027</td>
<td>PR</td>
<td>Peace Wind Bundle 1</td>
<td>117</td>
<td>492</td>
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<td>2027</td>
<td>VI</td>
<td>VI Small Hydro Bundle 1</td>
<td>44</td>
<td>131</td>
</tr>
</tbody>
</table>
Mid-Gap Mid-Gas Mid-GHG

Energy - Supply Demand Balance

Heritage Hydro & MCA/REV additions
Existing IPP
Heritage Thermal
2500 non firm
Alcan - 07 LTEPA
Wind
Small Hydro
Biomass & Geothermal
CCGT/SCGT
Large Hydro
Total Load (inc. T losses)
Load after DSM savings
Natural Gas Generation

◆ Burrard
  - Allowed full range of dispatch, plant generally does not run
  - Reflects current role as a backup source to non-firm Heritage Hydro or market purchases

◆ New gas generation committed and operated to:

<table>
<thead>
<tr>
<th>Resource</th>
<th>Firm Energy</th>
<th>Minimum Operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCGTs:</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>CCGT:</td>
<td>70%</td>
<td>70%</td>
</tr>
</tbody>
</table>

- Reflects new unit construction commitments would be based on an expectation of operation
- Considers impact of divergent GHG offset policies and carbon taxes across neighbouring jurisdictions may not persist
**Basic Portfolio Scenarios**

<table>
<thead>
<tr>
<th>Size of Gap</th>
<th>Cost of Thermal Generation</th>
<th>Relative Likelihood</th>
<th>PV</th>
<th>Thermal MW</th>
<th>Renewable MW</th>
<th>MCA REV MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Low</td>
<td>0.1%</td>
<td>$ 7,809</td>
<td>243</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>6.6%</td>
<td>$ 7,124</td>
<td>0</td>
<td>477</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>3.3%</td>
<td>$ 6,583</td>
<td>0</td>
<td>484</td>
<td>0</td>
</tr>
<tr>
<td>Large</td>
<td>LowGas-LowGHG</td>
<td>0.5%</td>
<td>$ 11,577</td>
<td>1474</td>
<td>305</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>MidGas-MidGHG</td>
<td>24.8%</td>
<td>$ 11,529</td>
<td>980</td>
<td>1181</td>
<td>0</td>
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<tr>
<td></td>
<td>HighGas-HighGHG</td>
<td>10.7%</td>
<td>$ 11,758</td>
<td>980</td>
<td>1297</td>
<td>0</td>
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<tr>
<td></td>
<td>HighGas-MidGHG</td>
<td>31.0%</td>
<td>$ 11,777</td>
<td>0</td>
<td>2932</td>
<td>0</td>
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<tr>
<td></td>
<td>HighGas-HighGHG</td>
<td>13.0%</td>
<td>$ 11,859</td>
<td>0</td>
<td>2932</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.1%</td>
<td>$ 17,692</td>
<td>1730</td>
<td>2479</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>6.6%</td>
<td>$ 17,669</td>
<td>1577</td>
<td>2652</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>3.3%</td>
<td>$ 18,490</td>
<td>737</td>
<td>4205</td>
<td>1000</td>
</tr>
</tbody>
</table>

- **Large Gap – High Thermal**
  - picks up Mica units 5 and 6
- **Also results in gas being selected late in period**
  - Going up renewable cost curves
Large-Gap High-Gas

Capacity - Supply Demand Balance

Her. Hydro, Res Smt, & MCA/REV addns
Existing IPP
Alcan - 07 LTEPA
Wind
Small Hydro
CCGT/SCGT
Large Hydro
Total Load (inc. T Losses)
Load after DSM
## Resource Options Overview

<table>
<thead>
<tr>
<th>Resource Option</th>
<th>Potential Capacity</th>
<th>Annual Energy</th>
<th>Range of UECs @6% ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Hydro</td>
<td>1,982</td>
<td>8,416</td>
<td>54-105</td>
</tr>
<tr>
<td>Biomass</td>
<td>534</td>
<td>4,272</td>
<td>49-158</td>
</tr>
<tr>
<td>Geothermal</td>
<td>100</td>
<td>800</td>
<td>59</td>
</tr>
<tr>
<td>Wind</td>
<td>5,013</td>
<td>16,403</td>
<td>70-155</td>
</tr>
</tbody>
</table>

### Gas Resource Options

<table>
<thead>
<tr>
<th>Gas Resource Options</th>
<th>Range of UECs @6% (Med Gas)</th>
<th>Range of UECs @6% (High Gas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic CCGT 50 MW</td>
<td>50</td>
<td>391</td>
</tr>
<tr>
<td>Generic CCGT 250 MW</td>
<td>243</td>
<td>1,887</td>
</tr>
<tr>
<td>Generic CCGT 500 MW</td>
<td>494</td>
<td>3,833</td>
</tr>
<tr>
<td>VI CCGT 250 MW</td>
<td>243</td>
<td>1,887</td>
</tr>
<tr>
<td>VI CCGT 500 MW</td>
<td>494</td>
<td>3,831</td>
</tr>
<tr>
<td>Burrard Half CCGT - CCGT</td>
<td>510</td>
<td>4,079</td>
</tr>
<tr>
<td>Burrard Full CCGT - CCGT</td>
<td>1,100</td>
<td>8,798</td>
</tr>
<tr>
<td>Small Cogen</td>
<td>300</td>
<td>2,400</td>
</tr>
</tbody>
</table>

2016-2027 Average Natsource GHG Offset Cost
- Low: 18
- Med: 19
- High: 43
Resource Supply Curves

2008 LTAP Supply Curves
Total Adjusted UECs

Average Annual Energy (GWh)

Unit Energy Cost ($/MWh)

Clean (2016)

Generic 500MW CCGT (High Gas/High GHG)

Generic 500MW CCGT (High Gas/Med GHG)

Generic 500MW CCGT (Med Gas/High GHG)

Generic 500MW CCGT (Med Gas/Med GHG)
Basic Portfolio Scenarios

- Lower Cost of Thermal should result in lower portfolio costs
- Up to a point!
  - Lower thermal costs makes gas relatively more cost effective relative to clean – more options to select from
- However, Lower Thermal costs also result in lower market prices
  - Reduces trade value
- See portfolio costs increase in Small Gap Case
Small-Gap Low-Thermal

Spot Market

Year

GWh

Spot Onpeak Energy Purchases GWh
Spot Offpeak Energy Purchases GWh
Spot Onpeak Energy Sales GWh
Spot Offpeak Energy Sales GWh
2007 Energy Policy Action # 21:
- Ensure clean or renewable electricity generation continues to account for at least 90 per cent of total generation
- States that BC is currently 90% clean

2008 LTAP Modeling Analysis
- Measurement based upon simulated generation output as compared to firm load
- Base Assumption: Resource selection constrained to meet 90% criteria
- Test Assumption: No constraint

Occurrences of Constraint with Base Assumption
- In high gap scenarios combined with low to mid gas scenarios
- In contingency scenarios with supply shortfalls
Scenario Implications Summary

- Scenario results – capacity, energy, trade & clean
- Size of Gap major driver of costs
- Gas resources picked at lower Thermal Costs
- Lower Thermal Costs
  - Reduces resource option costs
  - Reduces trade value
- Mica/Rev picked High Gap/High Thermal Case
- Increasing Renewable Cost Curve versus Uncertain gas
- Tracking Clean
  - Limits approached in Low Gas case
New Resources To Be Tested

- **DSM**
  - Appropriate level of DSM acquisition

- **Supply side acquisitions**
  - Type and size of near term calls

- **Mica and Revelstoke Peaking Capacity**
  - Need for new peaking capacity or energy shaping resources

- **Contingency resources**
  - Mica and Revelstoke Peaking Capacity
  - SCGTs
  - Transmission

- **Site C**
  - Option value of progressing Site C
DSM Portfolio Results

- A significant driver of cost differential in Gap is the cost effectiveness of DSM
- To test the cost effectiveness of the overall DSM programs, DSM has been tested at 3 levels:
  - No DSM
  - Moderate DSM program
  - Advanced DSM program

<table>
<thead>
<tr>
<th>DSM Plan</th>
<th>Load Growth</th>
<th>Cost of Thermal Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Portfolio (PV, $m) | DSM Options | |        |        |
|--------------------|-------------|--------------------------|
|                    | None        | Moderate (~10,000 GWh/y 2020) | Advanced (~12,000 GWh/y 2020) |
| Renewables (MW)    | $18,326     | $11,577                  | $11,062                     |
| Thermal (MW)       | 2518        | 305                      | 601                         |
|                    | 3701        | 1474                     | 980                         |

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
DSM Portfolio Results

- This is one case. Need to complete remaining scenarios

<table>
<thead>
<tr>
<th>Comparison Case</th>
<th>DSM Cost ($/MWh)</th>
<th>Supply Side Cost Saving ($/MWh)</th>
<th>Difference ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No DSM to Moderate DSM</td>
<td>$ 43</td>
<td>$ 119</td>
<td>$ 77</td>
</tr>
<tr>
<td>Moderate DSM to Advanced DSM</td>
<td>$ 50</td>
<td>$ 86</td>
<td>$ 37</td>
</tr>
</tbody>
</table>

![Graph showing Supply Side Saving and DSM Costs](image)

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Near Term Calls

- Some capacity and energy required in addition to planned DSM
  - Two acquisition processes identified in 2007 Energy Plan (standard contract for 10 MW or less) and biomass call

- Issue is the magnitude and type of next call

---

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
<table>
<thead>
<tr>
<th>Year</th>
<th>Zone</th>
<th>Unit</th>
<th>Installed Capacity (MW)</th>
<th>Firm Energy (GWh)</th>
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<tr>
<td>2012</td>
<td>LM</td>
<td>LM Small Hydro Bundle 1</td>
<td>119</td>
<td>425</td>
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<tr>
<td>2013</td>
<td>LM</td>
<td>Geothermal LM Bundle</td>
<td>100</td>
<td>800</td>
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<td>2014</td>
<td>LM</td>
<td>LM Small Hydro Bundle 2</td>
<td>179</td>
<td>637</td>
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<td>2016</td>
<td>PR</td>
<td>Peace Wind Bundle 2</td>
<td>232</td>
<td>950</td>
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<td>2016</td>
<td>LM</td>
<td>LM Small Hydro Bundle 3</td>
<td>212</td>
<td>716</td>
</tr>
<tr>
<td>2016</td>
<td>VI</td>
<td>MSW VI Bundle 1</td>
<td>51</td>
<td>412</td>
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<td>2017</td>
<td>CI</td>
<td>CI Small Hydro Bundle 1</td>
<td>35</td>
<td>112</td>
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<td>2017</td>
<td>KLY</td>
<td>KLY Small Hydro Bundle 1</td>
<td>68</td>
<td>193</td>
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<td>492</td>
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<td>EK</td>
<td>EK Small Hydro Bundle 1</td>
<td>140</td>
<td>368</td>
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<td>VI</td>
<td>VI Small Hydro Bundle 1</td>
<td>44</td>
<td>131</td>
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<tr>
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<td>NC</td>
<td>NC Small Hydro Bundle 1</td>
<td>162</td>
<td>542</td>
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<td>KLY</td>
<td>Biomass sawmill waste KLY</td>
<td>67</td>
<td>536</td>
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<td>NIC</td>
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<td>33</td>
<td>264</td>
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<td>LM Small Hydro Bundle 4</td>
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<td>468</td>
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<td>1477</td>
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<td>VI</td>
<td>VI Wind Bundle 1</td>
<td>127</td>
<td>415</td>
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<tr>
<td>2027</td>
<td>LM</td>
<td>LM Small Hydro Bundle 5</td>
<td>154</td>
<td>466</td>
</tr>
</tbody>
</table>
Mica and Revelstoke Peaking

◆ Mica and Revelstoke capacity - two drivers:
  ■ Peaking resources in the base resource plans; and
  ■ Contingency resources in the Contingency Resource Plans

◆ Shown earlier, Mica 5 and Mica 6 were selected in Large Gap/High Thermal cost scenarios

◆ Mica 5 and Mica 6 are part of our current contingency resource plans
  ■ expected to be part of updated CRPs
ILM Transmission Upgrade Project Delay

◆ 2006 IEP/LTAP:
  ■ Canadian Entitlement identified as key ILM delay contingency
    • Ultimately, further delays would drive gas in the LM/VI region
  ■ Commission Decision:
    • Next LTAP should also consider prolonged ILM delay

◆ 2008 LTAP
  ■ Selecting 5 years as prolonged delay

◆ Assessment of ILM delay impacts in Transmission Contingency Plan
Contingency Plans

◆ Contingency plans in the 2008 LTAP
  ■ Contingency Resource Plans that identify additional system generation capacity projects that need to be advanced and will form part of BC Hydro’s next NITS Application;
  ■ Transmission contingency in the event that the ILM Upgrade Project is delayed

◆ The contingency analyses for High Gap cases or ILM delay show need for natural gas (CCGTs or SCGTs)
  ■ Dispatchable capacity;
  ■ Short lead times; and
  ■ Ability to locate downstream of transmission constraints

◆ There is value in retaining non-clean portfolio room (10% non-clean) as an option for contingencies
  ■ An analysis of the impact of proceeding with current IPP acquisitions and the High or Low Gap scenarios unfolding further supports this view
Transmission Contingencies

- ILM Upgrade Project is currently scheduled for 2014
  - Burrard at 900 MW is required until the project is in service
  - Short term plan to rely on the CE and markets to fill gap
- Testing a delay of 5 years of ILM Upgrade Project
  - Selected as a significant, but plausible delay
- Increased importance to ensure Burrard will be reliable and available
Site C

- Large hydro project
  - Capacity and Energy
  - In 2007 Energy Plan
- Looking for Stage 2 approval
- Need to show it is an attractive option and when needed
Questions?
For More Information

Visit our Energy Planning website:
www.bchydro.com/iep

Or email us:
energy.planning@bchydro.com