

Greenhouse Gas (GHG) Price Forecast

OVERVIEW

This Brief summarizes the factors that are expected to influence the emerging GHG market price, and the approach taken to develop and update BC Hydro's GHG price forecast.

What is a GHG Price Forecast and Why is it Needed?

Increased public awareness about climate change has spurred the development of policy and regulatory frameworks at the provincial, federal (Canada and US), US state, and international levels to reduce GHG emissions. These policies are expected to create a market price for GHG emissions through mechanisms such as emissions trading allowances, carbon offsets and taxes. Since the electricity sector is a significant source of GHG emissions in North America¹, a market price on GHG emissions presents risks and opportunities that utilities need to consider in long-term planning.

BC Hydro retained Black and Veatch (B&V) to conduct a review of emerging GHG policy, with a view to estimating the impacts on the price of GHG emission allowances – the main market instrument used under emissions trading systems.

What Influences GHG Price?

Several factors influence the market price of GHG emissions. Once a market regulatory framework has been established, GHG price is influenced by the key policy levers of *stringency of emission reduction targets* and the degree of *compliance flexibility* allowed to regulated sectors in the form of offsets and other investments and incentives. In general, more stringent targets and strict compliance requirements lead to higher prices, while lower targets and flexible compliance options such as offsets or technology investments lead to lower prices.

However, as a result of the global economic downturn that began at the end of 2008 and continues to be felt, two over-arching factors were also considered in the design of the GHG price forecast. *Global Economic Growth* - the rate at which economies across the world, including the US economy, will grow relative to pre-recessionary levels – was chosen due to its significant influence on electricity load growth, energy commodity supply/demand balance, and the ability of private and public sectors to fund GHG abatement controls. *Government Policy Maker* – GHG regulation initiated at the national level, or led by regional initiatives such as the Western Climate Initiative (WCI) and state/provincial programs – was considered because of the potential impacts on the geographic breadth of emerging carbon markets, the penetration of conservation and efficiency policies, the stringency of other environmental regulation, and government funding for research & development.

¹ GHG emissions from electricity are primarily from the combustion of coal and gas, and vary widely from region to region depending on generation resource mix. The electricity sector emits 42% of GHGs in the US, 17% in Canada, and about 2% in British Columbia.

PURPOSE

The GHG price forecast projects future financial costs of GHG emissions under a range of policy scenarios that may unfold over the IRP planning horizon. By characterizing risks and opportunities associated with emitting and non-emitting (clean or renewable) resources, the GHG price forecast provides an input to the electricity price forecast and facilitates the evaluation of various portfolio options.

Since considerable uncertainty is associated with projecting future outcomes, scenarios were developed to further define the factors that are expected to significantly influence the GHG price trajectory, and to demonstrate a wide range of possible future conditions for broader use in the IRP risk assessment, as discussed in the Summary Brief, *Market Scenarios for the IRP Risk Framework*. B&V's proprietary Electric Industry Carbon Model was then used to forecast the price of GHG allowances for selected scenarios.

Policy Framework

Because of the enormous size and broad influence of the US economy, GHG policy at the national level in that country will be the primary force that influences the price of GHGs worldwide. At the time of analysis and modelling, the leading US legislative bill expected to influence the price of GHG emissions was the Waxman-Markey Clean Energy and Security Act of 2009 (H.R. 2454). This energy bill focused on three areas, and reflected not only an interest in regulating GHG emissions directly, but in driving investment in renewable energy and conservation to promote energy independency and promote economic development in "green jobs".

- 1) Clean Energy – Promoted the use of renewable energy and carbon capture and storage (CCS), including a national renewable portfolio standard (RPS) requiring electricity utilities to meet 6% of their load from renewable resources beginning in 2012, rising to 25% in 2025.
- 2) Energy Efficiency – Sought to increase energy efficiency through all sectors of the economy (buildings, appliances, transportation and industry).
- 3) Climate Change – Sought to place limits on GHG emissions of 20% below 2005 levels by 2020; 42% below 2005 levels by 2030; and 83% below 2005 levels by 2050.

Although the Waxman-Markey bill was passed by the US House of Representatives on June 26, 2009, further progress was halted over the summer of 2010 as climate policy was further debated by the Senate. Waxman-Markey provides useful policy levers to consider in scenario development and GHG price modelling, and was used by B&V in its "Base" model forecast of GHG prices in 2009 and subsequently, for the scenario development and GHG price modelling for BC Hydro.

Regionally, the WCI provides a strong framework and design for emission trading. Since B.C. is a key partner in the WCI, it is also a critical consideration for BC Hydro, with provincial legislation to enable emissions trading already in place², and further regulations under development. The WCI has set a regional target of 15% reduction by 2020 (from 2005 levels); B.C.'s legislated reduction targets are more aggressive, at 33% below 2007 levels by 2020 and 80% by 2050, with interim targets of six per cent by 2012 and 18 per cent by 2016.

It is recognized that the results of the GHG price forecast need to be interpreted within the current policy environment, which suggests that national action toward emission trading in the US and Canada will be delayed in the near term. The key policy developments that are likely to impact the price of GHGs for BC Hydro for the purposes of IRP planning include:

² B.C. Greenhouse Gas Reduction (Cap and Trade) Act, Reporting Regulation (in force), and forthcoming regulations expected for Emission Trading and Cap and Trade Offsets. <http://www.env.gov.bc.ca/cas/mitigation/ggrcta/>

- The low likelihood related to the success of any new legislative proposals to create a national GHG emission trading scheme in the US in the short term – suggesting regional and state/provincial action in the short term;
- The evolving relationship between the GHG policies of Canada and the US at the Federal level, where Canada has stated its commitment to align its policy and timing with that of the US; and
- The evolving relationship between the GHG policies of B.C. and its partners in the WCI, which suggests that emissions trading³ could be implemented starting January 1, 2012.

The Market Scenarios

BC Hydro's goal in selecting market scenarios for analysis with B&V's carbon model was to capture a broad range of possible ways the future could unfold⁴. Scenarios were selected to form a small number of diverse, internally consistent combinations of the key factors that would influence market prices, including GHG allowances. One of the desired outcomes was that the scenarios would create a wide range of GHG price trajectories to help inform the IRP risk assessment, recognizing that the likelihood of the price outcomes would vary significantly.

The main factors influencing GHG price used to define the scenarios are defined in the Appendix to this Brief. The Scenarios⁵ used for analysis are described below:

Scenario A – High global economic growth leads to high commodity demand and broad environmental regulation

This scenario is characterized by high global economic growth driven by successful fiscal and monetary policies. The positive economic conditions leads to strong environmental policies related to GHG emissions, including international emissions trading. Although the strong economy renews public and government interest in environmental impacts and issues, the costs of regulation are attenuated to some extent by increased government spending on R&D. A national RPS is assumed, and this combined with strong spending on R&D and high natural gas prices, drives significant development of renewable energy, lowering their costs. Given the international breadth and cooperative nature of GHG markets, targets were modelled as *Conservative*, with *Flexible* compliance options.

³ At the end of 2010, it appeared that California, B.C., Ontario, Quebec and potentially New Mexico would have regulations and administrative requirements in place to start emissions trading in 2012.

⁴ Market scenario development is further explained in the Summary Brief, *Market Scenarios for the IRP Risk Framework*.

⁵ It is important to note that, since the Scenarios initially used to develop the GHG price forecast were subsequently used to develop natural gas and REC price forecasts, and since additional modelling runs were required from the initial GHG analysis to strengthen the robustness of the analysis, the *letters A to E* used to number the market scenarios do not match the scenario *numbering* used by B&V in their GHG price forecast report. For reference: Scenario A = B&V 1; B = B&V 3; C = B&V 4; D = B&V 9; E = B&V 8.

Scenario B – Slow but steady global economic growth sees regional leaders paving the way for national GHG markets

With slower but promising economic growth, regional initiatives such as the WCI take the lead in establishing GHG regulatory markets, with national US and Canadian governments following suit by 2020. Full international cooperation on GHG trading is not envisioned in this scenario. *Base* targets and *Flexible* compliance mechanisms were included in the modelling, reflecting the lower ability of governments to emphasize environmental concerns under medium economic growth. Although there are delays in national renewable energy standards, development is strong in later years (post 2020).

Scenario C – Low economic growth delays national GHG market development

With slow economic growth and activity, this scenario envisions that GHG emissions start to fall worldwide, taking the urgency out of the climate change debate and lowering public and government interest in GHG regulation. Lower natural gas prices and low electricity load growth delay spending on renewable energy and RPS development. Investments in R&D in conservation are also down. Although some progressive governments continue with regional initiatives to regulate GHGs, national action is delayed until at least 2020. With low economic growth, both *Conservative* targets and *Flexible* compliance mechanisms were assumed in modelling.

Scenario D – Delayed high economic growth and lower international cooperation stifles national action, leaving the regions to regulate GHG emissions

Although this scenario sees high global economic growth, it is delayed until at least 2016. International agreements on GHG regulation are not reached, and the slower economic growth and lower GHG emissions in early years lead to low levels of public support for GHG regulation in the US and lower public spending on renewable energy R&D. As with Scenario C, progressive state and provincial governments continue to move forward with emission trading, albeit under higher cost pressures for market participants. For modelling, *Base* GHG targets and *Flexible* compliance mechanisms were assumed.

Scenario E – Low economic growth and activity lead to lower GHG emissions and the absence of market prices

This scenario is similar to C, however with persistent low economic growth and associated lower fuel prices and electricity load, GHG prices remain low and over time, regional leaders begin to turn away from their GHG policies to focus on more pressing economic demands of constituents.

The Modelling

B&V's Carbon Model is based on the premise that as the supply of GHG emission allowances⁶ decreases due to decreasing emission caps, the price will increase, leading to the addition and increased use of lower CO₂-emitting electricity generation resources. Since the electricity sector currently contributes a large portion of emissions in the US and Canada, B&V focuses its modelling efforts on these emissions, assuming that it will be equally costly for other sectors (transportation, buildings, other industry) to reduce emissions, so that allowance trading between sectors will not substantially impact price.

⁶ An emission allowance is a government-issued permit to emit 1 tonne CO₂-equivalent of GHG. In an emission trading, or "cap and trade" system, regulated entities must submit 1 allowance for every tonne of GHG emitted under the cap.

The model iterates the addition and economic dispatch of electricity generators under an assumed emission trading program to determine least cost technology to meet demand growth in each region in Canada and the US. The GHG reduction and avoidance measures used in the model include:

- Efficiency improvements
- Additional renewable capacity
- Retirement of inefficient coal units
- Additional natural gas (combined cycle) units in place of new coal-fueled units
- Reduced operation of (existing) coal units
- Increased operation of (existing) gas units
- Additional nuclear capacity, in regions where this exists or is allowed
- Use of integrated gasification combined cycle (IGCC) with CCS.

Results and Discussion

The results of the GHG price modelling are shown in Attachment 2 and summarized in Table 1. They demonstrate the complex interactions of the influencing factors – that is, although we strive to find factors that are independent, the effects of the factors chosen on commodity and resource prices, and the flexibility of policy choices, particularly under medium and high economic growth conditions, can impact the response of GHG prices to the influencing factors.

Some general trends that can be observed from the GHG price forecast results are:

- Low economic growth leads to sustained low GHG allowance prices, combined with low commodity prices and electricity load. Given these conditions, governments would likely shift focus to other issues than environmental regulation, potentially leading to a zero-price case.
- Medium and high economic growth tends to support interest by government in regulating GHG emissions. Depending on prevailing economic conditions driving commodity prices (natural gas, oil) and associated demand for renewable energy, GHG prices can increase significantly under these scenarios.
- Spending on R&D in the areas of renewable energy and conservation & efficiency can reduce the costs of these abatement options. However they tend to be correlated with high growth and active regulatory frameworks, therefore the increased demand for these options can increase GHG allowance price.
- High economic growth does not necessarily lead to high GHG prices, and can result in medium-level prices. Scenario A, which has high economic growth across the planning horizon, as well as high natural gas prices, does not result in the expected high GHG price due to the assumed cooperation by national governments to establish international-scale GHG markets. Scenario D on the other hand, assumes delayed onset of significant economic recovery, without national agreement on climate action, leaving the regulation to regional development and implementation, and smaller market size.
- High natural gas prices typically increase GHG abatement costs through switching to gas-fired electricity resources, causing the GHG price to increase for the sector and influencing market GHG price.

Additional sensitivity of GHG price can be seen from the impacts of the following policy outcomes:

- Penetration of electric vehicles: growth in this market would lead to increases in electricity load, potentially occurring mostly during off-peak hours. This increased load would impact the market for allowances and increase prices.
- Renewable energy and conservation and efficiency growth: the costs of development of renewable energy and the effectiveness of conservation & efficiency programs will impact the GHG price since these are potential GHG abatement options for the electricity sector.
- Natural gas prices: As noted above, as the price of natural gas increases, the GHG price increases.
- Electricity demand: As indicated for electric vehicle penetration, high electricity load will cause upward pressure on GHG price.
- Offset availability: because offsets can provide an additional compliance option under certain market assumptions, an increase in their use will lead to lower GHG prices in the market.

Table 1: GHG Price Forecast (Real 2010\$US/tonne) to 2040 for Market Scenarios

Scenario - Price	Year				
	2012	2015	2020	2030	2040
A – Mid	0	33	44	82	152
B – Mid	20	24	33	75	140
C – Low	8	10	13	11	21
D – High	44	54	73	136	251
E – Zero	0	0	0	0	0

Next Steps

It is important to note that the five forecast GHG price paths are largely determined by the elements making up each of the five market scenarios. In particular, GHG prices are sensitive to the assumed emissions trading regime. So, in order to assess how likely each GHG price path is, a broader consideration needs to be undertaken to judge the relative likelihoods of each market scenario.

The B&V analysis is based on electricity sector abatement costs, extended to the rest of the economy. As a next step, the forecasts need to be benchmarked to those conducted by other utilities, agencies and organizations, to ensure BC Hydro is using reasonable and credible prices for the IRP. Finally, policy levers that can further adjust GHG prices (ceilings, floors, other market safeguards) need to be evaluated for likelihood of application, to further evaluate the defensibility of the analysis.

KEY REFERENCE DOCUMENTS

- BC Hydro Greenhouse Gas Price Forecast: Scenario Development and Modeling, April 2010.
- Summary Brief, *Market Scenarios for the IRP Risk Framework*

Attachment 1: Description of Scenario Influence Factors

Scenario development was based on the factors defined below.

Three levels of Global Economic Growth:

- High – major economies return to average pre-recessionary trends by 2011
- Medium – moderate growth in developing countries and lower growth in developed countries
- Low – long-term growth remains much below pre-recession levels.

Three levels of Government Policy Maker:

- Regional – existing regional GHG pacts in the US and Canada, such as the Western Climate Initiative remain in place and lead regulation
- Regional/National – existing regional pacts lead regulation until 2020, after which national regime(s) in the US and Canada supersede these
- National – New national intervention in GHG regulation and market development in the near term preempt more localized regional programs.

The target stringency / compliance flexibility levers were captured as follows:

- Compliance Structure:
 - “Strict” (verifiable annual compliance requirements with limited use of offsets and a tightly controlled US market);
 - “Flexible” (a broader, flexible allowance market coordinated across the US and Canada with substantial ability to bank allowances and use international offsets).
- GHG Target (Cap) Levels:
 - “Base” (consistent with the 2009 Waxman-Markey targets, which was the main legislative proposal in the US at the time of the study);
 - “Aggressive” (faster near- and medium-term reductions);
 - “Conservative” (slower start and more gradual trajectory of reductions).

Attachment 2: GHG Price Forecast for Selected Scenarios

