

---

---

**2008 Long Term Acquisition Plan**

---

---



---

---

**APPENDIX G1**

**Natsource 2007 GHG Offset Forecast Report**

---

---

2007 GREENHOUSE GAS OFFSET FORECAST REPORT FOR BC HYDRO  
DECEMBER 1, 2007



**N A T S O U R C E**

**Table of Contents**

|                                                                                                                                          |           |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I. Purpose of Report</b>                                                                                                              | <b>3</b>  |
| <b>II. Regulatory and Policy Changes and Implications</b>                                                                                | <b>4</b>  |
| <b>A. Canada</b>                                                                                                                         | <b>4</b>  |
| <b>1. Federal Government</b>                                                                                                             | <b>4</b>  |
| <b>2. Provincial Plans, Programs and Policies</b>                                                                                        | <b>6</b>  |
| <b>B. U.S.</b>                                                                                                                           | <b>11</b> |
| <b>1. Federal Government</b>                                                                                                             | <b>11</b> |
| <b>2. State and Regional Regimes Affecting Western States</b>                                                                            | <b>14</b> |
| <b>3. WECC Jurisdictions Other than WCI Participants</b>                                                                                 | <b>21</b> |
| <b>4. Recent Developments in Other U.S. States</b>                                                                                       | <b>22</b> |
| <b>5. Implications for Development of Pricing Scenarios</b>                                                                              | <b>23</b> |
| <b>III. Policy Scenarios</b>                                                                                                             | <b>24</b> |
| <b>A. Considerations in Selecting Scenarios and Bounding the Analysis</b>                                                                | <b>24</b> |
| <b>B. Considerations in Selecting High-Price Scenarios with Respect to Federal Emission Reduction Targets in Canada and the U.S.</b>     | <b>24</b> |
| <b>C. Considerations in Selecting a Low-Price Scenario for Canada, and Sensitivity Cases to Account for More Stringent Targets in BC</b> | <b>25</b> |
| <b>D. Policy Scenarios</b>                                                                                                               | <b>26</b> |
| <b>1. Price Cap Scenario</b>                                                                                                             | <b>28</b> |
| <b>2. Linked Markets Scenario</b>                                                                                                        | <b>28</b> |
| <b>3. Made in North America – Aggressive Targets Scenario</b>                                                                            | <b>29</b> |
| <b>4. Likelihood of Different Scenarios</b>                                                                                              | <b>30</b> |
| <b>E. Price Sensitivity Analyses</b>                                                                                                     | <b>32</b> |
| <b>IV. Pricing Forecasts</b>                                                                                                             | <b>35</b> |
| <b>A. Economic Model Assumptions, Uncertainties and Limitations</b>                                                                      | <b>35</b> |
| <b>1. Differences Between Global and U.S. Trading Program Models</b>                                                                     | <b>35</b> |
| <b>2. Differences Between Assumptions in Economic Models and Real-World GHG Policy Implementation and Markets</b>                        | <b>36</b> |
| <b>3. Use of Marginal Cost Data, and Related Caveats</b>                                                                                 | <b>37</b> |
| <b>B. Nascent Stage of GHG Models and Unpredictable Nature of GHG Prices</b>                                                             | <b>38</b> |
| <b>C. GHG Price Estimates and Methodology</b>                                                                                            | <b>38</b> |
| <b>1. Price Cap Scenario</b>                                                                                                             | <b>39</b> |
| <b>2. Linked Markets Scenario</b>                                                                                                        | <b>40</b> |
| <b>3. Made in North America – Aggressive Targets Scenario</b>                                                                            | <b>43</b> |
| <b>D. Sensitivity Analyses</b>                                                                                                           | <b>45</b> |
| <b>1. BC Compliance Instruments Only</b>                                                                                                 | <b>47</b> |
| <b>2. WCI/WECC Compliance Instruments Only</b>                                                                                           | <b>49</b> |
| <b>V. Integrated Resource Plans and Greenhouse Gas Cost Adders</b>                                                                       | <b>51</b> |
| <b>A. U.S. Utilities</b>                                                                                                                 | <b>53</b> |
| <b>B. State Policy</b>                                                                                                                   | <b>60</b> |
| <b>VI. Conclusion</b>                                                                                                                    | <b>62</b> |
| <br>                                                                                                                                     |           |
| <b>Appendix I – Key Assumptions and Uncertainties in Economic Models</b>                                                                 | <b>65</b> |
| <b>Appendix II – Economic Models Used in the Analysis</b>                                                                                | <b>73</b> |

## **I. Purpose of Report**

As part of its 2007/08 acquisition and long-term planning processes, BC Hydro plans to update the greenhouse gas (GHG) price forecast used to develop the “GHG (\$MWh) Adjustment Table” in its Fiscal 2006 Open Call for Power. In addition, as part of the regular updating of its Electricity Price Forecast BC Hydro may include an adjustment for the cost of allowances for emitting GHGs.

This paper is a GHG offset forecast report that updates the scenario analysis and information submitted as BC Hydro 2006 Integrated Electricity Plan (IEP)/Long Term Acquisition Plan (LTAP), Appendix D, Attachment 4 (the 2006 Natsource Report).<sup>1</sup> The report:

1. Examines the key drivers of short-, medium- and long-term GHG policy based on recent developments and announcements regarding GHG and energy legislation, regulations and policy including but not limited to: British Columbia’s (BC) 2007 Greenhouse Gas Reduction Targets Act (Bill 44); the 2007 BC Energy Plan (“A Vision for Clean Energy Leadership” (2007)); the BC Speech from the Throne (13 February 2007); the BC Premier’s announcement of September 28, 2007 of new legislative measures to mandate GHG reduction targets; Canada’s proposed Regulatory Framework for Air Emissions; the Western Climate Initiative (WCI)<sup>2</sup> Memorandum of Understanding; California’s Senate Bill (SB) 1368 and Assembly Bill (AB) 32; Washington State’s Engrossed Substitute Senate Bill (ESSB) 6001; the various United States (U.S.) congressional bills and legislative proposals; and other relevant developments and announcements that may influence the future demand for and supply of GHG offsets.
2. Reviews new economic models and modeling results corresponding to U.S. congressional bills and legislative proposals.
3. Considers marginal abatement costs and planned or potential GHG emissions targets and/or potential emissions reduction activities in the states and provinces forming the WCI and the Western Electricity Coordinating Council (WECC). The report further identifies possible differences, if any, between marginal abatement costs for eligible offsets and market prices.
4. Updates the North American Integrated Resource Planning survey completed by Natsource in 2006 as part of the 2006 IEP/LTAP filing.
5. Identifies potential GHG regulatory regimes to be faced by a new fossil fuel-fired electricity generator in BC and in each WECC jurisdiction (California, Arizona, New

---

<sup>1</sup> The term "offset" in this report is typically interchangeable with "compliance instrument" that BC Hydro would need to purchase to comply with GHG regulatory regime(s).

<sup>2</sup> The WCI was originally called the Western Region Climate Action Initiative. See U.S. Policy and Developments section below for further discussion.

Mexico, Colorado, Utah, Nevada, Oregon, Idaho, Wyoming, Montana, Washington State and Alberta) from 2007 to 2050.

6. Develops three scenarios that may bound the range of potential policy and program responses to GHG emissions reductions for the period 2007 to 2050.
7. Provides a series of GHG price forecasts for 2007-2050 for compliance instruments<sup>3</sup> associated with each of the scenarios. A price sensitivity analysis is also provided for the period 2007 to 2020 during which time the BC Government may decide to pursue GHG emissions reduction programs either on its own or as part of a regional group such as the WCI or WECC.

## **II. Regulatory and Policy Changes and Implications**

Since Natsource developed the last pricing scenarios in 2005 as part of BC Hydro's 2006 IEP/LTAP filing, there have been a number of legislative, regulatory and policy initiatives in Canada and the U.S. that increase the probability that GHG emissions from electricity generating facilities in North America will be regulated. In BC in particular, on February 27, 2007 the Provincial Government released the 2007 BC Energy Plan which provides strong direction as to how the electricity generation sector will have to manage GHG emissions going forward. In addition, on November 20, 2007, the Provincial Government introduced Bill 44, which sets into law GHG targets for BC for 2020 and 2050, requires that interim targets be set for 2012 and 2016, and requires that the Government, including all public sector organizations and Crown corporations, become carbon neutral by 2010.

The following provides summaries of the most recent GHG legislative and regulatory proposals and programs. For each province and state, the implications for a new fossil-fuel fired electricity generation facility are also outlined.

### **Summary of Greenhouse Gas Regulatory Frameworks**

#### **A. Canada**

##### **1. Federal Government**

###### **a. Regulatory Framework for Air Emissions**

On April 26, 2007 the Federal Government announced a framework to regulate GHG and other air emissions from major industrial sectors. This "Regulatory Framework for Air Emissions"<sup>4</sup> (Regulatory Framework) will require large industrial emitters in Canada to reduce their GHG emissions intensity by 6% per year from 2006 levels from 2007 to 2010 and by a further 2% each year until 2015. Following a period of consultation with industry, the Provinces and other stakeholders, medium and longer term targets will be

---

<sup>3</sup> Compliance instruments could include a variety of commodities such as offsets, allowances, contributions to government funds, taxes, etc.

<sup>4</sup> Available at [www.ec.gc.ca](http://www.ec.gc.ca).

established with a goal of reducing absolute GHG emissions relative to 2006 levels by 20% by 2020 (approximately 1990 levels) for the country as a whole.<sup>5,6</sup>

The GHG portion of the Regulatory Framework is to be implemented by way of regulations promulgated under the *Canadian Environmental Protection Act 1999* (CEPA 1999), eliminating the need to pass new legislation. The Regulatory Framework sets a 2010 implementation date for the GHG emissions intensity reduction targets. The sectors that are covered include thermal electricity generation; oil and gas; forest products; smelting and refining; iron and steel; and cement, lime and chemicals. Facilities that are covered by the new regulations can comply in a number of ways including:

- Reducing their own emissions through internal actions;
- Contributing to a technology fund<sup>7</sup> consisting of two components: Deployment and Infrastructure, and Research and Development. Contribution rates to the two components of the fund will be at \$15 (nominal) per tonne for each of 2010, 2011 and 2012, \$20 (nominal) per tonne for 2013 and \$20 (nominal) per tonne escalating with GDP for each of the years out to 2017;
- Receiving credit for certified project investments<sup>8</sup> (an option being considered, but rules not yet established)
- A one-time recognition of early action for firms that took verified action between 1992 and 2006 to reduce their GHG emissions;
- Inter-firm emissions trading;
- Purchasing domestic offsets;
- Potential linkages with regulatory-based emissions trading systems in the U.S.<sup>9</sup>; and,
- Purchasing Certified Emissions Reductions (CERs) under the Kyoto Protocol's Clean Development Mechanism (CDM)<sup>10</sup> up to an amount equal to 10% of a firm's total GHG emissions target.

---

<sup>5</sup> Estimate based on 2005 emissions.

<sup>6</sup> Natural Resources Canada, *Canada's Energy Outlook: The Reference Case 2006*.

<http://www.nrcan.gc.ca/com/resoress/publications/peo/peo2006-eng.pdf>

<sup>7</sup> The proposed framework allows for contributions to either of two components of the Climate Change Technology Fund: 1. Deployment and Infrastructure Component: access as a percentage total target over 2010-2017 at a declining rate of 70% in 2010, 65% in 2011, 60% in 2012, 55% in 2013, 50% in 2014, 40% in 2015 and 10% in each of 2016 and 2017. 2. Research and Development Component: Access over 2010-2017 at 5 million tonnes per year.

<sup>8</sup> A certified project investment would be pre-certified by the Government as being an investment in a transformative technology that would incrementally reduce future emissions to receive credits from the Government for that investment. These credits could then be used towards a facility's regulatory obligations.

<sup>9</sup> The Regulatory Framework makes specific reference to the Western Regional Climate Action Initiative (later renamed WCI and described in detail later in report) and the Regional Greenhouse Gas Initiative (established in December 2005 by the governors of Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont) in this regard.

<sup>10</sup> The Regulatory Framework makes no reference to the potential use of Emissions Reduction Units (ERUs) from the Joint Implementation provision of the Kyoto Protocol.

Both CEPA 1999 and the Regulatory Framework include provisions to enter into “equivalency agreements” with Provinces that set GHG standards at least as stringent as the federal standards. Once signed, an equivalency agreement would lead to the suspension of the relevant CEPA 1999 GHG regulations, with only the Provincial regulations applying.<sup>11</sup>

**b. Other Federal GHG Legislative Developments**

In the 39<sup>th</sup> Session of Parliament a private member’s bill, Bill C-288, was introduced. The bill is entitled “An Act to ensure Canada meets its global climate change obligations under the Kyoto Protocol” (the *Kyoto Protocol Implementation Act*) and was given Royal Assent on June 22, 2007. The *Kyoto Protocol Implementation Act* requires the Federal Government to bring forward a plan to honor Canada’s commitments under the Kyoto Protocol. In response to the *Act*, the federal Government released “a Climate Change Plan for the Purposes of the *Kyoto Protocol Implementation Act*” in August 2007, which outlines the actions the Federal Government plans to take under the provisions of the Regulatory Framework described above. The proposal would not enable Canada to meet its emissions targets that are contained in the Kyoto Protocol.

On October 16, 2007 the Federal Speech from the Throne<sup>12</sup> confirmed the Federal Government’s intention to implement a national strategy to reduce Canada’s GHG emissions by 20% by 2020, and 60 to 70% by 2050, noting the strategy will institute binding national regulations on GHG emissions across all major industrial sectors and establish a carbon emissions trading market. The Throne Speech emphasized the view that climate change requires a global solution and noted the importance of engaging the international community through APEC, the G8 and the United Nations, to press for a new international agreement that cuts global emissions in half by 2050.

**2. Provincial Plans, Programs and Policies**

**a. Canadian Council of the Federation**

On August 10, 2007, the Canadian Council of the Federation (made up of all thirteen Canadian Provincial and Territorial premiers) committed to reduce GHG emissions and address the impacts of climate change. To achieve these goals, each Premier agreed to implement a range of energy conservation, adaptation and GHG emission reduction strategies within each of their respective jurisdictions. However, the Premiers failed to

---

<sup>11</sup>Section 10 of CEPA 1999 allows the use of equivalency agreements where, by Cabinet decision, a regulation under CEPA 1999 is declared to no longer apply in a Province, a Territory or an area under the jurisdiction of an aboriginal government that has equivalent requirements. The equivalent regulation does not have to have the same wording as the CEPA 1999 regulation, but have the same effect. Equivalency agreements are possible for CEPA 1999 regulations dealing with, among other things, toxic substances, international air or international water pollution and environmental emergencies. CEPA 1999 requires that all proposed equivalency and administrative agreements undergo a 60-day public comment period. Agreements terminate five years after coming into force to ensure regular review and renewal as necessary. Agreements may be terminated at any time with three months notice. See [http://www.ec.gc.ca/ceparegistry/the\\_act/guide04/s18.cfm#182](http://www.ec.gc.ca/ceparegistry/the_act/guide04/s18.cfm#182)

<sup>12</sup> Government of Canada, *Strong Leadership: Speech from the Throne*, October 16, 2007, <http://www.sft.gc.ca/grfx/docs/sftddt-e.pdf>.

reach consensus on a program that would strengthen the emissions reduction targets being proposed in the Federal framework. Alberta, Nova Scotia, the Yukon and Newfoundland all opposed any type of cap and trade system for large industrial emitters, despite pressure from the Premiers of BC, Ontario, Manitoba and Quebec. This failure to reach consensus may enable the Federal Government to implement its program which is similar to the approach being taken by those Provinces firmly opposed to a cap and trade system.

The Council members committed to the following specific actions:

- Join The Climate Registry;
- Collectively produce an additional 25,000 megawatts (MW) of renewable energy by 2020;
- Develop and implement programs, standards or incentives aimed at improving energy efficiency in buildings, vehicles, appliances and other energy-using products; and
- Recapture methane gas from landfills.

The Premiers also expressed particular interest in using sustainable forestry and agricultural management techniques to potentially create carbon offsets in the future.

## **b. Individual Provincial Governments**

### **i. British Columbia**

On February 27, 2007, Premier Gordon Campbell announced the 2007 Energy Plan. Policies, measures and requirements in the 2007 Energy Plan and the 2007 Provincial Speech from the Throne that will affect BC Hydro and its management of GHG emissions include:

- BC's goal is to reduce overall GHG emissions by one-third by 2020. (This target and others was set into law in Bill 44, which is discussed below.) If met, this target would bring emissions 10% below their 1990 level, matching the most aggressive target set to date by any province or state in North America.<sup>13,14</sup> The 2020 emissions target is more ambitious than the targets announced by the Canadian Federal Government. As announced in the Speech from the Throne on February 13, 2007, a Climate Action Team must also determine the most credible and economically viable targets to be set for 2012, and 2016, and a longer-term target for 2050;
- All new electricity generation projects will have zero net GHG emissions (Policy Action No. 18);
- Zero net GHG emissions from existing thermal generation power plants by 2016 (Policy Action No. 19);

---

<sup>13</sup> BC Speech from the Throne, 2007, p. 14: "...[the government] will aim to reduce BC's greenhouse gas emissions by at least 33 per cent below 2007 levels by 2020. This will place British Columbia's greenhouse gas emissions at 10 per cent under 1990 levels by 2020."

<sup>14</sup> Eight states – Maine, New York, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut and Oregon – have set an identical target.

- Zero GHG emissions from any new coal thermal electricity facilities (i.e. any coal-fired electricity project would require 100 percent carbon sequestration) (Policy Action No. 20). If this policy is made into regulation or law, it would effectively ban new coal thermal facilities unless CO<sub>2</sub> can be captured and sequestered;
- Ensure clean or renewable energy generation continues to account for at least 90% of total generation (Policy Action No. 21); and
- No nuclear power (Policy Action No. 23).

In addition, the 2007 Energy Plan includes other policies and measures such as energy conservation targets, new building efficiency standards for public buildings, elimination of flaring from oil and gas exploration activities and mandated standards for renewable fuels for diesel. Many of the GHG emissions reductions associated with these activities, if the activities were to be left unregulated, could potentially qualify as being eligible offsets in a domestic emissions trading system. However, if these policies and measures are implemented by use of regulation, the resulting emissions reductions may be declared ineligible to qualify as domestic GHG offsets, since the promulgation of the regulations would make it mandatory to undertake these activities and therefore they would be considered business-as-usual. Should such a regulatory approach be taken, the potential supply of offsets that could be created in and purchased from BC would be lessened.

On September 28, 2007 Premier Gordon Campbell signaled that legislation will be introduced in the spring of 2008 to allow for the creation of market mechanisms and make BC the first province in Canada to legally require “hard caps” on GHG emissions. These caps will be used as part the WCI regional cap and trade system which is scheduled to be developed by August 2008. Premier Campbell also announced that BC government travel could be offset through \$25/tonne CO<sub>2</sub>e contributions to a new BC Carbon Trust that would invest in valid offset projects in BC, and that the Trust would be “open to individuals, companies and other levels of government to help them become carbon neutral and help reduce emissions by supporting a made-in-BC offset project.”<sup>15</sup>

On November 20, 2007 BC introduced Bill 44, which sets into law BC’s GHG emissions target of at least 33 percent below 2007 levels by 2020, and at least 80 percent below 2007 levels by 2050.<sup>16</sup> It requires that interim GHG targets for 2012 and 2016 be set by the end of 2008. Bill 44 also requires that the Provincial Government and public sector organizations (including “provincial ministries and agencies, schools, colleges, universities, health authorities and Crown corporations”) be carbon neutral in 2010 and thereafter, and pursue actions to minimize GHG emissions in 2008 and 2009.<sup>17</sup> In those years, the Government must also be carbon neutral with respect to official travel. After they take actions to minimize emissions, the Government and public sector organizations

---

<sup>15</sup> British Columbia Office of the Premier, News Release: “Premier Outlines New Steps to Tackle Climate Change,” September 28, 2007, [http://www2.news.gov.bc.ca/news\\_releases\\_2005-2009/2007OTP0141-001209.htm](http://www2.news.gov.bc.ca/news_releases_2005-2009/2007OTP0141-001209.htm)

<sup>16</sup> British Columbia Bill Number 44 – 2007, Greenhouse Gas Reduction Targets Act, [http://www.leg.bc.ca/38th3rd/1st\\_read/gov44-1.htm](http://www.leg.bc.ca/38th3rd/1st_read/gov44-1.htm)

<sup>17</sup> British Columbia Office of the Premier, News Release: “B.C. Introduces Climate Action Legislation,” November 20, 2007, [http://www2.news.gov.bc.ca/news\\_releases\\_2005-2009/2007OTP0181-001489.htm](http://www2.news.gov.bc.ca/news_releases_2005-2009/2007OTP0181-001489.htm)

may apply emission offsets to meet the carbon neutral requirement. Bill 44 indicates that the Lieutenant Governor in Council may make regulations that would establish one or more provincial emission offset systems, and/or provide authority for recognizing units from other jurisdictions' offset systems for compliance. However, it does not mention the BC Carbon Trust noted in Premier Campbell's September 28 announcement. It is our understanding that the BC Government intends to make the fund available to public sector organizations including BC Hydro as a means of compliance with the carbon neutral requirement, and that it would not be available to covered entities as a means of compliance with mandatory GHG targets.

A key question is to what extent the Province's forthcoming climate change legislative and regulatory program will be harmonized with the Canadian Federal Government's GHG policies and regulatory framework. As noted above, consensus among all provincial governments on a national cap and trade program was unachievable. Under CEPA 1999 BC is able to implement more stringent programs than the Federal Government, as there is no requirement that provincial and territorial GHG policies be abandoned in favor of Federal policies (as long as provinces and territories demonstrate that the environmental results of their policies are at least equivalent to the environmental results to be achieved by Federal regulations). Similarly, BC could also decide to maintain its participation in the WCI program, and to meet its target, even after a Federal program has commenced.

A new gas or oil-fired electrical generator in BC would be subject to the 2007 Energy Plan requirement to completely offset GHG emissions and a new coal-fired generator would be subject to the 2007 Energy Plan's requirement to meet a zero GHG emissions standard through "clean coal" fired generation technology and carbon sequestration.<sup>18</sup> These targets have been adopted as a portion of the regional aggregate WCI goal. While a new fossil fuel-fired generator in BC would also be subject to applicable requirements/targets under the Federal emissions intensity program, those requirements would likely be met through compliance with BC requirements, which are more stringent.

## **ii. Alberta**

The Province of Alberta passed the *Climate Change and Emissions Management Act* (CCEMA) in 2003. It includes a goal to reduce emissions intensity to at least 50% of 1990 levels by 2020. The Specified Gas Emitters Regulation under CCEMA came into force on August 1, 2007 and requires established facilities<sup>19</sup> in Alberta emitting more than 100,000 tonnes of GHGs per year to reduce their GHG emissions intensity by 12 percent from their baseline emissions intensity<sup>20</sup> starting July 1, 2007. These reductions can be met by improving efficiency, buying offsets created in Alberta of 2002 and later vintage, or contributing to the Climate Change and Emissions Management Fund (the

---

<sup>18</sup> "The BC Energy Plan: A Vision for Clean Energy Leadership" 2007, p.13

<sup>19</sup> For the purposes of the Specified Gas Emitters Regulation, an established facility is one that completed its first year of commercial operation before January 1, 2000 or has completed 8 years of commercial operation.

<sup>20</sup> The Baseline Emissions Intensity (BEI) for established emitters is the average emissions intensity over three years of operations during the period of 2003-2005.

Management Fund).<sup>21</sup> The Management Fund grants unlimited access to all regulated entities to make compliance contributions at the rate of \$15 per tonne to an Alberta-only technology fund or to purchase Alberta-only offsets from GHG reduction projects undertaken outside the regulated sectors. Alberta is not a signatory of the WCI, but is one of the WECC jurisdictions.

A new fossil fuel-fired generator in Alberta would be subject to the provisions of the Specified Gas Emitters Regulation, which specifies that the baseline emissions intensity (BEI) for a new facility is the intensity in the third year of commercial operation of the facility.<sup>22</sup> Thus, for the first three years of operation, there are no regulatory requirements for a new plant to reduce its emissions intensity. In year 4, the plant would be required under the Specified Gas Emitters Regulation to reduce its emissions intensity by 2% per year for each of the next five years of operation. At that time (i.e. following year 8 of operations), the plant would become an established facility, and would be required to comply with the 12% emissions intensity reduction required of established facilities.<sup>23</sup>

### **iii. Manitoba**

On June 12, 2007, Manitoba became the second Canadian province to sign onto the WCI agreement. The WCI's reduction goal represents an aggregate regional target which encompasses the Manitoba Government's individual GHG reduction target of 6% below 1990 levels by 2012.<sup>24,25</sup>

In Manitoba's Speech from the Throne on November 20, Premier Gary Doer announced plans to introduce legislation that would reduce GHG emissions below 2000 levels by 2010, and to phase down the use of Manitoba's last remaining coal-fired plant.<sup>26</sup> An official with Manitoba's environment department said that "the phase-down [of the coal plant] will ensure that it is used only for emergencies" when hydroelectric dam levels drop, and that emissions from the coal plant would be offset by buying carbon credits or through energy efficiency initiatives.<sup>27</sup>

A new fossil fuel-fired generator in Manitoba would be subject to the Province's short-term binding Kyoto targets for GHG emissions (i. e. 6 percent below 1990 levels by 2012) which have been integrated into the regional emission reduction targets under the

---

<sup>21</sup> Draft Protocols that outline how to quantify and verify emissions reductions for different types of projects can be found here: [http://www.climatechangecentral.com/default.asp?V\\_DOC\\_ID=2308](http://www.climatechangecentral.com/default.asp?V_DOC_ID=2308).

<sup>22</sup> For the purposes of the Specified Gas Emitters Regulation, a new facility is one that completed its first year of commercial operation on December 31, 2000 or a subsequent year, or has completed less than 8 years of commercial operation.

<sup>23</sup> See "Specified Gas Emitters Regulation 2007" under the CCEMA. This regulation, which came into force on August 1, 2007 supersedes the Transition Principles provisions of March 2004 that required any new coal-fired facilities in Alberta to offset GHG emissions to a CCGT standard.

<sup>24</sup> Western Climate Initiative Statement of Regional Goal, August 22, 2007, p. 4. <http://www.westernclimateinitiative.org/ewebeditpro/items/O104F13006.pdf>

<sup>25</sup> Manitoba also signed the Midwestern Greenhouse Gas Accord (see discussion in subsection B.4 below).

<sup>26</sup> Manitoba, press release: "Throne speech builds Manitoba for the future with a skilled and green economy," November 20, 2007, <http://news.gov.mb.ca/news/index,print.html?archive=&item=2655>

<sup>27</sup> Point Carbon, "Manitoba to shut down last remaining coal facility: premier," November 20, 2007, [www.pointcarbon.com](http://www.pointcarbon.com) (subscription required).

WCI. While a new fossil fuel-fired generator in Manitoba would be subject to applicable requirements/targets under the Federal emissions intensity program, those requirements would likely be met through compliance with the Manitoba/WCI requirements.

#### **iv. Other Provinces**

Although not directly applicable to the pricing scenarios, the positions of other Provinces are important to provide context, in particular with respect to the likelihood of BC remaining outside of a Federal program on GHG emissions reductions. BC and the Provinces of Ontario and Quebec have called on the Federal Government to embrace a national cap and trade system. In June 2007, Saskatchewan released its Saskatchewan Energy and Climate Change Plan with goals of stabilizing the level of GHG emissions by 2010, reducing emissions to 32% below current (2004) levels by 2020, and reducing emissions by 80% from current (2004) levels by 2050.<sup>28</sup> On June 18, 2007, Ontario announced the targets for GHG emissions that follow: 6% lower than 1990 levels by 2014, 15% lower than 1990 levels by 2020 and 80% lower than 1990 levels by 2050.<sup>29</sup> Quebec has embraced the targets in the Kyoto Protocol and has developed a program to achieve them, including the introduction on October 1, 2007 of Canada's first carbon tax designed to raise funding for implementing Quebec's climate policies. Atlantic Provinces, such as Nova Scotia and Newfoundland, which are likely to develop offshore oil and gas resources have adopted similar positions to the province of Alberta. They support emissions intensity targets with price caps to protect themselves against increases in carbon prices.

### **B. U.S.**

#### **1. Federal Government**

The political situation in which the U.S. Congress is debating GHG policy has dramatically shifted since the Democrats became the majority party in Congress, and since August 2006 when California adopted ambitious legislation requiring significant reductions in GHG emissions.

As the majority party, Democrats now control committees with jurisdiction over GHG legislation, and there is the strong potential that there will be votes on GHG legislation before the 2008 Presidential election. However, the complexity of GHG legislation suggests that a significant amount of debate may need to take place over the course of several years (as in the case of the *Clean Air Act*) before legislation can be passed. Nevertheless several factors have given new impetus for GHG legislation at the federal level. These include the change in control of the Congress, the proliferation of programs adopted at the state level, the Supreme Court decision finding that the U.S.

---

<sup>28</sup> *Saskatchewan Energy and Climate Change Plan*, 2007.

<http://www.saskatchewan.ca/Default.aspx?DN=b92e42b6-6ab2-448a-a8d7-f698cad62eec>

<sup>29</sup> <http://www.premier.gov.on.ca/news/Product.asp?ProductID=1397>

Environmental Protection Agency (EPA) has the authority to regulate carbon dioxide (CO<sub>2</sub>) and other GHG emissions, and others.<sup>30</sup>

Several pieces of legislation have been introduced in the 110<sup>th</sup> Congress that would require GHG reductions and incorporate an emissions trading program. These proposals include Senator McCain's and Senator Lieberman's *Climate Stewardship and Innovation Act* (S. 280), Senator Sanders' and Senator Boxer's *Global Warming Pollution Reduction Act* (S. 309), Senator Bingaman's and Senator Specter's *Low Carbon Economy Act* (S. 1766), and Senator Lieberman's and Senator Warner's *America's Climate Security Act* (S. 2191), among several others. Although some question whether legislation will be signed into law until 2009-2010, considerable debate on legislation that imposes GHG reduction requirements can be expected over the next two years.

In the Senate, Senator Boxer is now Chairman of the Environment and Public Works (EPW) Committee, which has jurisdiction over GHG legislation. Chairwoman Boxer plans to hold hearings on S. 2191 and hopes to pass legislation through the EPW Committee by the end of 2007.<sup>31</sup> Senator Warner is the first Republican on the EPW Committee to support an economy wide approach to GHG emissions. However, it remains to be seen whether the bill's stringency will make it difficult to build enough support for full Senate approval.

In the House of Representatives, Representative John Dingell, chairman of the House Energy Committee (which has jurisdiction over GHG legislation), and Representative Rick Boucher, chairman of the Subcommittee on Energy and Air Quality, have publicly announced that the Committee intends to debate comprehensive GHG proposals in the near future.<sup>32</sup> As a preview to these proposals, the House Energy and Commerce Committee is issuing a series of "white papers" intended to lay out basic design elements of a GHG emissions trading program and identify issues which may require further discussion. The first paper, which was issued on October 3, 2007, concludes that a U.S. emissions trading program should be economy-wide in scope, and would need to reduce emissions to between 60 and 80 percent below current levels by 2050.<sup>33</sup> Speaker of the House Nancy Pelosi has created the new Select Committee on Energy Independence and Global Warming, chaired by Edward Markey, to hold hearings, investigations, and to

---

<sup>30</sup> Supreme Court, *Commonwealth of Massachusetts v. EPA*, 05-1120, April 2007  
<http://www.supremecourtus.gov/opinions/06pdf/05-1120.pdf>

<sup>31</sup> Boxer Statement on Lieberman-Warner Climate Proposal, Environment and Public Works Committee webpage:  
[http://epw.senate.gov/public/index.cfm?FuseAction=Majority.PressReleases&ContentRecord\\_id=273f94ab-802a-23ad-4aa0-ef11b80af3b1&Region\\_id=&Issue\\_id=](http://epw.senate.gov/public/index.cfm?FuseAction=Majority.PressReleases&ContentRecord_id=273f94ab-802a-23ad-4aa0-ef11b80af3b1&Region_id=&Issue_id=)

<sup>32</sup> Wall Street Journal, "Changed Climate on Warming," March 20, 2007.  
[http://online.wsj.com/public/article/SB117435263958342214-kheCGQZm3RrfNE4IUgcsE3xu\\_A8\\_20080318.html](http://online.wsj.com/public/article/SB117435263958342214-kheCGQZm3RrfNE4IUgcsE3xu_A8_20080318.html).

<sup>33</sup> "Climate Change Legislation Design White Paper: Scope of a Cap and Trade Program," House Energy and Commerce Committee, October 3, 2007,  
[http://energycommerce.house.gov/Climate\\_Change/White\\_Paper.100307.pdf](http://energycommerce.house.gov/Climate_Change/White_Paper.100307.pdf)

make recommendations on strategies to reduce GHG emissions. Speaker Pelosi has also expressed her intention to bring GHG legislation to the House floor by the end of 2007.<sup>34</sup>

Table 1 below provides a side-by-side overview of four emissions trading proposals introduced in the 110<sup>th</sup> Congress which reflect the wide range of emission reduction targets that could be incorporated in legislation. S. 1766 is the least stringent of the proposals, while S. 309 is the most stringent. S. 2191 appears on first glance to be slightly more stringent than S. 280. However, as S. 2191 only covers 75% of total emissions while S. 280 covers 85% of total emissions, S. 2191 may allow higher total U.S. emissions than S. 280.

**Table 1: Side-by-Side Federal Legislation in 110<sup>th</sup> Congress<sup>35</sup>**

| Bill Number                     | S. 280 <sup>36</sup>                                                                                                                                                                                                                                                                        | S. 309 <sup>37</sup>                                                                                                                                                                                                                                  | S. 1766 <sup>38</sup>                                                                                                                                                                                                                                                                                                           | S. 2191 <sup>39</sup>                                                                                                                                                                                                                                              |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sponsors                        | Sen. Joe Lieberman (I-CT)<br>Sen. John McCain (R-AZ)                                                                                                                                                                                                                                        | Sen. Barbara Boxer (D-CA)<br>Sen. Bernie Sanders (I-VT)                                                                                                                                                                                               | Sen. Jeff Bingaman (D-NM)<br>Sen. Arlen Specter (R-PA)                                                                                                                                                                                                                                                                          | Sen. Joe Lieberman (I-CT)<br>Sen. John Warner (R-VA)                                                                                                                                                                                                               |
| Date Introduced and Last Action | Introduced January 12, 2007; hearings held in Senate EPW Subcommittee July 24, 2007                                                                                                                                                                                                         | Introduced January 16, 2007; referred to EPW on June 3, 2007                                                                                                                                                                                          | Introduced July 11, 2007; referred to EPW on August 2, 2007                                                                                                                                                                                                                                                                     | Introduced October 18, 2007; legislative markup in Senate EPW Subcommittee November 1, 2007.                                                                                                                                                                       |
| GHG Emission Limits             | <p>&gt; Cap is set approximately 17% above 1990 levels for covered sectors between 2012-2019 (6130 MMt)</p> <p>&gt; Cap is set approximately equal to 1990 levels between 2020-2029 (5239 MMt) and approximately 22% below 1990 levels between 2030-2049 (4100 MMt) for covered sectors</p> | <p>&gt; Freezes emissions in 2010, decreasing approximately 2% annually until reaching 1990 levels by 2020 for covered sectors.</p> <p>&gt; Caps set at 1/3 of 80% (27%) below 1990 levels by 2030 and 2/3 of 80% (53%) below 1990 levels by 2040</p> | <p>&gt; Cap set approximately 26% above 1990 levels in 2012 (6652 MMt) for covered sectors decreasing about 1% per year until reaching approximately 17% above 1990 levels by 2020 (6188 MMt)</p> <p>&gt; Cap is set between 2021-2030 emissions and reduced to 9% below 1990 levels (4819 MMt) by 2030 for covered sectors</p> | <p>&gt; Cap is set at approximately 13% above 1990 levels (5200 MMt) by 2012 and 3% below 1990 levels by 2020 (4432 MMt) for covered sectors</p> <p>&gt; Cap is set at 24% below 1990 by 2030 and 45% below 1990 levels (3512 MMt) by 2040 for covered sectors</p> |

<sup>34</sup> *Climate Change and Business*, Volume XII, Issue XI, June 2007.

[http://www.bcse.org/publications/climate\\_change\\_and\\_business/BCSE\\_June\\_2007.pdf](http://www.bcse.org/publications/climate_change_and_business/BCSE_June_2007.pdf)

<sup>35</sup> Cumulative allowance data taken from: Paltsev, Sergey, et al. Massachusetts Institute of Technology (MIT). *MIT Joint Program on the Science and Policy of Global Change, Assessment of Cap and Trade Proposals*. Report No. 146. April 2007. [http://web.mit.edu/globalchange/www/MITJPSPGC\\_Rpt146.pdf](http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt146.pdf). Reduction targets for each bill except the Warner/Lieberman bill were obtained from the Senate Energy Committee's website:

[http://energy.senate.gov/public/\\_files/ClimateLegislationSidebySide110thCongress.pdf](http://energy.senate.gov/public/_files/ClimateLegislationSidebySide110thCongress.pdf). Approximately 86% coverage in the Bingaman/Specter bill and reduction levels expressed as a percentage of 1990 levels for the Warner/Lieberman bill were calculated using EIA, AEO 2007 projections, as provided in the Reference case scenario in the analysis of Senator McCain's and Senator Lieberman's Climate Stewardship and Innovation Act (S.280) <http://www.eia.doe.gov/oiaf/servicerpt/csia/excel/s280base.xls>

<sup>36</sup> U.S. Government Printing Office, S. 280, *Climate Stewardship and Innovation Act of 2007*, [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110\\_cong\\_bills&docid=f:s280is.txt.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:s280is.txt.pdf)

<sup>37</sup> U.S. Government Printing Office, S. 309, *Global Warming Pollution Reduction Act of 2007*, [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110\\_cong\\_bills&docid=f:s309is.txt.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:s309is.txt.pdf)

<sup>38</sup> U.S. Government Printing Office, S. 1766, *Low Carbon Economy Act of 2007*, [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110\\_cong\\_bills&docid=f:s1766is.txt.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:s1766is.txt.pdf)

<sup>39</sup> U.S. Government Printing Office, S. 2191, *America's Climate Security Act of 2007*, [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110\\_cong\\_bills&docid=f:s2191is.txt.pdf](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:s2191is.txt.pdf)

|                              |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                      |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                              | <p>&gt; By 2050, cap is set approximately 60% below 1990 levels (2096 MMt) for covered sectors</p> <p>&gt; Allows for cumulative national allowances of 216 billion metric tons (BMT) from 2012-50, and 186 BMT for covered sectors<sup>40</sup></p>                                | <p>&gt; By 2050, cap will be 80% below 1990 levels</p> <p>&gt; Allows for cumulative national allowances of 167 BMT from 2012-50</p>                                                                                                                           | <p>&gt; From 2030 and beyond caps remain at 4819 MMt for covered sectors (9% below 1990 levels)</p> <p>&gt; President can set cap at 60% below 2006 levels (53% below 1990 levels (2475 MMt)) contingent upon international participation</p> <p>&gt; Roughly mid-way between the Bingaman-Specter draft bill of January 2007 (which allowed for cumulative allowances of approximately 306 BMT from 2012-50) and the McCain-Lieberman bill</p> | <p>&gt; By 2050, cap will be 66% below 1990 levels (1560 MMt) for covered sectors</p> <p>&gt; May be comparable in cumulative national allowances in 2012-50 to the McCain-Lieberman bill</p>                                                        |
| Regulated Industries         | Power plants, large manufacturing and commercial facilities as well as transportation fuels at the refinery or the import terminal (85% of total national GHG emissions)                                                                                                            | Economy-wide covering most major sectors of U.S. economy, including power plants and transportation (% of total national GHG emissions unspecified)                                                                                                            | Upstream coverage for petroleum, natural gas, and non CO <sub>2</sub> GHGs and downstream coverage for coal facilities that use over 5,000 tons of coal per year (~86% of total national GHG emissions)                                                                                                                                                                                                                                         | Electric power generation, transportation, and heavy industry sectors (~75% of total national GHG emissions)                                                                                                                                         |
| Offsets                      | Offsets (including domestic and international) may be used for compliance up to an annual amount equal to 30% of an entity's allowance allocation if those offsets include 1.5% in agricultural sequestration, otherwise offsets may account for a maximum of 15% of the allocation | Specific use of offsets is not included; however, the Department of Agriculture is directed to develop standards for biological sequestration of carbon in forests and soils, and the EPA is required to promulgate standards for geological disposal of GHGs. | Allows use of domestic offsets that meet broadly accepted standards. Up to 5% are set aside for agricultural sequestration. Also allows discounted credits for offsets not meeting approved standards. The President can also implement and international offset program, allowing not more than 10% of compliance obligation to be met in this manner.                                                                                         | Domestic offsets may be used for compliance up to an annual amount equal to 15% of an entity's allowance allocation, and allowances purchased on a foreign trading market (after EPA Administrator certification) may be used for an additional 15%. |
| Cost Control and Flexibility | Allows for unlimited banking and allows borrowing from future targets no more than 5 years in advance to meet up to 25% of compliance.                                                                                                                                              | Establishes a "technology-indexed stop price" that freezes the cap if allowances prices become too high relative to zero-carbon or low-carbon technologies                                                                                                     | A price ceiling, or "safety valve," on carbon set at \$12 per ton, increasing 5% above inflation. Unlimited banking is also allowed.                                                                                                                                                                                                                                                                                                            | Allows for unlimited banking allowed and up to 15% of allowances per year can be borrowed at a default interest rate (this percentage can be increased by the Carbon Market Efficiency Board).                                                       |

In addition to the legislation described above, other proposals have been introduced in the 110<sup>th</sup> Congress in both the Senate and the House of Representatives. All of the emission reduction targets in these proposals fall within the target range of S. 1766 and S. 309, with the exception of Representative Waxman's Safe Climate Act (H.R. 1590), which is slightly more stringent than S. 309.

## 2. State and Regional Regimes Affecting Western States

In the last two years, almost every state legislature covered in this assessment has introduced proposals that either establish GHG reduction goals or institute new GHG performance standards for power generators, or both.<sup>41</sup> These proposals include California's SB 1368 and AB 32, and Washington State's ESSB 6001, among numerous other statutory bills and executive orders.<sup>42</sup> Given that California accounts for 10% of

<sup>40</sup> The 216 BMT figure includes emissions from non-covered sectors. In practice, those sectors do not receive allowances; their emissions are simply expected to grow under BAU to a cumulative level equal to 30 BMT during 2012-2050 (i.e. the difference between 216 BMT and 186 BMT).

<sup>41</sup> British Columbia, California, Washington State, Oregon, Arizona, New Mexico, Utah, Alberta, Colorado, Montana, Nevada, Idaho and Wyoming are the specific states and provinces covered in this assessment. They are all members of the WECC.

<sup>42</sup> AB 32 was passed into law as the California Global Warming Solutions Act of 2006 in September 2006.

the U.S. economy and that key leaders from California are in important leadership positions in the U.S. House of Representatives and U.S. Senate, its efforts likely will impact U.S. Federal policy.

**a. WCI States**

The WCI was launched on February 26, 2007 by the governors of Arizona, California, New Mexico, Oregon and Washington. Utah, BC, Manitoba, and Montana have also signed onto the agreement since its inception and several other U.S. states and Canadian provinces are participating as observers. Of the thirteen WECC jurisdictions covered in this assessment, more than half (8) are also members of the WCI including the U.S. states of Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington State.<sup>43</sup> In addition, BC and Manitoba are participants of the WCI. BC is also a member of the WECC, while Manitoba is not.

On August 22, 2007 the WCI announced its regional aggregate emission reduction goal to be 15 percent below 2005 levels by 2020.<sup>44</sup> This regional goal was calculated by aggregating each WCI participant's differentiated GHG reduction target into a regional target to indicate the level of reductions that participants' targets would deliver in aggregate. The estimated goal excludes emission reductions efforts in Manitoba (because of a lack of emission projections available), and in the state of Utah (which has not yet set a target). To achieve these goals, WCI signatories agreed to design a regional market-based multi-sector mechanism by no later than August 26, 2008. However, it is unclear whether U.S. Federal GHG legislation will preempt state-level or regional-level GHG policies. Consequently, it is uncertain whether emissions targets and requirements established under the WCI would continue in effect if Congress approves a national emissions trading program after the creation of a WCI trading program. Emission reduction targets and emission restrictions impacting thermal electricity generators in U.S. states participating in WCI are summarized below.

**b. California**

The *California Global Warming Solutions Act of 2006* (codified in the Health and Safety Code, Division 25.5, Section 38500) requires California to reduce economy-wide GHG emissions to 1990 levels by 2020 beginning in January 2012.<sup>45</sup> The *Act*, commonly known as AB 32, was signed into law by Governor Schwarzenegger in September 2006. The Governor's Executive Order S-3-05, which was issued in 2005, provides additional targets: 2000 levels by 2010, 1990 levels by 2020, and 80 percent below 1990 levels by 2050.<sup>46</sup> The focus of California's efforts appears to be on meeting the 2020 target

---

<sup>43</sup> Colorado, Kansas, Nevada, Ontario, Quebec, Saskatchewan, Sonora and Wyoming are participating as observers according to the WCI website. Montana, which had been an observer, will become a participant as indicated in a letter from Governor Brian Schweitzer on November 19, 2007 (<http://governor.mt.gov/brian/wci112007.pdf>).

<sup>44</sup> Western Climate Initiative, Statement of Regional Goal, August 22, 2007 <http://www.westernclimateinitiative.org/ewebeditpro/items/O104F13012.pdf>

<sup>45</sup> Health and Safety Code <http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=hsc&codebody=&hits=20>

<sup>46</sup> By January 1, 2008, the CARB must determine what the 1990 emissions levels were, which will effectively establish the cap. <http://www.arb.ca.gov/ag/manuremgmt/ab32.pdf>

established by law under AB32, and not on the more immediate 2010 target in the Executive Order. Recently, the agency responsible for deciding how California will achieve its GHG target under AB32, the California Air Resources Board (CARB), declared that a cap and trade program, integrated with direct regulation, will most likely become part of California's reduction strategy.<sup>47</sup> Based on recommendations by CARB's Market Advisory Committee, sectors covered by the program would initially include the power sector and industrial sectors, and could later be expanded to the transport sector and other sectors.

Another law, SB 1368 (codified in the Public Utilities Code, Chapter 3, Division 4.1), requires that all load serving entities entering into long-term financial commitments for baseload generation comply with a GHG performance standard.<sup>48,49</sup> The California Public Utilities Commission (CPUC) specified this GHG performance standard in January 2007 (Rulemaking 06-04-009). The emissions performance standard mandates that all new long-term commitments for baseload generation and local publicly owned electric utilities serving California (e.g., major investments, new construction, more than five-year long contracts) be limited to power plants with emission levels no higher than a combined cycle gas turbine facility (CCGT). In Decision Number 07-01-039, the CPUC selected an emissions rate of 1,100 pounds of CO<sub>2</sub>/MWh to be the standard because it "reasonably accounts for potential CCGT plant "outliers" from the average data on CCGT emissions rates."<sup>50</sup> CO<sub>2</sub> emissions that are captured and injected into geological formations are not counted in determining a unit's compliance, although other offsets cannot be used for compliance. This standard effectively bans new long-term commitments for baseload coal-fired generation unless CO<sub>2</sub> can be captured and sequestered.

This performance standard applies to both in-state and out-of-state generators and was established by the CPUC as an interim measure until a load-based GHG emissions cap is adopted and enforced. The CPUC is in the process of considering a load-based emissions trading program for electricity generators that could be incorporated into CARB's overall emissions trading program. Load-based emissions trading programs address emissions at the level of load serving entities, which are defined in S. 2191 as public or private entities that have a legal, regulatory, or contractual obligation to deliver electricity to retail consumers, and whose rates and costs are, except in the case of a registered electric cooperative, regulated by a State agency, regulatory commission, municipality, or public utility district. This definition appears consistent with the CPUC's.

---

<sup>47</sup> AB 32 directs CARB to adopt a plan by January 1, 2009 indicating how emission levels will be achieved from major GHG sources via regulations, market mechanisms, or other measures. The CARB has already adopted three early action regulations that impose a low carbon fuel standard, ban certain refrigerants used in cars, and require landfills to capture methane gas emitted by decomposing refuse.

[http://www.arb.ca.gov/cc/042307workshop/early\\_action\\_report.pdf](http://www.arb.ca.gov/cc/042307workshop/early_action_report.pdf)

<sup>48</sup> California Senate Bill 1368,

[http://www.energy.ca.gov/ghgstandards/documents/sb\\_1368\\_bill\\_20060929\\_chaptered.pdf](http://www.energy.ca.gov/ghgstandards/documents/sb_1368_bill_20060929_chaptered.pdf)

<sup>49</sup> California Public Utilities Code, <http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=puc&codebody=&hits=20>

<sup>50</sup> California Public Utilities Commission. Decision Number 07-01-039. January 25, 2007.

[http://www.cpuc.ca.gov/word\\_pdf/FINAL\\_DECISION/64072.pdf](http://www.cpuc.ca.gov/word_pdf/FINAL_DECISION/64072.pdf) (p. 8).

According to the California Energy Commission (CEC), part of “SB 1368[’s]...focus is ensuring that substantial investments are not made that would lead to further costs when AB 32, or a similar program establishing a greenhouse gas emissions limit, is implemented [i.e. the WCI].”<sup>51</sup> This would be the case, for example, if new and existing CCGT facilities subject to the performance standard received “grandfathered” allowance allocations under AB 32 equal to their output multiplied by the performance standard. (We note it remains to be seen how or whether CCGT facilities would receive allowance allocations, since CARB could opt for a load-based program or another approach such as a source-based program.) In summary, however, CEC’s statement may not definitively rule out the possibility that CCGT plants would face GHG emission targets more stringent than the performance standard.

A new baseload generation or local publicly owned electric fossil fuel unit in California would be subject to the state’s binding GHG emission targets (i.e. 1990 levels by 2020) as well as emission performance standards requiring emissions to be at least below 1,100 pounds of CO<sub>2</sub>/MWh. The GHG emissions targets would be established by the level of grandfathered allowances provided to each new unit. New units would need to purchase allowances in the market to cover any emissions they may have in excess of the allocation. As noted above, it is unclear whether the target could be set at a level lower than the performance standard.

**c. Washington State**

ESSB 6001, signed into law by Governor Gregoire on May 3, 2007, establishes goals to reduce GHG emissions to 1990 levels by 2020, 25 percent below 1990 levels by 2035, and 50 percent below 1990 levels by 2050, although the targets are unenforceable by law.<sup>52</sup> Like California’s SB 1368, the bill also establishes a GHG emissions performance standard for power generators. The standard, which takes effect July 1, 2008, mandates that all new long-term commitments for baseload generation and investor-owned electric utilities must meet emissions that are lower than 1,100 pounds of CO<sub>2</sub>/MWh or the equivalent of a CCGT facility.<sup>53</sup> As a means to achieve the standard, ESSB 6001 permits facilities to capture and sequester CO<sub>2</sub> in geologic formations, but other offsets cannot be used to comply with the standard. This standard effectively bans new long-term commitments for baseload coal-fired generation unless CO<sub>2</sub> can be captured and sequestered.

---

<sup>51</sup> California Energy Commission. “Electricity Committee’s Explanation of Changes to Regulations of Establishing and Implementing a Greenhouse Gas Emissions Performance Standard for Local Publicly Owned Utilities in Response to the Office of Administrative Law’s Disapproval Decision.” July 29, 2007. [http://www.energy.ca.gov/ghgstandards/documents/2007-08-29\\_business\\_meeting/2007-08-10\\_EXPLANATION\\_OF\\_CHANGES\\_REGS.PDF](http://www.energy.ca.gov/ghgstandards/documents/2007-08-29_business_meeting/2007-08-10_EXPLANATION_OF_CHANGES_REGS.PDF).

<sup>52</sup> ESSB 6001 Bill summary: <http://www.leg.wa.gov/pub/billinfo/2007-08/Pdf/Bill%20Reports/Senate/6001-S.SBR.pdf>

<sup>53</sup> The emission level benchmark for CCGT plants is to be updated every five years by the Department of Community, Trade and Development.

House Bill (HB) 3141, which was passed in March 2004 (adding chapter 70 to Title 80 of the Revised Code of Washington), institutes a mitigation plan requiring fossil fuel-fired power plants of greater than 25 MW capacity coming on line after July 1, 2004 to offset approximately 20 percent of their CO<sub>2</sub> emissions over a 30-year period.<sup>54</sup> In addition, expansion plans at existing facilities are also subject to the 20 percent offset requirement. Specifically, plants greater than 350 MW that expand to increase CO<sub>2</sub> emissions by over 15% after July 1, 2004, and existing plants between 25 and 350 MW that expand to increase output by 25 MW or emissions by over 15% after July 1, 2004 will also be required to meet the 20 percent offset requirement. Compliance can be achieved through either: 1) payment to a third party to provide mitigation;<sup>55</sup> 2) direct purchase of permanent carbon credits; or 3) investment in applicant-controlled CO<sub>2</sub> mitigation projects, including combined heat and power (cogeneration).

Lastly, in July 2001 the city of Seattle passed Resolution 30316 which sets a city-wide goal of reducing GHG emissions at least 7% by 2010. In addition, Seattle's Earth Day Resolution 30144 (2000) and Resolution 30359 (2001) formalized Seattle City Light's (the city's public electric utility) commitment to achieving all of the city's electricity needs with zero net GHG emissions by 2005.<sup>56,57</sup> The city of Seattle announced that the zero net GHG emissions goal had been achieved in November 2005.<sup>58</sup>

A new fossil fuel unit in Washington would be subject to the state's binding GHG emission targets (i.e. 1990 levels by 2020, 25 percent below 1990 levels by 2035, and 50 percent below 1990 levels by 2050) as well as emission performance standards, which establish a limit of 1,100 pounds of CO<sub>2</sub>/MWh. It remains to be determined whether the unit's GHG target could be lower than the performance standard; this depends on how emissions limits are developed down to the plant and sector level. A fossil-fuel unit would also be required to meet the offset requirements established under HB 3141, although these offsets would not be counted towards meeting the emissions performance standard.<sup>59</sup> A unit sited in Seattle's jurisdiction would be subject to the city-wide GHG emissions goal (i.e. 7% reduction from 1990 levels by 2010) and would be required to operate with zero net GHG emissions.

---

<sup>54</sup> Washington House Bill 3141. <http://www.leg.wa.gov/pub/billinfo/2003-04/Pdf/Bills/House%20Passed%20Legislature/3141-S.PL.pdf>.

<sup>55</sup> Ibid. Rate paid to a third party is \$1.60/tonne, although this rate can be adjusted by no more than 50% every two years.

<sup>56</sup> Resolution 30144 <http://clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?s1=&s2=&s3=30144&s4=&Sect4=AND&l=20&Sect1=IMAGE&Sect2=THESON&Sect3=PLURON&Sect5=RESN1&Sect6=HITOFF&d=RESN&p=1&u=/~public/resn1.htm&r=1&f=G>

<sup>57</sup> Resolution 30359, <http://clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?s1=&s2=&s3=30359&s4=&Sect4=AND&l=20&Sect1=IMAGE&Sect2=THESON&Sect3=PLURON&Sect5=RESN1&Sect6=HITOFF&d=RESN&p=1&u=/~public/resn1.htm&r=1&f=G>

<sup>58</sup> City Light First in Nation to Reach Zero Net Emissions Goal  
<http://www.seattle.gov/news/detail.asp?id=5656&dept=40>

<sup>59</sup> Based on phone conversations with Jessica Coven, Policy Associate, at Climate Solutions in Seattle, Washington.

**d. Oregon**

On August 7, 2007, Governor Ted Kulongoski signed into law HB 3543. This bill establishes a policy to reduce GHG emissions to 10 percent below 1990 levels by 2020 and 75 percent below 1990 levels by 2050, although the targets are unenforceable by law.<sup>60</sup>

In 1997, the Oregon Legislature passed House Bill 3283 authorizing the Energy Facility Siting Council (Council) to establish CO<sub>2</sub> emissions standards for new units and units in operation in the state. The Council has set CO<sub>2</sub> standards for baseload natural gas-fired plants, non-baseload power plants (such as peaking plants), and non-generating energy facilities (such as compressors and underground natural gas storage facilities) that emit CO<sub>2</sub> (Division 24, Chapter 345 in Oregon Administrative Rules (OAR)). The standard for baseload and non-baseload plants is set at 0.675 pounds of CO<sub>2</sub> per kilowatt hour, equal to 17 percent below the most efficient CCGT plant in operation in the U.S. The standard for non-generating facilities is set at 0.504 pounds of CO<sub>2</sub> per horsepower hour. To comply with this standard, power plants can choose to develop their own offset projects (after obtaining Council approval) or they can use the “monetary path” and pay offset funds to a qualified organization (i.e. the Climate Trust). The Climate Trust is responsible for using the funds to purchase GHG offsets generated by emission reduction projects.<sup>61</sup> In addition, it is possible that exporters of electricity into California from Oregon will be required to track the emissions intensity of those exports under a future California trading program (if such requirements survive any potential legal challenges).

A new fossil fuel-fired generator in Oregon may be subject to the state’s proposed GHG emission targets (i.e. 10 percent below 1990 levels by 2020 and 75 percent below 1990 levels by 2050) if they become enforceable as well as emission performance standards. If the GHG targets become enforceable, it also remains to be determined whether a new fossil fuel-fired generator’s GHG target could be lower than the performance standard; this depends on how emissions limits are devolved down to the plant and sector level.

**e. Arizona**

On September 8, 2006, Governor Janet Napolitano issued Executive Order 2006-13, which establishes a non-binding goal that GHG emissions be at 2000 levels by 2020 and 50 percent below 2000 levels by 2040.<sup>62</sup> Although no legislation has been passed in the state, Arizona has established a Climate Advisory Group which released its final report in August 2006 analyzing policy recommendations to reduce GHG emissions, including cap and trade programs, offset opportunities, and performance standards. It is uncertain whether these policies will be adopted. In addition, it is possible that exporters of electricity into California from Arizona will be required to track the emissions intensity

---

<sup>60</sup> Oregon House Bill 3543, <http://www.leg.state.or.us/07reg/measpdf/hb3500.dir/hb3543.en.pdf>

<sup>61</sup> [http://egov.oregon.gov/ENERGY/SITING/standards.shtml#Need\\_Standard\\_for\\_Nongenerating\\_Facilities](http://egov.oregon.gov/ENERGY/SITING/standards.shtml#Need_Standard_for_Nongenerating_Facilities)

<sup>62</sup> State of Arizona, Executive Order 2006-13 [http://www.governor.state.az.us/dms/upload/EO\\_2006-13\\_090806.pdf](http://www.governor.state.az.us/dms/upload/EO_2006-13_090806.pdf)

of those exports under a future California trading program (if such requirements survive any potential legal challenges).

If the GHG targets set out in Executive Order 2006-13 are adopted into law, a new fossil fuel-fired generator in Arizona would be subject to the state's proposed GHG emission targets (i.e. 2020 and 50 percent below 2000 levels by 2050).

**f. New Mexico**

In June 2005, Governor Bill Richardson issued Executive Order 2005-033, which sets non-binding emission targets at 2000 levels by 2012, 10 percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050.<sup>63</sup> Although no legislation has been passed in the state, New Mexico has established a Climate Advisory Group which released its final report in December 2006 analyzing policy recommendations to reduce GHG emissions, including cap and trade programs, offset opportunities, and performance standards. It is uncertain whether these policies will be adopted.

If the GHG targets set out in Executive Order 2005-033 are adopted into law, a new fossil fuel-fired generator in New Mexico would be subject to the state's proposed GHG emission targets (i.e. 2000 levels by 2012, 10 percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050).

**g. Montana**

On November 19, 2007, Governor Brian Schweitzer announced that Montana will join WCI.<sup>64</sup> A report presented to the Governor at his announcement describes how a GHG target of 1990 levels by 2020 could be met. This may suggest that this target will be adopted.<sup>65</sup>

On May 14, 2007, Montana passed HB 25. It requires coal-fired generators constructed after January 1, 2007 to capture and sequester a minimum of 50 percent of their CO<sub>2</sub> emissions, and requires natural gas-fired plants built after the same date to implement cost-effective offsets.<sup>66</sup>

HB 25 is the only current legislation mandating GHG requirements for new fossil fuel-fired generators in Montana.

---

<sup>63</sup>State of New Mexico, Executive Order 2005-033

[http://www.governor.state.nm.us/orders/2005/EO\\_2005\\_033.pdf](http://www.governor.state.nm.us/orders/2005/EO_2005_033.pdf)

<sup>64</sup> <http://governor.mt.gov/brian/wci112007.pdf>

<sup>65</sup> Point Carbon, Carbon Market North America, "Montana to join WCI," November 21, 2007, [www.pointcarbon.com](http://www.pointcarbon.com) (subscription required).

<sup>66</sup> Cost-effective offsets are "any combination of certified actions that are taken to reduce carbon dioxide emissions or that increase the absorption of carbon dioxide, which collectively do not increase the cost of electricity produced annually on a per mega-watt basis by more than 2.5%."

<http://www.pewclimate.org/docUploads/montanaHB0025%20%282%29.pdf>

**h. Utah**

Utah remains the only state in the WCI partnership that has no current emissions target or any legislation regulating GHG emissions.<sup>67</sup> As a member of the WCI, Utah is required to announce its GHG emission reduction targets by May 2008.<sup>68</sup>

**3. WECC Jurisdictions Other than WCI Participants**

The following states are part of WECC but are not full participants in WCI (although some participate as observers).

**a. Colorado**

Colorado has taken a slightly different approach than most other states. Many localities such as cities and counties have adopted GHG programs. Specifically, Denver, Boulder, Aspen, Fort Collins, and other council cities participating in the International Council for Local Environmental Initiatives have agreed to meet the original U.S. Kyoto target of 7 percent below 1990 GHG emission levels by 2012. In addition, Boulder has agreed to implement a Climate Action Plan Tax.<sup>69</sup> The Plan, effective April 1, 2007 through March 31, 2013, levies a tax on electricity usage per kilowatt hour for residents and businesses of the city of Boulder.

On November 5, 2007, Governor Bill Ritter released a Colorado Climate Action Plan, which includes a provision for establishing an agricultural carbon sequestration and offset program and establishes non-binding goals to reduce GHG emissions to 20 percent below 2005 levels by 2020 and 80 percent below 2005 levels by 2050. The Plan also notes Governor Ritter's intention to formalize these goals by issuing a Global Warming Executive Order by the end of 2007.

If the GHG targets outlined in the Colorado Climate Action Plan are established by an executive order and adopted into law, a new fossil fuel-fired generator in Colorado would be subject to the state's proposed GHG emission targets (i.e. 20 percent below 2005 levels by 2020 and 80 percent below 2005 levels by 2050). Depending on where a new fossil fuel-fired generator is sited, the generator could potentially be subject to a city's binding GHG emission target (i.e. 7 percent below 1990 levels by 2012). While Colorado only participates in the WCI as an observer, the Climate Action Plan states that Colorado would officially join the WCI if "there is no demonstrable progress on the national front" on climate legislation, but does not specify any timeline.

**b. Nevada**

Besides Colorado and Montana, the majority of the Western states affiliated only with WECC have adopted minimal or no programs at all. For example, SB 422, passed in

---

<sup>67</sup> Utah has established a Blue Ribbon Climate Group that will study different policy recommendations to mitigate GHG emissions. The council is to report its findings to the governor in the fall of 2007.

<sup>68</sup> Based on a phone conversation with the office of Diane Nielson, Utah's WCI partner contact.

<sup>69</sup> City of Boulder, Climate Action Tax Plan, approved November 2006.

[http://www.bouldercolorado.gov/files/Environmental%20Affairs/climate%20and%20energy/cap\\_final\\_25sept06.pdf](http://www.bouldercolorado.gov/files/Environmental%20Affairs/climate%20and%20energy/cap_final_25sept06.pdf)

Nevada, requires electric generators with a capacity greater than 5 MW to report GHG emissions to the newly established state GHG registry.<sup>70</sup> However, it is possible that exporters of electricity into California will also be required to track the emissions intensity of those exports under a future California trading program (if such requirements survive any potential legal challenges). Nevada is also participating in the WCI as an observer.

**c. Idaho**

House Bill 689, which was passed in 2006, imposes a moratorium on the permitting, licensing or construction of specific coal-fired power plants from April 7, 2006 to April 1, 2008.<sup>71</sup> Only independent merchant power suppliers are affected by the moratorium, while utilities regulated by the Idaho Public Utilities Commission (IPUC) are subjected to the IPUC approval process. At present, a new fossil fuel fired generator faces no other GHG emission regulations in Idaho other than HB 689.

**d. Wyoming**

No legislation has been passed addressing GHG emissions targets or reductions in Wyoming. Wyoming is participating in the WCI as an observer.

**4. Recent Developments in Other U.S. States**

In addition to the states included in the WCI and in WECC jurisdictions, other states throughout the U.S. have undertaken a number of GHG related legislative, regulatory and policy initiatives. In New England, ten states are participating in a carbon dioxide trading program known as the Regional Greenhouse Gas Initiative (RGGI) in which an emission cap will be set at current levels in 2009, and then reduced 10% by 2019.<sup>72</sup> Another regional effort was announced on November 15, 2007, when Illinois, Iowa, Kansas, Michigan, Minnesota, Wisconsin and Manitoba established the Midwestern Greenhouse Gas Accord. Under the Accord, these jurisdictions will establish (within eight months) GHG emission targets consistent with the Intergovernmental Panel on Climate Change's (IPCC) recommendation of a 60 to 80 percent reduction by mid-century.<sup>73</sup> They will establish a regional multi-sector cap-and-trade system and a model rule within one year.

Florida, Hawaii, Illinois, and Minnesota have all established GHG emissions targets despite being unaffiliated with any regional trading program.<sup>74</sup> Dozens of coal-fired

---

<sup>70</sup> S. 422 excludes electricity generated by renewable sources.

[http://www.leg.state.nv.us/74th/Bills/SB/SB422\\_EN.pdf](http://www.leg.state.nv.us/74th/Bills/SB/SB422_EN.pdf)

<sup>71</sup> HB 689 <http://www3.state.id.us/oasis/2006/H0689.html>

<sup>72</sup> The Regional Greenhouse Gas Initiative was established in December 2005 by the governors of Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont. Massachusetts, Rhode Island and Maryland have also joined RGGI. The District of Columbia, Pennsylvania, the Eastern Canadian Provinces and New Brunswick are participating as observers.

<sup>73</sup> Office of Governor Jim Doyle, press release: "Ten Midwestern Leaders Sign Greenhouse Gas Reduction Accord," November 15, 2007,

[http://www.wisgov.state.wi.us/journal\\_media\\_detail.asp?locid=19&prid=3027](http://www.wisgov.state.wi.us/journal_media_detail.asp?locid=19&prid=3027)

<sup>74</sup> Pew Center on Global Climate Change webpage, "States with Greenhouse Gas Emission Targets," [http://pewclimate.org/what\\_s\\_being\\_done/in\\_the\\_states/emissionstargets\\_map.cfm](http://pewclimate.org/what_s_being_done/in_the_states/emissionstargets_map.cfm)

power plant proposals nationwide have been delayed or rejected as utilities face increasing pressure due to concerns over global warming.<sup>75</sup> This includes the Kansas Department of Health's decision to be the first government agency in the U.S. to cite CO<sub>2</sub> emissions as the reason for rejecting an air permit for a proposed coal-fired electricity plant.<sup>76</sup> These and a number of other developments throughout North America and elsewhere, highlight the growing public interest in mitigating GHG emissions.

## **5. Implications for Development of Pricing Scenarios**

The key policy drivers that will impact BC Hydro include:

- The policies and forthcoming legislated regulations of the Province of BC;
- The evolution of Canadian Federal GHG policy;
- The approach that the Province of BC takes in response to Federal policy;
- The evolving relationship between the GHG policies of BC and the states in the WCI and WECC; and
- The evolving relationship between the GHG policies of Canada and the United States at the Federal level.

It is difficult to predict with certainty the exact path that GHG policy will take during the period from now until 2050. However, based on the evolution of previous environmental policies<sup>77</sup> in both Canada and the U.S., the following observations can be made:

- The most likely policy evolution will see Federal GHG regulatory programs in both Canada and the U.S. in place by no later than 2020. A more detailed discussion on the likelihood of GHG legislation being implemented in Canada and the U.S. is provided in Section III. These programs likely will supersede and be harmonized with individual state or provincial programs and other regional initiatives that may be in existence now or are planned for the short term future. To reduce compliance costs and costs to the economy, these programs are likely to offer significant compliance flexibility, including unlimited (or relatively unrestricted) access to international offsets. As such, the most likely long-term end point of relevance to BC Hydro may be closest to the "Linked Markets" scenario described in Section III of the report.
- It is quite possible that for the next 5-10 years, the BC Government will choose to pursue a regulatory program either on its own or as part of a regional group such as the WCI and/or WECC. The degree of compliance flexibility that will be

---

<sup>75</sup> Brown, Matthew, "Plans for Coal Power Plants Scrapped," *Forbes Magazine* website, October 18, 2007, <http://www.forbes.com/feeds/ap/2007/10/18/ap4232867.html>

<sup>76</sup> Mufson, Steven, "Power Plan Rejected Over Carbon Dioxide For The First Time," *The Washington Post* website, October 19, 2007, <http://www.forbes.com/feeds/ap/2007/10/18/ap4232867.html>

<sup>77</sup> For example, in the U.S., a period of state level air quality initiatives preceded harmonization of air quality regulations at a national level through federal legislation (the Clean Air Act). Similarly in Canada, the federal government, working with the provinces under the Canadian Council of Ministers of Environment, developed a harmonized regulatory approach to criteria air contaminants to provide a uniform regulatory environment at a national level.

allowed by the BC Government as reflected in part by the breadth of access to compliance instruments outside the province will have a significant impact on potential costs associated with GHG emissions regulations in the short term. For this reason, Section IV contains sensitivity analyses for each of the scenarios to accommodate a short-term situation during which BC may be out of sync with the Federal Governments of both Canada and the U.S.

- In the short term to approximately 2015, the GHG emissions reduction targets to be faced by BC industry will likely be more stringent than those being faced in other jurisdictions (e.g. Alberta) and the compliance options are likely to be more limited. This would result in compliance costs in BC being higher than those in other parts of the country.
- There are no foreseeable policy scenarios in which GHG prices would be zero.

A more detailed discussion on the likelihood of different policy scenarios and sensitivity cases is provided in Section III.

### **III. Policy Scenarios**

#### **A. Considerations in Selecting Scenarios and Bounding the Analysis**

Scenarios are constructed for the purpose of developing lower and upper bounds for estimates of the cost of compliance instruments. The scenarios take into account a range of possible policy outcomes and the types of policy scenarios considered in GHG policy-related economic models. They are not a prediction of the future. The scenarios and pricing forecasts developed for this report, the commentary accompanying the pricing forecasts, and the price sensitivity analyses provide estimates and assessment of the boundaries of possible compliance costs that BC Hydro could face in the future.

As noted in Section II, given the political momentum and public awareness of GHG control efforts, and various GHG policy developments, including but not limited to Canada's proposed Regulatory Framework, the BC Government's plan to establish a hard GHG emissions cap in 2012, the WCI (and BC's participation in WCI), and several GHG legislative proposals being considered in the U.S. Congress, the authors are of the view that there are no foreseeable policy scenarios in which GHG prices would be zero.

#### **B. Considerations in Selecting a High-Price Scenario with Respect to Federal Emission Reduction Targets in Canada and the U.S.**

The "Linked Markets" and "Made in North America – Aggressive Targets" scenarios described below serve as the middle- and high-price scenarios, and both incorporate a target of 550 parts per million volume (ppmv) carbon dioxide concentration. The analysis incorporates this target for several reasons, which are discussed in greater detail in Appendix I on economic model assumptions. First, this target is considered by a wide range of economic analyses. Second, it roughly corresponds to emission reduction targets in a U.S. legislative proposal (S. 280) if certain assumptions are made about targets undertaken by the rest of the world. Given that S. 280 is the subject of two recent

economic analyses, price estimates from these analyses can be utilized. Equally important, the S. 280 targets have similar stringency to those in a number of U.S. legislative proposals (including S. 2191, which is expected to be voted on by the EPW), and those targets collectively represent the higher end (in terms of stringency) of targets that the U.S. Congress is currently considering. Third, a 550 ppmv target would require very stringent emission reductions globally and therefore may serve as a reasonable upper bound, particularly in light of the prohibitive costs of meeting a 450 ppmv target (e.g. one study estimates prices of \$91 in 2020, \$295 in 2050). We also assume that it is unlikely that the international community would agree to a 450 ppmv target given that the concentration level has already surpassed 380 ppmv in 2005, and global GHG emissions are projected to increase significantly due to increasing emissions from such developing countries as China and India.<sup>78</sup>

Based on these considerations, this analysis opts not to consider estimates of prices under targets more stringent than those associated with a 550 ppmv concentration target. Instead, as a basis for a high-price scenario, the analysis considers a scenario with limited compliance flexibility. The amount of compliance flexibility assumed by economic models is a key determinant of prices. For example, a recent study by the EPA<sup>79</sup> finds that under the emissions trading program proposed by Senators Lieberman and McCain, prices in 2030 would increase by approximately 300% if no domestic or international offsets were allowed, relative to a scenario in which no restrictions were imposed on the use of international and domestic offsets. In light of this dynamic, and given the availability of economic models that consider limits on compliance flexibility, the high-price scenario in this analysis is one in which the U.S. and Canada allow no use of international offsets. From a political perspective, such a scenario could occur if the U.S. and Canada seek to facilitate the turnover of old, emissions-intensive power plants as part of efforts to meet ambitious emission reduction targets. This turnover would be hastened and domestic abatement could be greatly increased if international offsets were not made available.

### **C. Considerations in Selecting a Low-Price Scenario for Canada, and Sensitivity Cases to Account for More Stringent Targets in BC**

From a policy perspective in Canada, on the one hand, much of Canadian industry is advocating for the continuation of a price cap that would provide compliance cost certainty under the longer term targets that Canada will impose. If this policy scenario were to materialize, this “made in Canada” approach would imply that the Federal Government would impose a cap on the cost of compliance instruments and maintain it over time. This scenario is taken into account in the “Price Cap” scenario discussed below.

---

<sup>78</sup> Nordhaus, 2007, *The Challenge of Global Warming: Economic Models and Environmental Policy*, July 2007. [http://nordhaus.econ.yale.edu/dice\\_mss\\_072407\\_all.pdf](http://nordhaus.econ.yale.edu/dice_mss_072407_all.pdf)

<sup>79</sup> EPA, *EPA Analysis of The Climate Stewardship and Innovation Act of 2007, S. 280 in 110<sup>th</sup> Congress*, July 16, 2007, <http://www.epa.gov/climatechange/downloads/s280fullbrief.pdf>

On the other hand, a number of provincial jurisdictions have indicated that Alberta's approach and the proposed Federal Regulatory Framework are not a credible response to climate change. BC is one of these provinces, and it appears likely the BC Government will implement a more stringent program. As noted in Section II, the 2007 Speech from the Throne established a goal of reducing BC's GHG emissions to 10% below 1990 levels by 2020. In addition, BC plans to introduce legislation in spring 2008 to allow for the creation of market mechanisms and to legally require hard caps on GHG emissions for 2012, 2016, and 2020.<sup>80</sup> A policy outcome in which BC firms face more stringent GHG emission reduction requirements than those imposed at the Federal level appears to have a medium to high probability of being in effect for the short term (at least through 2015), and could result in carbon prices in BC being substantially higher than in jurisdictions that allow contributions to a technology fund at a fixed rate to be used for compliance or that utilize other mechanisms to provide compliance cost certainty. As discussed below, a key factor that would influence carbon prices in BC is whether or not BC firms would be able to use offsets or allowances from other jurisdictions, such as from states and provinces participating in WCI. At present, BC plans to participate in WCI, and WCI members agreed to design a regional market-based multi-sector mechanism (such as a cap and trade program) by approximately August 2008. If BC allows for use of WCI allowances and eligible WCI offsets, this would significantly reduce costs relative to a scenario in which BC only allows for the use of offsets created within BC.

As time goes on, it is likely that pressure will mount for the development of a harmonized approach in the U.S. and Canada – i.e. one in which all states and provinces adopt the targets in the respective federal GHG program. It is difficult to predict the specific form and timing of a harmonized Canadian federal program and a harmonized U.S. federal program, but it is likely that a national approach in each country would be developed within a decade. Additional discussion on the likelihood of different policy scenarios is provided below in subsections D.4 and E.

In the scenarios that follow, sensitivity cases are included to correspond to a path forward in which BC either uses BC compliance instruments only, or participates in a regional group for a period of 10 years or more. These sensitivity cases vary according to the geographic scope of compliance instruments that BC-emitting entities would be able to use for compliance, ranging from BC only to the WRI/WECC region.

#### **D. Policy Scenarios**

Table 2 summarizes the key elements and assumptions of the three scenarios used for this study. Detailed descriptions of each scenario follow. After the detailed descriptions, a discussion on the relative likelihood of each of the scenarios is provided. The sensitivity cases, which consider scenarios in which BC takes on GHG emission reduction targets that differ from Canadian federal targets, are then addressed in subsection E.

---

<sup>80</sup> British Columbia Office of the Premier, News Release: "Premier Outlines New Steps to Tackle Climate Change," September 28, 2007, [http://www2.news.gov.bc.ca/news\\_releases\\_2005-2009/2007OTP0141-001209.htm](http://www2.news.gov.bc.ca/news_releases_2005-2009/2007OTP0141-001209.htm)

**Table 2 – Key Elements and Assumptions of Policy Scenarios**

| <b>“Price Cap” Scenario</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>“Linked Markets” Scenario</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>“Made in North America – Aggressive Targets” Scenario</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p style="text-align: center;"><b>CANADA FEDERAL PROGRAM</b></p> <p>From 2010</p> <ul style="list-style-type: none"> <li>• Intensity targets with price cap (technology fund contributions)</li> <li>• Domestic offsets allowed</li> </ul> <p style="text-align: center;"><b>U.S. FEDERAL PROGRAM</b></p> <p>From 2012</p> <ul style="list-style-type: none"> <li>• Bingaman bill with price cap</li> <li>• Domestic offsets allowed</li> </ul> <p style="text-align: center;"><b>LINKAGES</b></p> <p>Canada and U.S. do not link</p> <p>Canada and U.S. do not join an international regime</p> <p>Regional initiatives superseded by federal program</p> | <p style="text-align: center;"><b>CANADA FEDERAL PROGRAM</b></p> <p>2010-2015</p> <ul style="list-style-type: none"> <li>• Intensity targets with price cap (technology fund contributions)</li> <li>• Domestic/international offsets allowed</li> </ul> <p>After 2015</p> <ul style="list-style-type: none"> <li>• Target consistent with achieving a 550 ppmv concentration target (such as McCain-Lieberman bill - 60% below 1990 by 2050)</li> <li>• Limited or no constraints on domestic/international offsets</li> </ul> <p style="text-align: center;"><b>U.S. FEDERAL PROGRAM</b></p> <p>From 2012</p> <ul style="list-style-type: none"> <li>• Targets consistent with 550 ppmv concentration target (such as McCain-Lieberman bill - 60% below 1990 by 2050)</li> <li>• Limited or no constraints on domestic/international offsets</li> </ul> <p style="text-align: center;"><b>LINKAGES</b></p> <p>Canada and U.S. link after 2015</p> <p>Canada and U.S. join an international regime by 2020</p> <p>Regional initiatives superseded by federal program in U.S. by 2012 and in Canada by the end of 2015</p> | <p style="text-align: center;"><b>CANADA FEDERAL PROGRAM</b></p> <p>2010-2011</p> <ul style="list-style-type: none"> <li>• Intensity targets with price cap (technology fund contributions)</li> </ul> <p>From 2012</p> <ul style="list-style-type: none"> <li>• Target consistent with achieving a 550 ppmv concentration target (such as McCain-Lieberman – 60% below 1990 by 2050, or Lieberman-Warner– 65% below 1990 by 2050)</li> <li>• Domestic offsets allowed</li> <li>• No international offsets</li> </ul> <p style="text-align: center;"><b>U.S. FEDERAL PROGRAM</b></p> <p>From 2012</p> <ul style="list-style-type: none"> <li>• Ambitious targets (like McCain-Lieberman – 60% below 1990 by 2050, or Lieberman-Warner– 65% below 1990 by 2050)</li> <li>• Domestic offsets allowed</li> <li>• No international offsets</li> </ul> <p style="text-align: center;"><b>LINKAGES</b></p> <p>Canada and U.S. link in 2012</p> <p>Canada and U.S. do not join an international regime</p> <p>Regional initiatives superseded by federal program</p> |

## **1. Price Cap Scenario**

In this scenario, Canada and the U.S. are outside of an international agreement and implement less ambitious but what appear to be politically feasible policies – e.g. S. 1766 in the U.S., which is the least stringent of current U.S. legislative proposals that may receive serious consideration, and which also incorporates a price cap. Reductions would be mandated in the U.S. beginning in 2012, the year in which the current S. 1766 would be implemented. Canada implements its GHG intensity targets and allows for technology fund contributions for compliance starting in 2010.<sup>81</sup> In this scenario, BC does not adopt a more stringent policy and conforms to the Federal plan. Domestic offsets systems would be authorized for compliance with emissions targets in both the Canadian and U.S. systems. Regional initiatives and individual provincial and state initiatives (with the possible exception of California's) would be superseded by federal regulations in both Canada and the U.S. Under this scenario, linkages with other carbon markets would be difficult.

This scenario would be possible if Canadian governments are willing (for economic competitiveness reasons) to accept that LFEs may make significant use of the price cap, which could jeopardize their ability to meet emission reduction targets; and if the U.S. Congress cannot reach consensus on a proposal more stringent than S. 1766. (A discussion on the likelihood of the different scenarios is provided in subsection 4 below.) This situation could occur in the absence of any post-2012 international agreement that includes the world's largest emitters, including China, India and the U.S.

## **2. Linked Markets Scenario**

In this scenario, Canada and the U.S. implement more ambitious reduction targets than in the low scenario (e.g. S. 280 would set a target of 60% below 1990 GHG emissions levels by 2050), and all countries undertake actions consistent with achieving a 550 ppmv concentration target. In this scenario, it is assumed that the U.S. and Canada join an international regime by 2020. For the U.S., joining an international regime requires that the Parties agree to the treaty and the U.S. Senate ratifies it by two-thirds majority and passes implementing legislation. It is highly improbable that this would occur in the short term. We assume the U.S. passes a domestic GHG emission control program in the 2009-2010 timeframe and authorizes the use of domestic and international offsets. In this scenario, it is assumed that the U.S. trading program would begin in 2012, the year in which the current S. 280 and S. 2191 proposals would be implemented. The U.S. would then join an international regime by 2020 while maintaining its targets.

In this scenario, Canada would maintain its current policy approach, including an intensity target with a technology fund compliance option, through the end of 2015. At that point, Canada would abandon this approach given that the current regulatory

---

<sup>81</sup> Note that the “tech fund tax” starts at \$15 in 2010, goes up to \$20 in 2013, and increases with GDP starting in 2014, while S. 1766 starts at \$12 in 2012 and increases each year at 5% above inflation. Given that the S. 1766 price cap would grow significantly over time, we use the technology fund tax as the basis for a low price scenario.

framework extends to that date.<sup>82</sup> Canada then would adopt more stringent absolute emissions targets comparable to those adopted by the U.S., and link its trading program to the U.S. trading program. It is assumed that limited constraints (i.e. S. 280's 30% offset limit) or no constraints would be imposed on international trading or domestic offsets. It is also assumed that both the U.S. and Canada would allow CERs to be used for compliance starting in 2012, even before joining an international regime.

Regional initiatives and individual provincial and state initiatives would be superseded by the Federal program adopted in the U.S. by 2012 (with the possible exception of California's), and the new Federal program adopted in Canada by the end of 2015.

This scenario would be possible if the Federal Government and state and provincial politicians agreed on the need for ambitious Federal programs.

### **3. Made in North America – Aggressive Targets Scenario**

Canada and the U.S. adopt a trading program with ambitious targets (like S. 280 – 60% below 1990 by 2050, or S. 2191 – 65% below 1990 by 2050), but do not link to other programs or allow for international offsets. This scenario would be possible if negotiations on a successor agreement to the Kyoto treaty break down and/or a splinter group emerges (which could be formed based on North American Free Trade Agreement (NAFTA) countries or the Asia-Pacific Partnership for Clean Development and Climate). In this case, there could be differences among regional groups regarding eligibility of allowances and offsets from other regions, paving the way for restrictions on linking and the imposition of constraints on the use of international offsets for compliance in the U.S./Canada program. In Canada, it is assumed that a new Federal Government eliminates the technology fund based on uncertainties associated with its performance, but offers compliance flexibility through the use of domestic offsets and trading. The trading program would begin in 2012, the year in which S. 2191 would be implemented. It would be assumed that Canada would continue with a variation on its intensity and technology fund approach until 2012, at which point Canada would adopt targets comparable to those in the U.S. Regional initiatives and individual provincial and state initiatives (with the possible exception of California's) would be superseded by federal regulations in both Canada and the U.S.

This scenario could occur if the Canadian Federal Government decides that the climate change issue requires more ambitious action than the intensity-based approach, despite the challenge involved in making the necessary legislative changes prior to 2015. As noted above, it also could occur if the U.S. and Canada seek to facilitate the turnover of old, emissions-intensive power plants as part of efforts to meet ambitious GHG emission reduction targets.

---

<sup>82</sup> The first phase of Canada's proposed Federal Regulatory Framework extends to 2015. While it does specify price cap levels out to 2017, for the purposes of this scenario we assume that the framework and its price caps would be phased out in 2015.

#### 4. Likelihood of the Different Scenarios

As noted in subsection A above, scenarios are constructed for the purpose of developing lower and upper bounds for estimates of the cost of compliance instruments. The scenarios take into account a range of possible policy outcomes and the types of policy scenarios considered in GHG policy-related economic models. They are not a prediction of the future. The scenarios and pricing forecasts developed for this report, the commentary accompanying the pricing forecasts, and the price sensitivity analyses provide estimates and assessment of the boundaries of possible compliance costs that BC Hydro could face in the future. Nevertheless, we recognize that an important output of this analysis is a set of price estimates that BC Hydro could consider for planning purposes. In view of this, the following discussion provides our views on the likelihood of different scenarios in the short term and the long term.

In our view, the Linked Markets scenario appears to be the most likely scenario in the long term among those considered in this analysis, although there are numerous dynamics that could change this view. With respect to emission reduction targets, there is the potential that the U.S. will adopt targets consistent with a global 550 ppmv CO<sub>2</sub> concentration target, such as those incorporated in S. 280 or S. 2191 proposals. S. 2191 is expected to be voted on in the Senate Environment Committee. In addition, a discussion paper issued by the House Energy and Commerce Committee indicates that a U.S. emissions trading program would need to reduce emissions to between 60 and 80 percent below current levels by 2050, which is comparable to reduction requirements in S. 280 and S. 2191, and therefore is also consistent with a global 550 ppmv CO<sub>2</sub> concentration target.

In view of this potentially growing consensus regarding future GHG emissions targets, it appears less likely that proposals that include less ambitious targets, such as those included in S. 1766 (which is considered in the Price Cap scenario), will be adopted. S. 1766 also includes a price cap, which appeared to be more popular when Senator Bingaman introduced an earlier version of his proposal two years ago. There is increasing interest in evaluating other mechanisms designed to control costs,<sup>83</sup> but price caps appear to have less support, perhaps because they could jeopardize the achievement of any emissions cap. In summary, given current views in Congress on price caps and targets, the Price Cap scenario may be less likely to occur than the Linked Markets scenario, as discussed below. However, it is still possible that concerns over costs could result in serious consideration of a price cap.

We also note that a price cap that increases to \$18 (in \$CDN 2008) and is maintained at that level, as we have assumed in the Price Cap scenario (see Section III.D), may be somewhat unlikely. It is nevertheless possible, as the Canadian Federal Government

---

<sup>83</sup> For example, S. 2191 incorporates provisions allowing a Carbon Market Efficiency Board to increase the amount of borrowing of allowance from future periods that is allowed as a cost-relief measure if prices exceed an agreed-upon level. While borrowing allows for emissions to increase beyond current cap levels, the emissions must be “paid back” by higher levels of emission reductions in the period from which allowances were borrowed, thereby preserving the integrity of the emissions cap over time.

could decide that the most politically feasible approach is to allow for price cap payments at an affordable level until key technologies are developed that can achieve significant emission reductions. We adopted the price cap pricing assumptions because the Canadian price cap under the Regulatory Framework reaches \$18 starting in 2013 and stays at that level through 2017, after which the cap is no longer specified. In addition, using a price cap that does not go above \$18 in the period through 2050 allows for a clear delineation between the low-price Price Cap scenario and the mid-range Linked Markets scenario, which has prices that are not far from \$18 in the period until 2030 (see Section III.D).

As discussed above, the targets in the Linked Markets scenario and the Made in North America – Aggressive Targets scenario appear to be more likely in the long term than those in the Price Cap scenario. Other provisions in the Linked Markets scenario may make that scenario more likely than the other scenarios to occur in the long term in view of cost concerns. Unlimited (or relatively unconstrained) access to both domestic and international offsets has a significant impact on costs. The issue of costs will be at the forefront of the debate in the U.S. on a GHG control program. Given concerns over costs, policy makers may decide that providing regulated entities with compliance flexibility through access to offsets is an acceptable and necessary way to reduce program costs. However, opposition to unlimited access to offsets, particularly international offsets, may lead the Congress to impose limits on the use of international offsets. While it is difficult to predict the final outcome, we would expect that a U.S. emissions trading program would allow for significant, but perhaps not unlimited, use of domestic and international offsets for compliance. This outcome would be closer to the scenario envisioned in the Linked Markets scenario than that in the Made in North America – Aggressive Targets scenario.

The Made in North America – Aggressive Targets scenario, in which use of international offsets is prohibited, could occur if the U.S. and Canadian governments decide that it is important for to achieve emission reduction targets through domestic actions, and/or if there is significant skepticism about the environmental value of international offsets. The latter concern was raised during hearings in the Senate Environment Committee. This approach could also gain the support of Senators who would like to facilitate the turnover of older emissions-intensive power plants. Prohibiting use of international offsets would be one way to increase the likelihood that such plants would either be retired or retrofitted with carbon capture and storage technology. However, given the importance of coal in the U.S. and Canadian power sectors, and given the impact on compliance costs of restrictions on offset use, the approach to international offsets in the Made in North America – Aggressive Targets scenario may be less likely than the unlimited offsets approach incorporated in the Linked Markets scenario. On the other hand, as noted above, opposition to unrestricted use of international offsets in the U.S. could mean that a final program could include some restrictions on offset use. On balance, we expect that Congress is more likely to adopt offsets provisions that are closer to those in the Linked Markets scenario than those in the Made in North America – Aggressive Targets scenario, in an attempt to reduce costs of an emissions trading program with ambitious targets to as low a level as possible. Therefore, and in summary, we view the Linked

Markets scenario as the most likely of the scenarios considered by this analysis in the long term.

In the short term, there likely will be differences in emission reduction requirements between BC and the Canadian Federal Government, and possibly between jurisdictions participating in WCI and the U.S. Federal Government. In Canada, differences between requirements in BC and at the federal level are most likely to occur in the context of the current Federal approach to GHG policy. More details are provided in the discussion of the sensitivity cases in subsection E below.

### **E. Price Sensitivity Analyses**

As discussed above, price sensitivity cases were developed to capture a scenario in which BC decides to meet its provincial emission reduction targets and to set geographic restrictions on instruments (e.g. offsets) that could be used for compliance with the BC program's emissions targets. A description of the sensitivity cases is provided below.

In the first sensitivity case, BC decides that it will undertake to meet its own emission reduction targets starting in 2012, consistent with its announcement that legislation will be introduced in spring 2008 to allow for the creation of market mechanisms and to legally require hard caps on GHG emissions for 2012, 2016, and 2020.<sup>84</sup> In this "BC compliance instruments only" case, BC decides it will meet its own target without using offsets or compliance instruments from outside the province. One sign that the BC Government may consider such an approach is the provision in the 2007 BC Energy Plan that BC would seek to meet its requirement for zero net GHG emissions from existing thermal generation power plants by 2016 "through carbon offsets from other activities in British Columbia."<sup>85</sup> The Canadian Federal Government would need to make a determination in 2010 of the equivalency of the environmental results of the BC GHG program vis-à-vis the federal GHG program under the Regulatory Framework. We assume that the Federal Government would determine that the BC GHG program meets the equivalency test (i.e. that the emission reduction requirements of the BC program are at least as stringent as those in the Federal Government's GHG program) over the duration of the federal program (2010-15), despite the recent announcement that the first hard emissions cap in BC would be set for 2012 and not for 2010.

In the second sensitivity case, BC decides that it will undertake to meet its own emission reduction target as a participant in a WCI regional trading program, starting in 2012. In this case, BC would meet its target using eligible offsets as authorized under the WCI program, which may be limited to those created within the WCI/WECC region. In addition, BC would also allow for use of WCI/WECC allowances for compliance, given

---

<sup>84</sup> British Columbia Office of the Premier, News Release: "Premier Outlines New Steps to Tackle Climate Change," September 28, 2007, [http://www2.news.gov.bc.ca/news\\_releases\\_2005-2009/2007OTP0141-001209.htm](http://www2.news.gov.bc.ca/news_releases_2005-2009/2007OTP0141-001209.htm)

<sup>85</sup> Government of BC, *The BC Energy Plan: A Vision for Clean Energy Leadership*, February 27, 2007, p. 13.

that WCI/WECC emission allowances would also be eligible for compliance in the WCI/WECC regional trading scheme.

The “BC compliance instruments only” case is unlikely in view of the very high costs associated with meeting the BC target while limiting eligible offsets to those generated in BC, as estimated in Section III.D (\$78/tonne CO<sub>2</sub>e or higher in 2012, and \$140/tonne CO<sub>2</sub>e or higher in 2015). If BC implements its current plan to set and meet its GHG emissions targets for 2012, 2016 and 2020, it is more likely that it will allow offsets from outside of BC to be used for compliance. Given BC’s participation in WCI, a scenario in which BC allowed firms to use WCI allowances and offsets from other WCI and WECC jurisdictions for compliance appears to be a more likely scenario than a “BC compliance instruments only” scenario. Allowing for the use of WCI/WECC allowances and offsets would reduce compliance costs, and also would be consistent with BC’s participation in a WCI regional trading program, which could start as early as 2012 (given that the California GHG emissions trading program would be scheduled to begin in 2012).

We note, however, that there are important uncertainties surrounding the WCI/WECC sensitivity case. First, it is our view that a scenario in which BC sets and meets its GHG targets in the short term is most likely to occur in the context of a policy scenario in which the Canadian Federal program includes modest emissions targets and a price cap. Under this scenario, BC could determine that a more aggressive GHG policy is required. It is more likely that BC would set and meet its GHG target if the proposed Regulatory Framework for Air Emissions remained in place through 2015, than if this or a successor Federal Government established a more ambitious approach to climate change that included more stringent targets and eliminated the price cap. As noted above, the Linked Markets scenario assumes that the Canadian Federal Government adopts a more stringent target and eliminates the price cap after 2015, while the Made in North America – Stringent Targets scenario assumes that the more stringent target is adopted (and the price cap is eliminated) starting in 2012. At present, it appears that the Regulatory Framework is more likely than not to stay in place until 2015, given the position of the current government and the political and legislative difficulty of adopting a more stringent GHG plan. However, we note the possibility that this government or a successor could change its views or that public opinion could impose pressure to adopt more stringent GHG targets.

Second, it is uncertain whether U.S. states participating in WCI would opt to – or would be allowed to -- continue to pursue their individual state GHG targets if the U.S. Congress passes legislation to create a federal emissions trading program. The final form and timing of a U.S. Federal GHG program is still very unclear, although there appears to be growing momentum for developing an economy-wide emissions trading program, and several proposals (including S. 280 and S. 2191) would begin to limit emissions in 2012. If WCI participants in the U.S. are primarily motivated by a desire to influence the development of federal GHG legislation, they could choose to abandon their targets and adopt U.S. Federal targets if the latter are deemed to be sufficiently stringent. In addition, Federal legislation could explicitly preempt U.S. states from adopting different GHG emission reduction requirements than those established in Federal legislation

(although California could be exempted from this prohibition in view of prior legislation which allowed California to adopt alternatives to a federal approach). On the other hand, there is a precedent in the U.S. for California to adopt and maintain more stringent air quality regulations than those at the Federal level, and for other states to follow their lead. Senators and Representatives from states participating in WCI could strongly oppose legislative language preempting states from setting their own, more stringent GHG targets. It is still very early to predict whether state GHG targets will be pre-empted by Federal legislation. In our view, different requirements at the state and Federal level will be difficult to maintain over time, given the added cost burden and compliance complexity that this would impose on the private sector and the likely opposition of companies that own and operate assets in states with more stringent targets and GHG policies or that have differing targets and GHG policies. However, it is possible that in the initial years of a Federal trading program, opposition to Federal pre-emption could enable states with targets more stringent than the Federal targets to maintain their targets.

In that scenario, a WCI/WECC regional trading program could operate alongside a U.S. Federal trading program. However, there is still the question of whether BC would be allowed to use WCI allowances and offsets from U.S. states participating in WCI. The Canadian Federal Government will need to evaluate whether the environmental results of BC's GHG program are at least equivalent to those of the Federal Government, which come into effect in 2010. As part of that evaluation, the Federal Government may consider whether the ability of BC entities to use WCI allowances and offsets for compliance affects BC's case for equivalency. In our view, it seems unlikely that the Canadian Federal Government would rule against BC's case for equivalency on this basis, given that each of the U.S. states participating in WCI have a hard emissions cap, and that any offsets provisions in the WCI regional program would likely reflect participating jurisdictions' shared objective of ensuring the environmental integrity of their program. However, it is possible that the Canadian Federal Government could rule that the use of WCI allowances and offsets for compliance in BC undermines BC's equivalency case, and that BC should instead only allow the use of offsets created in Canada.

In light of these uncertainties and caveats, it appears that the WCI/WECC sensitivity case represents the most likely scenario (out of the scenarios considered in this analysis) for estimating GHG prices in BC in the short-term (2012-2015). More specifically, it appears that the most likely prices in this period would be those in the WCI/WECC sensitivity case applied to the Linked Markets scenario. As noted previously, the Linked Markets scenario assumes that the current Canadian Federal GHG program, including the price cap, continues through 2015, and that a U.S. federal program with targets consistent with a 550 ppmv global concentration target (e.g. S. 280) begins in 2012.

By 2020, it appears that BC would harmonize its approach with the Canadian Federal Government, and WCI/WECC states would adopt the U.S. Federal Government's GHG targets. As discussed in subsection D.4 above, it appears that the Linked Markets scenario is the most likely scenario (out of those considered in this analysis) in the longer term (i.e. starting in 2020). Therefore, we assume that prices in BC are most likely to be

those in the Linked Markets scenario starting in 2020. The summary of price estimates in the Conclusion section of the analysis reflects these assumptions.

Notwithstanding our statements regarding likelihood and timing of different scenarios above, at the request of BC Hydro, we apply the sensitivity cases to all scenarios in Section IV. In addition, we have provided price estimates in the sensitivity cases for 2015 and 2020 in the Linked Markets and Made in North America – Aggressive Targets scenarios, despite the fact that the Linked Markets scenario assumes that local and regional programs are superseded after 2015, and the Made in North America – Aggressive Targets scenario assumes that these programs are superseded starting in 2012. As might be expected, the sensitivity cases result in higher prices for BC than in the scenarios considered without sensitivity cases. Thus, results for the sensitivity cases can be considered to represent alternative upper-bound estimates for each of the scenarios.

A description of how the sensitivity cases are applied to each scenario is provided in the pricing section below.

#### **IV. Pricing Forecasts**

This section provides GHG price estimates for three planning scenarios and the two sensitivity cases described in Section III. The price estimates are largely based on estimates provided by economic models, and are also informed by our understanding of and experience in GHG policy and carbon markets.

To provide context for the price estimates, subsection A provides a brief overview of key assumptions, uncertainties and limitations of economic models. It also briefly summarizes the models and price estimates that were used as a basis for generating the price estimates, and the cases in which we drew upon market and policy experience in assessing which model estimates to consider in our price estimates. A more detailed discussion on economic model assumptions, uncertainties and limitations is provided in Appendix I. To provide further context, subsection B highlights some of the uncertainties surrounding price forecasting in a nascent GHG market that has seen and will continue to see significant price volatility and unpredictability.

##### **A. Economic Model Assumptions, Uncertainties and Limitations**

###### **1. Differences Between Global and U.S. Trading Program Models**

The analysis in this report considers both “global economic models” (described below) and models of a U.S. trading program that also consider marginal costs in other countries (“U.S. trading program models”). Global economic models are known in modeling parlance as “integrated assessment models.” They overlay economic models on top of global climate models, and estimate the economically efficient emission reduction trajectory consistent with meeting a given target. The targets considered in global models, such as those summarized in the recent Fourth Assessment Report of the IPCC, are typically atmospheric concentration stabilization targets for CO<sub>2</sub> (e.g. 550 ppmv), or

equivalent radiative forcing targets (e.g. 4 to 5 W/m<sup>2</sup> (watts per square meter)) if more than one GHG is included. Global economic models typically optimize many of the key factors that will affect GHG prices, including the timing and location of emission reductions (which is known as “when” and “where” flexibility), and gases reduced (known as “what” flexibility). In contrast, the U.S. trading program models (such as models of prices under S. 280) considered in this report assume specific hard emissions targets and timetables. They assume that these targets must be met in specified years, and allow for the banking forward of surplus reductions, but not borrowing.

The assumption in global models that reductions take place across time and jurisdictions in a least-cost manner, without any pre-established targets or timetables apart from the long-term atmospheric concentration target, is a key reason why global models generally result in lower GHG price estimates than U.S. trading program models. For example, global models tend to assume that a large portion of emission reductions occur in the second half of the century. This is consistent with global models’ solving for the emissions trajectory that achieves stabilization by the end of the century at the least possible cost, as many of the technologies required to achieve significant emission reductions (e.g. carbon capture and storage) may not be commercially available and competitive until 2030 or later. In contrast, the hard targets and timetables incorporated in U.S. trading program models, both for the U.S. and other countries, may not delay significant emission reductions to the second half of the century. This leads to higher price estimates in such models.

## **2. Differences Between Assumptions in Economic Models and Real-World GHG Policy Implementation and Markets**

There are many important differences between model assumptions (particularly those in global models) and the way in which emission reduction targets and policies are likely to be implemented in practice. These differences generally lead price estimates in economic models to be low (i.e. biased in a downward direction).

As noted in the IPCC report, the vast majority of global models assume transparent markets, no transaction costs, and adoption of cost-effective mitigation (e.g. a carbon tax, or cap and trade programs covering all GHG emissions).<sup>86</sup> In practice, GHG markets are not fully transparent, and while market liquidity has increased, they are far from being fully efficient – particularly markets for project-based reductions (i.e. CERs and ERUs<sup>87</sup>). In addition, to date there is not a single example of a country that has achieved completely cost-effective mitigation through a carbon tax or universal cap and trade. Countries participating in the Kyoto Protocol have implemented a range of GHG policies

---

<sup>86</sup> IPCC 2007, op. cit.

<sup>87</sup> CERs are Certified Emission Reductions created from CDM projects in developing countries. ERUs are Emission Reduction Units created from Joint Implementation (JI) projects in countries with economies in transition (e.g. Russia, Ukraine and Eastern European countries). CERs and ERUs can be used by national governments for compliance with national Kyoto Protocol emissions reduction requirements, by EU firms for compliance with targets under the EU Emissions Trading Scheme (EU ETS), and by Japanese firms for compliance with voluntary emissions targets under the Keidanren Voluntary Action Plan.

and measures (i.e. regulation) for different sectors which are typically significantly less cost-effective than an economy-wide cap and trade program.

Economic models also tend to estimate unrealistically low prices for international offsets because: 1) they are based on bottom-up estimates of marginal costs, which can be overly optimistic (see discussion on marginal costs below); and, 2) they do not capture market dynamics that currently influence prices for eligible international offsets – i.e. CERs created from CCDM projects in developing countries. While economic models base their estimates of international offset (i.e. CER) prices on marginal costs, in practice CER prices are strongly influenced by prices for EU Allowances (EUAs)<sup>88</sup> because both EUAs and CERs (for the most part) can be used for compliance under the EU Emissions Trading Scheme. The ability of most European power producers to recover the cost of allowances in electricity prices, and current prices for coal and gas, increase demand for and prices of EUAs, which in turn results in CER prices that are far higher than marginal costs of abatement for the projects that create CERs.<sup>89</sup> Since economic models, whether they be U.S. trading program models or global models, do not take such dynamics into account, it is likely that they underestimate the price of international offsets, and other prices (e.g. allowance prices in the U.S. GHG market) that are affected by the price of international credits.

### **3. Use of Marginal Cost Data, and Related Caveats**

Marginal cost data (i.e. \$/tonne CO<sub>2</sub>e estimates of abating emissions using a particular technology or from a particular activity) underlie estimates of domestic and international offsets in economic models, and also provide the basis for our estimates of offset and compliance instrument prices in the sensitivity cases, as discussed later in this section. Marginal cost estimates are typically based on the “technical costs” of emissions abatement opportunities. Such estimates may be significantly lower than actual market prices. First, they may not account for: 1) barriers that can prevent the implementation of emission abatement activities; or 2) the time required for diffusion of information or technology.<sup>90</sup> They also may only consider the cost of achieving the reduction, and not of achieving reductions that are recognized under a regulatory program and convertible into offsets valid for compliance. Additionally, it is unlikely that all technically achievable reductions will be convertible into offsets in a regulatory regime due to difficulties in measuring and verifying reductions.

Models also do not capture the dynamic that CERs are priced based on buyers’ willingness to pay, which has been higher than the marginal costs of abatement from projects. Buyers that have a compliance shortfall are often willing to pay a premium to

---

<sup>88</sup> EU Allowances are emissions permits issued to entities covered under the EU Emissions Trading Scheme. They can be freely traded, used for compliance, or banked into the post-2012 trading period.

<sup>89</sup>At the time of this writing, EU Allowances (EUAs) in 2008-12 (i.e. Phase 2 of the EU Emissions Trading Scheme (EU ETS) are trading for approximately €20 per tonne CO<sub>2</sub>, or approximately CDN \$29.

Estimates of Phase 2 EUA prices by developed by the research departments of financial institutions and consulting firms range from approximately €15 to €35, or approximately CDN \$22 - \$50.

<sup>90</sup> U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007*, July 2007, [http://www.eia.doe.gov/oiaf/service\\_rpts.htm](http://www.eia.doe.gov/oiaf/service_rpts.htm).

ensure that they beat out competing bids and secure CERs. The scarcity and uncertainty of CER supply has factored into the psychology of buyers, and has had the impact of raising prices.

**B. Nascent Stage of GHG Models and Unpredictable Nature of GHG Prices**

Although GHG markets have grown significantly since 2005, the first year of the EU Emissions Trading Scheme, they are still in a nascent stage. Furthermore, prices are subject to a wide range of factors that are difficult to predict, as suggested by the wide range of EUA price estimates for a relatively near-term period (2008-12). For example, it is difficult to predict with confidence the likelihood that Russia will seek to flood the GHG market with its surplus (or “hot air”) Assigned Amount Units (AAUs), whether developed countries participating in the Kyoto Protocol would buy those instruments, and the impact on EUA and CER prices of such developments. Given these and many more uncertainties surrounding price forecasting in the short term, one must recognize that there are significant challenges to estimating prices beyond 2012. A wide range of potential policies will be implemented in different jurisdictions in timeframes that are difficult to predict. These policies will determine future prices, along with market dynamics that are also difficult to predict, particularly in such a nascent market. As a result, many caveats must be assigned to GHG price forecasts.

**C. GHG Price Estimates and Methodology**

The prices contained in Table 3 correspond to the three planning scenarios referenced in Section III. (Prices for the sensitivity cases are provided in subsection D.4 below.) A discussion on the assumptions and methodologies for the price estimates in each of the scenarios follows, including a table summarizing the economic models and other sources used in developing the price estimates.

Table 3 – Price Estimates for Three Planning Scenarios

| Price Estimates for Planning Scenarios <sup>91</sup><br>(CDN \$2008) |             |      |               |                             |         |         |           |           |
|----------------------------------------------------------------------|-------------|------|---------------|-----------------------------|---------|---------|-----------|-----------|
| Year                                                                 |             | 2010 | 2012          | 2015                        | 2020    | 2030    | 2040      | 2050      |
| <b>Price Cap Scenario</b>                                            |             | \$14 | \$14          | \$18                        | \$18    | \$18    | \$18      | \$18      |
| <b>Linked Markets Scenario</b>                                       | Price Range | n.a. | Canada: \$14  | Canada: \$18                | \$15-25 | \$24-54 | \$39-59   | \$63-97   |
|                                                                      |             |      | U.S.: \$12-18 | U.S.: \$11-17 <sup>92</sup> |         |         |           |           |
|                                                                      | Mid Point   |      | Canada: \$14  | Canada: \$18                | \$20    | \$39    | \$49      | \$80      |
|                                                                      |             |      | U.S.: \$15    | U.S.: \$14                  |         |         |           |           |
| <b>Made in North America Aggressive Targets Scenario</b>             | Price Range | n.a. | \$16-24       | \$24-47                     | \$35-57 | \$65-84 | \$112-124 | \$166-187 |
|                                                                      | Mid Point   |      | \$20          | \$36                        | \$46    | \$75    | \$118     | \$177     |

1. Price Cap Scenario

- In this scenario, Canada and U.S. remain outside of an international agreement and implement less ambitious but what appear to be politically feasible policies (regional and state/provincial initiatives except California’s are superseded by federal regulations);
- Prices presented in Table 3 are prices in Canada based on the price cap under the current proposed Federal Regulatory Framework. No economic models were used to estimate prices for this scenario.
- The program proposed by the Government of Canada specifies price cap values through 2017.<sup>93</sup> For purposes of this Price Cap scenario, we assume the price cap continues through 2050 (it increases based on the rate of nominal GDP growth

<sup>91</sup> In 2012, only one pricing estimate was available in each of the Linked Markets and the Made in North America Climate Champions scenarios. In each case when only a single numerical result from a model is available, the range is calculated based on +/-20% of the model pricing estimate.

<sup>92</sup> The price range in 2015 (\$11-17) is lower than the price range in 2012 (\$12-18). This result is counter-intuitive, and can be explained as follows. There is only one price estimate available for 2012 (\$15). To provide a range, we adjusted that estimate by +/-20% resulting in \$12-18 in 2012. In contrast, there were several model estimates available in 2015, ranging from \$11 to \$17, which we did not adjust by a factor of +/-20%. (Note that the study providing the \$11 estimate in 2015 did not provide an estimate for 2012.)

<sup>93</sup> The price cap in the Regulatory Framework for Canada is derived from the allowable contributions by industrial emitters to a Technology Development Fund. There are two components to the fund – a technology deployment component that ramps down to near zero in 2017 and a technology research fund for which there is no specified sunset. In the Price Cap scenario, we assume that there is sufficient pressure brought to bear on the federal government to agree on an indefinite continuation of both components of the Fund through to 2050 or alternatively the creation of another price cap vehicle.

each year, but after nominal prices are discounted back to January 1, 2008 dollars, the price cap stays flat after 2014).

- Only Canada's price cap is provided because it is assumed in this scenario that U.S. and Canada do not link, and that BC Hydro would be affected only by Canadian policy. Prices in the U.S. could be similar until 2022, as the U.S. price cap under S. 1766 is lower than or equal to the Canadian price cap until that time. After 2022, the U.S. price cap increases while the Canadian price cap remains flat. More specific price estimates for the U.S. are not available, as the only estimate of U.S. prices under S. 1766 is based on assumptions regarding technology development and other factors that are likely to be overly optimistic.<sup>94</sup>

## **2. Linked Markets Scenario**

- In this scenario, Canada and the U.S. implement ambitious targets (e.g. S. 280) and all countries' targets are consistent with achieving a 550 ppmv concentration target in an economically efficient fashion.
- Canada and U.S. join an international regime by 2020, but allow for the use of CERs for compliance starting in 2012, and also link their trading programs after 2015.
- In this scenario, Canada allows for technology fund payments (i.e. price cap) through the end of 2015, to meet its ambitious targets and to allow for linking with the U.S.
- Prices in Canada reach the price cap in the first year that Canada implements ambitious targets (2012). Prices for Canadian firms and U.S. firms are presented separately in 2012 and 2015. After 2015 prices in the table apply to both the U.S. and Canada.
- Limited constraints (i.e. S. 280's 30% offset limit) or no constraints are imposed on use of domestic and international offsets for compliance.
- The ranges were derived from U.S. trading program models estimating prices under S. 280, including the central scenario featuring the 30% limit on use of domestic and offsets, and a scenario in which there is no limit on the use of international and domestic offsets. These models and their price estimates are summarized in Table 4 below. Additional details on these models are provided in Appendix II.

---

<sup>94</sup> National Commission on Energy Policy (NCEP), *Economic Analysis of Updated Commission Recommendations*, June 2007. The report provides estimates for 2020 and 2030 based on a policy case which incorporates EIA high technology assumptions and assumes that other policies and measures in the bill will lower compliance costs. Other analyses of cap and trade legislation, such as EIA's and EPA's, do not incorporate high technology assumptions in their core case analysis, and do not make assumptions regarding the impact of policies and measures on prices under a cap and trade program.

**Table 4 – Economic Models Used to Estimate GHG Prices in Linked Markets Scenario**

| Report                                                                                          | Model                                                                                                                                                                                                                                                                 | Policy Assumptions                                                                                                                                                                 | Model Price Estimates                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| U.S. Energy Information Agency (EIA) 2007 analysis of McCain-Lieberman bill <sup>95</sup>       | EIA's National Energy Modeling System (U.S. trading program model which incorporates targets for rest of world)                                                                                                                                                       | Our GHG price ranges include EIA's price estimates for two offset scenarios: 1) central scenario that reflects the 30% offset limit in the bill; and 2) unlimited offset scenario. | Central scenario:<br>2012: \$15<br>2015: \$17<br>2020: \$25<br>2030: \$54<br>Post-2030: n.a.<br>Unlimited offsets:<br>2012: \$15<br>2015: \$17<br>2020: \$22<br>2030: \$29<br>Post-2030: n.a.                                                                                                  |
| U.S. Environmental Protection Agency (EPA) 2007 analysis of McCain-Lieberman bill <sup>96</sup> | The Resource Triangle Institute's ADAGE model (U.S. trading program model which incorporates targets for rest of world), and the IGEM model (U.S. trading program model which incorporates targets for rest of world) (each model generates separate price estimates) | Our GHG price ranges include EPA's price estimates for two offset scenarios: 1) central scenario that reflects the 30% offset limit in the bill; and 2) unlimited offset scenario. | IGEM central scenario:<br>2015: \$15<br>2020: \$18<br>2030: \$31<br>2040: \$49<br>2050: \$80<br>ADAGE central scenario:<br>2015: \$17<br>2020: \$23<br>2030: \$36<br>2040: \$59<br>2050: \$97<br>IGEM unlimited offsets:<br>2015: \$11<br>2020: \$15<br>2030: \$24<br>2040: \$39<br>2050: \$63 |

- In view of current market prices, price forecasts for the EU ETS, and the expectation of more stringent emission reduction requirements in the future, the ranges do not include price estimates from global models that were reported in the IPCC's Fourth Assessment Report. In general, the IPCC models estimate very low prices because they are global models which, by design, estimate costs under the economically optimal approach for achieving a long-term atmospheric concentration target. They assume maximum flexibility regarding when, where and what GHG emissions are reduced in meeting a concentration target of 550

<sup>95</sup> U.S. Energy Information Administration, *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007*, July 2007, [http://www.eia.doe.gov/oiaf/service\\_rpts.htm](http://www.eia.doe.gov/oiaf/service_rpts.htm)

<sup>96</sup> U.S. Environmental Protection Agency, *Analysis of Senate Bill S.280 in the 110th Congress, The Climate Stewardship and Innovation Act of 2007*, July 2007, <http://www.epa.gov/climatechange/economicanalyses.html#s280>

ppmv by 2100. Given this flexibility, these models likely delay significant reductions until after 2050 in order to benefit from advanced technologies that are assumed not to be available or cost-competitive before then. (See more detailed discussion in subsection A above and in Appendix I.) In practice, however, emissions trading programs (such as those being considered in the U.S.) will include hard GHG caps for specific years. Therefore, apart from a possible limited use of borrowing, in general entities will not be allowed to postpone emission reduction requirements. In addition, the range of eligible international offsets is likely more limited than that envisioned in global models, which assume maximum where and what flexibility.

Based on data received from economists contributing to the IPCC report, the average of model prices for scenarios comparable to a 550 ppmv target was CDN \$4.96 for 2030 and CDN \$11.32 in 2050. These prices are far lower than other prices we obtained from economic models (i.e. \$24-\$54 in 2030 and \$63-\$97 in 2050), and appear to be implausible based on current market prices (e.g. approximately €20 (CDN \$29) per tonne CO<sub>2</sub> for EU Allowances), EU ETS price forecasts (see below), and the expectation of more ambitious emission reduction targets in the future. Consequently price estimates from IPCC models are not included in our GHG price ranges.

- Even after excluding these model results, there are several reasons to believe that market prices in this scenario would be higher than those reflected in our price range. As noted above, at the time of this writing, EUAs for 2008-12 (i.e. Phase 2 of the EU Emissions Trading Scheme (EU ETS)) are trading for approximately €20 per tonne CO<sub>2</sub>, or approximately CDN \$29.<sup>97</sup> Estimates of Phase 2 EUA prices developed by the research departments of financial institutions and consulting firms range from approximately €15 to €35, or approximately CDN \$22 – CDN \$50.<sup>98 99</sup> These price estimates reflect a consideration of factors and circumstances affecting EUA prices that are not considered in global economic models, which focus on global prices and assume maximum flexibility and markets that operate perfectly. In the 2013-20 period, EUA prices could be higher than in the Phase 2 period, based on the strong likelihood that emission reduction targets for EU ETS will be more stringent in order to meet the European Commission's target for the EU of 20% below 1990 emissions levels by 2020.<sup>100</sup> For example, Deutsche Bank estimates that prices in Phase 3 will be €35 (CDN \$50). These EUA price forecasts are considerably higher than the global GHG

<sup>97</sup> Based upon an exchange rate of approximately \$CDN 1.44 to 1 euro (www.oanda.com), and rounding to the nearest Canadian dollar.

<sup>98</sup> The €15 price estimate is the central ICF estimate for 2008-12 cited in 'Emission Permits May Fall to EUR8 a Ton, ICF Says,' Bloomberg, June 18, 2007. The €35 price estimate is Deutsche Bank's estimate provided in "DB Global Markets Research , Carbon Emissions – Banking on Higher Prices: We See EUAs at E35/t Over 2008-2020," July 2007.

<sup>99</sup> Based upon an exchange rate of approximately \$CDN 1.44 to 1 euro (www.oanda.com), and rounding to the nearest Canadian dollar.

<sup>100</sup> Europa: Gateway to the European Union website, Press Release: "Limiting Global Climate Change to 2 Degrees Celsius," <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/16>

price ranges suggested by model estimates in 2012 (CDN \$12-18), 2015 (CDN \$11-17) and 2020 (CDN \$15-26). The EUA price forecasts are relevant because in the Linked Markets scenario, it is assumed that there is unlimited access to international offsets for compliance. Such offsets will include CERs or others that will be authorized for use in a post-Kyoto international framework. To date, EUA prices have been a key factor driving CER prices because for the most part, they can be used for compliance under the EU ETS and they have equivalent compliance value. EUA prices likely will continue to drive CER prices for several years, given that sellers will seek to sell to the highest bidder, and that EU ETS emission reduction requirements are more stringent than U.S. emission reduction requirements under the McCain-Lieberman bill, at least until 2020. Thus, if U.S. domestic abatement options, including offsets, are exhausted at prices lower than CER prices in the 2012-20 period, prices in a U.S. program could go as high as the levels suggested by EUA price forecasts in the 2012-20 period.

- Another reason why prices may be higher than suggested by our model estimates is that the EPA and EIA model estimates do not consider the specific impact of linking to a Canadian trading program – they simply assume that the U.S. has unlimited access to international offsets from developing countries. (In contrast, the global model estimates assume that all countries link and can access least-cost reductions from any geographic location) Based on the marginal cost estimates for Canada in the Jaccard 2007 study,<sup>101</sup> and for the U.S. in the EPA and EIA analyses of S. 280, it appears that Canada has higher marginal costs of abatement, and would be a net buyer if it linked to a U.S. trading program. This would drive U.S. prices higher if there are abatement opportunities in the U.S. that were priced lower than international offset prices.

### **3. Made in North America – Aggressive Targets Scenario**

- In this scenario, Canada and U.S. implement ambitious targets (e.g. S. 280) that start in 2012, but do not link to a post-Kyoto international regime.
- U.S. and Canada do not allow use of international offsets. The price range includes models of S. 280 that assume no international offsets and global models of a U.S. trading program with similar targets through 2050 (consistent with a 550 ppmv concentration scenario) and that does not allow international offsets.
- The U.S. and Canada link their trading programs starting in 2012. Prices in Table 3 apply to both the U.S. and Canada.
- The Canadian Federal Government eliminates the price cap/technology fund compliance option starting in 2012.
- The GHG price ranges for this scenario were derived from: 1) EIA's U.S. trading program model estimating prices under S. 280, but without the use of international offsets (note that EPA's analysis did not include this specific

---

<sup>101</sup> MK Jaccard and Associates, *Cost Curves for GHG Emission Reduction in Canada: The Kyoto Period and Beyond – Final Analysis Report* (January 2007), <http://www.greenparty.ca/files/JaccardFullReport.pdf>, further described in Appendix II.

scenario, and therefore was not considered); and 2) three global models that, instead of being used to determine prices under a least-cost approach for reaching a particular atmospheric GHG concentration target, were used to model specific hard emissions targets in the U.S. and in the rest of the world. We considered a scenario in which the U.S. issued a cumulative volume of emission allowances in 2012-50 equal to 203 billion metric tons (Bt) CO<sub>2</sub>e (i.e. the “203 Bt scenario”). This emissions level is similar to levels that would be allowed under S. 280.<sup>102</sup> When emissions levels assumed for other countries in the 203 Bt scenario are taken into account, this scenario’s implied emissions targets are similar to those consistent with a 550 ppmv atmospheric GHG concentration target.<sup>103</sup> The models assume no international trading and unlimited domestic offsets, consistent with the Made in North America – Aggressive Targets scenario. These models and their price estimates are summarized in Table 5 below. Additional details on these models are provided in Appendix II.

**Table 5 – Economic Models Used to Estimate GHG Prices in Made In North America – Aggressive Targets Scenario**

| <b>Report</b>                                                                              | <b>Model</b>                                                                                                    | <b>Policy Assumptions</b>                                                                                                                                                                             | <b>Model Price Estimates</b>                                            |
|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| U.S. Energy Information Agency (EIA) 2007 analysis of McCain-Lieberman bill <sup>104</sup> | EIA’s National Energy Modeling System (U.S. trading program model which incorporates targets for rest of world) | EIA’s scenario in which the 30% offset limit in the bill is limited to domestic offsets; no international offsets are allowed.                                                                        | 2012: \$20<br>2015: \$24<br>2020: \$35<br>2030: \$65<br>Post-2030: n.a. |
| MIT analysis for 2007 Duke University symposium on economic modeling                       | EPPA (global model that estimates costs associated with specific targets in U.S. and rest of world)             | No international trading, and unlimited domestic offsets; U.S. targets based on 203 Bt scenario; combined, U.S. and rest of world targets are consistent with a 550 ppmv global concentration target. | 2015: \$47<br>2020: \$57<br>2030: \$84<br>2040: \$124<br>2050: \$184    |

<sup>102</sup> Three models were used to estimate this and other targets in preparation for a July 2007 symposium on climate economic modeling organized by Duke University’s Nicholas Institute for Environmental Policy Solutions (<http://www.nicholas.duke.edu/econmodeling>). The targets that were used by the three models (which are described below in Table 5) were based on those developed by the Massachusetts Institute of Technology (MIT) in another analysis (MIT Program on the Science and Policy of Global Climate Change, *Assessment of U.S. Cap and Trade Proposals*, Sergey Paltsev et al., report number 146, April 2007, [http://web.mit.edu/globalchange/www/MITJSPGC\\_Rpt146.pdf](http://web.mit.edu/globalchange/www/MITJSPGC_Rpt146.pdf); targets and comparison with McCain-Lieberman bill provided on p. 13).

<sup>103</sup> MIT Program on the Science and Policy of Global Climate Change, *Assessment of U.S. Cap and Trade Proposals*, Sergey Paltsev et al., report number 146, April 2007, [http://web.mit.edu/globalchange/www/MITJSPGC\\_Rpt146.pdf](http://web.mit.edu/globalchange/www/MITJSPGC_Rpt146.pdf); comparison with 550 ppmv target provided on p. 49.

<sup>104</sup> U.S. Energy Information Administration, Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007, July 2007, [http://www.eia.doe.gov/oiaf/service\\_rpts.htm](http://www.eia.doe.gov/oiaf/service_rpts.htm)

|                                                                                              |                                                                                                      |                                                                                                                                                                                                       |                                                                      |
|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Research Triangle Institute (RTI) analysis for modeling symposium                            | ADAGE (global model that estimates costs associated with specific targets in U.S. and rest of world) | No international trading, and unlimited domestic offsets; U.S. targets based on 203 Bt scenario; combined, U.S. and rest of world targets are consistent with a 550 ppmv global concentration target. | 2015: \$35<br>2020: \$44<br>2030: \$71<br>2040: \$116<br>2050: \$187 |
| Pacific Northwest National Laboratory/University of Maryland analysis for modeling symposium | SGM (global model that estimates costs associated with specific targets in U.S. and rest of world)   | No international trading, and unlimited domestic offsets; U.S. targets based on 203 Bt scenario; combined, U.S. and rest of world targets are consistent with a 550 ppmv global concentration target. | 2015: \$42<br>2020: \$51<br>2030: \$76<br>2040: \$112<br>2050: \$166 |

- The economic models that came closest to capturing the specific policies and timeframes incorporated in the Made in North America – Aggressive Targets scenario assume that the U.S. meets S. 280 targets, or similar targets consistent with a 550 ppmv concentration scenario, without use of international offsets. They do not take into account linking of U.S. and Canadian trading programs. Based on marginal cost curves in the Jaccard 2007 study and those used in EIA’s analysis of S. 280, it appears that there are greater low-cost abatement options in the U.S. than in Canada. Therefore, we would expect that Canada will be a net buyer of U.S. compliance instruments. Since the model estimates do not capture this dynamic, actual prices in this scenario could be higher than suggested by the model prices, all else being equal.
- The range does not include IPCC model estimates, since those estimates assume unlimited flexibility, including unlimited access to international offsets, while the Made in North America – Aggressive Target scenario assumes no international offsets.

**D. Sensitivity Analysis**

As discussed above, the sensitivity analysis examines possible prices that could result if BC implements a policy that is significantly different from those being considered by the federal governments of both Canada and the U.S.

In the first sensitivity case, BC decides that it will undertake to meet its own emission reduction targets starting in 2012. As noted above, BC has set a target of 33% below 2007 levels by 2020, and will set interim targets for 2012 and 2016. It is assumed in this sensitivity case that BC would only allow for use of offsets from projects within BC. In the second sensitivity case, BC decides that it will undertake to meet its own emission reduction target as a participant in a WCI regional trading program, starting in 2012. BC would allow for use of WCI/WECC offsets and allowances for compliance. As discussed

in Section III.E, it is our view that the second (WCI/WECC) case is the more likely scenario.

Prices in these cases are considered through 2020, reflecting our view that BC is unlikely to pursue a separate target (whether alone or as part of WCI/WECC) beyond 2020 in any scenario. We assume that BC participates in a broader federal program that corresponds to one of the three planning scenarios used in Table 3 after 2020. Table 6 presents the results. Prices in the table are prices that BC would face under each sensitivity case.

**Table 6 – Sensitivity Analysis on Limiting Geographic Eligibility of GHG Compliance Instruments**

| Price Estimates for Sensitivity Cases <sup>105,106</sup><br>(CDN \$2008) |           |          |           |                |
|--------------------------------------------------------------------------|-----------|----------|-----------|----------------|
| Year                                                                     |           | 2012     | 2015      | 2020           |
| <b>BC compliance instruments only</b>                                    |           |          |           |                |
| As applied to all scenarios                                              | Range     | \$78-116 | \$140-258 | \$258 - >\$323 |
|                                                                          | Mid Point | \$97     | \$199     | > \$291        |
| <b>WCI/WECC compliance instruments only</b>                              |           |          |           |                |
| Price Cap scenario <sup>107</sup>                                        | Range     | \$9-14   | \$16-46   | \$29-\$126     |
|                                                                          | Mid Point | \$12     | \$31      | \$78           |

A discussion on the assumptions and methodologies for the sensitivity cases follows, including a discussion of the marginal abatement cost studies and economic models used in developing the price estimates.

**1. BC Compliance Instruments Only**

The “BC compliance instruments only” sensitivity case was applied to each of the three policy scenarios as follows:

- In the Price Cap scenario, BC pursues its target (10% below 1990 levels by 2020) in the context of a modest Canadian Federal program with a price cap that is assumed to be extended to 2050. BC does not have access to price cap payments under its program. The Canadian program is not linked to the U.S. federal program. Thus, BC compliance buyers could theoretically need to compete against non-BC Canadian buyers to purchase BC offsets. However, non-BC Canadian buyers would not be willing to pay more than the Canadian Federal price cap.
- In the Linked Markets scenario, BC pursues its target in the context of an ambitious Canadian Federal program. However, the Canadian program allows for technology fund payments (i.e. price cap) through the end of 2015. BC does not have access to price cap payments under its program. The U.S. and Canada link

<sup>105</sup> Figures in italics have been calculated through interpolation.

<sup>106</sup> In 2012 only one pricing estimate was available in the “BC compliance instruments only” case (the estimate based on Jaccard 2007 marginal costs, without sequestration). The range was calculated based on +/-20% of the available pricing estimate. In 2020, a lower estimate (with sequestration) and an upper estimate (without sequestration) were available. The lower 2015 estimate (with sequestration) was obtained by interpolating between the 2012 and 2020 lower estimates. The upper 2015 estimate (without sequestration) was obtained directly from the Jaccard 2007 study. In the “WCI/WECC compliance instruments only” case, only one pricing estimate (the low estimate based on the Rose 2006 study) was available in 2012. The range was calculated based on +/-20% of the available pricing estimate.

<sup>107</sup> Estimates for other scenarios could not be provided due to data limitations for this sensitivity case, as discussed below.

their markets after 2015. Consequently, BC compliance buyers could theoretically need to compete against non-BC Canadian buyers (who have access to a price cap through 2015) immediately and U.S. buyers starting after 2015. U.S. and non-BC Canadian buyers also have access to CERs.

- In the “Made in North America – Aggressive Targets” scenario, BC pursues its target in the context of ambitious U.S. and Canadian federal programs which link starting in 2012 but do not allow for use of international offsets. The Canadian Federal Government eliminates the price cap/technology fund compliance option starting in 2012. BC compliance buyers could theoretically need to compete against non-BC Canadian buyers and U.S. buyers starting in 2012.

Based on estimated marginal costs in BC, which are very high, we conclude that prices in this sensitivity case would be the same under all three of the scenarios, based on the following reasoning.

- Prices are based on the marginal cost of emission reductions in BC and demand for BC-based reductions in each scenario.
- The upper price estimate is based on marginal cost estimates in the Jaccard 2007 study. That study is a marginal cost analysis focusing on domestic Canadian GHG abatement options. It provides a single GHG marginal abatement curve (MAC) for each province, and estimates volumes of GHG abatement in BC at different hypothetical GHG prices. The study excludes landfills and sequestration in its cost curves. As a result of BC’s ambitious targets, GHG prices in BC must reach extremely high levels to achieve the required volume of reductions, based on the Jaccard 2007 study.<sup>108</sup>
- The lower estimate reflects adjustment of the MAC for BC in the Jaccard 2007 study to include a forest sequestration supply estimate from an article focusing on estimating the potential volume and cost of forest sequestration in western Canada. We adjusted the sequestration supply estimate downward by 50% to account for measurement and eligibility issues.<sup>109</sup> This approach is consistent with the types of adjustments to MACs made in the EIA and EPA analyses of S. 280, for example.
- In the Price Cap scenario, there would be no demand for BC offsets from non-BC Canadian buyers because – based on the Jaccard 2007 study and the sequestration estimates -- marginal costs in BC are far higher than the price cap. U.S. buyers would not be able to access BC offsets because the U.S. program is not linked to Canada’s. (Prices in the U.S. would be at or lower than the U.S. price cap, which increases from CDN \$11 in 2012 to CDN \$13 in 2015 to CDN \$16 in 2020.) Therefore, we estimate prices for the sensitivity case based on the assumption that BC buyers are the only source of demand for BC-based reductions.
- In the Linked Markets scenario and the Made in North America - Aggressive Targets scenario, targets in the U.S. and Canada are more stringent, and estimated

<sup>108</sup> MK Jaccard and Associates, 2007, op. cit..

<sup>109</sup> G. Cornelis van Kooten, Brad Stennes, Emina Kreemar-Nozic and Ruud van Gorkom, *Economics of Afforestation for Carbon Sequestration in Western Canada*, January 2000. [http://www.sfmnetwork.ca/docs/e/WP\\_1999-9.pdf](http://www.sfmnetwork.ca/docs/e/WP_1999-9.pdf) (working paper copy)

prices are higher (see Table 3), than in the Price Cap scenario. This could mean that there theoretically could be demand for BC offsets from outside of BC. However, given that marginal costs in BC are high relative to other Canadian provinces and relative to the U.S., we would expect there to be little or no demand from outside of BC for BC offsets. Therefore, for these scenarios we also estimate prices for the sensitivity case based on the assumption that BC buyers are the only source of demand for BC-based reductions.

## **2. WCI/WECC Compliance Instruments Only**

In this sensitivity case we assume that BC meets its target, links to a WCI/WECC regional trading program, and allows for use of compliance instruments from any state/province in WCI or WECC (assuming that all WECC states eventually join WCI) starting in 2012.

In theory, the “WCI/WECC compliance instruments only” sensitivity case would be applied to each of the three policy scenarios as follows. However, as discussed after the bullets that follow, limited data prevents us from obtaining separate price estimates for this sensitivity case for each policy scenario.

- In the Price Cap scenario, BC pursues its target in the context of the WCI/WECC regional trading program, which operates alongside of a modest Canadian Federal program with a price cap that is assumed to be extended to 2050. BC and WCI/WECC participants do not have access to price cap payments under their program. The Canadian program is not linked to the U.S. Federal program, which also has a price cap. BC and other WCI/WECC participants would compete against non-WCI/WECC buyers in the U.S. and Canada for reductions from the WCI/WECC region. However, non-WCI/WECC buyers in Canada and the U.S. would not be willing to pay more than their respective price caps.
- In the Linked Markets scenario, BC pursues its target in the context of the WCI/WECC regional trading program, which operates alongside of ambitious U.S. and Canadian Federal programs. However, the Canadian program allows for technology fund payments (i.e. price cap) through the end of 2015. BC and WCI/WECC participants do not have access to price cap payments under their program. The U.S. and Canada link their markets after 2015. U.S. and non-BC Canadian buyers also have access to CERs. BC and other WCI/WECC participants would compete against non-WCI/WECC buyers in the U.S. and Canada for reductions from the WCI/WECC region. However, non-BC buyers in Canada would not be willing to pay more than the price cap up until 2015.
- In the Made in North America – Aggressive Targets scenario, BC pursues its target in the context of the WCI/WECC regional trading program, which operates alongside of ambitious U.S. and Canadian Federal programs which link starting in 2012 but do not allow for use of international offsets. The Canadian Federal Government eliminates the price cap/technology fund compliance option starting in 2012. BC and other WCI/WECC participants would compete against non-

WCI/WECC buyers in the U.S. and Canada for reductions from the WCI/WECC region starting in 2012.

Data is limited for this case. Specifically, marginal costs are not available for several WECC states. The one modeling study (Rose 2006<sup>110</sup>) on WCI that we could obtain doesn't include BC, Alberta, Manitoba and several WECC states. It also appears to create marginal cost curves based on limited information on specific marginal cost opportunities in each state. In our view, its estimates of a WCI price are likely to be too low.<sup>111</sup> Thus, we use the Rose estimates as a lower bound for the price range. The upper bound is based on prices in a detailed economic modeling study by Charles River Associates which estimates the costs of meeting California's GHG emissions target of 1990 levels by 2020.<sup>112</sup> We used this study's estimates as a proxy for WCI/WECC offset prices based on the logic that follows. Based on marginal abatement curves for BC, Manitoba and Alberta in the Jaccard 2007 study, and the adjusted forest sequestration supply estimate, if BC expands offset eligibility to include Manitoba and Alberta, offset prices would decrease from > CDN \$323 to CDN \$258 (without sequestration) and from CDN \$258 to CDN \$194 (with sequestration) in 2020.<sup>113, 114</sup> Based on these results, we would expect offset prices to decrease further by expanding eligibility to other WCI/WECC jurisdictions. The Charles River Associates study's estimates of permit prices in California (\$46 in 2015, \$126 in 2020) appear to support this point, and it is possible that other WCI/WECC jurisdictions will have even lower marginal costs. In addition, as the largest economy in the WCI/WECC region, California's marginal costs/prices can be expected to have a strong influence on equilibrium prices in the WCI/WECC region. In light of these considerations, we use the California prices as an upper bound.

The price range presented in the table reflects the sensitivity case occurring as part of the Price Cap scenario. In that scenario, we assume that prices in the WCI/WECC region would not be affected by demand for WCI/WECC offsets from outside of that region based on the price cap and the range of prices in the WCI/WECC region. As discussed

---

<sup>110</sup> Adam Rose, Professor of Energy, Environmental and Regional Economics, the Pennsylvania State University (August 2006), *Economic Analysis of a Cap and Trade System for Carbon Dioxide Emission Reduction in the Western States*, <http://www.nmclimatechange.us/ewebeditpro/items/O117F9100.pdf>

<sup>111</sup> The Rose study estimates significantly lower marginal costs of abatement in California than the Charles River study. In addition, Stavins et al 2007 notes that several other studies (Rose not included) that estimated low marginal costs in California were overly optimistic, failed to take various barriers and costs into account, and were therefore not credible. Stavins et al, *Too Good to Be True? An Examination of Three Economic Assessments of California Climate Change Policy*, March 2007.

<sup>112</sup> Charles River Associates International, *Program on Technology Innovation: Economic Analysis of California Climate Initiatives: An Integrated Approach. Volume 1: Summary for Policymakers* (June 2007), further described in Appendix II.

<sup>113</sup> MK Jaccard and Associates, 2007, op. cit.

<sup>114</sup> Sequestration supply estimate is based on G. Cornelis van Kooten, Brad Stennes, Emina Krcmar-Nozic and Ruud van Gorkom, *Economics of Afforestation for Carbon Sequestration in Western Canada*, (January 2000).

below, data limitations prevent us from adjusting the price estimates to reflect the sensitivity case occurring in other scenarios.

We would expect prices of compliance instruments in the WCI/WECC region to increase in the Made in North America -- Aggressive Targets scenario due to more stringent targets and higher estimated prices (see Table 3) in Canada and the U.S. than in the Price Cap scenario, and our expectation that the WCI/WECC region would have some cost-effective abatement options that would attract demand from states and provinces outside of the WCI/WECC region. However, given that data for this sensitivity case is limited and that our estimates rely on proxies, specific adjustments to our price estimates to reflect increased demand are not possible. The Linked Markets scenario also has more stringent targets and higher estimated prices than the Price Cap scenario. Estimated prices in the Linked Markets scenario are lower than in the Made in North America Aggressive targets scenario, partly because it allows for the use of international offsets. Therefore, prices of compliance instruments in the WCI/WECC region could be lower in the Linked Markets scenario than in the Made in North America Aggressive Targets scenario due to international offsets displacing demand for WCI/WECC instruments from other states and jurisdictions.

## **V. Integrated Resource Plans and Greenhouse Gas Cost Adders**

Utilities evaluate the potential impacts of GHG regulations in their resource planning and procurement processes. As an independent way of evaluating Natsource's estimated GHG price ranges provided in Section IV, we reviewed GHG cost adders used by utilities in the U.S. in their Integrated Resource Plans (IRPs) and Long-Term Procurement Plans (LTPPs).<sup>115</sup> This section contains detailed summaries of the GHG regulatory scenarios, GHG adders, and associated assumptions considered by twelve U.S. utilities in their IRPs and LTPPs based on information publicly available. It also provides a detailed overview of existing policies regarding the use of GHG adders in the states of California, Oregon and New Mexico.<sup>116</sup>

The table below summarizes the range of GHG cost adder values in the IRPs and LTPPs analyzed in this section.

---

<sup>115</sup> This section updates the North American Integrated Resource Planning survey provided in the 2006 Natsource Report.

<sup>116</sup> All adder values in this section are provided in January 1, 2008 CDN dollars per metric ton (tonne) of CO<sub>2</sub>e.

Table 7: Summary of GHG Cost Adders<sup>117</sup>

| Entity                     | Process                          | GHG Adder Range <sup>118</sup><br>(CDN\$2008/tonne of CO <sub>2</sub> e) | Timeframe of Analysis for GHG Adders |
|----------------------------|----------------------------------|--------------------------------------------------------------------------|--------------------------------------|
| PacifiCorp                 | IRP (2007) <sup>119</sup>        | \$0 - \$69.60                                                            | 2007-2026                            |
| Northwestern Energy        | RPP (2005) <sup>120</sup>        | \$6.50 - \$36.93                                                         | 2010-2025                            |
| Puget Sound Energy         | IRP (2007) <sup>121</sup>        | \$7.19 - \$48.97                                                         | 2012-2027                            |
| Idaho Power Company        | IRP (2006) <sup>122</sup>        | \$0 - \$60.06                                                            | 2006-2025                            |
| Avista Utilities           | IRP (2007) <sup>123</sup>        | \$0 - \$41.57                                                            | 2015-2027                            |
| Portland General Electric  | IRP (2007) <sup>124</sup>        | \$8.36 - \$69.19                                                         | 2010-2027                            |
| Seattle City Light         | IRP (2006) <sup>125</sup>        | \$6.01 - \$101.16                                                        | 2006-2026                            |
| Tri-State                  | IRP (2007) <sup>126</sup>        | \$11.71 - \$43.65                                                        | 2007-2026                            |
| Colorado Springs           | IRP (2007, Draft) <sup>127</sup> | \$0-\$108.26                                                             | 2010-2027                            |
| Southern California Edison | LTPP (2006) <sup>128</sup>       | \$10.22                                                                  | 2007-2016                            |

<sup>117</sup> Original prices were converted to January 1, 2008 CDN dollars per metric ton (tonne) of CO<sub>2</sub>e as follows. Prices per short ton were converted into prices per tonne based on 1 short ton = 0.9072 metric tons. Next, prices were converted to US \$2007 based on Consumer Price Index (CPI) data from the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor. Specifically, prices expressed in terms of future year dollars (2008 and beyond) were converted into \$2007 using a discount factor equal to the average inflation rate over the past 10 years, approximately 2.66% (<http://data.bls.gov/cgi-bin/cpicalc.pl>). Prices expressed in past year dollars (prior to 2007) were converted into US \$2007 using historical annual inflation rates based on “CPI -All Urban Consumers 1982-84=100 - CUUR0000SA0” data series (<http://www.bls.gov/cpi/home.htm>). Subsequently, adder prices were converted into \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada’s CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007 (<http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>).

<sup>118</sup> These ranges include all GHG values assumed over time in each IRP/LTTP. As the table illustrates, the specific timeframe of analysis considered in each IRP/LTTP differs (see discussion in subsection A of this section for additional detail on this and other assumptions).

<sup>119</sup> PacifiCorp 2007 Integrated Resource Plan, <http://www.pacificcorp.com/File/File74765.pdf>

<sup>120</sup> NorthWestern Energy’s 2005 Electric Default Resource Procurement Plan, <http://www.montanaenergyforum.com/plan.html>

<sup>121</sup> Puget Sound Energy 2007 Integrated Resource Plan, <http://www.pse.com/energyEnvironment/pse2007irpView.aspx>

<sup>122</sup> Idaho Power Company’s 2006 IRP, [http://www.idahopower.com/pdfs/energycenter/irp/2006/2006\\_IRP.pdf](http://www.idahopower.com/pdfs/energycenter/irp/2006/2006_IRP.pdf)

<sup>123</sup> Avista’s 2007 Electric Integrated Resource Plan, <http://www.avistautilities.com/resources/plans/electric.asp>

<sup>124</sup> Portland General Electric 2007 Integrated Resource Plan, [http://www.portlandgeneral.com/about\\_pge/current\\_issues/energy\\_strategy/pge\\_irp\\_2007.pdf](http://www.portlandgeneral.com/about_pge/current_issues/energy_strategy/pge_irp_2007.pdf)

<sup>125</sup> Seattle City Light 2006 Integrated Resource Plan, <http://www.seattle.gov/light/news/issues/irp/docs/SCLIRP2006.pdf>

<sup>126</sup> Tri-State Generation 2007 Integrated Resource Plan, <http://www.tristategt.org/NewsCenter/NewsItems/Tri-State%20IRP%2002-15-2007.pdf>

<sup>127</sup> Colorado Springs 2007 Electric Integrated Resources Plan Presentation, April 20, 2007 <http://www.csu.org/about/projects/eirp/participation/13744.pdf>

|                                                  |                            |         |           |
|--------------------------------------------------|----------------------------|---------|-----------|
| <b>Pacific Gas and Electric</b>                  | LTPP (2006) <sup>129</sup> | \$10.22 | 2007-2016 |
| <b>San Diego Gas and Electric</b> <sup>130</sup> | RFO <sup>131</sup>         | \$10.22 | n.a.      |

We conclude that GHG adder ranges summarized in Table 7 are similar to Natsource’s estimated ranges for GHG prices provided in Section IV.

It should be noted that several of the IRPs and LTPPs reviewed in this report do not explicitly consider recent economic models or recent trends in GHG regulation in North America that we consider in this analysis. As discussed in greater detail below, GHG adder prices are based in some cases on outdated models and proposals. For instance, Portland General Electric’s and Avista’s 2007 IRPs include scenarios based on Senator McCain’s and Senator Lieberman’s Climate Stewardship Act of 2003, which differs from the 2007 version of the bill. Similarly, Puget Sound Energy’s 2007 IRP includes a “Green World” scenario based on the EPA’s analysis of Senator Jeffords’ Clean Power Act, which was introduced on January 25, 2005. In contrast, Natsource’s GHG price forecasts are based on the most recent economic modeling and legislative proposals available at the time of this writing, such as EIA’s and EPA’s 2007 analyses of S. 280 (Senator McCain’s and Senator Lieberman’s Climate Stewardship and Innovation Act of 2007).

**A. U.S. Utilities**

**a. PacifiCorp**

PacifiCorp -- a large utility serving the western U.S., including Utah, Wyoming, Oregon, Washington, and parts of Idaho and California -- published its most recent IRP in May 2007.<sup>132</sup> Given uncertainties surrounding the potential cost of emissions, the cost of CO<sub>2</sub> is treated as an exogenous portfolio risk and addressed through “scenario analysis” in the IRP.<sup>133</sup> All portfolios were analyzed for five CO<sub>2</sub> adder cases including CDN \$0 per metric ton (tonne), CDN \$9.13/tonne, CDN \$17.11/tonne, CDN \$43.36/tonne, and CDN

---

<sup>128</sup> Southern California Edison Company’s 2006 Procurement Plan, Volume 3 (public version), December 11, 2006.  
[http://www3.sce.com/sscc/law/dis/dbattach1e.nsf/0/2BACC678A141EF91882572420010C6F0/\\$FILE/R.06-02-013+-+PPOIR+-+SCE+2006+LTPP+Vol.+3+-+Redacted.pdf](http://www3.sce.com/sscc/law/dis/dbattach1e.nsf/0/2BACC678A141EF91882572420010C6F0/$FILE/R.06-02-013+-+PPOIR+-+SCE+2006+LTPP+Vol.+3+-+Redacted.pdf)

<sup>129</sup> 2006 Long-Term Procurement Plan, Volume I – Amendment, Pacific Gas and Electric Company, March 5, 2007.  
[https://www.pge.com/regulation/LongTermProcureOIR/Testimony/PGE/2007/LongTermProcureOIR\\_Test\\_PGE\\_20070305-01.pdf](https://www.pge.com/regulation/LongTermProcureOIR/Testimony/PGE/2007/LongTermProcureOIR_Test_PGE_20070305-01.pdf)

<sup>130</sup> San Diego Gas and Electric (SDG&E) does not include a GHG adder in its 2006 LTPP, however it does use a GHG adder in Request for Offers (RFOs) as required by California’s existing regulations (see subsection B below for additional detail on SDG&E and California’s state policies regarding the use of GHG adders in resource planning).

<sup>131</sup> Request for Offer.

<sup>132</sup> PacifiCorp 2007 Integrated Resource Plan, <http://www.pacificcorp.com/File/File74765.pdf>.

<sup>133</sup> Ibid, p. 130 for more detailed information on “Scenario Risk Analysis” performed in the IRP.

\$69.60/tonne.<sup>134</sup> The scenarios assume that CO<sub>2</sub> emissions will be capped at 2000 levels and that a cap and trade program will begin in 2010. To account for timing uncertainty, “2010 CO<sub>2</sub> costs are probability-weighted by a factor of 0.50” and “2011 costs are weighted by a factor of 0.75”, while the full CO<sub>2</sub> adder price is assumed to be realized by 2012.<sup>135</sup> For the CDN \$69.60 cost adder case, the trading program is still assumed to start in 2010, but “it’s not fully phased in until 2016”.<sup>136</sup>

**b. Northwestern Energy**

In its 2005 Electric Default Supply Resource Procurement Plan, Northwestern Energy (NWE) assesses the effect of potential CO<sub>2</sub> taxes on portfolio costs. Two carbon tax scenarios were developed: the Expected Case and the High Case based on estimates provided in the Northwest Power and Conservation Council’s (NPCC) Fifth Power Plan (2005).<sup>137,138</sup> The Expected Case assumes that a CO<sub>2</sub> tax of CDN \$6.50/tonne will be implemented beginning in 2010. The tax increases to CDN \$12.61/tonne in 2017 and remains at that level through 2025. NWE’s High Case assumes a CO<sub>2</sub> tax of CDN \$19.49/tonne beginning in 2010; the tax increases to CDN \$36.93/tonne in 2017 and remains at that level through 2025.<sup>139,140,141</sup>

**c. Puget Sound Energy**

Puget Sound Energy’s 2007 IRP includes a low carbon cost scenario (reference scenario) and a high carbon cost scenario. The reference case or “Current Trends” scenario

---

<sup>134</sup> Ibid, pp.6, 117. Adder values in the plan were US \$0, US \$8, US \$15, US \$38, and US \$61/short ton CO<sub>2</sub> (in 2008 dollars). Prices per short ton were converted into prices per tonne (1 ton = 0.9072 metric tons), and were then converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007.

<sup>135</sup> Ibid, p. 133.

<sup>136</sup> Ibid.

<sup>137</sup> NWE believes the High Case is possible but not highly likely. See 2005 Electric Default Supply Resource Procurement Plan, Volume 1, p. 56,

[http://www.montanaenergyforum.com/pdf/2005\\_Plan/2005\\_v1\\_ExecutiveSummary.pdf](http://www.montanaenergyforum.com/pdf/2005_Plan/2005_v1_ExecutiveSummary.pdf)

<sup>138</sup> See the 2006 Natsource Report for more detail on the NPCC’s Fifth Plan.

<sup>139</sup> 2005 Electric Default Supply Resource Procurement Plan Volume 2, Chapter 5,

[http://www.montanaenergyforum.com/pdf/2005\\_Plan/2005\\_v2\\_CH5.pdf](http://www.montanaenergyforum.com/pdf/2005_Plan/2005_v2_CH5.pdf)

<sup>140</sup> Ibid, p. 8. We assume charges from 2010 to 2025 are expressed in nominal dollars and in short tons and convert them to prices per tonne (1 ton = 0.9072 metric tons). We then convert them to \$2007 U.S. using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. Next charges were converted into CDN dollars using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007.

Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada’s CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>141</sup> In both scenarios, the CO<sub>2</sub> tax is converted into a \$/MWh adder for each of the portfolio’s resources. This is done by computing a levelized CO<sub>2</sub> charge (\$/ton) based on NWE’s discount rate and the year different resources come on line (2010, 2012 or 2013). We assume levelized charges are expressed in U.S. \$2004, which is the year the model was calibrated on. This charge (\$/ton) is then converted into \$/MWh based on the emission values of the different resources. The timeframe considered extends to 2025. The resulting levelized charges range from CDN \$11.79 to CDN \$13.53 per tonne (based on the year a particular resource comes on line -- 2010, 2012 or 2013) in the Expected Case, and from CDN \$34.85 to CDN \$39.86 per tonne in the High Case.

considers CO<sub>2</sub> prices based on the (U.S.) National Commission on Energy Policy's (NCEP) 2004 recommendations on a cap and trade program, supported by Senator Bingaman and Senator Domenici.<sup>142</sup> The reference case assumes a CO<sub>2</sub> adder of CDN \$7.19/tonne in 2012, increasing at an annual real rate of 5% per year to CDN \$8.61/tonne in 2020 and CDN \$10.08/tonne in 2027.<sup>143</sup>

Projected prices for CO<sub>2</sub> in the "Green World" scenario are based on the EPA's estimates under Senator Jeffords' Clean Power Act (S.150) introduced on January 25, 2005.<sup>144</sup> The "Green World" scenario assumes a carbon charge starting at CDN \$25.48 per tonne in 2012 and increasing to CDN \$37.76 in 2020 and CDN \$48.97 per tonne in 2027.<sup>145,146</sup>

#### **d. Idaho Power Company**

Idaho Power Company's 2006 IRP incorporates a base case cost adder of CDN \$16.82 beginning in 2012. In addition, it has a high-end sensitivity case of CDN \$60.06 per tonne beginning in 2012 and a low-end sensitivity case that assumes no CO<sub>2</sub> adder (CDN \$0 per tonne).<sup>147,148</sup> Using the Aurora Electric Market Model, adder prices were analyzed

<sup>142</sup> The National Commission on Energy Policy, "Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges", December 2004.

[http://www.energycommission.org/files/contentFiles/report\\_noninteractive\\_44566feaabc5d.pdf](http://www.energycommission.org/files/contentFiles/report_noninteractive_44566feaabc5d.pdf). Cited in Puget Sound Energy 2007 Integrated Resource Plan, Chapter 3: Key Analysis Components, <http://www.pse.com/energyEnvironment/2007IRP/Chapters/3-KeyAnalysisComponents.pdf>.

<sup>143</sup> Adder values in the Current Trends scenario are US \$7.00 per short ton in 2012, US \$10.34 per short ton in 2020, and US \$14.55 per short ton in 2027 (nominal dollars). Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). In addition, prices were converted into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. Subsequently, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>144</sup> U.S. Environmental Protection Agency, Office of Air and Radiation, "Multi-Pollutant Analysis: Comparison Briefing", October 2005.

<http://www.epa.gov/airmarkets/progsregs/cair/docs/comparisonbriefing.pdf>. Cited in Puget Sound Energy 2007 Integrated Resource Plan, Chapter 3: Key Analysis Components.

<http://www.pse.com/energyEnvironment/2007IRP/Chapters/3-KeyAnalysisComponents.pdf>.

<sup>145</sup> Adder values in the Green World scenario are US \$24.81/short ton CO<sub>2</sub>, US \$45.35/per short ton CO<sub>2</sub>, and US \$70.68/short ton CO<sub>2</sub> (nominal dollars). Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). In addition, prices were converted into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. Subsequently, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007.

Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>146</sup> Chapter 3, p. 11, Key Analysis Components, Puget Sound Energy 2007 IRP,

<http://www.pse.com/energyEnvironment/2007IRP/Chapters/3-KeyAnalysisComponents.pdf>

<sup>147</sup> Idaho Power Company's 2006 IRP, p. 71,

[http://www.idahopower.com/pdfs/energycenter/irp/2006/2006\\_IRP.pdf](http://www.idahopower.com/pdfs/energycenter/irp/2006/2006_IRP.pdf).

<sup>148</sup> Adder values in the plan were US \$0, US \$14 and US \$50/short ton CO<sub>2</sub> (2006 dollars). Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). Prices were then converted into 2007 dollars using historical annual inflation rates based on CPI data from the BLS available at

in 12 different resource portfolios over a 20-year study period. Adder levels were selected in accordance with Order 93-695 from the Oregon Public Utilities Commission (OPUC) and in anticipation of potential state and/or Federal CO<sub>2</sub> regulations (see State Policy subsection below for more detail).<sup>149</sup>

**e. Avista Utilities**

Avista Utilities, serving Washington and Idaho, released its 2007 Electric IRP in August 31, 2007.<sup>150</sup> According to the 2007 Electric IRP, two future carbon tax scenarios will be considered: the Base Case and the High Carbon Charges Future scenario. In addition, the IRP considers an Unconstrained Carbon Future scenario, which assumes no carbon tax is enacted, in order to provide a reference against which to compare the cost of a cap-and-trade program. The Base Case assumes a distribution of possible cap-and-trade scenarios that has a mean value based on NCEP's recommendations of 2004. This mean value is CDN \$7.64/tonne in 2015 (start date), increasing to CDN \$9.94 per tonne of CO<sub>2</sub> in 2027.<sup>151,152</sup> The High Carbon Charges Future scenario is based on estimated prices under the 2003 version of the McCain-Lieberman legislation. Prices in this scenario are estimated to be CDN \$27.35 in 2015 (start date), and CDN \$41.57 in 2027.<sup>153,154</sup>

**f. Portland General Electric**

<http://www.bls.gov/cpi/home.htm>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>149</sup> Idaho Power Company's 2006 IRP, p. 79,

[http://www.idahopower.com/pdfs/energycenter/irp/2006/2006\\_IRP.pdf](http://www.idahopower.com/pdfs/energycenter/irp/2006/2006_IRP.pdf).

<sup>150</sup> Avista's 2007 Electric Integrated Resource Plan,

<http://www.avistautilities.com/resources/plans/documents/2007AvistaIRP.pdf>

<sup>151</sup> Ibid, pp. 4-8.

<sup>152</sup> For the NCEP scenario, the values in the IRP were US\$ 0/short ton in 2008, US\$8.94/short ton in 2015, \$14.34/short ton in 2027 (nominal dollars). Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). In addition, prices were converted into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. We then converted prices to CDN dollars based on the exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>153</sup> Based on email communications with John Lyons from Avista (August 20th and 21st, 2007) and 2007 Electric Integrated Resource Plan Supplement, p. 94,

<http://www.avistautilities.com/resources/plans/documents/2007AvistaIRPSupplemental.pdf>

<sup>154</sup> For the McCain-Lieberman scenario, the values in the IRP were US \$32 per short ton in 2015 and US \$60 per short ton (nominal dollars) in 2027. Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). In addition, prices were converted into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. We then convert the U.S. dollar values into \$CDN based on the exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

Portland General Electric's 2007 IRP assumes a base case CO<sub>2</sub> emission tax beginning in 2010 and set at CDN \$8.36 per tonne. The tax increases at 5% (nominal) per year until 2025, and at the rate of inflation thereafter. This is based on the CO<sub>2</sub> safety valve price originally proposed by the NCEP's recommendations on GHG policy in December 2004.<sup>155,156</sup> The IRP also includes three CO<sub>2</sub> tax sensitivities of CDN \$17.30, CDN \$43.24, and CDN \$69.19 per tonne.<sup>157</sup> These values are consistent with those prescribed by the OPUC Order 93-965 (see State Policy section for more detail).

**g. Seattle City Light**

Seattle City Light (SCL), serving the City of Seattle, is required to offset emissions from the use of fossil fuels in order to meet the city's electricity needs with zero net GHG emissions (see Section II for more detail). SCL's 2006 IRP considers several future CO<sub>2</sub> policy scenarios, as well as a CDN \$ 6.01/tonne offset price.<sup>158</sup> The Reference Case, the Return to Reliability scenario and the Terrorism and Turmoil scenario all assume no federal GHG regulations are implemented. Prices in these scenarios are based on the estimated average cost of offsets for SCL, approximately CDN \$ 6.01/tonne of CO<sub>2</sub> over 2007-2026.<sup>159</sup> In contrast, the Green World and Nuclear Resurgence scenarios assume a federal program starting in 2014. These scenarios assume emissions costs of CDN \$ 6.01 per tonne from 2006 to 2013 (the offset price); CDN \$ 25.07 per tonne from 2014-2019; CDN \$ 64.62 per tonne from 2020-2025; and CDN \$ 101.16 per tonne in 2026.<sup>160,161</sup>

**h. Tri-State Generation and Transmission Association**

---

<sup>155</sup> Portland General Electric 2007 IRP, pp. 91-92,

[http://www.portlandgeneral.com/about\\_pge/current\\_issues/energy\\_strategy/pge\\_irp\\_2007.pdf](http://www.portlandgeneral.com/about_pge/current_issues/energy_strategy/pge_irp_2007.pdf).

<sup>156</sup> The National Commission on Energy Policy, "Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges," December 2004. Portland General Electric's 2007 IRP points out that NCEP issued an updated proposal (in 2007) which raises the initial safety valve price from US \$7.72 (in 2010 dollars) to US \$11.03 (in 2012 dollars) per short ton. The updated price was not included in any of PGE's analyses.

<sup>157</sup> The base case emissions tax value in the plan was US \$7.72/short ton CO<sub>2</sub> (in 2010 dollars). This price per short ton was converted into price per tonne (1 short ton = 0.9072 metric tons). It was then converted into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. The three CO<sub>2</sub> tax sensitivity values were US \$14.40, US \$36, and US \$57.60/short ton CO<sub>2</sub> (in 2006 dollars). Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). Prices were then converted into 2007 dollars using historical annual inflation rates based on CPI data from the BLS available at <http://www.bls.gov/cpi/home.htm>. Next, all adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>

<sup>158</sup> Seattle City Light 2006 Integrated Resource Plan p. 46, <http://www.seattle.gov/light/news/issues/irp/docs/SCLIRP2006.pdf>

<sup>159</sup> Appendix D, pp. 41, 44, <http://www.seattle.gov/light/news/issues/irp/docs/SCLIRP2006Appendices.pdf>

<sup>160</sup> Ibid.

<sup>161</sup> We assume adders are expressed in short tons.

Tri-State Generation's 2007 IRP analyzes the impact on portfolio costs of a future CO<sub>2</sub> carbon tax.<sup>162</sup> Tri-State assumes three different carbon adder levels beginning in 2007: CDN \$11.71, CDN \$29.28 and CDN \$40.99 per tonne.<sup>163</sup> These price adders are projected through 2026 using a 3% average annual inflation rate starting in 2007. The resulting carbon adders are CDN \$12.47, CDN \$31.18 and CDN \$43.65 in 2026.

**i. Colorado Springs Utilities**

Colorado Springs Utilities (CSU) is in the process of finalizing its 2007 Electric Integrated Resource Plan, which is expected to be completed in September-October 2007.<sup>164</sup> A CSU presentation addressing the 2007 IRP indicates that a low, a medium and a high scenario will be considered.<sup>165</sup> The Low Environmental Regulation Assumptions scenario includes no carbon adder (i.e. this scenario assumes a price of CDN \$0 per tonne of CO<sub>2</sub>). The Medium Environmental Regulation Assumptions scenario assumes a CO<sub>2</sub> price of CDN \$9.74 (effective in 2010). This price adder was derived from a negotiated settlement between Xcel Energy and several Colorado environmental groups in which Xcel committed to using a CDN \$9.74 adder with a 2.5% escalator in its long-term Least-Cost Plan (LCP).<sup>166</sup> The High Environmental Regulation Assumptions scenario assumes a price of CDN \$32.48 per tonne of CO<sub>2</sub> (effective in 2010). This scenario is based on future legislation with potentially high safety valves or absolute emissions caps that are less stringent than Kyoto targets. Finally, the 2007 IRP will include a sensitivity analysis assuming a CO<sub>2</sub> price of \$108.26 per tonne in a scenario in which the Kyoto Protocol is adopted by Congress.<sup>167,168</sup> All price adders in CSU's IRP were projected through 2027 using the 2.5% per year escalator.

---

<sup>162</sup> Tri-State Generation 2007 Integrated Resource Plan, February 15, 2007, <http://www.tristategt.org/NewsCenter/NewsItems/Tri-State%20IRP%2002-15-2007.pdf>

<sup>163</sup> Ibid, p. 172. Adder values in the plan were US \$10, US \$25 and US \$35 per short ton CO<sub>2</sub> (in 2007 dollars). Prices per short ton were converted into prices per tonne (1 ton = 0.9072 metric tons), and were then converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>

<sup>164</sup> Based on communications with Colorado Springs Utilities.

<sup>165</sup> Colorado Springs 2007 Electric Integrated Resources Plan Presentation, April 20, 2007, p. 18, <http://www.csu.org/about/projects/eirp/participation/13744.pdf>.

<sup>166</sup> Further details regarding Xcel's negotiated agreement can be found in the Xcel Energy News Release: "Comprehensive settlement endorsed for Excel Energy resource plan." December 3, 2004. [http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1\\_15531\\_18513-16686-0\\_0\\_0-0,00.html](http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_15531_18513-16686-0_0_0-0,00.html).

<sup>167</sup> Adder prices in CSU's 2007 IRP were US \$0, US \$9, US \$30 and US \$100 per short ton (in 2010 dollars). All prices per short ton were converted into prices per tonne (1 ton = 0.9072 metric tons). In addition, prices were converted into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>168</sup> Information relating to price adder assumptions was obtained via email with Vicki Card and John Romero of Colorado Springs Utilities.

**j. Southern California Edison**

On December 11, 2006, Southern California Edison (SCE) filed its 2007-2016 LTTP.<sup>169</sup> The LTTP discusses a number of procurement policies and state laws including the CPUC's prescribed GHG adders (see subsection on state policy below for more detail). SCE uses a levelized GHG cost adder of CDN \$10.22 per tonne.<sup>170</sup> This adder level is consistent with California's current regulations on the use of GHG adders.

**k. Pacific Gas and Electric**

In December 2006, Pacific Gas and Electric (PG&E) filed its 2006 LTTP which was last updated on March 5, 2007.<sup>171</sup> PG&E's LTTP analyzes various GHG cost factors including the impacts of California's SB 1368 and AB 32 and the effect of a GHG price adder on the company's future procurement decisions. Consistent with California's state policy on the use of GHG adders (described in more detail below), PG&E uses a CDN \$10.22 per tonne GHG price adder. This adder escalates 5% annually in subsequent years.<sup>172,173</sup> These factors were incorporated into PG&E's LTTP to determine the company's optimal procurement portfolio over the next 10 years and beyond.

**l. San Diego Gas and Electric**

---

<sup>169</sup> Company's 2006 Procurement Plan, Volume 3 (public version), Southern California Edison, December 11, 2006, p. 3-9, [http://www3.sce.com/sscc/law/dis/dbattach1e.nsf/0/2BACC678A141EF91882572420010C6F0/\\$FILE/R.06-02-013+-+PPOIR+-+SCE+2006+LTTP+Vol.+3+-+Redacted.pdf](http://www3.sce.com/sscc/law/dis/dbattach1e.nsf/0/2BACC678A141EF91882572420010C6F0/$FILE/R.06-02-013+-+PPOIR+-+SCE+2006+LTTP+Vol.+3+-+Redacted.pdf). This is the company's equivalent to an IRP.

<sup>170</sup> The adder price of US \$8 per short ton CO<sub>2</sub> used in SCEs, PG&Es, and SDG&Es long-term procurement plans were derived from the annual levelized value determined in the CPUC's Decision Number 05-04-024 and pursuant to Decision Number 04-12-048. This price per short ton was converted into price per tonne (1 ton = 0.9072 metric tons) and was then converted into 2007 dollars using historical annual inflation rates based on CPI data from the BLS available at <http://www.bls.gov/cpi/home.htm>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007 (<http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>).

<sup>171</sup> Pacific Gas and Electric Company, 2006 Long-Term Procurement Plan, Volume I – Amendment, March 5, 2007, p. III-26, [https://www.pge.com/regulation/LongTermProcureOIR/Testimony/PGE/2007/LongTermProcureOIR\\_Test\\_PGE\\_20070305-01.pdf](https://www.pge.com/regulation/LongTermProcureOIR/Testimony/PGE/2007/LongTermProcureOIR_Test_PGE_20070305-01.pdf)

<sup>172</sup> Based on the 2006 Long-Term Procurement Plan and email exchanges with Sebastian Csapo at PG&E.

<sup>173</sup> The adder price of US \$8 per short ton CO<sub>2</sub> was derived from the annual levelized value determined in the CPUC's Decision Number 05-04-024 and pursuant to Decision Number 04-12-048. This price per short ton was converted into price per tonne (1 ton = 0.9072 metric tons) and into 2007 dollars using historical annual inflation rates based on CPI data from the BLS available at <http://www.bls.gov/cpi/home.htm>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

On December 11, 2006, San Diego Gas and Electric (SDG&E) filed its 2007-2016 LTTPP.<sup>174</sup> Although SDG&E does not apply a GHG price adder in its LTTPP, it uses an adder of CDN \$10.22 per tonne when evaluating resource selection in Request for Offers, or RFOs, as prescribed by California's state policy (described in more detail below).<sup>175</sup>

## **B. State Policy**

This section provides an overview of GHG adders prescribed by the states of California, Oregon and New Mexico.

### **a. California**

On April 2005, the CPUC adopted a policy that directs California's largest utilities (PG&E, SCE, Southern California Gas Company and SDG&E) to complete avoided cost of energy calculations based on a new methodology.<sup>176</sup> The methodology, developed by consulting firm E3, incorporates a levelized CO<sub>2</sub> adder of CDN \$10.22 per tonne, increasing at 5% per year.<sup>177</sup> This is based on a CO<sub>2</sub> price of CDN \$6.20 per tonne in 2005, CDN \$14.26 per tonne by 2008, and CDN \$17.51 per tonne by 2013.<sup>178,179</sup> CPUC's policy requires the utilities to apply these CO<sub>2</sub> price adders as an analytic tool in the evaluation of energy efficiency programs and other procurement processes. Specifically, for contracts greater than or equal to five years in length, the utilities are required to employ a GHG adder when evaluating fossil and renewable generation bids received via an all source RFO.<sup>180</sup>

On October 2007, the CEC released a draft of their 2007 Integrated Energy Policy Report (IEPR). The IEPR, prepared by the CEC every two years, provides energy policy recommendations based on an integrated assessment of future trends in California's

<sup>174</sup> San Diego Gas & Electric, 2007-2016 Long-Term Procurement Plan, Volume I, December 11, 2006, p. 18, <http://www.sdge.com/regulatory/tariff/docs/2007-2016SDGELTPPVOLUME1PUBLIC.pdf>

<sup>175</sup> Based on SDG&E's 2007-2016 Long-Term Procurement Plan and email exchanges with Wendy Keilani at Sempra Utilities, SDG&E's parent company.

<sup>176</sup> California Public Utilities Commission, Decision 05-04-024, April 7, 2005, p. 4, [http://www.cpuc.ca.gov/word\\_pdf/FINAL\\_DECISION/45284.pdf](http://www.cpuc.ca.gov/word_pdf/FINAL_DECISION/45284.pdf)

<sup>177</sup> Energy and Environmental Economics, Inc. (E3), Methodology and Forecast of Long Term Avoided Costs for the Evaluation of California Energy Efficiency Programs, October 25, 2004. Pp. 79, 82, [http://ethree.com/CPUC/E3\\_Avoided\\_Costs\\_Final.pdf](http://ethree.com/CPUC/E3_Avoided_Costs_Final.pdf). Cited in California Public Utilities Commission, Decision 05-04-024, April 7, 2005

<sup>178</sup> Ibid, pp. 88-89; and California Public Utilities Commission, Decision 05-04-024, April 7, 2005, p. 29, [http://www.cpuc.ca.gov/word\\_pdf/FINAL\\_DECISION/45284.pdf](http://www.cpuc.ca.gov/word_pdf/FINAL_DECISION/45284.pdf)

<sup>179</sup> All prices per short ton were converted to prices per tonne (1 ton = 0.9072 metric tons), and into 2007 dollars (from assumed 2005 dollars) using historical annual inflation rates based on CPI data from the BLS available at <http://www.bls.gov/cpi/home.htm>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada's CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>180</sup> California Public Utilities Commission (CPUC). "Order Instituting Rulemaking to Promote Policy and Program Coordination and Integration in Electric Utility Resource Planning," December 16, 2004. p. 47, [http://www.cpuc.ca.gov/WORD\\_PDF/FINAL\\_DECISION/43224.PDF](http://www.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/43224.PDF)

electricity, natural gas and transportation sectors. In the 2007 draft report, the CEC indicates that estimates of the cost per tonne of CO<sub>2</sub> used in western utility resource planning range from \$0 to \$68 per tonne, and are above those prescribed by the CPUC.<sup>181,182</sup> In addition, the CEC notes that recent estimates of the cost of CO<sub>2</sub> emissions in 2020 (\$11.71-\$38.65 per tonne) by Synapse, an energy economics consulting firm, are higher than the GHG adders required by CPUC.<sup>183,184,185</sup> The Synapse report states that this range is “reasonably plausible for use in resource planning.”

## **b. Oregon**

In 1993, the OPUC mandated that utilities must use various CO<sub>2</sub> adder prices when conducting scenario analyses in long term resource plans. Order 93-695 requires utilities to use price adders of CDN \$0 per tonne, CDN \$19.14 per tonne, \$47.86 per tonne, and \$76.58 per tonne of CO<sub>2</sub>, or price adders at least within the range of \$0 and \$76.58 per tonne CO<sub>2</sub> when conducting the analyses.<sup>186,187</sup> In January 2007, the OPUC adopted Order Number 07-002, which is aimed at revising the least-cost resource planning requirements for utilities. The order directs the OPUC to investigate the treatment of CO<sub>2</sub> risk in IRPs and how best to establish reasonable CO<sub>2</sub> base case and trigger point costs, although no specific price adder is proposed. In addition, the order directs utilities

---

<sup>181</sup> 2007 Integrated Energy Policy Report, Draft Committee Report, p. 115

<http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CTD.PDF>

<sup>182</sup> Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). Next, adder prices were converted from (assumed) US \$2007 to CDN \$2007 using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada’s CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>183</sup> 2006 IEPR Update, p. 55, <http://www.energy.ca.gov/2006publications/CEC-100-2006-001/CEC-100-2006-001-CMF.PDF>. Cited in 2007 Integrated Energy Policy Report, Draft Committee Report, p.115.

<sup>184</sup> Prices per short ton were converted into prices per tonne (1 short ton = 0.9072 metric tons). Prices were then converted from (assumed) US \$2007 to CDN \$2007 using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada’s CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

<sup>185</sup> The original estimates in the report are as follows. Estimates of a levelized value for CO<sub>2</sub> range from \$8.5 (Low Case) to \$30.8 (High Case) per short ton in the 2010-2040 period (2005 dollars). In addition, estimates of carbon prices in 2020 range from \$10 (Low Case) to \$40 (High Case) per short ton (2005 dollars). See Synapse Energy Economics Inc, *Climate Change and Power: Carbon Dioxide Emissions Costs and Electricity Resource Planning*, p. 41 <http://www.synapse-energy.com/Downloads/SynapsePaper.2006-06.0.Climate-Change-and-Power.A0009.pdf>.

<sup>186</sup> Order Number 93-695, May 17, 1993, referenced in OPUC Staff Report November 2006, <http://www.puc.state.or.us/PUC/meetings/pmemos/2006/112106/reg5.pdf>

<sup>187</sup> Adder prices in Order 93-695 were US \$0, US \$10, US \$25 and US \$40 per short ton (in 1990 dollars). All prices per short ton were converted into prices per tonne (1 ton = 0.9072 metric tons), and from 1990 dollars into 2007 dollars using historical inflation rates based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada’s CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

to use their expected cost for CO<sub>2</sub> in its base case pursuant to the cost range established under Order 93-695.<sup>188</sup>

**c. New Mexico**

On May 16, 2007 the New Mexico Public Regulation Commission adopted a policy directing electric utilities to incorporate various prices for carbon emissions when filing their IRPs.<sup>189</sup> For each new IRP filing, utilities are required to conduct sensitivity analyses using CO<sub>2</sub> adder prices of CDN \$8 per tonne, CDN \$20 per tonne, CDN \$40 per tonne, and any other utility-proposed CO<sub>2</sub> emission price that is considered fair and reasonable by the Commission.<sup>190</sup> Each CO<sub>2</sub> price is to be analyzed as an operating cost beginning in 2010 and must be escalated at 2.5% annually starting in 2011.

**VI. Conclusion**

The price estimates in the table below reflect prices associated with the scenarios and sensitivity cases that we believe are most likely to occur (relative to the other scenarios considered in this analysis) over the 2012-50 time horizon, as discussed in detail in Section III. The prices in the table represent estimated GHG prices during this period for BC firms (and for firms in other jurisdictions participating in the WCI/WECC regional trading program in 2012-15), for Canadian firms facing requirements under a Canadian Federal GHG program, and for U.S. firms facing requirements under a U.S. federal GHG program. For planning and modeling purposes, if a single estimate is required for each year, the mid-point of each range of price estimates is provided. All estimates are provided in January 1, 2008 Canadian dollars.

As shown in the table, estimated prices for BC in 2012 and 2015 are those associated with the WCI/WECC sensitivity case. As discussed in detail in Section III.E, the “BC compliance instruments only” case is unlikely in view of the very high costs associated with meeting the BC target while limiting eligible offsets to those generated in BC. Subject to the caveats and conditions identified in sections III and IV and other significant uncertainties, it appears that: 1) the WCI/WECC sensitivity case represents the most likely scenario for estimating GHG prices in BC in 2012-2015; and 2) the Linked Markets scenario represents the most likely scenario for estimating GHG prices in the

<sup>188</sup> Oregon Public Utilities Commission, Order Number 07-002, January 8, 2007, <http://apps.puc.state.or.us/orders/2007ords/07-002.pdf>.

<sup>189</sup> Case No. 06-00448-UT: Order Approving Recommended Decision and Adopting Standardized Carbon Emission Costs for Integrated Resource Plans, May 16, 2007, <http://www.puc.state.nm.us/generalcounsel/pdf/06-00448-Utorderapproving.pdf>

<sup>190</sup> Adder prices were US \$8, US \$20, and US \$40 per metric ton (we assume expressed in 2010 dollars). All prices were converted from 2010 dollars into 2007 dollars using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl> using a discount factor equal to the average inflation rate over the past 10 years. This is approximately 2.66% based on CPI data from the BLS in <http://data.bls.gov/cgi-bin/cpicalc.pl>. Next, adder prices were converted from \$US to \$CDN using an exchange rate of US \$1 = CDN \$1.05 obtained from [www.xe.com](http://www.xe.com) on July 20, 2007. Lastly, prices were converted to 2008 CDN dollars based on the Bank of Canada’s CPI projections for the 3<sup>rd</sup> and 4<sup>th</sup> quarter of 2007, <http://www.bankofcanada.ca/en/mpr/pdf/update120707.pdf>.

Canadian Federal program and the U.S. in 2012-15. To reiterate, the Linked Markets scenario assumes that the current Canadian Federal GHG program, including the price cap, continues through 2015, and a U.S. federal program with targets consistent with a 550 ppmv global concentration target (e.g. S. 280) begins in 2012.

Starting in 2020, estimated prices in all jurisdictions are those associated with the Linked Markets scenario. This scenario appears to be the most likely scenario among those considered in this analysis starting in 2020, subject to the caveats and conditions discussed in Sections III and IV and other significant uncertainties. By 2020, it appears that BC would harmonize its approach with the Canadian Federal Government, and WCI/WECC states would adopt the U.S. Federal Government's GHG targets. Different requirements at the state and Federal level will be difficult to maintain over time, given the added cost burden and compliance complexity that this would impose on the private sector and the likely opposition of companies that own and operate assets in states with more stringent targets and GHG policies or that have differing targets and GHG policies.

**Table 8: GHG Price Estimates for Policy Scenarios Assessed to be Most Likely in 2012-15 and 2020-50**

| Year                                                                                       | 2012                                        | 2015    | 2020                           | 2030    | 2040    | 2050    |
|--------------------------------------------------------------------------------------------|---------------------------------------------|---------|--------------------------------|---------|---------|---------|
| <b>Most Likely Policy Scenario</b>                                                         | <b>WCI/WECC Compliance Instruments Only</b> |         | <b>Linked Markets Scenario</b> |         |         |         |
| <b>BC Price Ranges (all prices CDN\$2008/tonne CO<sub>2</sub>e)</b>                        | \$9-14                                      | \$16-46 | \$15-25                        | \$24-54 | \$39-59 | \$63-97 |
| <b>BC Mid-Point</b>                                                                        | \$12                                        | \$31    | \$20                           | \$39    | \$49    | \$80    |
| <b>Canadian Federal Program (intensity target and price cap through 2015) Price Ranges</b> | \$14                                        | \$18    | \$15-25                        | \$24-54 | \$39-59 | \$63-97 |
| <b>Canadian Mid-Point</b>                                                                  | \$14                                        | \$18    | \$20                           | \$39    | \$49    | \$80    |

|                                                                                |         |                        |         |         |         |         |
|--------------------------------------------------------------------------------|---------|------------------------|---------|---------|---------|---------|
| <b>U.S. Federal Program (McCain-Lieberman or similar in 2012) Price Ranges</b> | \$12-18 | \$11-17 <sup>191</sup> | \$15-25 | \$24-54 | \$39-59 | \$63-97 |
| <b>U.S. Mid-Point</b>                                                          | \$15    | \$14                   | \$20    | \$39    | \$49    | \$80    |

---

<sup>191</sup> The price range in 2015 (\$11-17) is lower than the price range in 2012 (\$12-18). This result is counter-intuitive, and can be explained as follows. There is only one price estimate available for 2012 (\$15). To provide a range, we adjusted that estimate by +/-20% resulting in \$12-18 in 2012. In contrast, there were several model estimates available in 2015, ranging from \$11 to \$17, which we did not adjust by a factor of +/-20%. (Note that the study providing the \$11 estimate in 2015 did not provide an estimate for 2012.)

## **Appendix I – Key Assumptions and Uncertainties in Economic Models**

As discussed in Section IV, this analysis considers economic models that incorporate various GHG policy scenarios to derive future GHG prices. By design, these models often adopt simplistic assumptions regarding future implementation of GHG policies and markets that operate in a frictionless fashion and with perfect economic efficiency. Since these assumptions influence estimates of GHG prices, this appendix provides additional details on key assumptions in, and differences between, models to place model estimates in context and to identify and understand important uncertainties.

### **A. The United Nations Framework Convention on Climate Change (UNFCCC)**

The Convention's objective follows:

“The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.”

The UNFCCC process has not yet specified a particular target concentration. However, to stabilize concentrations at any level ranging from 450 ppmv to 750 ppmv,<sup>192</sup> significant reductions of GHG emissions from emission levels that might be anticipated if present trends were to continue need to be achieved on a global basis during the course of the 21<sup>st</sup> century. The magnitude of the reductions is dependant on the ceiling that is ultimately selected and the level of future GHG emissions.

### **B. Overview of Scenarios and Assumptions Incorporated in Economic Models of Emissions Trading Considered in this Study**

#### **1. Concentration Targets in Climate Policy-related Economic Models**

The IPCC has issued its fourth assessment report, which includes a review and assessment of economic models which consider the costs of reaching long-term concentration targets.<sup>193</sup> As noted in the IPCC report, models commonly consider targets for stabilizing the atmospheric CO<sub>2</sub> concentration, or, if more than one GHG is included,

<sup>192</sup> Concentrations of CO<sub>2</sub> today are approximately 380 ppmv, and, under a range of illustrative scenarios developed by the Intergovernmental Panel on Climate Change (IPCC), are forecast to rise rapidly and reach as high as 540 to 970 ppmv by the turn of the next century (IPCC Third Assessment Report: Climate Change 2001 Synthesis Report – Summary for Policymakers: <http://www.ipcc.ch/pub/un/syren/syren/spm.pdf>).

<sup>193</sup> Intergovernmental Panel on Climate Change (IPCC), IPCC Fourth Assessment Report, Working Group 3, Chapter 3: Issues related to mitigation in the long-term context, 2007, [http://www.mnp.nl/ipcc/pages\\_media/FAR4docs/final%20pdfs%20of%20chapters%20WGIII/IPCC%20WGIII\\_chapter%203\\_final.pdf](http://www.mnp.nl/ipcc/pages_media/FAR4docs/final%20pdfs%20of%20chapters%20WGIII/IPCC%20WGIII_chapter%203_final.pdf)

the corresponding target of stabilizing radiative forcing.<sup>194</sup> The scenarios that are most studied are those that aim to stabilize radiative forcing at 4 to 5 W/m<sup>2</sup> (watts per square meter) or 490 to 570 ppmv (parts per million) CO<sub>2</sub>.<sup>195</sup>

Within this group, 550 ppmv (or comparable radiative forcing targets) is commonly considered, and provides a useful benchmark for several reasons. First, it is extremely ambitious in terms of the level of global emission reductions required to achieve the target. A 550 ppmv target may serve as a reasonable upper bound in terms of stringency, particularly in light of the difficulty of meeting a 450 ppmv target. At this time, it appears unlikely that the international community would agree to a 450 ppmv target given that the concentration level has already surpassed 380 ppmv in 2005, and global emissions are projected to increase significantly due to increasing emissions from developing countries such as China and India.<sup>196</sup> Price estimates from economic models show prohibitive costs of meeting a 450 ppmv target (e.g. one study estimates prices of \$90 in 2020, \$291 in 2050).<sup>197</sup>

The 550 ppmv target concentration is also used because it can serve as a bridge between: 1) “integrated assessment models” (which we refer to as “global models”) that overlay economic models on top of global climate models, and that estimate the economically efficient emission reduction trajectory consistent with meeting the target (i.e. an idealized policy scenario), and 2) models of specific U.S. GHG policies and targets that are currently under consideration, which more closely reflect the magnitude and timing of the emission reduction targets that could be implemented, at least in the U.S. Specifically, a study by the Massachusetts Institute of Technology (MIT) suggests that the emissions targets incorporated in S. 280 are consistent with the U.S. targets that would be needed to help achieve a global stabilization target of 550 ppmv, provided that both developed and developing nations also undertake ambitious targets that are specified in the study.<sup>198</sup> The S. 280 targets for covered sectors are approximately 17% above 1990 levels from 2012-19, 1990 levels from 2020-29, 22% below 1990 levels from 2030-49, and 60% below 1990 levels starting in 2050. Other developed country targets would decrease from Kyoto emissions levels in 2012 to 50% below 1990 levels in 2050, and developing country targets would begin at 2015 levels starting in 2025, and would decrease to 2000 levels in 2035.<sup>199</sup> The link between a 550 ppmv scenario and targets in S. 280 (and in other bills currently under consideration, such as S. 2191, which many believe will be the vehicle voted on in the EPW) is particularly useful in that two economic modeling

<sup>194</sup> IPCC 2007, op. cit. A radiative forcing target weights the concentrations of different gases by their radiative properties, and is measured in watts per square meter (W/m<sup>2</sup>).

<sup>195</sup> IPCC 2007, op. cit.

<sup>196</sup> Nordhaus, 2007, *The Challenge of Global Warming: Economic Models and Environmental Policy*, July 2007.

<sup>197</sup> IGSM (MIT) model in U.S. Climate Change Science Program (CCSP), *CCSP Synthesis and Assessment, Product 2.1, Part A: Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations*, July 2007, <http://www.climatechange.gov/Library/sap/sap2-1/finalreport/sap2-1a-final-all.pdf>

<sup>198</sup> Massachusetts Institute of Technology (MIT) Joint Program on the Science and Policy of Global Change, *Assessment of U.S. Cap-and-Trade Proposals*, Sergey Paltsev, John M. Reilly, Henry D. Jacoby, Angelo C. Gurgel, Gilbert E. Metcalf, Andrei P. Sokolov and Jennifer F. Holak Report No. 146, April 2007, [http://web.mit.edu/globalchange/www/MITJPSPGC\\_Rpt146.pdf](http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt146.pdf)

<sup>199</sup> MIT 2007, op. cit.

analyses of this legislation have been performed. This allows for the consideration of price estimates from both global and U.S.-focused models. In addition, as the targets in S. 280 are ambitious and in the upper range of targets currently being considered in Congress, modeling estimates for this legislation are particularly relevant for this analysis.

At the time of this analysis, international negotiations have not yet begun in earnest on GHG emission reduction targets in the post-2012 period. Therefore, it remains to be seen whether these discussions, and a possible eventual agreement, with or without the U.S., will be based on a concentration target, such as 550 ppmv, or another type of target, such as a radiative forcing target or target that attempts to cap temperature increases. An example of this type of target is the EU's global goal of preventing an increase in temperature of more than 2 degrees Celsius above the temperature in pre-industrial times, which is required to prevent irrevocable consequences from global climate change.<sup>200</sup> This target informs the EU's pledge to reduce its GHG emissions by at least 20% from 1990 levels by 2020 or by 30% if a satisfactory global agreement is reached.<sup>201</sup> In any event, it appears likely that any target adopted in international discussions will seek to avoid dangerous anthropogenic interference with the climate system, and that it will require significant emission reductions, such as those required under a 550 ppmv target.

Regardless of the long term concentration target that is ultimately agreed to, the key dynamics that will affect the future cost of stabilization and the price of GHG compliance instruments include the allocation of the carbon budget between nations, when developing nations begin to participate in the effort to stabilize, technological advancements, and the pathway that is adopted to achieve the target concentration ceiling (i.e. the stabilization path). With regard to the stabilization path, models that assume more rapid emission reductions in the first half of the century tend to estimate higher prices from 2020-2040 than those that assume that most of the emissions reductions required for stabilization take place in the second half of the century. Additional discussion on factors affecting economic model price estimates is provided below.

## **2. Drivers of Differences Between Global Model Results, and Related Uncertainties**

The GHG price estimates included in the IPCC Fourth Assessment Report are derived from global economic models that typically optimize many of the key factors that will affect GHG prices, including the timing and location of emission reductions (which is known as “when” and “where” flexibility), and gases reduced (known as “what” flexibility). These models are designed to calculate the minimum-cost emission trajectory associated with a given target (e.g. a concentration target or a radiative forcing target).

---

<sup>200</sup> <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/16>. The IPCC Fourth Assessment report concludes that probable temperature rise by the end of the century will be 1.8 to 4 degrees Celsius (presentation entitled, “Climate Change: Mitigation; AR4 of the Intergovernmental Panel on Climate Change,” by Professor Ogunlade R. Davidson, Co-Chair of Working Group III, Division of Technology, Industry and Economics, United Nations Environment Program, Paris, France, June 29, 2007 ([http://www.ipcc.ch/CC\\_Science\\_Paris0707.ppt#301,1,Climate Change: Mitigation AR4 of the Intergovernmental Panel on Climate Change \(IPCC\)](http://www.ipcc.ch/CC_Science_Paris0707.ppt#301,1,Climate%20Change:%20Mitigation%20AR4%20of%20the%20Intergovernmental%20Panel%20on%20Climate%20Change%20(IPCC))))

<sup>201</sup> Ogunlade 2007, op. cit.

While these models hold this approach in common, there are many different inputs within these models that may have a significant impact on GHG price estimates. A brief discussion of some of the important differences in the elements and assumptions of global models follows.

The IPCC's Fourth Assessment report and studies cited in that report note some of the leading sources of differences in the estimates provided by global economic models, apart from differences in concentration targets.<sup>202</sup> As would be expected, models that incorporate relatively high baseline emission estimates (i.e. reference case or business as usual (BAU) estimates) tend to estimate higher costs for comparable stabilization targets. Differences in baseline estimates themselves are due to uncertainties to the variables that impact GHG emissions including population growth, economic activity, and energy production, conversion and end use. Models with the highest costs tend to be those that combine assumptions of very slow induced technology change (i.e. technology changes beyond BAU levels induced by policies and measures) with high baseline emissions. Other important factors that have been found to have strong impacts on cost outputs in models include: how revenues are used (i.e. revenues from auctions under assumed economy-wide cap and trade programs, or, equivalently, from carbon taxes); the levels of when, where and what flexibility (timing of reductions, trading, inclusion of all six Kyoto Protocol GHGs rather than just CO<sub>2</sub>, and banking); the use of backstop technologies (i.e. technologies that achieve significant reductions in emissions, such as zero-carbon energy technologies); the number and type of technologies covered; and substitution elasticities, which relate to abatement costs. In addition, models that incorporate intertemporal optimization (i.e. in which economic actors are assumed to act with perfect foresight) tend to show lower prices than recursive dynamic models in which mitigation options are adopted based only on today's carbon price. Finally, the strongest divergence among models relates to their assumptions on the contribution of land use-related mitigation. This variation is due to uncertainties regarding competition for land between bio-energy plantations and use of land for terrestrial sinks.

As suggested by the discussion above, the many differences among models and their cost and GHG price estimates are due in large part to multiple inputs and assumptions and significant uncertainties relating to those inputs and assumptions. Any consideration of GHG price estimates needs to be viewed in this context.

### **3. Differences Between Global Models and U.S. and Rest-of-World Models**

The analysis in this paper considers both global economic models and models of a U.S. trading program that incorporate specific targets and timetables and allow for the use of both domestic and international offsets. As discussed below, the models that which assume earlier reductions and restrict the use of "where" flexibility tend to lead to higher prices.

Global economic models that estimate GHG prices associated with meeting a particular stabilization target tend to assume full "when, where and what" flexibility, such that

---

<sup>202</sup> Information from this paragraph derives from IPCC unless otherwise noted.

emission reductions of GHGs (not limited to CO<sub>2</sub>) are assumed to occur whenever and wherever in the world they are most cost-effective. In contrast, the U.S. trading program models considered in this paper assume specific “hard” targets and timelines. Specifically, analyses by the EPA and EIA estimate GHG prices under S. 280, which would set targets of 2004 levels (or approximately 16% above 1990 levels) from 2012-19, 1990 levels from 2020-29, 21% below 1990 levels from 2030-49, and 57% below 1990 levels starting in 2050. In addition to these U.S. targets, the EPA analysis also assumes targets for other developed and developing countries that, together with the U.S. targets, would be consistent with a 550 ppmv CO<sub>2</sub> concentration target: other developed country targets would decrease from Kyoto emissions levels in 2012 to 50% below 1990 levels in 2050, and developing country targets would begin at 2015 levels starting in 2025, and would decrease to 2000 levels in 2035 (the EIA analysis modifies these targets in its study).<sup>203</sup> The two studies assume that these targets must be met in specified years, and allow for the banking forward of surplus reductions, but not borrowing. Global models, on the other hand, allow reductions to take place across time and jurisdictions in a least-cost manner, and do not incorporate pre-established targets or timetables apart from the concentration target. This is a key reason why global models result in generally lower GHG price estimates.

#### **4. Differences Between Assumptions in Economic Models and Real-world GHG Policy Implementation and Markets**

In addition to the various differences among assumptions incorporated in different global models, and differences between global models and U.S. models, there are many important differences between model assumptions (global models in particular) and the way in which emission reduction targets and policies are likely to be implemented in practice.

As noted in the IPCC report, the vast majority of global models assume transparent markets, no transaction costs, and adoption of cost-effective mitigation (e.g. a carbon tax, or cap and trade programs covering all GHG emissions).<sup>204</sup> If one or more of these assumptions is different in practice, there will be notable differences between model outputs and real-world outcomes. For example, costs will increase significantly if only industrialized countries take on targets, or if any element of what, where or when flexibility is constrained by policy choice.<sup>205</sup>

There are several ways in which these assumptions diverge from GHG policies and markets as they have been implemented and have operated to date. GHG markets are not fully transparent, and while market liquidity has increased, they are far from being fully

---

<sup>203</sup> The targets in the EPA report were selected based on assumptions in MIT 2007, op. cit. That study provides comparisons of GHG limits under different U.S. GHG proposals and those consistent with a 550 ppmv target. U.S. Environmental Protection Agency (EPA), *EPA Analysis of The Climate Stewardship and Innovation Act of 2007, S. 280 in 110<sup>th</sup> Congress*, July 16, 2007, <http://www.epa.gov/climatechange/downloads/s280fullbrief.pdf>

<sup>204</sup> IPCC 2007, op. cit.

<sup>205</sup> IPCC 2007, op. cit.

efficient – particularly markets for project-based reductions (i.e. CERs and ERUs<sup>206</sup>). To date, there is not a single example of a country that has achieved completely cost effective mitigation through a carbon tax or universal cap and trade. In practice, countries participating in the Kyoto Protocol have implemented a range of GHG policies and measures for different sectors. These policies and measures can be significantly less cost-effective than an economy-wide cap and trade (e.g. fuel economy standards for vehicles have high costs per tonne of GHG emissions abatement). The EU is the only region in which market-based mechanisms currently play a very significant role, and even there, the EU Emissions Trading Scheme covers just under 50% of the EU's CO<sub>2</sub> emissions and approximately 40% of the EU's GHG emissions. Thus, in practice regulatory measures are used to a great extent to reduce GHG emissions. As a result, costs for meeting Kyoto targets will be higher than those estimated by a typical global model, which assumes cost-effective mitigation in all participating countries.

In addition to these important differences, economic models tend to estimate unrealistically low prices for international offsets because: 1) they are based on bottom-up estimates of marginal costs, which can be overly optimistic (see discussion on marginal costs); and, 2) they do not capture market dynamics that currently influence prices for CERs created from CDM projects in developing countries. CER prices are strongly influenced by prices for EU Allowances (EUAs)<sup>207</sup> because both EUAs and CERs (for the most part) can be used for compliance under the EU Emissions Trading Scheme. EUA prices are significantly higher than the marginal costs of creating CERs from CDM projects due to specific dynamics in the EU ETS market that are not captured in economic models. The ability of most European power producers to recover the cost of allowances in electricity prices, and current prices for coal and gas, increase demand for and prices of EUAs, which in turn results in CER prices that are far higher than marginal costs of abatement for the projects that create CERs.<sup>208</sup> Since economic models, whether they be U.S. trading program or global models, do not take such dynamics into account, it is likely that they underestimate the price of international offsets, and other prices (e.g. prices in the U.S. GHG market) that are affected by the price of international credits.

---

<sup>206</sup> CERs are Certified Emission Reductions created from Clean Development Mechanism (CDM) projects in developing countries. ERUs are Emission Reduction Units created from Joint Implementation (JI) projects in countries with economies in transition (e.g. Russia, Ukraine and Eastern European countries). CERs and ERUs can be used by national governments for compliance with national Kyoto Protocol emissions reduction requirements, by EU firms for compliance with targets under the EU Emissions Trading Scheme (EU ETS), and by Japanese firms for compliance with voluntary emissions targets under the Keidanren Voluntary Action Plan.

<sup>207</sup> EU Allowances are emissions permits issued to entities covered under the EU Emissions Trading Scheme. They can be freely traded, used for compliance, or banked into the post-2012 trading period.

<sup>208</sup> At the time of this writing, EU Allowances (EUAs) in 2008-12 (i.e. Phase 2 of the EU Emissions Trading Scheme (EU ETS)) are trading for approximately €20 per tonne CO<sub>2</sub>, or approximately CDN \$29. Estimates of Phase 2 EUA prices developed by the research departments of financial institutions and consulting firms range from approximately €15 to €35, or approximately CDN \$22 - \$50.

## 5. Use of Marginal Cost Data, and Related Caveats

Marginal cost data (i.e. \$/tonne CO<sub>2</sub>e estimates of abating emissions using a particular technology or from a particular activity) underlie estimates of domestic and international offsets in economic models, and also provide the basis for our estimates of offset and compliance instrument prices in the sensitivity cases, as discussed in Section IV. Marginal cost estimates are typically based on the “technical costs” of emissions abatement opportunities. Such estimates may be significantly lower than actual market prices. First, they may not account for: 1) barriers that can prevent the implementation of emission abatement activities; or 2) the time required for diffusion of information or technology.<sup>209</sup> They also may only consider the cost of achieving the reduction, and not of achieving reductions that are recognized under a regulatory program and convertible into offsets valid for compliance. Costs to create eligible offsets include costs for intermediaries, costs for measurement, monitoring and verification, and legal costs. All of these costs are necessary to originate, develop and create offsets. Internal costs include those for staff to undertake detailed filings that require legal and engineering expertise, and for development of internal systems to manage and audit contracts. Additionally, it is unlikely that all technically achievable reductions will be convertible into offsets in a regulatory regime due to difficulties in measuring and verifying reductions.

Some models recognize these factors and attempt to address them through various adjustments to marginal cost curves. However, most models either do not address them or are not sufficiently transparent to indicate whether they are addressed. Even the models that do address these issues (such as the EIA analysis of S. 280) do not fully take into account the way in which prices are set in the current GHG market. Specifically, CERs are priced based on buyers’ willingness to pay, which has been higher than the marginal costs of abatement from projects, even if those costs are adjusted upwards to take various transaction costs into account. Buyers that have a compliance shortfall are often willing to pay a premium to ensure that they beat out competing bids and secure CERs. The scarcity and uncertainty of CER supply has factored into the psychology of buyers, and has had the impact of raising prices. We are not aware of any model that is able to capture this dynamic. In addition, economic models typically do not capture dynamics in the EU ETS that are contributing to higher CER prices, as noted above.

## 6. Nascent Stage of GHG Models and Unpredictable Nature of GHG Prices

Although GHG markets have grown significantly since 2005, the first year of the EU Emissions Trading Scheme, they are still in a nascent stage. Furthermore, prices are subject to a wide range of factors that are difficult to predict, as suggested by the wide range of EUA price estimates for a relatively near-term period (2008-12). For example, it is not possible to predict with any confidence whether Russia will seek to flood the GHG market with its surplus (or “hot air”) Assigned Amount Units (AAUs), whether

<sup>209</sup> U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 280*, the Climate Stewardship and Innovation Act of 2007, July 2007, [http://www.eia.doe.gov/oiaf/servicrpt/csia/pdf/sroiaf\(2007\)04.pdf](http://www.eia.doe.gov/oiaf/servicrpt/csia/pdf/sroiaf(2007)04.pdf).

developed countries participating in the Kyoto Protocol would buy those instruments, and the resulting impact on EUA and CER prices. Given the significant uncertainties surrounding prices in the 2008-12 period, there are significant challenges to estimating prices beyond 2012, and many caveats must be assigned to such price estimates, as suggested by the discussion in this appendix.

**Appendix II – Economic Models Used in the Analysis**

The following discussion briefly summarizes the economic models used to estimate prices in the policy scenarios and the sensitivity cases, and provides references.

**A. Economic Models Used in the Policy Scenarios**

**National Commission on Energy Policy (NCEP), *Economic Analysis of Updated Commission Recommendations, June 2007.*<sup>210</sup>**

The NCEP study estimates prices for the NCEP’s recommended cap-and-trade program, which is nearly identical to S. 1766’s proposed cap-and-trade program. We consider the NCEP study in the Price Cap scenario as a possible source of GHG price estimates for the U.S. under S. 1766. The study provides estimates for 2020 and 2030 based on a policy case which incorporates EIA high technology assumptions and assumes that other policies and measures in the bill will lower compliance costs. Other analyses of cap and trade legislation, such as EIA’s and EPA’s, do not incorporate high technology assumptions in their core case analysis, and do not make assumptions regarding the impact of policies and measures on prices under a cap and trade program. For this reason, we believe the NCEP estimates of GHG prices under S. 1766 are overly optimistic, and adopt a proxy assumption that U.S. prices under S. 1766 would be at or below the price cap, which increases from \$CDN 11 in 2012 to \$70 in 2050.

**U.S. Energy Information Administration (EIA), *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007, July 2007*<sup>211</sup>**

The EIA study estimates GHG prices for 2012-30 under S. 280. It uses EIA’s *Annual Energy Outlook* to calculate baseline emissions, and EIA’s National Energy Modeling System (NEMS) to estimate energy-related CO<sub>2</sub> emissions under the policy. It also provides MACs based in some cases on EIA adjustments of EPA’s MACs (see bullet below under sensitivity cases). That bill would create a U.S. economy-wide GHG trading program setting the following emission reduction targets:

- 2012-19: 2004 levels (or approximately 17% above 1990 levels)
- 2020-29: 1990 levels
- 2030-49: 22% below 1990 levels
- 2050-: 60% below 1990 levels

It would set an annual limit on the use of offsets equal to 30% of an entity’s allowance allocation if those offsets include 1.5% in agricultural sequestration, otherwise offsets may account for a maximum of 15% of the allocation. The EIA study assumes the following emissions targets for countries other than the U.S.:

- EU: 20% below 1990 levels in 2020, 30% below in 2030

---

<sup>210</sup>

[http://www.energycommission.org/files/contentFiles/NCEP\\_Technical\\_Appendix\\_June\\_2007\\_4683bf3e2ca9b.pdf](http://www.energycommission.org/files/contentFiles/NCEP_Technical_Appendix_June_2007_4683bf3e2ca9b.pdf)

<sup>211</sup> [http://www.eia.doe.gov/oiaf/servicerpt/csia/pdf/sroiaf\(2007\)04.pdf](http://www.eia.doe.gov/oiaf/servicerpt/csia/pdf/sroiaf(2007)04.pdf)

- Other Group 1 (developed) countries: 10% below 1990 levels in 2020, 20% below in 2030
- Developing countries (Group 2): 2020 levels in 2025. So Group 1 more stringent than EPA/MIT, group 2 less stringent.
- The Group 1 targets are more stringent than those assumed by EPA and in the Duke conference models, and the Group 2 targets are less stringent; see EPA and Duke conference models below.

The EIA study considers a policy case scenario (which incorporates the 30% offsets limit) and an unlimited offsets scenario. GHG price estimates for these scenarios are incorporated in the price ranges for the Linked Markets scenario, which assumes that Canada and the U.S. implement ambitious targets (e.g. S. 280) and all countries' targets are consistent with achieving a 550 ppmv concentration target in an economically efficient fashion, and that limited constraints (i.e. S. 280's 30% offset limit) or no constraints would be imposed on international trading or domestic offsets.

**U.S. Environmental Protection Agency, *Analysis of Senate Bill S.280 in the 110th Congress, The Climate Stewardship and Innovation Act of 2007*, July 2007<sup>212</sup>**

The EPA study estimates GHG prices for 2012-50 under S. 280. It uses two different computable general equilibrium models: the Resource Triangle Institute's ADAGE model (see also the Ross study below) and the IGEM model to provide two sets of GHG price estimates. It considers a policy case scenario (which incorporates the 30% offsets limit) and an unlimited offsets scenario. GHG price estimates for these scenarios are incorporated in the price ranges for the Linked Markets scenario. It makes the same assumptions on non-U.S. emissions targets as those used in the Duke modeling conference:

- Group 1 (developed) countries follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050.
- Group 2 countries 2025 = 2015 levels; then 2000 levels in 2035-50.

**U.S. Climate Change Science Program (CCSP), *CCSP Synthesis and Assessment, Product 2.1, Part A: Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations*, July 2007.<sup>213</sup>**

The CCSP study includes three economic models, which were selected based on the criteria for the study:

- The Integrated Global Systems Model (IGSM) of the Massachusetts Institute of Technology's Joint Program on the Science and Policy of Global Change
- The MiniCAM Model of the Joint Global Change Research Institute, which is a partnership between the Pacific Northwest National Laboratory and the University of Maryland

---

<sup>212</sup> <http://www.epa.gov/climatechange/economicanalyses.html#s280>

<sup>213</sup> <http://www.climate-science.gov/Library/sap/sap2-1/finalreport/default.htm>

- The Model for Evaluating the Regional and Global Effects (MERGE) of GHG reduction policies developed jointly at Stanford University and the Electric Power Research Institute.

The study considers scenarios designed to stabilize atmospheric concentrations of CO<sub>2</sub> emissions at approximately 450, 550, 650 and 750 ppmv. We consider GHG price estimates for the 550 ppmv scenario in the Linked Markets scenario. Prices are provided for 2020, 2030 and 2050. It assumes that all GHG policies expire in 2012 (i.e. the U.S. meets its current emissions intensity target, and Kyoto Protocol (KP) participants meet their KP emissions targets) that emissions reductions take place wherever, whenever, and using whichever GHG was most cost-effective to meet limits. The models look ahead to 2100, which provides additional time to stabilize concentrations, and reduces costs in near term. As noted in Section IV, our price estimates in the Linked Markets scenario exclude results from two non-IPCC global models (MERGE and MiniCAM) because they are result in \$3-5 prices in 2020 and \$12-24 prices in 2050, which do not appear plausible.

***IPCC, IPCC Fourth Assessment Report, Working Group 3, Chapter 3: Issues related to mitigation in the long-term context, 2007.***<sup>214</sup>

The IPCC report considers the most recent available global economic modeling estimates of GHG prices and costs under different GHG targets. We reviewed modeling results provided by Keywan Riahi of IIASA in Austria (a lead author of the IPCC report's chapter on economic model results) for models that considered radiative forcing targets of 4.5 to 5 W/m<sup>2</sup>, which is approximately equivalent to an atmospheric CO<sub>2</sub> concentration target of 550 ppmv. In general, the IPCC models estimate very low prices because they assume maximum flexibility regarding the key variable regarding when / where and what GHG emissions are reduced in meeting a concentration target of 550 ppmv by 2100. The average of model prices for scenarios comparable to a 550 ppmv target was \$3.85 (base year unknown) for 2030 and \$8.80 in 2050. These prices are far lower than other prices we obtained, and appear to be implausible based on current market prices and more ambitious targets in the future.

**Economic models presented at conference entitled, “Economic Modeling of Federal Climate Legislation: Advancing Model Transparency and Technology Policy Development,” Washington, DC, Duke University’s Nicholas Institute for Environmental Policy Solutions, July 18, 2007.**

Results from the models were summarized in the following presentation: Brian Murray, Duke University’s Nicolas Institute for Environmental Policy Solutions, *Session I: Bounding Analyses of Climate Bills Using Selected Models*, July 18, 2007.<sup>215</sup>

Citations for the presentations on the models themselves follow:

<sup>214</sup>

[http://www.mnp.nl/ipcc/pages\\_media/FAR4docs/final%20pdfs%20of%20chapters%20WGIII/IPCC%20WGIII\\_chapter%203\\_final.pdf](http://www.mnp.nl/ipcc/pages_media/FAR4docs/final%20pdfs%20of%20chapters%20WGIII/IPCC%20WGIII_chapter%203_final.pdf)

<sup>215</sup> [http://www.nicholas.duke.edu/econmodeling/presentations/Session%20I%20synthesis\\_Murray.ppt](http://www.nicholas.duke.edu/econmodeling/presentations/Session%20I%20synthesis_Murray.ppt)

- Henry Jacoby, MIT Joint Center on MIT Joint Program on the Science and Policy of Global Change, *Assessment of U.S. Cap and Trade Proposals*, EPPA model<sup>216</sup>
- Martin Ross, RTI International, *Assessing Cap-and-Trade Proposals at the Global, National, and Sub-national scales with the ADAGE Model*<sup>217</sup>
- Ronald Sands, Pacific Northwest National Laboratory/University of Maryland Joint Global Change Research Institute, *Application of Second Generation Model (SGM) to U.S. Cap and Trade Reference Scenarios*.<sup>218</sup>

The models presented at the conference all consider GHG prices under U.S. targets that cap cumulative U.S. emissions until 2050 at different levels. They all assume no international trading of offsets. They also assume non-U.S. emissions targets as follows:

- Group 1 (developed) countries follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050.
- Group 2 countries 2025 = 2015 levels; then 2000 levels in 2035-50

In the Made in North America – Aggressive Targets scenario, which assumes no use of international offsets and emissions targets that are consistent with a 550 ppmv scenario (such as those in the McCain-Lieberman bill), we consider GHG price estimates from these models for their 203 billion metric tons scenario, which is comparable to emission levels through 2050 for the McCain-Lieberman bill.

## **B. Economic Models Used in Sensitivity Cases**

### ***Cost Curves for GHG Emission Reduction in Canada: The Kyoto Period and Beyond Final Analysis Report, MK Jaccard and Associates (MKJA) (January 2007)***<sup>219</sup>

MKJA uses a technology-simulation model (Canadian Integrated Modeling System, CIMS) to develop cost curves for reducing GHG emissions in 2010, 2015, 2020 and 2030. The study provides cost curves for GHG emission reductions at the regional, national and sector level, based the economy’s response to different GHG charges. GHG charges would be equivalent to an emissions tax or permit price. GHG charges associated with a level of emissions reduction are indicative of the marginal cost of achieving that level of reductions or target. We used MKJA cost curves as an input in our sensitivity analysis to: 1) estimate prices BC would face to achieve the province’s emission reduction target in the “BC compliance instruments only” sensitivity case; and 2) estimate prices when BC expands offset eligibility to include Manitoba and Alberta in the “WCI/WECC compliance instruments only” sensitivity case (see Section IV.E for more detail).

<sup>216</sup> <http://www.nicholas.duke.edu/econmodeling/presentations/Jacoby%20-%20Nicholas%20Symposium%207-18-07.ppt#455>

<sup>217</sup> <http://www.nicholas.duke.edu/econmodeling/presentations/Ross%20-%20Nicholas%20Symposium%20July%202007.PPT>

<sup>218</sup> [http://www.nicholas.duke.edu/econmodeling/presentations/Sands\\_Nicholas\\_Symposium\\_v3b.ppt](http://www.nicholas.duke.edu/econmodeling/presentations/Sands_Nicholas_Symposium_v3b.ppt)

<sup>219</sup> MK Jaccard and Associates, 2007, op. cit.

***Economic Analysis of a Cap and Trade System for Carbon Dioxide Emission Reduction in the Western States, Adam Rose, Professor of Energy, Environmental and Regional Economics, the Pennsylvania State University (August 2006)***<sup>220</sup>

The study models a cap and trade system to reduce CO<sub>2</sub> emissions in 11 Western States (Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington and Wyoming). The study estimates the market clearing price in 2012 and in 2020 for reducing emissions in the region to 2000 levels and to 10% below 2000 levels by 2020. We estimate the targets assumed in the study are consistent with current reductions commitments in WCI. In our view, Professor Rose's estimates of the marginal abatement costs in the WCI region are low. In particular, the study estimates significantly lower marginal costs of abatement in California than the Charles River study (see below). We use estimated prices in this study as a lower bound estimate in the "WCI/WECC compliance instruments only" sensitivity case (see Section IV.E for more detail).

***Program on Technology Innovation: Economic Analysis of California Climate Initiatives: An Integrated Approach. Volume 1: Summary for Policymakers, Charles River Associates International***<sup>221</sup> (June 2007)

The study uses the Multi-Region National-North American Electricity and Environment Model (MRN-NEEM) to examine a range of carbon policy implementation scenarios in California. The study estimates permit prices for CO<sub>2</sub> required to achieve California's GHG emissions target of 1990 levels by 2020. The study cites the Stavins 2007 report<sup>222</sup>, which calls into question the accuracy of low marginal cost estimates for California in several studies. We use estimated prices in this study as a proxy for WCI/WECC offset prices in the "WCI/WECC compliance instruments only" sensitivity case (see Section IV.E for more detail on the approach).

***Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007, U.S. Energy Information Administration (EIA) (July 2007)***<sup>223</sup>

EIA's estimate of the economic impacts of S.280, the Climate Stewardship and Innovation Act of 2007 (the McCain-Lieberman bill). The report provides estimates of the effects of S. 280 on energy markets and the economy, and estimates of GHG prices, through 2030. The study provides MACs for: 1) non-CO<sub>2</sub> GHG domestic offset supply from assumed covered sources: coal-related methane, nitrous oxide from adipic and nitric acid production, and fluorinated gases; 2) domestic offsets supplied from non-covered and exempt emissions sources: methane from natural gas and oil systems, landfills,

<sup>220</sup> <http://www.nmclimatechange.us/ewebeditpro/items/O117F9100.pdf>

<sup>221</sup> [http://www.crai.com/pubs/pub\\_7285.pdf](http://www.crai.com/pubs/pub_7285.pdf)

<sup>222</sup> Stavins et al, Too Good to Be True? An Examination of Three Economic Assessments of California Climate Change Policy, March 2007, [http://ksgnotes1.harvard.edu/Research/wpaper.nsf/rwp/RWP07-016/\\$File/rwp\\_07\\_016\\_stavins.pdf](http://ksgnotes1.harvard.edu/Research/wpaper.nsf/rwp/RWP07-016/$File/rwp_07_016_stavins.pdf)

<sup>223</sup> [http://www.eia.doe.gov/oiaf/servicerpt/csia/pdf/sroiaf\(2007\)04.pdf](http://www.eia.doe.gov/oiaf/servicerpt/csia/pdf/sroiaf(2007)04.pdf)

agriculture; nitrous oxide from agriculture, and carbon sequestration from agriculture and forestry; and 3) estimates of potential supply of surplus international offsets to the United States.