BC hydro

Integrated Resource Plan

Appendix 5B-1

Greenhouse Gas Price Forecast Report

BUILDING A WORLD OF DIFFERENCE®

BC HYDRO

Greenhouse Gas Price Forecast: Scenario Development and Modeling

April 2010

BLACK & VEATCH
Building a world of difference.

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EXECUTIVE SUMMARY

1 EXECUTIVE SUMMARY

1.1 Introduction and Summary of Methodology

BC Hydro is the third largest electric utility in Canada and provides electricity service to over 94% of British Columbia's residents. BC Hydro operates 30 hydroelectric facilities and three natural gas-fueled thermal power plants. About 80% of the province's electricity is produced by major hydroelectric generating stations on the Columbia and Peace rivers. BC Hydro generates between 43,000 and 54,000 gigawatt hours (GWh) of electricity annually, depending on prevailing water levels. As such it has the responsibility to meet customers needs in a manner that is demonstrably in the best interest of customers and is responsive to governmental direction.

In September 2009, BC Hydro engaged Black & Veatch to conduct a study of emerging policy and regulations pertaining to greenhouse gas (GHG) emissions and the potential impact on the BC Hydro system. The objective of study was to develop a series of plausible scenarios that reflected various GHG requirements and determine effect on carbon prices.. The study was comprised of three key and interrelated components:

- Policy Analysis
- Scenario Definition
- Carbon and Dispatch Modeling

The Policy Analysis task involved a comprehensive review of the current status of national GHG policies in Canada and the United States, regional policies in the Western Electricity Coordinating Council (WECC) being developed under the Western Climate Initiative (WCI), and individual policies of BC and all US states in the WECC.

The Policy Analysis provided the foundation for developing a series of realistic market cases. In the Scenario Definition task, Black & Veatch worked with the BC Hydro staff to define a range of realistic electricity market cases and then further refined the cases to create nine more defined overarching scenarios based upon the key market drivers. The scenarios included assumptions regarding government and environmental regulations, economics, technologies and political policies to create a broad range of plausible future states with attached probabilities. The scenarios characterized market conditions that could potentially influence future CO_2 allowance prices. Of the fifty four market cases defined, nine scenarios were developed of which, five scenarios were selected for modeling carbon prices and dispatch modeling.

Black & Veatch's proprietary Electric Industry Carbon Model was used to forecast CO_2 prices and the associated forecast of energy generation and capacity resources for each scenario. In addition, a base case scenario was modeled. The base case scenario incorporated Black & Veatch's Fall 2009 WECC Energy Market Perspective (EMP), a commercially available regional electric market forecast. Three of the five scenarios and the base case scenario were selected and hourly power market simulations were produced using PROMOD IV.

1.2 Key Results and Conclusions

1.2.1 Scenario Definitions

The central issue of this project is the future path for the prices of CO_2 allowances. The study uses a set of scenarios to focus on those factors that may significantly influence the trajectory of CO_2 allowance prices in the 2010 to 2040 period. One of the key intended outputs from the scenario definition process was a set of directional influences – by scenario – on the variables in the Black & Veatch Electric Industry Carbon Model that heavily influence estimated carbon prices. For example, would oil and gas prices tend to move higher (relative to the base case) in this scenario?

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The three possible future states for Global Growth are defined as:

- **High Global Growth:** Major economies return by 2011 to average pre-recessionary trends for long-term GDP growth per year. Very high growth in Brazil, Russia, India and China (BRICs), moderate growth in developed countries.
- **Medium Global Growth:** Moderate growth (5% to 8%) in developing countries, lower growth (2% to 2.5%) in Organisation for Economic Co-Operation and Development (OECD) countries
- **Low Global Growth:** Long-term growth trend remains much below pre-recession levels. Little per capita growth in OECD nations; less than 1% to 1.5% annual GDP growth. Developing countries grow, but slowly, 2% to 3%.

Other than some differences in the speed of recovery from the current recession, the scenarios do not attempt to forecast short-term business cycle variations in growth. The growth percentages are an average and held constant over the long term.

The three possible future states for Government Actor are defined as:

- **Regional Actor**: Existing regional greenhouse gas compacts in U.S. and Canada remain in place. No large new national interventions in energy markets and environmental regulation.
- **Regional/National Actors**: Only existing regional greenhouse gas compacts until 2020, then pre-empted by a national regime.
- **National Actor**: New national intervention in the near term in greenhouse gas/energy markets and other regulatory domains. National Actor pre-empts more localized regional interventions.

1.2.2 Scenario Summaries

The nine defined scenarios are given below. Five cases were chosen for quantitative analysis with the Black & Veatch Electric Industry Carbon Model. The five cases are:

- Scenario 1 – High Growth National Actor
- Scenario 2 – Medium Growth National Actor
- Scenario 3 – Medium Growth Regional/National Actor
- Scenario 4 – Low Growth Regional/National Actor
- Scenario 5 – High Growth Regional Actor

1.2.3 Carbon Model Results

The carbon price forecasts generated by the Black & Veatch carbon model for the five scenarios are summarized in nominal and real terms shown in Figure ES-1 below. From these figures and tables, Scenarios 1 through 3 (High Growth-National Actor [HG-NA], Medium Growth-National Actor [MG-NA], and Medium Growth-Regional/National Actor [MG-RNA]) yield very similar CO_2 price forecasts. Scenario 2 (MG-NA) is close to Black & Veatch's reference case scenario for forecast CO_2 prices. The impact of electric vehicle loads pushing prices up is closely offset by assumptions of higher efficiency and renewable resource penetration.

In addition for Scenario 1 (HG-NA), it appears that the upward push on prices from high loads, gas prices and reduced nuclear penetration is offset by higher efficiency and renewable penetrations and the assumption that the electric industry gets its full load ratio share of offsets.

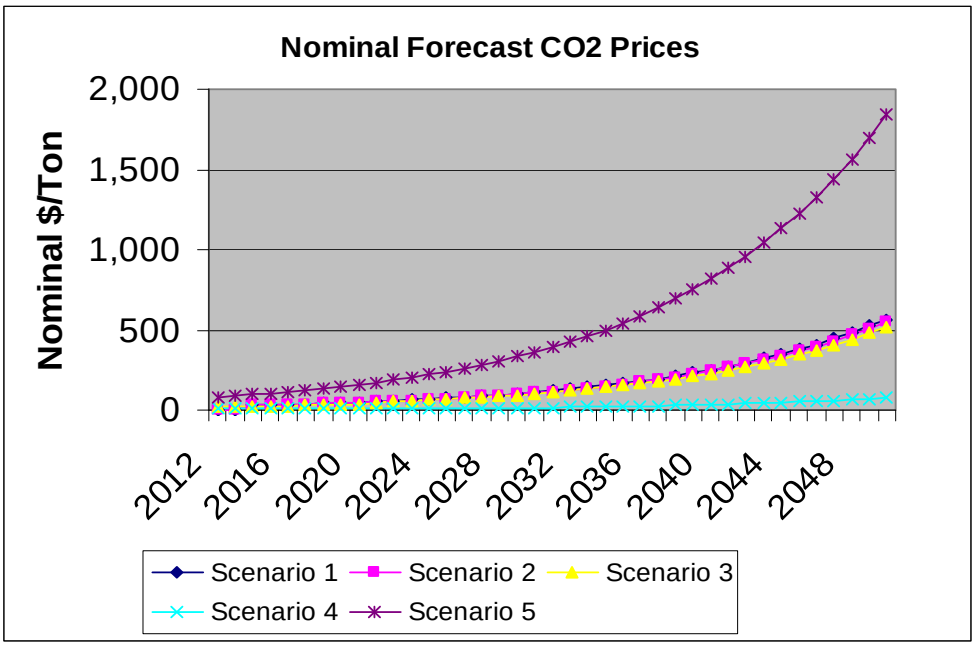
In Scenario 3 (MG-RNA), the delayed controls in much of the United States and Canada that result from the delay of Waxman-Markey produce a significant increase in the 2021 CO_2 price. However, the increased renewable and nuclear penetrations and full offsets tend to push the price down while the load from electric cars and integrated gasification combined cycle (IGCC) costs that are 25% more expensive push the price higher. The net effect is a forecast very close to that of Scenarios 1 and 2.

EXECUTIVE SUMMARY

In Scenario 4 (Low Growth-Regional/National Actor [LG-RNA]), the assumption of level loads and full load ratio share of offsets results in no need for IGCC and much lower CO_2 prices.

Finally, while Scenario 5 (High Growth-Regional Actor [HG-RA]) assumes CO_2 caps are applied to only the WCI area, the low levels of existing coal generation in that region necessitates a reliance on the idea that combined-cycle capacity will be replaced by IGCC capacity that is assumed to cost 50% more than the baseline assumption. In spite of the lower cap, the reliance on very expensive IGCC capacity produces an extremely high CO_2 price forecast for the WCI region.

Figure ES-1 Forecast CO_2 Prices



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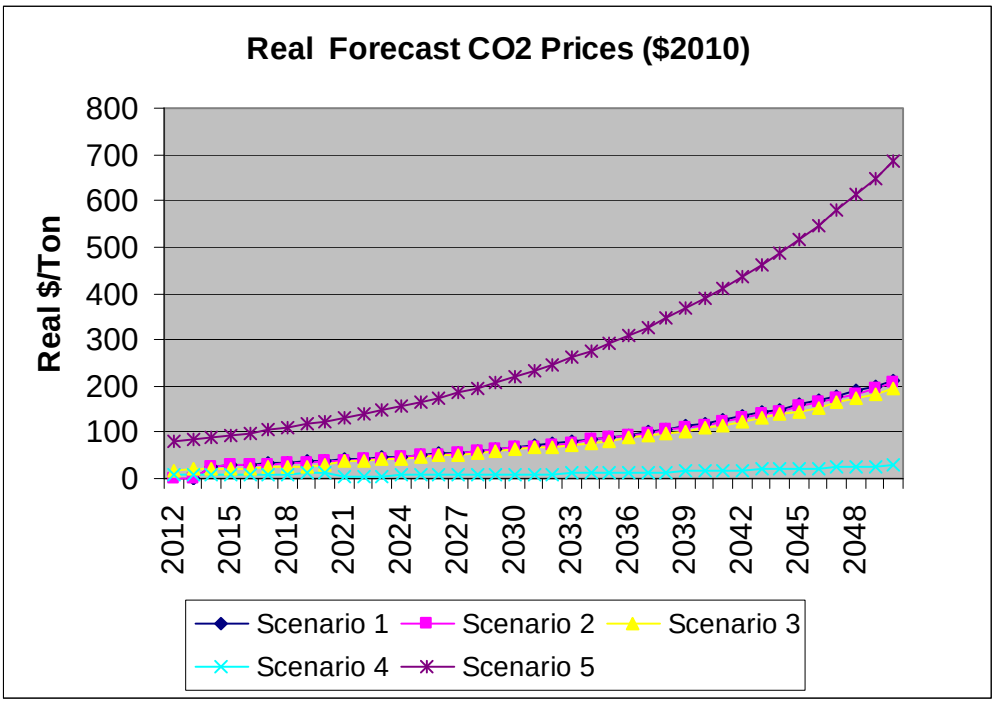


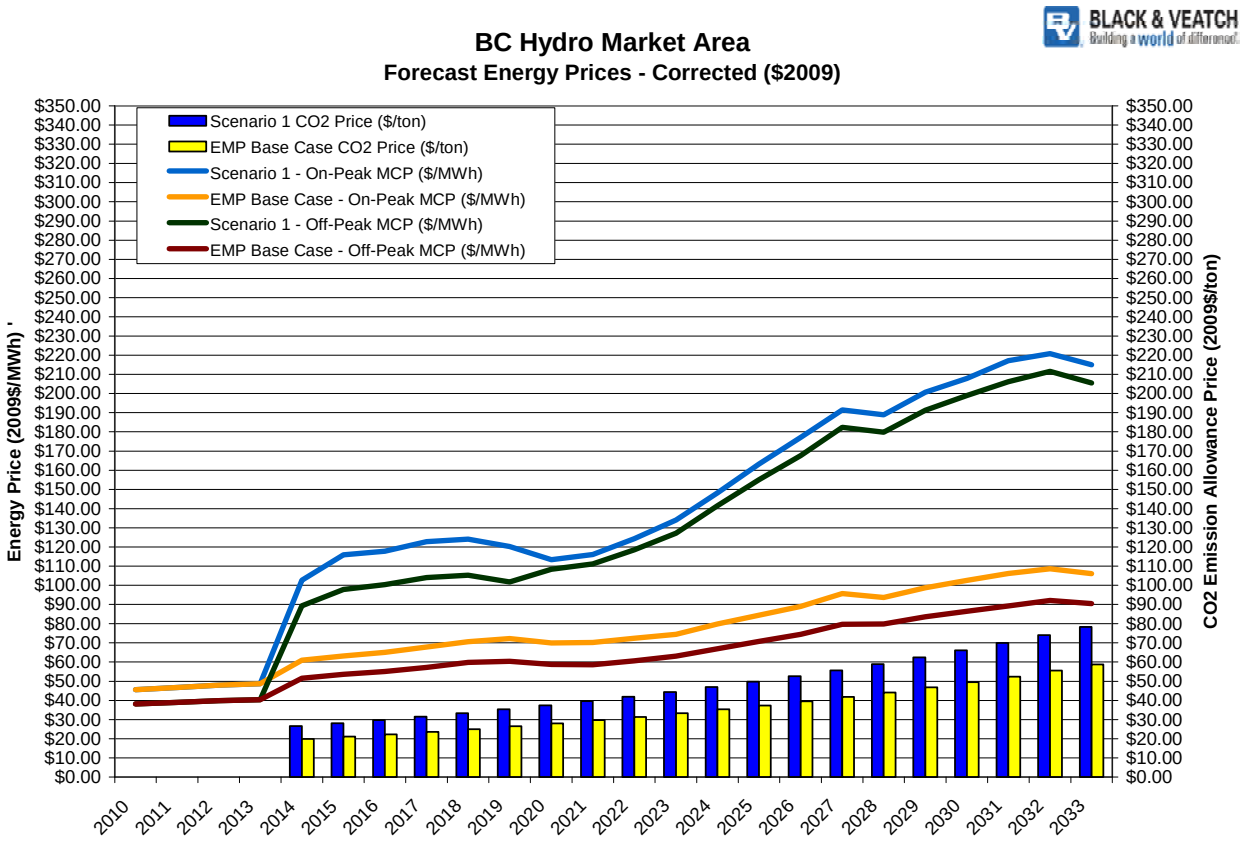
1.2.4 Simulation Model Results

Implementation of Scenarios 1, 3 and 4 has significant impact upon forecast electricity prices.

Figure ES-2 provides an illustration of forecast energy prices under Scenario 1, in comparison to the Energy Market Perspective base case. A comparison of projected CO_2 prices is also shown in Figure ES-2.

EXECUTIVE SUMMARY

Figure ES-2 – Comparison of BC Hydro Forecast Energy Prices – Scenario 1 and EMP Base Case

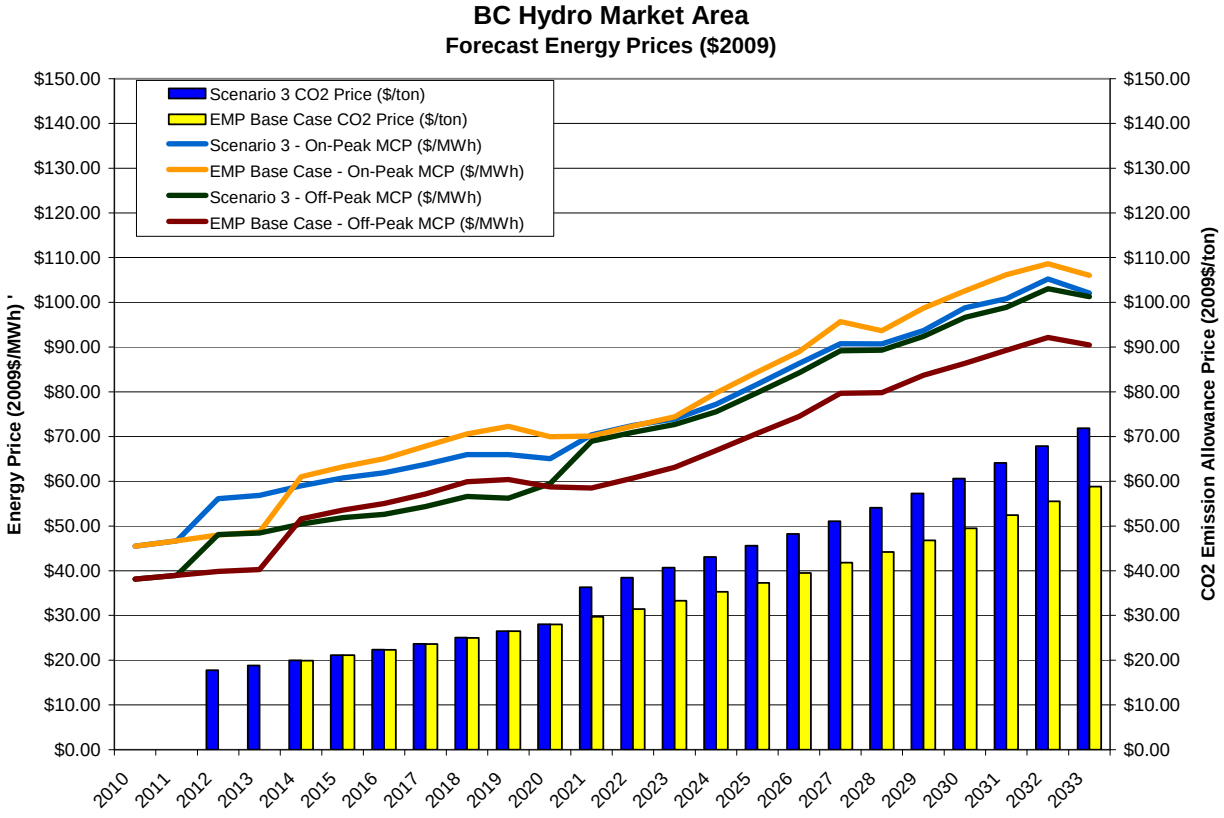


As shown in Figure ES-2, forecast energy prices are considerably higher under Scenario 1 than under the base case. This is driven by both higher projected CO_2 prices, and also by higher projected growth in electricity demand and natural gas prices. After 2020, the projected spread between on-peak and off-peak power prices is lower under Scenario 1, which is driven by assumed increases in off-peak demand from penetration of plug-in electric vehicles.

Figure ES-3 provides a comparison of projected BC Hydro energy prices for Scenario 3 and the Energy Market Perspective base case.

EXECUTIVE SUMMARY

Figure ES-3 – Comparison of BC Hydro Forecast Energy Prices – Scenario 3 and EMP Base Case



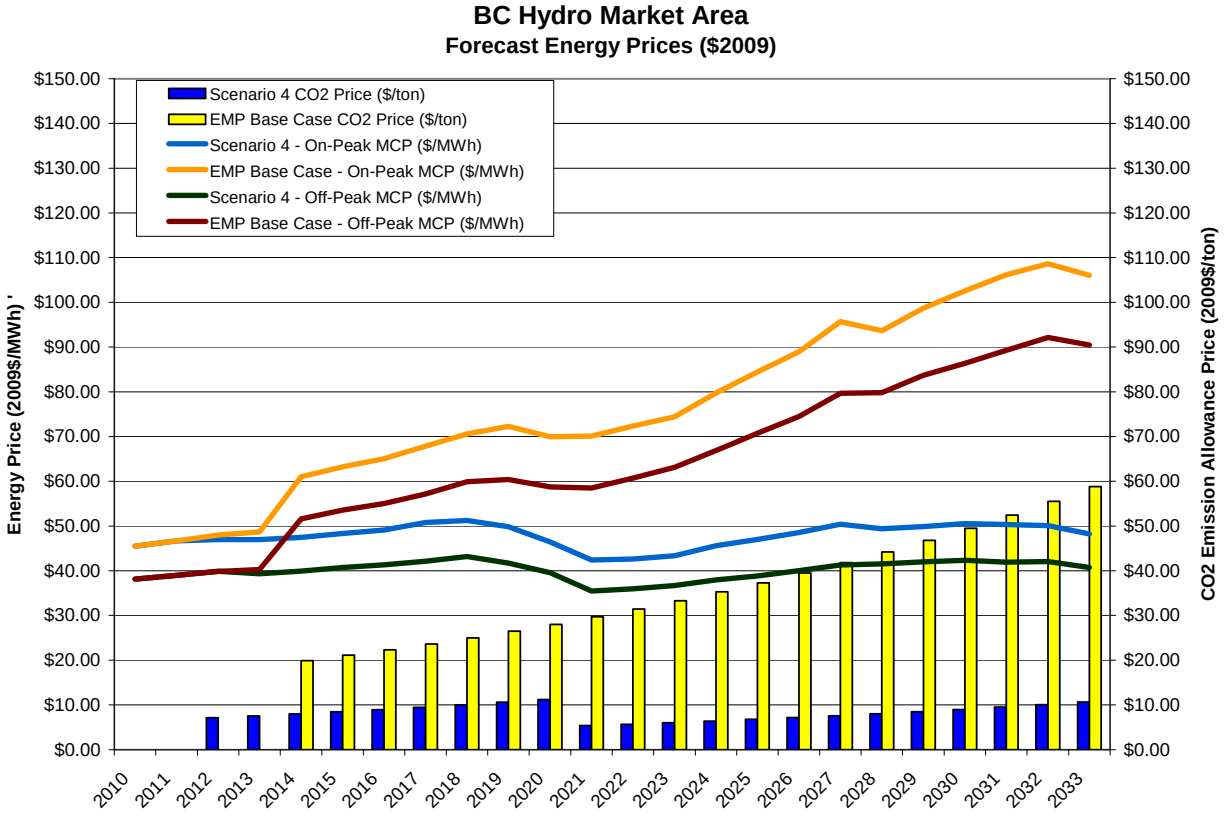
As shown in Figure ES-3, forecast power prices are higher in Scenario 3 in 2012 and 2013, due to the assumption that greenhouse gas pricing begins two years earlier than assumed in the base case, and under a WCI regulatory regime rather than under a federal program. In the 2014-2020 timeframe, Scenario 3 calls for a greater level of renewable penetration in the WECC than assumed in the Black & Veatch Fall 2009 Energy Market Perspective, and comparable CO_2 pricing. As such, power prices under Scenario 3 are lower than the market perspective base case during that period. In the 2020 and later time period, annual energy demand is 8% higher in Scenario 3 due to assumed growth in the fleet of electric cars. The increased energy demand is assumed to occur exclusively in off-peak periods, which translates into actual increases in off-peak energy demand of around 18%. In addition, CO_2 prices are higher under Scenario 3 beginning in 2021, with assumed implementation of the federal greenhouse gas program.

The overall impact upon energy market prices is mixed under Scenario 3 in the 2020 and later period. On-peak power prices are close between the two cases in the 2021 through 2023 period and then lower in later years under Scenario 3, as the increased renewable and IGCC entry offsets the impact of higher CO_2 prices. In off-peak periods, power prices are considerably higher under Scenario 3, with the higher CO_2 prices and with the increases in off-peak demand due to electric vehicles.

Figure ES-4 provides an illustration of projected BC Hydro energy prices under Scenario 4.

EXECUTIVE SUMMARY

Figure ES-4 – Comparison of BC Hydro Forecast Energy Prices – Scenario 4 and EMP Base Case



As shown in Figure ES-4, projected power prices are generally equivalent or lower under Scenario 4 throughout the study period. Scenario 4 has modest CO_2 pricing beginning two years prior than under the Black & Veatch market perspective base case but, beginning in 2014, projected CO_2 prices are substantially lower under Scenario 4. Scenario 4, however, also has relatively flat natural gas prices and electricity demand throughout the forecast period. The impact of lower natural gas prices and electricity demand more than offsets the impact of CO_2 prices in the 2012 through 2013 period, so that projected on-peak power prices are lower under Scenario 4, and off-peak prices are equivalent to the Energy Market Perspective base case. Beginning 2014, when higher CO_2 prices are included in the base case, both on-peak and off-peak power prices are considerably lower under Scenario 4. The spread between the two cases increases throughout the study period, with higher natural gas prices, electricity demand, and CO_2 prices in the base case driving the increasing power price spread.

INTRODUCTION

2 INTRODUCTION

BC Hydro is the third largest electric utility in Canada and provides electricity service to over 94% of British Columbia's residents. BC Hydro operates 30 hydroelectric facilities and three natural gas-fueled thermal power plants. About 80% of the province's electricity is produced by major hydroelectric generating stations on the Columbia and Peace rivers. BC Hydro generates between 43,000 and 54,000 gigawatt hours (GWh) of electricity annually, depending on prevailing water levels. As such it has the responsibility to meet customer needs in a manner that is demonstrably in the best interest of customers and is responsive to governmental direction.

In September 2009, BC Hydro engaged Black & Veatch to conduct a study of emerging policy and regulations pertaining to greenhouse gas (GHG) emissions and the potential impact on the BC Hydro system. The objective of study was to develop a series of plausible scenarios that reflected various GHG requirements and determine effect on carbon prices.. The study was comprised of three key and interrelated components:

- Policy Analysis
- Scenario Definition
- Carbon and Dispatch Modeling

The Policy Analysis task involved a comprehensive review of the current status of national GHG policies in Canada and the United States, regional policies in the WECC being developed under the Western Climate Initiative, and individual policies of BC and all US states in the WECC.

The Policy Analysis provided the foundation for developing a series of realistic scenarios. In the Scenario Definition task, Black & Veatch worked with the BC Hydro staff to define a range of realistic electricity market scenarios. The scenarios included assumptions regarding government and environmental regulations, economics, technologies and political policies to create a broad range of plausible future states with attached probabilities. The scenarios characterized market conditions that could potentially influence future CO_2 allowance prices. Fifty four scenarios were defined of which, five of scenarios were selected for modeling carbon prices and dispatch modeling.

Black & Veatch's proprietary Electric Industry Carbon Model was used to forecast CO_2 prices and the associated forecast of energy generation and capacity resources for each scenario. In addition, a base case scenario was modeled. The base case scenario incorporated Black & Veatch's Fall 2009 Energy Market Perspective, a commercially available regional electric market forecast. Three of the five scenarios and the base case scenario were selected and hourly power market simulations were produced using PROMOD IV.

The results and methodology for each of the three tasks are described in the following sections of this report.

3 POLICY ANALYSIS

Black & Veatch reviewed the current status of established and emerging greenhouse gas policies, legislation and regulations that affect the jurisdictions that impact BC Hydro. Specifically, Black & Veatch researched and summarized the status of national greenhouse gas policies in Canada and the United States, regional policies in the WECC being developed under the Western Climate Initiative, and individual policies of British Columbia and all U.S. states in the WECC. This section provides a summary of the policy review. A detailed discussion of individual policies and regulations are provided in Appendix A.

Due to the varying degrees and extent of greenhouse gas policy initiatives being undertaken in the different jurisdictions, the review was focused on summarizing those policies and programs that could have the most significant impact on BC Hydro's future operations and energy sales. Where applicable, the review of each jurisdiction outlines the reduction targets, implementation mechanisms, regulated sectors, and reporting requirements. Where policies include the implementation of an emission trading program, the geographic boundaries, distribution of allowances, use of offsets, allowable compliance mechanisms, cost controls, and linkage to other programs are summarized. Brief summaries of any relevant economic analyses performed for these trading programs are referenced as well. Related polices for clean and renewable energy requirements, such as renewable portfolio standards, are also reviewed for each jurisdiction.

Regulators and legislators on both sides of the Canadian border have focused on a variety of greenhouse gas initiatives at both the federal and state or provincial levels. While reduction levels and compliance schedules vary among existing and pending policies, all policies are moving in a same direction. The following summarizes the key policies reviewed in this analysis. Section 6 provides a detailed summary of the Policy Analysis.

- Canadian – Federal
  - Reduce GHG emissions 20% below 2006 levels by 2020
  - 60-70% reduction in GHG emissions by 2050
  - Promote carbon capture and storage compliance targets
  - Transition from emission intensive targets to fixed emission targets by 2020-2025
  - Establish a Canadian cap and trade market but flexible to integrate with a North American regional cap and trade market.
- British Columbia[1]
  - GHG Reduction Target Act (GGRTA)
    - 33% reduction below the 2007 GHG levels by 2020
    - 80% reduction below the 2007 GHG levels by 2050
  - British Columbia Interim Goals
    - 6% reduction below 2007 GHG levels by 2012
    - 18% reduction below 2007 GHG levels by 2016
  - Energy Plan and GHG Reduction Targets Act and Statutes Amendment Act
    - Zero net GHG on all electric generation by 2016
    - Clean and renewable generation must account for 90% of generation
    - 50% of new electricity demand must be met with conservation by 2020
  - Cap and Trade Act

[1] This study was conducted prior to the passage of the Clean Energy Act (CEA) and therefore, the CEA was not considered in the subsequent scenario development and price forecasts.

  - Establish framework to participate in regional (WCI) cap and trade market
- Carbon Tax Act
  - Establishes a tax for carbon emissions
- British Columbia 2007 Energy Plan
  - 90% of generation in British Columbia is provided by renewables

- United States – Federal
  - American Clean Energy and Security Act (Waxman-Markey)
    - GHG emissions are reduced 20% below 2005 levels by 2020
    - Cap and Trade Program
      - 3% reduction from 2005 levels by 2012
      - 17% reduction from 2005 levels by 2020
      - 42% reduction from 2005 levels by 2030
      - 83% reduction from 2005 levels by 2050

The scenario definitions discussed in the following sections were based upon the assumptions and requirements laid out in each of the policies above. The scenarios differed in their assumptions regarding regional versus country specific cap and trade program and emission levels. The base case for the study defined using the assumptions from the Waxman-Markey bill.

4 SCENARIO DEFINITION

The Scenario Definition task draws upon insights from the Policy Analysis, in combination with analyses of other major drivers of energy and carbon prices. These considerations together form a foundation for developing a series of realistic, coherent scenarios about future market conditions that could potentially influence CO_2 allowance prices. The scenarios included assumptions regarding energy and greenhouse gas regulations, other governmental policies, macroeconomic conditions, technology change, and energy supply/demand conditions. The interplay of assumptions defined a broad range of plausible future states with attached probabilities, from which a subset of scenarios was selected for carbon price modeling and dispatch modeling, as described in Sections 4 and 5.

4.1 Objectives for Scenario Definition

4.1.1 Central issue: Carbon Prices

The potential future price of carbon dioxide (CO_2) allowances was the central issue in defining the scenarios used to discern the market activity that could occur across a broad range of plausible future events.

4.1.2 Scenarios Intended to Inform Modeling Cases

The scenarios and related cases that emerged from the analysis are intended to generate thoughtful dialogue about how the future may unfold. This can be helpful for enterprise-level strategic planning and risk management. More importantly for this project, the scenario analysis was also used to develop internally consistent qualitative and quantitative assumptions for the market simulation models for electricity and CO_2 allowance prices.

4.1.3 Desired Wide Range of Carbon Prices

To test the robustness of its resource plans and strategies, BC Hydro asked Black & Veatch to construct scenarios and related modelling that would be expected to produce a wide range of CO_2 allowance price trajectories. The selection of five model cases for more detailed quantitative analysis was guided in part by this desire to cover a comprehensive range of carbon prices.

4.2 Scenario Definition Process

4.2.1 Use of Carbon-Focused Scenarios

A scenario is a coherent view[2] of the future, combining a number of major elements (economics, technology, environment, regulation, social-political) in a consistent and plausible manner. Not all scenarios are equally probable, of course. Scenarios help make sense of emerging future trends and events. They are typically used for broader corporate planning and enable a company to "rehearse" the future, test current strategies, and generate novel approaches to making decisions involving planning for the future.

Scenarios can be used for many different purposes in corporate planning. Since the central issue of this project was the future path for the prices of CO_2 allowances, the use of scenarios was focused on those factors that may significantly influence the trajectory of CO_2 allowance prices in the 2010 to 2040 period. One of the key intended outputs from the scenario definition process was a set of directional influences – by scenario – on the variables in the Black & Veatch Electric Industry Carbon Model that heavily influence estimated carbon prices. For example, would oil and gas prices tend to move higher (relative to the base case) in this scenario?

[2] The term coherent view used in this study refers to a plausible or logical view of future market conditions.

SCENARIO DEFINITION

The results of the scenario analysis will be used to provide key inputs to BC Hydro resource planning analyses, and to meet required long-range planning requirements such as the 2011 Integrated Resource Plan.

4.2.2 Key Dimensions of Uncertainty

The critical dimensions of uncertainty, which help define the broad outlines of the scenarios, were chosen with an eye toward the types of uncertainty that affect the drivers of carbon prices. The BC Hydro and Black & Veatch team considered a number of approaches to defining the major dimensions of uncertainty. After evaluating a number of possible dimensions, the team decided that the most powerful drivers will be economic conditions and the environmental regulatory regime. So the critical dimensions of uncertainty, which form the axes for mapping the scenarios, are:

- Global Growth (economic).
- Government Actor (greenhouse gas regulation).

The Global Growth dimension was chosen to address such uncertainties as:

- Energy commodity supply/ demand balance.
- Growth in demand for energy services.
- Degree of global economic integration.
- Ability to fund aggressive greenhouse gas controls through public or private sources or a combination thereof.

The Government Actor dimension addresses the uncertainties of:

- Greenhouse gas regulation, including the geographic breadth of the carbon market.
- Other environmental regulation.
- Demand Side Management /Energy Efficiency (DSM/EE) penetration.
- Energy market structure and integration with regional carbon markets.
- Government funding for energy RD&D.

The team initially discussed a typical 2x2 matrix of scenarios to adequately capture the range of different states for the critical dimensions of uncertainty. BC Hydro preferred to configure the scenarios with an odd number of states to enable construction of a more normal statistical distribution of scenario probabilities. This approach informed construction of the probability tree and selection of modeling cases (see section 3.4 Case Definitions and Selection for more detail). Therefore, we have employed a 3x3 matrix, where each of the two dimensions of uncertainty takes on three future states.

The timeframe for the scenarios was defined by BC Hydro to be 2010 through 2040. After an initial attempt at breaking this long period into three sub-periods, the team recognized that the sub-period structure added significant complexity and little additional value, given BC Hydro's focus on using the scenarios to feed into quantitative models that cover the whole period.

4.3 Scenario Descriptions

4.3.1 Scenario Structure

Three possible future states for Global Growth are defined:

- **High Global Growth:** Major economies return by 2011 to average pre-recessionary trends for long-term GDP growth per year.
  - China: 12%+
  - India, Brazil, Russia: 7%+
  - U.S., Canada: ~3.5%

SCENARIO DEFINITION

- **Medium Global Growth:** Moderate growth (5% to 8%) in developing countries, lower growth (2% to 2.5%) in Organisation for Economic Co-Operation and Development (OECD) countries
- **Low Global Growth:** Long-term growth trend remains much below pre-recession levels. Little per capita growth in OECD nations; less than 1% to 1.5% annual GDP growth. Developing countries grow, but slowly, 2% to 4%.

Other than some differences in the speed of recovery from the current recession, the scenarios do not attempt to forecast short-term business cycle variations in growth over the 2010-2040 period. The growth percentages are an average and held constant over the long term.

The three possible future states for Government Actor are defined as:

- **Regional Actor**: Existing regional greenhouse gas compacts in U.S. and Canada remain in place. No large new national interventions in energy markets and environmental regulation.
- **Regional/National Actors**: Only existing regional greenhouse gas compacts until 2020, then pre-empted by a national regime.
- **National Actor**: New national intervention in the near term in greenhouse gas/energy markets and other regulatory domains. National Actor pre-empts more localized regional interventions.

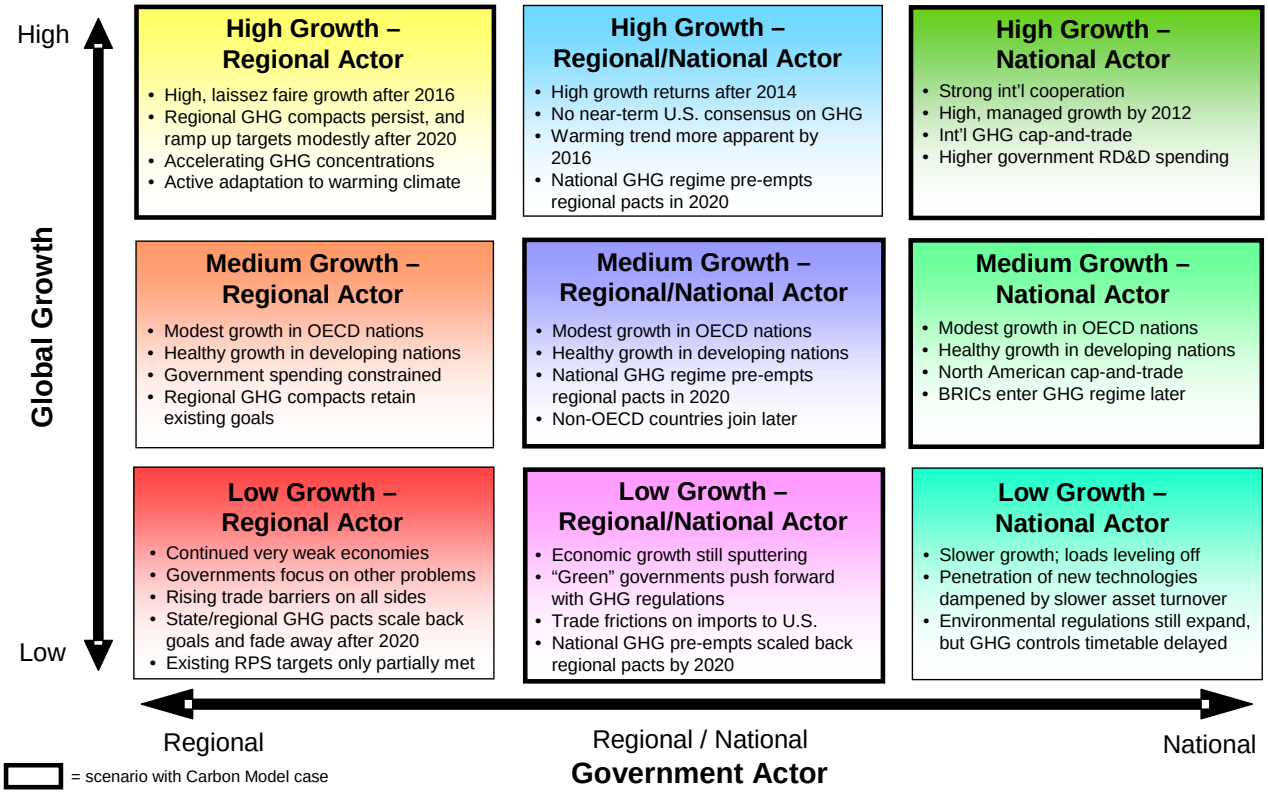
4.3.2 Scenario Summaries

The nine defined scenarios are specified and summarized at a high level below. Five scenarios were chosen for quantitative analysis with the Black & Veatch Electric Industry Carbon Model. The five cases are:

- Scenario 1 – High Growth National Actor
- Scenario 2 – Medium Growth National Actor
- Scenario 3 – Medium Growth Regional/National Actor
- Scenario 4 – Low Growth Regional/National Actor
- Scenario 5 – High Growth Regional Actor

See Section 3.4 for a description of the process for choosing cases for modeling.

SCENARIO DEFINITION



4.4 Case Definitions and Selection

4.4.1 Additional Drivers Considered

To accommodate BC Hydro's concern that the two dimensions of uncertainty did not adequately capture the major drivers of carbon prices, and the team's desire to evaluate explicitly the effects of two major drivers that are arguably independent of Global Growth and Government Actor, the scenarios were subdivided further for modeling purposes along the additional dimensions of Greenhouse Gas Compliance Structure and Greenhouse Gas Cap Levels. These two drivers have significant influence on carbon prices but are not strongly correlated with the main scenario dimensions.

The possible future states for these additional drivers were defined as:

- Greenhouse Gas Compliance Structure
  - **Strict**: verifiable annual compliance with applicable national or regional greenhouse gas caps; lower allowed use of offsets; more tightly controlled and segregated U.S. market.
  - **Flexible**: broader, more flexible allowance market, with substantial banking and international offsets; close coordination between U.S. and Canada allowance markets.

- Greenhouse Gas Cap Levels
  - **Base**: Consistent with the 2009 Waxman-Markey trajectory. Used in Black & Veatch Energy Market Perspective (a detailed description is provided in Appendix E). 83% greenhouse gas emissions reduction by 2050.
  - **Aggressive**: Faster near-term and medium greenhouse gas reductions; same reduction target by 2050.
  - **Conservative**: Slower start and more gradual trajectory for greenhouse gas reductions; smaller reduction target (60%) by 2050.

SCENARIO DEFINITION

4.4.2 Probability Tree Structure

The addition of these two new drivers created a tree of 54 (3x3x2x3) distinct cases, or combinations of the future states of all four drivers. It was impractical and too costly to model each of these 54 cases. Therefore, approximate probabilities, based on input from team members, were assigned to the possible future states for each driver in each case.

Three probability trees were developed to reflect the high, medium and low growth scenarios and the various outcomes: regional or national actor; flexible or strict scenarios for regional/national actor and conservative, base or aggressive compliance for each flexible or strict scenario. Triads (three-way branches) were used where possible at the probability tree junctions; e.g. high, medium, low economic growth, This allowed construction of a more normal (bell-shaped) distribution of case probabilities, and improved the team's ability to select modeling cases from the peak of the probability density (mean), and from the lower and upper tails.

The team recognized that some of the drivers were weakly but significantly correlated. For example:

- High growth is correlated with strict compliance. Strict compliance is more costly, and would more likely be more palatable in higher growth future states.

These cross-correlations were captured in the probabilities assigned to the various branches of the probability tree of cases.

4.4.3 Estimates of Probabilities for Tree Branches

The final probability tree is shown in Appendix C.

4.4.4 Selection of Five Cases for Carbon Model

BC Hydro determined that five cases should be adequate for quantitative modeling. But it still wanted to capture a broad range of possible carbon price trajectories in those cases. Consequently, the five (out of 54) cases were selected so as to represent distinct points along an implicit carbon price probability curve: Low Price / Low Probability, Medium-Low Price / Medium Probability, Medium Price / High Probability, Medium-High Price / Medium Probability, and High Price / Low Probability. (The probabilities referenced here are not absolute, but relative to the estimated probabilities of the other cases.) The expected carbon prices were based on the informed opinion of Black & Veatch's modelers. Those expectations were of course subject to confirmation in the actual Carbon Model runs, since the interplay of the various variables affecting carbon prices is quite complex.

The selection of cases for modeling also tried to spread the cases across a range of scenario states, to achieve further robustness in our modeling analysis. The cases selected for modeling include the following and are highlighted cases in the probability tree (see Appendix C) :

- Scenario 1 – High Growth National Actor – which is expected to produce medium/low carbon prices and have a medium probability of occurring.
- Scenario 2 – Medium Growth National Actor– which is expected to produce high carbon prices and have a low probability of occurring.
- Scenario 3 – Medium Growth Regional/National Actor– which is expected to produce medium carbon prices and have a high probability of occurring.
- Scenario 4 – Low Growth Regional/National Actor– which is expected to produce medium/high carbon prices and have a medium probability of occurring.
- Scenario 5 – High Growth Regional Actor– which is expected to produce low carbon prices and have a medium probability of occurring.

SCENARIO DEFINITION

The cases were structured within the scenarios to ensure modeling of a broad range of driver configurations, and consequent broad range in carbon prices.

4.4.5 Descriptions of Five Scenarios Chosen for Carbon Modeling

4.4.5.1 Key Assumption:

In defining scenario details and estimating scenario probabilities, the following correlation was assumed between Global Growth and the Government Actor.

- In those scenarios where growth is strong or trending positive, national governments can make the environment and climate change more of a priority. This influence is shown through either increased regulation of emissions, driving the use of renewable energy, subsidizing green technology, or supporting more widespread cap and trade programs.
- In those scenarios where there is lower growth, national governments' attentions are diverted towards economic and social policies and away from the environment. With the national governments playing a reduced role in framing the environmental and climate change regulations, regional compacts and individual provinces/states are left to act on their own.

The five scenarios that each contains a case chosen for detailed modeling are summarized as follows.

1. **High Global Growth – National Actor**: In this scenario, global growth returns to pre-recessionary levels by 2012, mostly driven by national governments' successful fiscal and monetary policies. Since most global economies are doing well, there is a great amount of international cooperation on climate change that leads to a standard global approach to carbon trading. Strong national government actors in the United States and Canada finally pass a national Renewable Portfolio Standard, superseding any regional/provincial/state requirements.

   With economies returning to good health, demand increases for oil, commodities, and all goods in general. As a result, industrial output increases in the U.S. and Canada, spurring additional demand for power. Buoyed by high oil prices, oil sands projects are again economical, although concerns about the possible environmental impact are still a threat to success.

   Cooperative agreements on protections for intellectual property rights and high growth and investment opportunities lead to increased spending on R&D. Governments around the world subsidize R&D into green technology with carbon capture and storage (CCS) and nuclear being the main beneficiaries.

   Although lending and investor confidence return quickly, growth and deficit spending keep interest rates higher and increase the cost of financing.

2. **Medium Global Growth – National Actor:** Overall growth stays below pre-recessionary levels, but developing nations and OECD nations manage to produce robust and moderate growth trends, respectively. Brazil, Russia, India and China (the BRICs) and other developing nations sustain an average 5% to 8% growth rate.

   As the economies begin to grow, increased demand for oil raises prices, resulting in higher production costs and making oil sands economical. Significant volatility in global natural gas prices continues through at least 2025, with somewhat reduced amplitude and fewer extreme movements. With only moderate growth; nuclear never fully ramps up, leaving modular nuclear to gain a foothold. Energy R&D is not a priority, leaving CCS with relatively high, uncompetitive costs.

   With the economy improving, national governments implement nationwide RPS standards, with only a moderate ramp-up in requirements. Canada and the United States establish an integrated cap and trade

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program. While the early cap and trade schemes are fragmented, the addition of the BRIC countries after 2020 smooths out disparities through the middle and latter parts of the scenario.

3. **Medium Global Growth – Regional/National Actor:** This scenario also shows slow but steady economic growth globally. The developing countries show the most promise for an upward trajectory. The BRIC countries again show the best recovery with growth rates averaging 5% to 8% after 2012. With new production costs of oil increasing, the oil sands development is again economically viable.

   With a slower but steady growth rate, the Western Climate Initiative and other regional greenhouse gas initiatives take the lead. Though these compacts have successfully reached their 2020 goals, National greenhouse gas agreements are passed, pre-empting the need for regional pacts by 2020. The BRICs and other developing countries also formulate greenhouse gas initiatives. While in "Medium-Global Growth — National Action scenario," different countries normalize their greenhouse gas regimes, this scenario does not see full international agreement, leaving a patchwork of national schemes to contend with.

4. **Low Global Growth – Regional/National Actor**. Low growth forestalls much progress in greenhouse gas regulations as governments place higher priority on restoring economic growth. Financial markets are slow to recover. Consumers are wary globally, due to stubbornly high unemployment, keeping consumers spending low.

   The years of slow economic growth have taken some of the urgency out of the climate change debate. With low industrial outputs and lower electricity demand, emissions have fallen worldwide.

   Government stimulus packages that were passed at the height of the economic crisis to spur economies are now saddling these nations with large deficits and higher interest rates. Falling or flat electricity sales pose major financial issues for many utilities.

   The more progressive "green" governments still push ahead with greenhouse gas regulations as a way to perhaps spur a new industry and to do their part for the planet. However, most action is delayed until after 2020 for developed countries and even later for developing nations. Other governments, however, scale back efforts for greenhouse gas regulations as they focus on the economy. Protectionist policies invoke trade barriers causing little availability of international offsets. Economic concerns force even the most progressive regions to scale back their greenhouse gas initiatives until after 2020.

   Lower investment and slower asset turnover slow the penetration of new technologies such as electric vehicle, nuclear, and CCS.

5. **High Global Growth – Regional Actor:** While the first high growth scenario is dependent upon managed growth, this scenario envisions a smaller government role in providing economic stimulus. As a result, pre-recessionary growth levels do not return until the 2016 timeframe.

   With no international agreements on the horizon, China and India increase their output to regain their economic status. In the process, they both record all-time high greenhouse gas emissions. Unfettered by national regulations and driven by the higher oil prices, oil sands development surges.

   The near term (2010-2016) years of low growth initially dampen greenhouse gas emissions, and climate change impacts are incremental. As a result, widespread public skepticism in the U.S. over the reality of global warming or the need to address it immediately has undermined political support for any aggressive national schemes for greenhouse gas regulations.

   The lack of a strong national role in energy and environmental policy has left a patchwork of regional compacts although most do not gain traction until after 2020. With little or no financial incentives and no

relief for siting concerns, transmission is slow to develop, delaying achievement of renewable energy targets. Clean tech investment is left to the private sector and development remains slow.

There is little substitution for fossil fuels, although attractive fuel prices do increase the share of natural gas.

Discussion of the model inputs as well as the additional drivers of compliance regime and greenhouse gas levels for each of the modeling scenarios can be found in section 3.4 Case Definitions and Selection.

4.4.6 Input Variable Vectors from Each Case

For each of the cases selected for modeling, the scenario definition team worked with the carbon model team to define the behavior of relative values for the 2010-2040 vectors of seven important modeling variables, taking into consideration the combination of the growth and actor dimensions for that scenario. The direction and relative magnitude of the input variables were based upon previous modeling experience and the impacts on carbon prices. The directionality of the vectors was assessed vs. the values for those variables in the base case (see Appendix E), by means of arrows signifying the degree of change, with one to three arrows up for levels of relative increase and one to three arrows down for levels of relative decrease. The base case was the Fall 2009 Black & Veatch Energy Market Perspective and its component input variable vectors. The Energy Market Perspective is a detailed regional forecast of electricity and natural gas prices, with transmission-constrained economic dispatch. The same set of modeling tools is used for the PROMOD analysis in Section 6 below.

The tables below show the assumed directional changes for the major input variable vectors, and the supporting logic for the assumptions.

Model Input Vectors	(vs. base)	Explanation
High Global Growth - National Actor – Scenario 1		
Electricity loads	↑↑	Higher traditional load growth + electric vehicle penetration
Fuel prices	↑↑	High growth + environmental restrictions on production
Fossil capacity costs	↑	High commodity prices + high interest rates
Nuclear penetration	↓	Stronger environmental regulation and NIMBY issues
Renewables targets	↑↑	High carbon prices + national RPS
Efficiency penetration	↑↑↑	Gov't and market push for efficiency
CCS costs	↓	Gov't RD&D funding + greenhouse gas targets
Medium Global Growth - National Actor – Scenario 2		
Electricity loads	→	Close to base case assumptions +plug-in electric cars
Fuel prices	↑	Environmental restrictions on production
Fossil capacity costs	→	Close to base case assumptions
Nuclear penetration	→	Close to base case assumptions
Renewables targets	↑↑	National RPS targets higher than base case assumptions
Efficiency penetration	↑↑	Gov't and market push; lower prices than in high growth scenario
CCS costs	→	Less gov't spending on RD&D less than high growth scenario
Medium Global Growth - Regional/National Actor - Scenario 3		
Electricity loads	→	Close to base case assumptions
Fuel prices	→	Weaker regulatory constraints than possible with national actor
Fossil capacity costs	→	Close to base case assumptions
Nuclear penetration	↑	More regulatory friendly toward nuclear development
Renewables targets	↑	Delayed national RPS targets end up higher than base
Efficiency penetration	→	Close to base case assumptions
CCS costs	↑	Delayed development of CCS due to later national action

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Model Input Vectors	(vs. base)	Explanation
Low Global Growth - Regional/National Actor - Scenario 4		
Electricity loads	↓↓	Low economic growth + carbon controls; not much EV penetration
Fuel prices	↓↓	Lower fuel demands + continued technology advances
Fossil capacity costs	↓	Low commodity prices + lower interest rates
Nuclear penetration	↓	Unfavorable investment climate
Renewables targets	↓↓	Worries about higher costs of renewables and delayed national RPS
Efficiency penetration	↓↓	Tough to afford investments + lower energy prices
CCS costs	↑	Slow development of CCS
High Global Growth - Regional Actor – Scenario 5		
Electricity loads	↑	Higher growth
Fuel prices	→	Coal build-out elsewhere
Fossil capacity costs	↑	Higher commodity prices
Nuclear penetration	↑	Less regulation
Renewables targets	→	Fits base EMP assumptions
Efficiency penetration	↓	No big national or price push
CCS costs	↑↑	Slow development attributable to…?

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5.1 Introduction

The objective of this analysis was to develop defendable and transparent forecasts of CO_2 allowance prices for use by BC Hydro in various planning initiatives. As explained in Section 3, Black & Veatch characterized a range of scenarios of future conditions that could influence future CO_2 allowance prices and reviewed these scenarios with BC Hydro. From the 54 potential cases, five were chosen to provide a reasonable range in forecast CO_2 prices. Development and selection of the five cases is discussed elsewhere in this report. The underlying assumption in all cases considered in this analysis was that CO_2 would be regulated in the U.S. and Canada under cap and trade legislation in which CO_2 emissions are controlled each year by requiring surrender of a CO_2 allowance for each tonne of CO_2 emitted and limiting the allowances allocated. By allowing CO_2 allowances to be traded, a market will theoretically form for allowances that will induce the collective use of the least-cost CO_2 abatement measures first producing an economically efficient solution and minimizing the cost impact of the emissions reduction. At the time of this analysis, two legislative proposals were considered most likely to apply to BC Hydro, the Western Climate Initiative and the Waxman-Markey bill, (officially called HR 2454, the American Clean Energy and Security Act of 2009, drafted by Reps. Henry Waxman of California and Ed Markey of Massachusetts). Both proposals are described in detail in another section of this report. In accordance with the expectation that Canada will join whatever program is adopted by the United States, based on announcements by the Canadian federal government in January 2010 following the December 2009 COP15 meetings in Copenhagen, The Waxman-Markey bill was assumed to be expanded to cover Canada with the same percent emission reduction caps. As described earlier, the Western Climate Initiative currently covers four Canadian provinces representing a significant portion of the economy and the western region of the United States.

This report section describes the market model used to develop the forecast prices, the forecasts of future industry, economic, and regulatory assumptions used in each scenario, the resulting forecast of CO_2 allowance prices and the key determinants of the CO_2 price forecast in each scenario.

5.2 CO_2 Market Model

The premise behind Black & Veatch's proprietary Electric Industry Carbon Model is that as the supply of allowances decreases in accordance with decreasing caps on emissions, the price will increase, spawning the addition and increased use of lower CO_2 emitting electricity generation sources. Black & Veatch has focused on the electricity sector of the economy as the sector that currently contributes over one third of CO_2 emissions in the U.S. and Canada. In addition, Black & Veatch assumes it will be equally costly for the other sectors of the economy (transportation and buildings and industry) to reduce CO_2 emissions making allowance trading between sectors inconsequential. A flow chart of Black & Veatch's Electric Industry Carbon Model for electric generators is shown in Figure 1.0 below.

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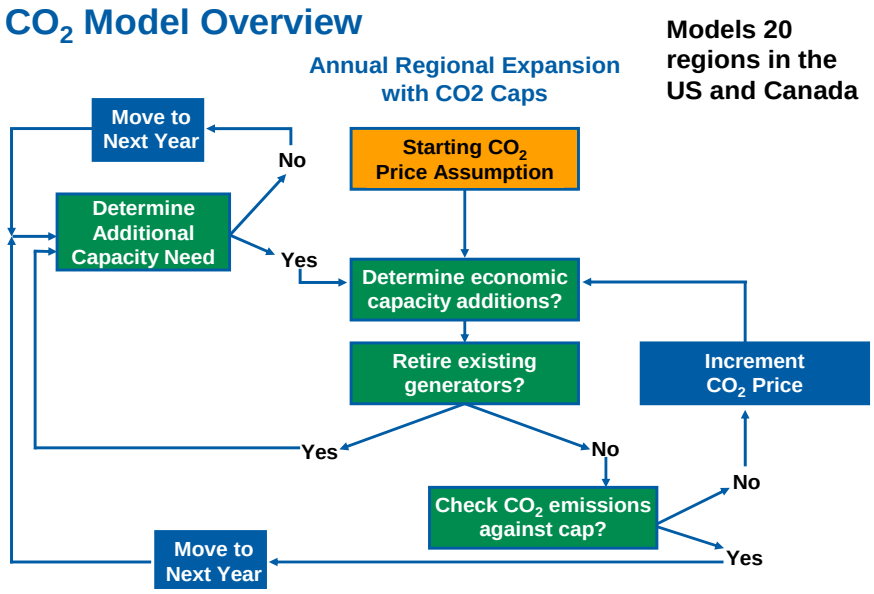
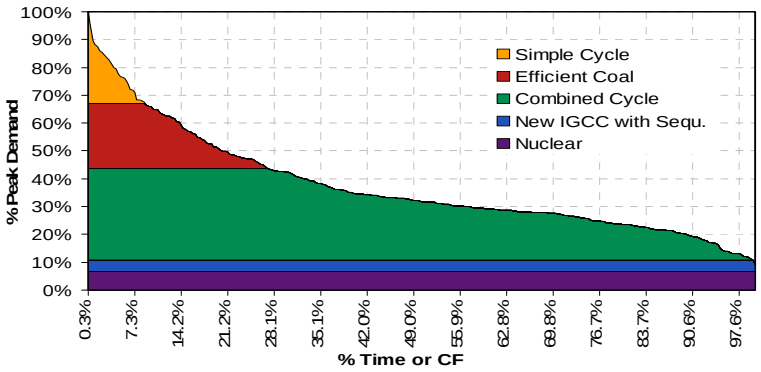
Figure 1.0 - CO_2 Market Model Flow Chart



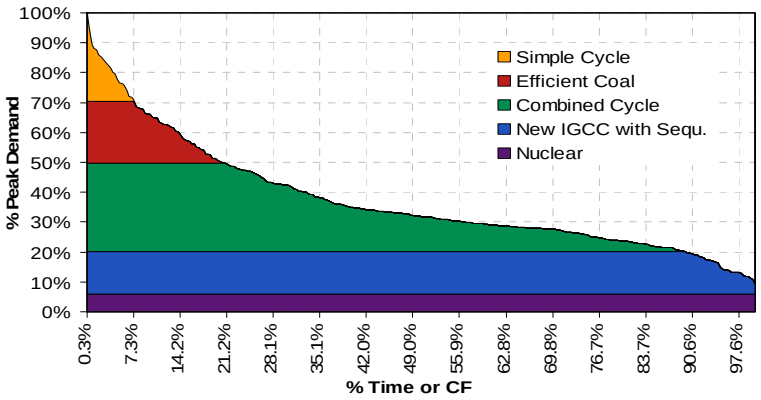
Modeling the addition and economic dispatch of electricity generators under a cap and trade program is an iterative process as shown in Figure 1.0. It starts with a CO_2 price assumption used to compare generating technologies for determining the least-cost technology to meet demand growth in each of 20 regions in the U.S. and Canada. That starting CO_2 value is also used in the initial generator dispatch decisions as shown in Figure 2.0

Figure 2.0 - Influence of CO_2 Prices on Generator Dispatch



By 2040, CO_2 and natural gas prices are sufficiently high to cause some combined-cycle generators to be dispatched as base load generators after nuclear and IGCC generators with CCS.

CARBON MODEL ANALYSIS



CO_2 and natural gas prices in SPP in 2030 are not sufficient to cause combined cycle generators to dispatch ahead of efficient coal generators. Combined cycle generators maintain their place as intermediate resources operating at 12% to 30% capacity factors.

In each of the 20 regions, sequentially at two year intervals, forecast peak demands plus required reserves are compared to cumulative generating capacity to determine if additional capacity is needed. If so, the most economic technology is chosen given the input forecasts of fuel prices, efficiencies, capital costs, fixed and variable O&M costs and emission rates. After selection of the new generators, new and existing generation is economically dispatched to meet annual loads and annual CO_2 emissions are estimated. CO_2 emissions are tallied for all the regions in the area assumed to be covered by the cap and trade program and the total emissions are compared to the CO_2 emission cap. If total emissions for the trading area are below the cap, the model moves on to the next year. If total emissions are above the cap, the model iterates back through the technology selection and dispatch loop using a slightly higher CO_2 price. The Black & Veatch Electric Industry Carbon Model applies the following carbon dioxide abatement/avoidance measures:

- Efficiency improvements.
- Additional nuclear capacity.
- Additional renewable capacity.
- Retirement of inefficient coal units.
- Additional natural gas (combined cycle) units in place of new coal-fueled units.
- Reduced operation of coal units.
- Increased operation of natural gas units.
- Use of integrated gasification combined cycle (IGCC) with carbon capture and sequestration (CCS).

Additional points are included in the model are described below.

Existing coal-fueled generators are tested to see if the power market will continue to cover their “going forward” fixed costs. Since all regional power markets are assumed to cover the amortized capital and fixed operating costs of a simple cycle combustion turbine, the economic viability of existing coal units is estimated by comparing their fixed operating costs less their energy margin to the fixed operating costs plus amortized capital costs of new combustion turbines. A sustainable market must cover these costs over the long run. The energy margin for the coal generators is estimated as the difference between coal fuel plus coal variable O&M costs and combustion turbine fuel and variable O&M costs at the estimated capacity factor of the coal units.

Because in all compliance cases considered allowances can be banked for use in future years, the under- or over-production of CO_2 emissions (above or below the annual cap) is recorded with under-production producing credits or deposits and over-production making withdrawals. The target is to balance the bank of allocated allowances by 2050 when allocated allowances are targeted to be 83% below 2005 CO_2 emission levels consistent with targeted concentrations of greenhouse gases in the atmosphere.

As described in Section 6, the Waxman-Markey bill and the Western Climate Initiative proposal allow for offsets to also be used to meet CO_2 reduction targets, subject to their availability and subject to a formulaic cap on their use each year. The Electric Industry Carbon Model allows the user to input a forecast of available offsets and it calculates the cap on the use of offsets in accordance with the formula. Since offsets are assumed to be less costly than allowances to develop and marginally less costly to purchase, offsets are always assumed to meet the annual CO_2 reductions first with allowances supplying the rest. As a result, the model calculates the most constraining of available offsets or of the restriction on their annual use when estimating how many offsets will be used each year.

The Electric Industry Carbon Model applies a constant escalation rate of 8.5% to all forecasts of CO_2 prices that reflects expectations of increasing marginal costs of CO_2 control and decreasing emission caps. The 8.5% also reflects an assumed arbitrage or discount rate assumed to be associated with decisions to bank allowances.

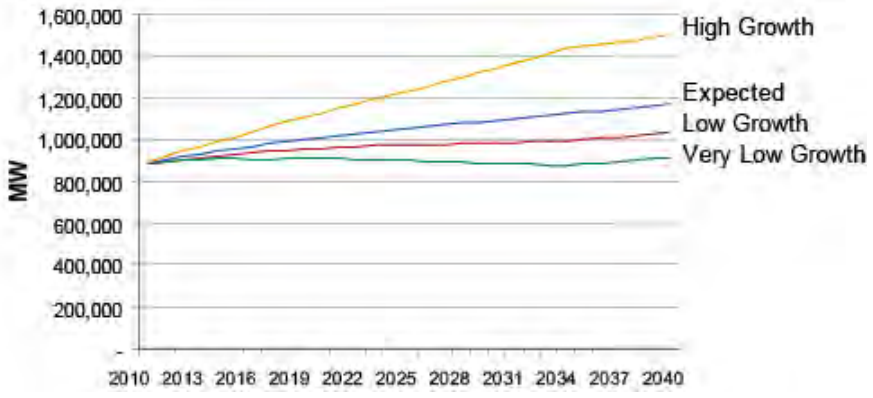
5.3 Baseline Forecasts

Black & Veatch drew upon experience across the entire electric sector at a national, provincial and regional council level to forecast baseline inputs to the Electric Industry Carbon Model. Most of these forecasts were derived from the Black & Veatch Energy Market Perspective. Estimates and forecasts of the following inputs were utilized in the Electric Industry Carbon Model:

5.3.1 Electricity Demand

- Peak Demand, Energy Levels and Growth – Separate forecasts of peak electricity demand were developed for each region. Figure 3.0 illustrates the aggregate growth forecasts for the U.S. and Canada.
- The compound growth rate is 1% for the Expected Growth Case.
- Typical Load Shapes (Load Duration Curves) – Baseline monthly load shapes for a typical day each month were assumed. These load shapes implied annual regional load factors of 55%.
- Required Reserve Margins – Provincial and regional reserve margins of 15% were assumed.

Figure 3.0 – Forecast Load Growth – U.S. and Canada



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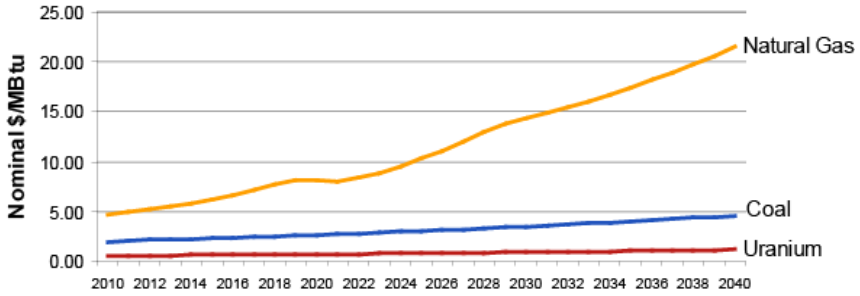
5.3.2 Fuel Prices

- Figure 4.0 illustrates the composite expected fuel prices used in this forecast.
- Coal Prices – Average delivered coal price forecasts were estimated for each region. The 2010 composite price of delivered coal is $1.98/MMBtu and the compound composite growth rate for the study period is 2.9%.
- Natural Gas Prices — Average delivered natural gas price forecasts were estimated for each region. The 2010 composite price of delivered natural gas is $4.64/MMBtu and the expected composite gas price growth rate is 5.4% as shown in Figure 4.0.
- Uranium Prices – The same uranium prices were used for each region. The 2010 composite price of delivered uranium is $0.56/MMBtu.

Figure 4.0 –Expected Composite Fuel Prices – U.S. and Canada



5.3.3 Renewables (Hydropower, Geothermal, Biomass and Wood, Solar and Wind)

- Existing Capacity and Generation
- New Renewable Capacity Additions and Associated Energy - Figures 5.0 to 7.0 illustrate the Black & Veatch Energy Market Perspective view of expected renewable additions from 2010 to 2040. The Energy Market Perspective also includes 4.2 GW of geothermal new units and 25.4 GW in new solar capacity located in the Western Electricity Coordinating Council (WECC) region. The renewables additions were multiplied by a factor of 2.5 applied to capacity of renewable additions coming online before 2020 in order to bring them into compliance with Waxman-Markey requirements of 15% renewable energy and 5% energy efficiency.
- Contribution to Peak Capacity – For purposes of determining the generating capacity needed to meet growth, the following percentage assumptions of firm capacity to nameplate capacity were used in the model: wind 10%, solar 20%, and geothermal 80%.

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Figure 5.0 – Expected Hydroelectric Additions

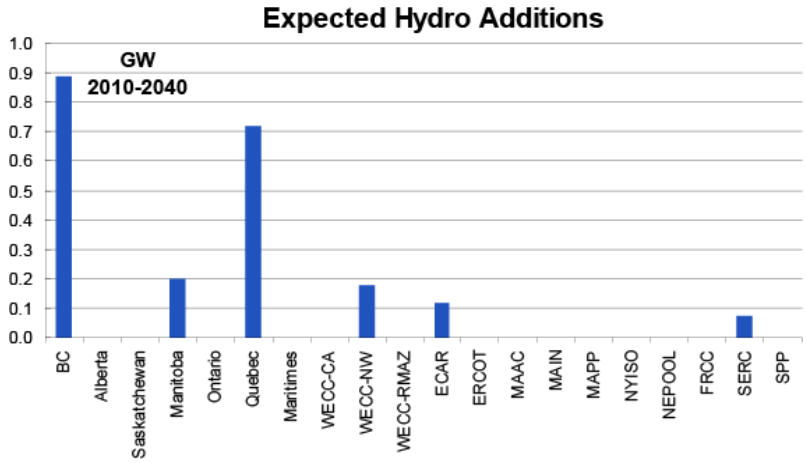


Figure 6.0 – Expected Biomass Additions

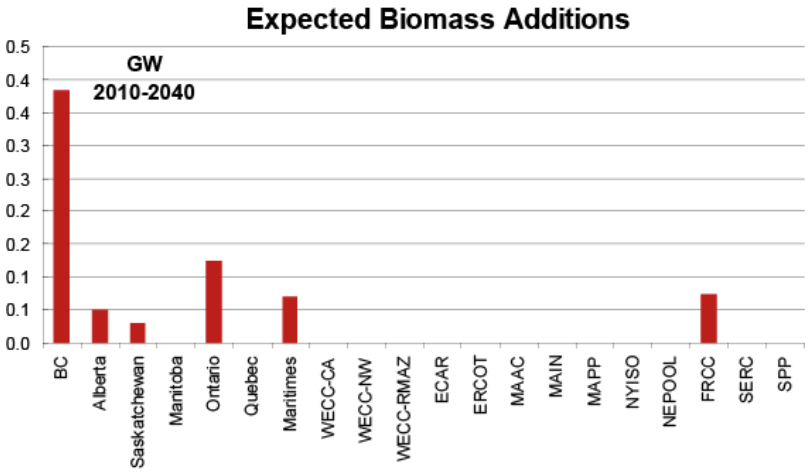
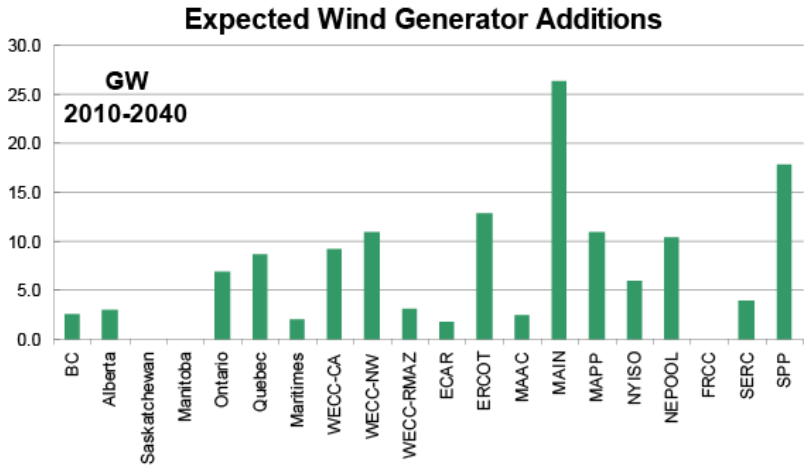


Figure 7.0 – Expected Wind Generator Additions



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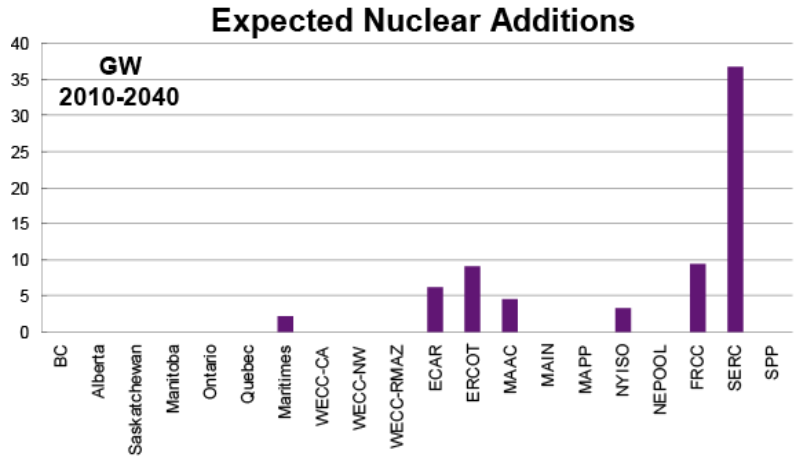
5.3.4 Nuclear

- Existing Capacity and Generation
- Planned New Nuclear Capacity Additions – Figure 8.0 shows the 2010-2040 cumulative new nuclear capacity assumed to be added in each region according to the Black & Veatch Energy Market Perspective..
- New nuclear plant capital and operating costs assumed in the model are shown in Table 1.0.

Figure 8.0



5.3.5 Conventional Technologies (Natural Gas - Simple Cycle and Combined Cycle; Pulverized Coal Units)

- Existing capacity by prime mover and fuel and generation costs.
- Capital Costs for new capacity (including indirect costs, fixed cost recovery factors) as shown in Table 1.0.
- Time to construct new units.
- Operating costs for new capacity (fixed and variable) as shown in Table 1.0.
- Emissions.
- Heat rate (efficiency).

Table 1.0 – Comparative Costs of New Generator Alternatives

	Capital	FOM	VOM
	(2009 $/kW)	(2009 $/kW-year)	(2009 $/MWh)
Nuclear	5,907	60.0	0.0
New Coal with PCCC*	6,315	58.0	18.0
Efficient Coal	3,509	26.5	2.1
Inefficient Coal	N/A	70.0	8.0
New IGCC with Sequ.	7,795	59.0	15.0
Post Comb Control Coal	3,500	60.0	20.0
Combined Cycle	1,264	6.9	4.0
Simple Cycle	677	6.8	16.0

* Pressurised combustion combined cycle

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5.3.6 Offsets

- Under the Western Climate Initiative, a maximum of 49% of the annual CO_2 emission reductions can be met with offsets. Black & Veatch assumed that 50% of the maximum reduction would be met with offsets. Therefore, the analysis assumes 25% of CO_2 emission reductions are met with offsets.
- Under Waxman-Markey, up to 2 billion tonnes per year of offsets (50% domestic and 50% international) can be used to meet required emissions reductions. The electric industry's load ratio share was estimated to be 39%. However, the baseline view from the Black & Veatch Energy Market Perspective is that only half of these offsets will be economically competitive and available due to competition from other sectors and/or complications associated with developing these offsets.
- Waxman-Markey also establishes a yearly maximum of approximately 30% of required allowances that can be met with offsets. The Electric Industry Carbon Model estimates and applies the most restrictive of the assumed constraints on the availability of offsets and the annual restriction on offset use when applying Waxman-Markey provisions.

5.4 Alternative Forecasts

Black & Veatch estimated likely variations of its baseline forecasts of the following inputs and utilized them in its carbon model to evaluate the five selected cases described in the next section.

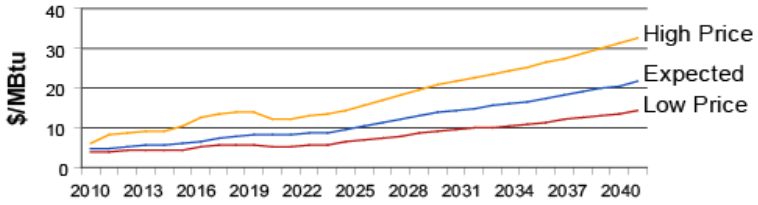
5.4.1 Electric Demand

As illustrated in Figure 3.0 above the compound load growth rate for the U.S. and Canada goes down to 0.5% for the Medium Growth Case, 0% for the Low Growth Case, and goes up to 2% for the High Growth Case.

5.4.2 Fuel Prices

A composite gas price growth rate of 6.2% was assumed for the High Gas Price Case and 4.2% was assumed for the Low Gas Price Case. This is illustrated in Figure 9.0 below.

Figure 9.0 – Composite Forecast Gas Prices



5.4.3 Renewables (Hydropower, Geothermal, Biomass and Wood, Solar and Wind)

New Renewable Capacity Additions and Associated Energy – Using the Low Renewables assumption, the expected renewables buildout, excluding hydroelectric additions, was reduced by one-third. The High Renewables assumption figured that non-hydroelectric additions prior to 2020 were doubled. Hydroelectric additions were not increased in these cases due to their large size and long lead time for development. Small hydro projects do not amount to a significant proportion of total capacity and this proportion is expected to remain small during the study period.

5.4.4 Nuclear

Planned New Nuclear Capacity Additions – Baseline nuclear additions shown in the previous subsection were assumed to be reduced by half in the Low Growth Scenario and increased by 50% in the High Growth Scenario.

5.4.5 Conventional Technologies (Natural Gas – Simple Cycle and Combined Cycle; Coal – Inefficient (older) Units and Efficient (newer) Units

Capital costs for new capacity were assumed to be reduced by 25% in the Low Growth Scenario and increased by 25% in the High Growth Scenario. A Very High Capacity Cost case was established for new IGCC with CCS with a corresponding increase of 50% with respect to the baseline capital cost estimate.

5.4.6 Offsets

The High Offsets case assumes that all 39% of the electric industry's load ratio share of offsets will be economically competitive and available.

5.4.7 Electric Vehicle Impacts on Load

To reflect the impact of electric vehicles, Black & Veatch referred to the forecast of alternative vehicle penetration cited in the U.S. Energy Information Administration (EIA) 2009 Annual Energy Outlook. In addition to the impact of increasing corporate average fuel economy standards on emissions in the transportation sector, EIA assumed that alternative vehicles including hybrids and plug-in electric vehicles could account for more than 60% of new light duty vehicle purchases by 2030. Using EIA estimates of driving miles by these vehicles each year and their efficiency, Black & Veatch estimated that each plug-in electric car would use approximately 4.2 MWh per year. This vehicle market share and use amounts to an approximate 8% increase in electric use all during off-peak hours. To model this impact, Black & Veatch modified the typical daily load shapes for each region to produce 59.4% load factors for the regional loads and to reflect the impact on CO_2 prices of these increased loads.

The combination of improved mileage and use of electric cars will potentially take the transportation sector a long way towards its goal of emissions reductions under Waxman-Markey.

5.5 Selected Scenarios

As described in Section 3.4, one case from each of five scenarios was chosen for quantitative analysis with the Black & Veatch Electric Industry Carbon Model. See Section 4.4 for the input variable vectors that were used for the carbon model analysis of each scenario. Section 3.4 also describes how a case was chosen from each selected scenario by specifying further the compliance structure and carbon caps that would apply. The cases were chosen with an eye toward producing a broad but not unrealistic range in the forecast price of CO_2 allowances.

While the objective of this report is to forecast CO_2 prices through 2040, Black & Veatch felt it was important to forecast CO_2 prices through 2050 in order to reflect the impact of meeting the ultimate target of an 83% reduction in emissions. Such a consideration appears to be especially important given the ability to bank allowances under the Waxman-Markey bill.

Figure 10.0 Selected Scenario Descriptions

Scenario 1
High Global Growth – National Action

- Strong int'l cooperation
- High, managed growth by 2012
- Int'l greenhouse gas cap-and-trade
- Higher government RD&D spending

Flexible compliance
Conservative caps

Scenario 2
Medium Global Growth – National Action

- Modest growth in OECD nations
- Healthy growth in developing nations
- North American cap-and-trade
- BRICs enter greenhouse gas regime later

Strict compliance
Aggressive caps

Scenario 3
Medium Global Growth –Regional/National Action

- Modest growth in OECD nations
- Healthy growth in developing nations
- National greenhouse gas regime pre-empts regional pacts in 2020
- Non-OECD countries join later

Flexible compliance
Base caps

Scenario 4
Low Global Growth – Regional/National Action

- Economic growth still sputtering
- "Green" governments push forward with greenhouse gas regulations
- Trade frictions on imports to U.S.
- National greenhouse gas pre-empts scaled back regional pacts by 2020

Flexible compliance
Conservative caps

Scenario 5
High Global Growth – Regional Action

- High, laissez faire growth after 2016
- Regional greenhouse gas compacts persist, and ramp up targets modestly after 2020
- Accelerating greenhouse gas concentrations
- Active adaptation to warming climate

Strict compliance
Aggressive caps

5.6 Forecast CO_2 Prices

The range of CO_2 prices forecast using the Electric Industry Carbon Model and assumptions from the previously described scenarios varies from $8/tonne to $83/tonne in the 2012-2014 time period. By 2020, these forecast CO_2 prices range from $7 to $160/tonne. While the assumptions used for the scenarios selected for BC Hydro are vastly different from the assumptions used in the EIA analysis of the Waxman-Markey bill, the range of forecasts are not dissimilar. The EIA forecast CO_2 prices range from $20 to $93/tonne (2007 dollars) compared to the Black & Veatch equivalent of $7 to $127 per tonne (2007 dollars) for the year 2020.

In a market for CO_2 allowances such as envisioned by the Waxman-Markey bill, the price necessary to induce the replacement of higher-carbon generation with less carbon-intensive generation includes the price necessary to switch to lower-carbon technology for the new generating capacity that will be needed to meet growth. This will require the higher capital and operating cost of the low-carbon technologies to compete with the lower capital and operating costs of the carbon-intensive technologies by way of a price assigned to the differential of their CO_2 emissions.

Figure 11.0 illustrates tradeoffs in the fixed and variable components of carbon intensive and low-carbon technologies for the year 2020. The variable components of levelized costs of new generation include both a $0 and a $49/tonne price for CO_2 emissions in the year 2020. Levelized costs in this chart are the amortized capital cost of the technology plus the weighted average of 20 years of fuel and O&M costs with the time value of money as the weighting factor. Twenty years of levelized costs will have the same present value as 20 years of capital charges and operating costs with fuel and O&M escalating each year. Comparing the red bars to the gold bars in Figure 11.0 indicates the increase in levelized variable costs associated with an assumed $49/tonne CO_2 price. The levelised costs shown in Figure 11.0 represent average levelized costs since costs will vary from region to region of the U.S. and Canada in accordance with differences in relative fuel prices and capital costs.

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Figure 11.0 Twenty-Year Levelized Fixed and Variable Costs of Alternative Generating Technologies

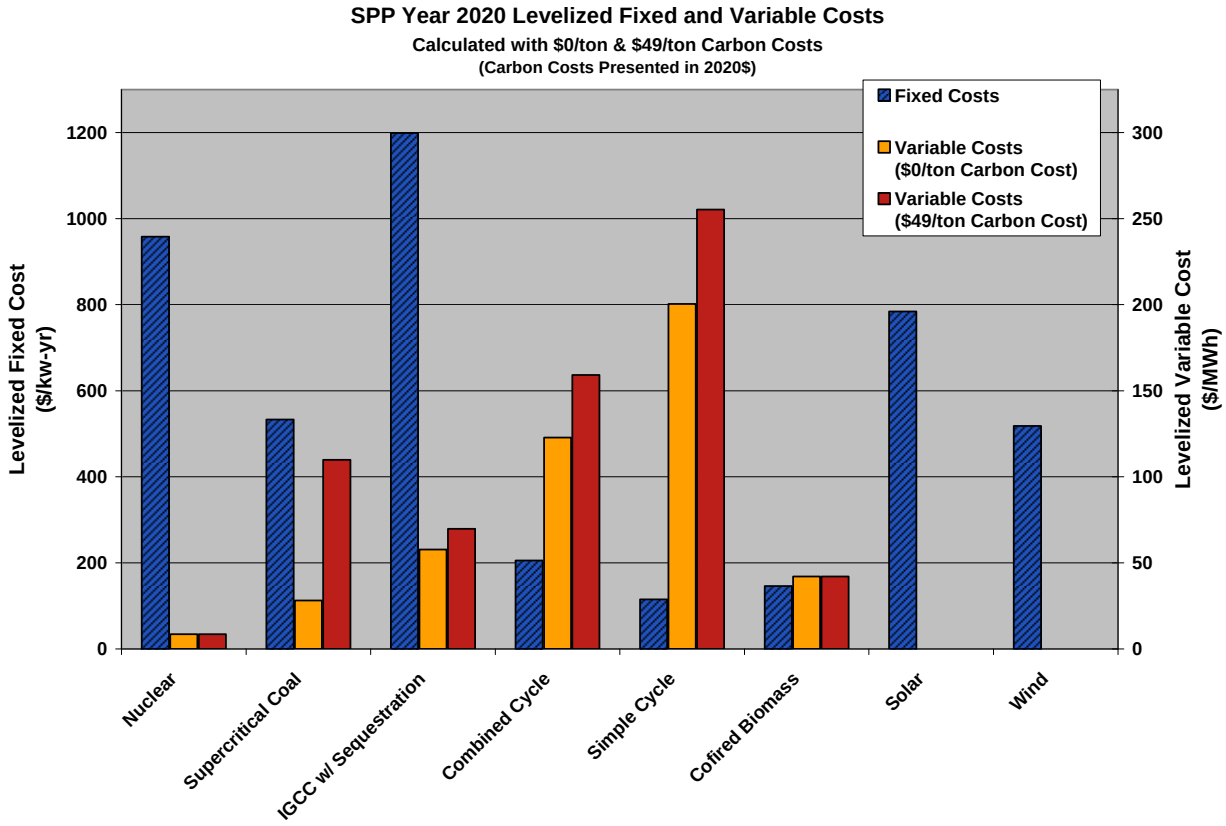

Figure 12.0 illustrates the comparison of levelized costs of new plants operational in 2020 over the full range of capacity factors to assist in comparing the new generating capacity alternatives in regions needing new capacity to meet growth at different capacity factors. From Figure 12.0, with a zero CO_2 price, the least-cost sources of new generating capacity to meet growth are those associated with high-quality wind resources and opportunities to apply biomass co-firing at existing coal plants. Each of these resources is limited to varying degrees based on the availability of wind and biomass resources throughout Canada and the United States. Beyond these renewable resources, the least-cost technology to run below a 13% capacity factor is simple cycle combustion turbines. Between a 13% and 40% capacity factor, the least cost technology is combined cycle combustion turbines. Above a 40% capacity factor, new super-critical coal generation is least-cost. Solar energy is not competitive by 2020 partly due to the expiration of the investment tax credit in 2016. By 2020, IGCC with CCS is still far from being cost-effective at any capacity factor.

In the presence of a \$49 CO_2 price, the limited renewable resources are even more cost-effective. Combined cycle generation is cost-effective over a broader range of capacity factors of between 10% and 58% beyond which nuclear capacity is most cost-effective. With constraints on the development of nuclear generation, the next best technology is combined-cycle up to a 75% capacity factor and new supercritical coal generation for any region needing new capacity to run more than 75% of the time. At an 85% capacity factor, it would take a CO_2 price of approximately \$79/tonne to equate the levelized costs of new IGCC capacity with new supercritical capacity and induce the addition of IGCC generation in 2020.

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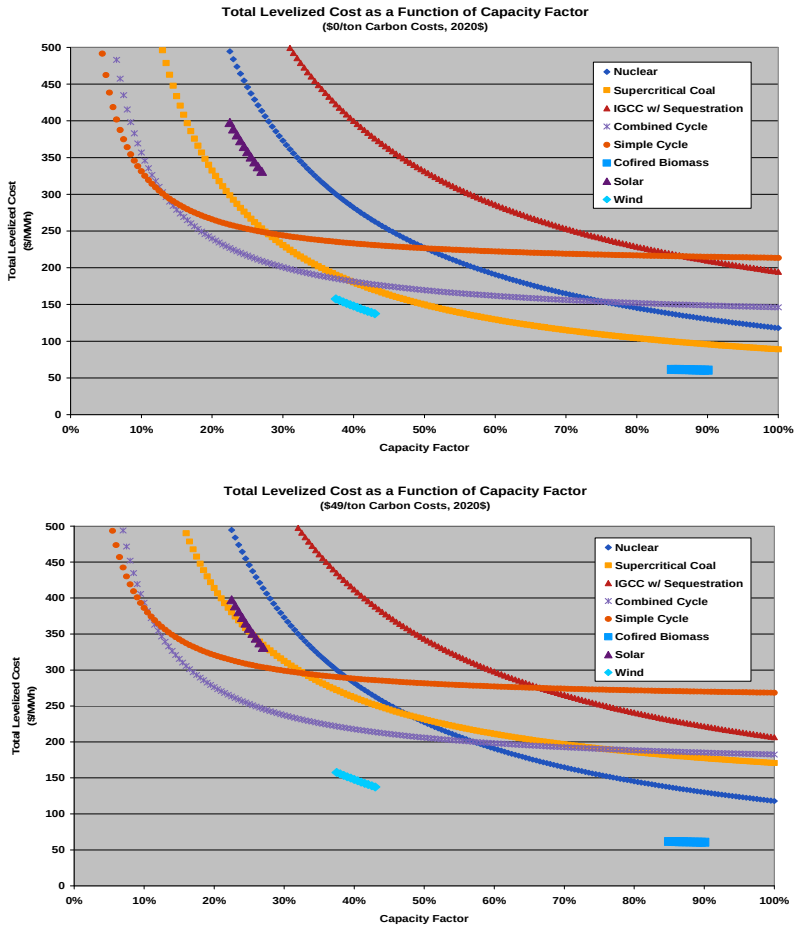
It would take a CO_2 price of $191/tonne to equate the levelized costs of new IGCC capacity with new combined cycle capacity at an 85% capacity factor and $466 per tonne to equate the prices at a 40% capacity factor. Similarly, it would take a CO_2 price of between $60 and $150 per tonne to make solar generation competitive with simple and combined cycle combustion turbines. Even then, most solar resources can only supply electricity between 20% and 30% of the time.

Finally, at an 85% capacity factor, it would take a CO_2 price of approximately $17/tonne to equate the levelized cost of new combined cycle capacity with new SCPC capacity; however, combined cycle technology still emits substantial CO_2.

Figure 12.0 Twenty-Year Levelized Costs of Alternative Generating Technologies as a Function of CO_2 Price and Capacity Factor



While the comparisons described above are appropriate for minimizing costs for new generation developed to meet growth, they do not address the CO_2 prices necessary to shift existing carbon-intensive generation to existing less carbon intensive generation which, for the most part, means the dispatch of gas fueled generation ahead of coal fueled generation. Such a substitution is dependent upon the current differential between natural gas and coal prices and the differential between their efficiency and their CO_2 emission rates. While these three differentials vary by region and plant, assuming a fuel price differential of $5.57/MBtu in 2020, a full-load heat rate differential of 2,300 Btu/kWh and an emission rate differential of 0.57 tonnes per MWh for

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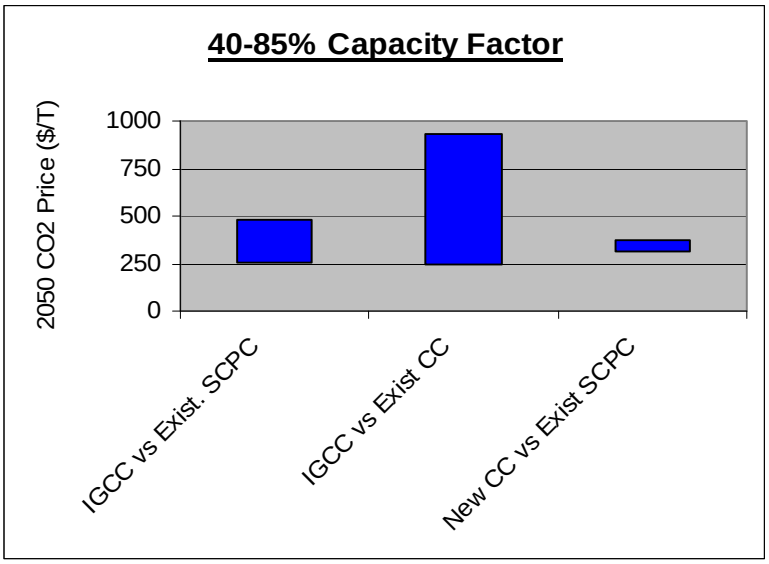
SCPC versus combined cycle generation yields a 2020 CO_2 price of $58 per tonne necessary to induce the dispatch of gas combined cycle generation ahead of efficient coal generation.

Figure 13.0 illustrates the range of CO_2 prices necessary to induce the substitution of new less carbon-intensive technologies for existing higher CO_2 emitting technologies by 2050 when CO_2 emissions are to be 83% below 2006 emission levels. The necessary CO_2 prices are shown for capacity factors ranging from 40% to 85%. The top of each bar in Figure 13.0 represents the CO_2 price above which the less carbon-intensive will be least-cost at an 85% capacity factor. The bottom of each bar represents the CO_2 price above which the less carbon-intensive technology will be least cost at a 40% capacity factor. From Figure 13.0, if new IGCC capacity must be added to eliminate CO_2 from an existing super-critical pulverized coal (SCPC) unit operating at a capacity factor of between 40% and 85% in order to sufficiently reduce emissions, the 2050 CO_2 price must reach between $255 and $482/tonne. If new IGCC capacity must be added to eliminate CO_2 from existing combined-cycle (CC) generation operating at a capacity factor of between 40% and 85%, the 2050 CO_2 price must reach between $241 and $936/tonne. Finally, if new CC capacity must be added to eliminate CO_2 from an existing super-critical pulverized coal unit operating at a capacity factor of between 40% and 85%, the 2050 CO_2 price must reach between $312 and $369/tonne.

Figure 13.0 CO_2 Prices That Support Replacement of Existing Generating Capacity



Because two generating technologies rarely substitute directly for one and other, generation expansion and dispatch models like the Electric Industry Carbon Model account for how new or replacement generators would actually be selected and operated in the context of the existing system, with the selection decision based on the expected levelized costs and the dispatch decision based on real-time operating costs. In so doing, these models minimize the estimated CO_2 price necessary to accomplish CO_2 reduction targets.

The following paragraphs describe the sensitivity of forecast CO_2 prices to changes in forecast market drivers varying one driver at a time. The forecast emission reductions, expansion plans and generation mix associated with each sensitivity case are contained in Appendix D. The sensitivity discussions are followed by descriptions of the model results for each of the selected scenarios.

5.6.1 Sensitivity Analyses

The following key drivers were analyzed for purposes of estimating the sensitivity of forecast CO_2 prices to reasonable changes in future market conditions:

- Plug-in electric vehicle penetration.
- Renewable energy and efficiency growth.
- Natural gas prices.
- Electric demand.
- Offset availability.

All sensitivity analyses forecast below were conducted relative to Scenario 2 (Medium Global Growth/National Actor) described above.

The sensitivity of CO_2 prices to significant growth in the penetration of plug-in electric vehicles was analyzed for two reasons. Such growth could realistically happen and affect the market for CO_2 allowances by the electric utility industry. In addition, CO_2 prices that bring both the electric and the transportation sector into compliance cover more than two-thirds of the energy related emissions in North America and are more likely to represent the cost of CO_2 allowances if and when all three sectors begin to trade emissions rights.

For purposes of this analysis, the focus was on determining the impact on electric loads of the assumption that 50% of light-duty vehicles could be plug-in electrics. With light-duty vehicles constituting 61% of the transportation sector's emissions of CO_2, converting half of these vehicles would amount to a 30% drop in emissions for the transportation sector assuming the electricity used to power the vehicles is 0 tonnes/GWh. That drop along with the use of offsets and lower cost additional efficiency gains could bring the transportation sector into compliance with the low caps targeted by Waxman-Markey. With each electric car estimated to use 3.5 to 4.2 MWh per year, a 50% penetration of light duty vehicles would increase U.S. and Canadian electric loads by 8%, all of which was assumed to occur during off-peak hours. Within Scenario 2, an 8% reduction in off-peak electric loads reduces the resultant 2014 CO_2 price by $9 per tonne.

Like electric power demand for plug-in vehicles, high electric load growth in general has a significant positive impact on CO_2 prices. Substituting a compound electric demand growth of 2%, a rate reflected in long-term historical trends, in place of 1% assumed in Scenario 2, increases the resultant CO_2 price by $14 to $15 per tonne.

The influence of the growth of renewable energy and energy efficiency is also significant. Scenario 2 assumes the Waxman-Markey target of 5% energy efficiency and 15% renewable energy is doubled. A sensitivity case for Scenario 2 assumed the original 5% and 15% for efficiency and renewable energy. The impact of these lower renewable and efficiency assumptions was quite significant in the context of Scenario 2 at between $11 and $12/tonne.

Another influential driver of future CO_2 prices under cap and trade legislation is the price of natural gas. As gas prices rise, switching to gas-fueled sources of electricity becomes more expensive. In this sensitivity case, the expected gas prices shown in Figure 9.0 were replaced with the high gas prices shown on the same figure. The result was an $8/tonne increase in the 2014 price of CO_2.

Finally, the influence of offsets on the price of CO_2 was analyzed by assuming no offsets are available for meeting the Waxman-Markey CO_2 targets. The impact on CO_2 prices in Scenario 2 was a $96 per tonne increase.

Because most of the key drivers of CO_2 prices under a cap and trade program are interdependent, their impacts are not additive as illustrated in the forecasts below for each selected scenario.

5.6.2 Scenario Forecasts

5.6.2.1 High Global Growth – National Action: Scenario 1

Several assumptions contribute to high CO_2 prices in Selected Scenario 1. High load growth (2% per year compared to 1.1% for North America), high natural gas prices, a 50 % reduction in new nuclear construction and an additional 8% increase in energy use (all during off-peak times) to recharge plug-in electric vehicles all push CO_2 prices higher than would be expected using Black & Veatch's Expected case forecasts. Higher efficiency achievements and renewable generation development and lower costs (-25%) for CCS tend to lessen the abatement measures needed from the CO_2 market and lower the cost of those measures that depend on CCS. Finally, the assumption of slightly higher caps in 2020 and 2030 and that the electric sector will be able to achieve its full load-ratio-share of offsets would reduce overall compliance costs.

As shown in Figure 14.0, the high load growth and electric vehicle penetration produce higher capacity and generation demands then any other scenario. High load growth, electric vehicle loads and low CCS costs also contribute to the economical addition of IGCC with CCS as early as the early 2020s and significant generation of "clean coal" based electricity by 2040. The associated price of CO_2 allowances in this scenario is $30/tonne in 2014 at the assumed start of the cap and trade program under Waxman-Markey. Forecast capacity and generation mix, emission reduction sources and resulting CO_2 prices for Scenario 1 are shown in Figure 14.0. In each emission graph, the area above the gold stripe, representing remaining emissions after efficiency reductions and the use of offsets, but below the blue line representing the CO_2 cap level, signifies the banking and borrowing of CO_2 allowances. In all cases, the net balance is within 5% of zero by 2050.

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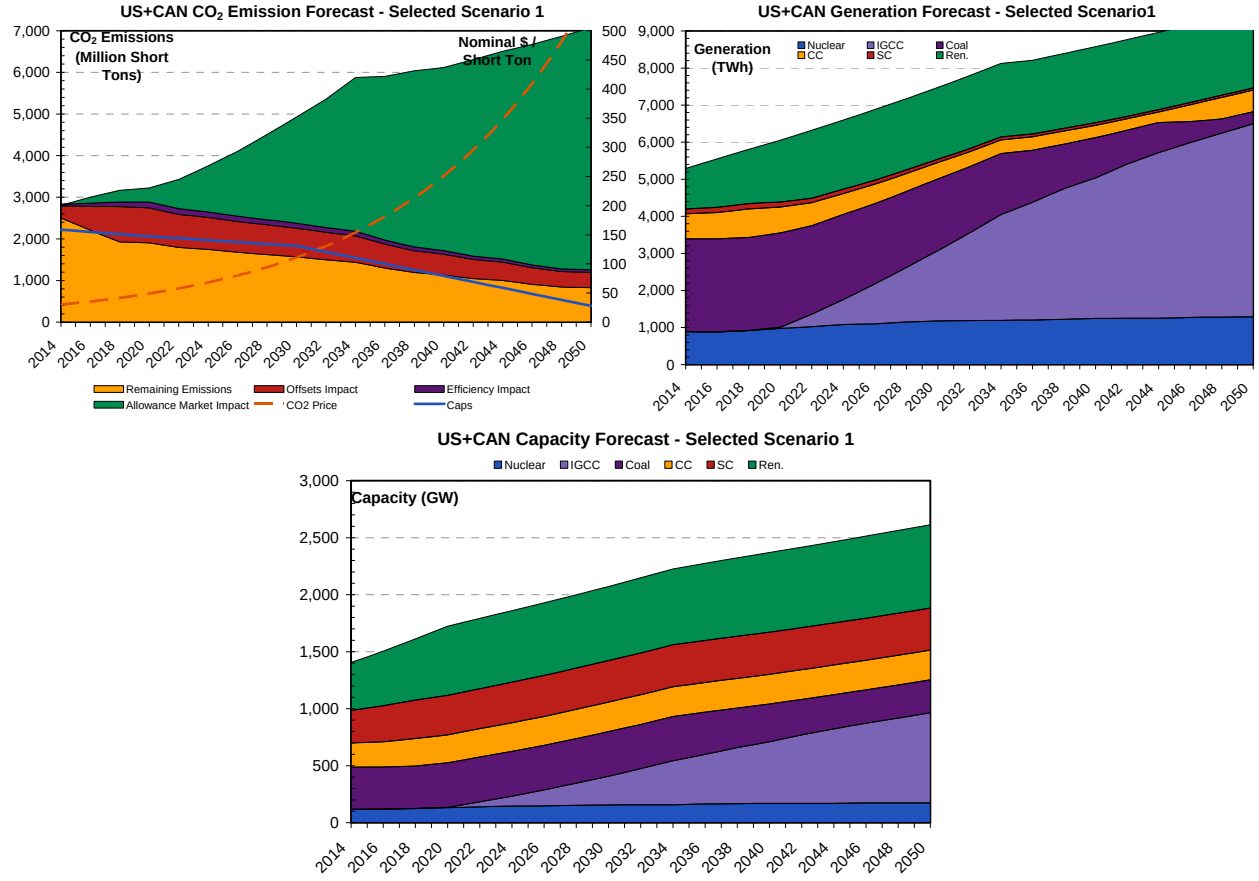
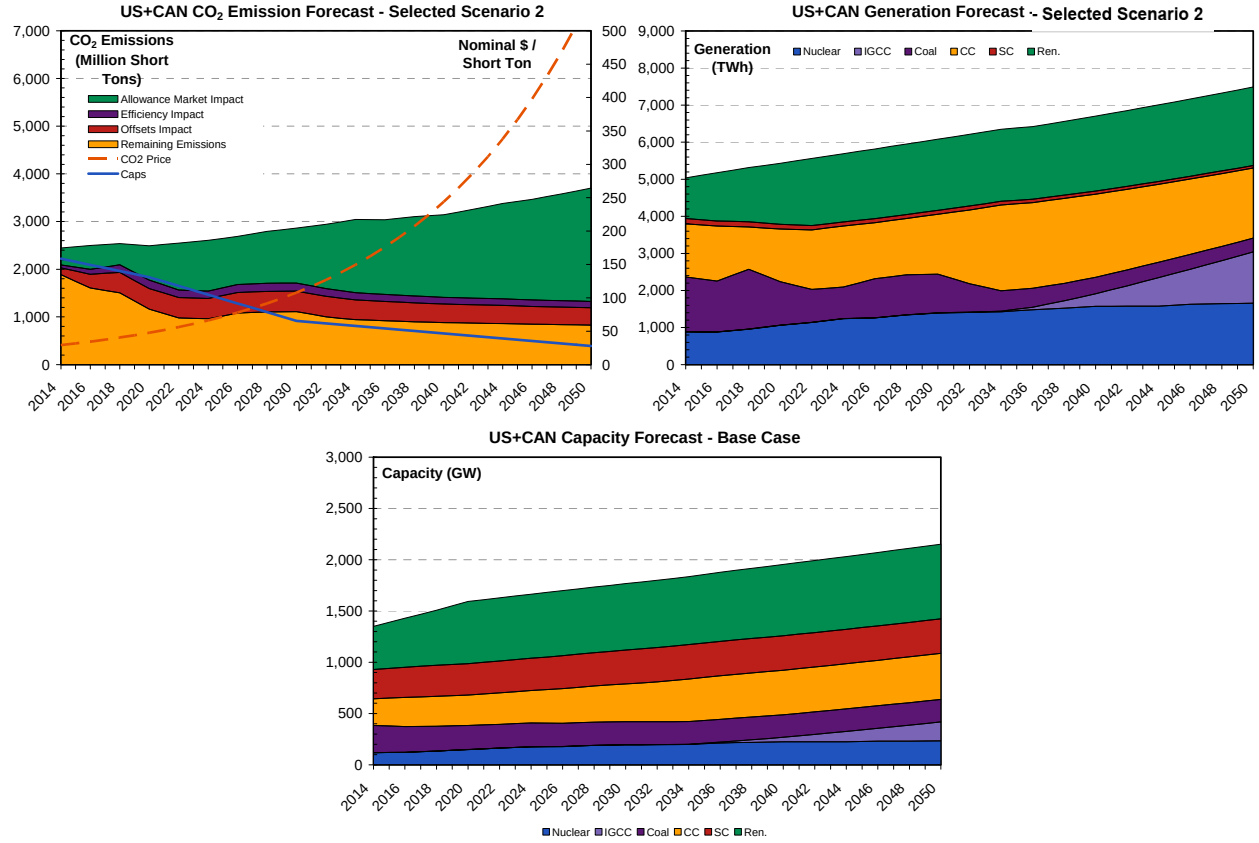
Figure 14.0 - Selected Scenario 1 - Forecast Generation and CO_2 Prices



5.6.2.2 Medium Global Growth – National Action: Scenario 2

In Scenario 2, several forecast variables, load growth, fuel prices, nuclear penetration and CCS, are not changed from Black & Veatch's Expected Case forecasts. No change in the caps is assumed from the Waxman-Markey provisions, and the electric industry is assumed to be able to compete for only 50% of its load ratio share of offsets. Renewable energy growth is doubled in this case as are the impacts of increased energy efficiency. The assumption of an 8% increase in electric loads associated with the growth of plug-in electric vehicles is the one factor contributing to upward pressure on CO_2 prices. The net outcome of these assumptions is a 2014 CO_2 price of $29/tonne. In Scenario 2, IGCC with CCS begins to be built on an economic basis by the late 2030s. Forecast capacity and generation mix, emission reduction sources and resulting CO_2 prices for Scenario2 are shown in Figure 15.0.

Figure 15.0 - Selected Scenario 2 - Forecast Generation and CO_2 Prices



5.6.2.3 Medium Global Growth – Regional/National Action: Scenario 3

Scenario 3 is one of the two scenarios in which the Western Climate Initiative is assumed to govern CO_2 emissions in British Columbia until 2020 at which time a national program for both Canada and the United States, like Waxman-Markey, is assumed to be enacted.

Electric loads, fuel prices and efficiency projections are forecast using Black & Veatch's independent expected forecasts. Nuclear and renewable penetrations are assumed to be high and electricity's full load-ratio-share of offsets is assumed to be acquired by the electric industry, and after 2020 would be similar the Waxman-Markey proposal. Electric vehicle loads are included in the loads beginning in 2020 in all the U.S. and Canada and CCS costs are assumed to be 25% higher than the baseline forecast. The resultant 2012 CO_2 price is $19/tonne. With the addition of the Waxman-Markey program and electric vehicle loads, the CO_2 price jumps to $49/tonne in 2021. CO_2 reductions are accomplished in this case by conversion of considerable amounts of generation from coal to natural gas. Because of the assumed premium on CCS costs, IGCC with CCS additions are delayed until after the end of the 2040 forecast period. Forecast capacity and generation mix, emission reduction sources and resulting CO_2 prices for Scenario 3 are shown in Figure 16.0.

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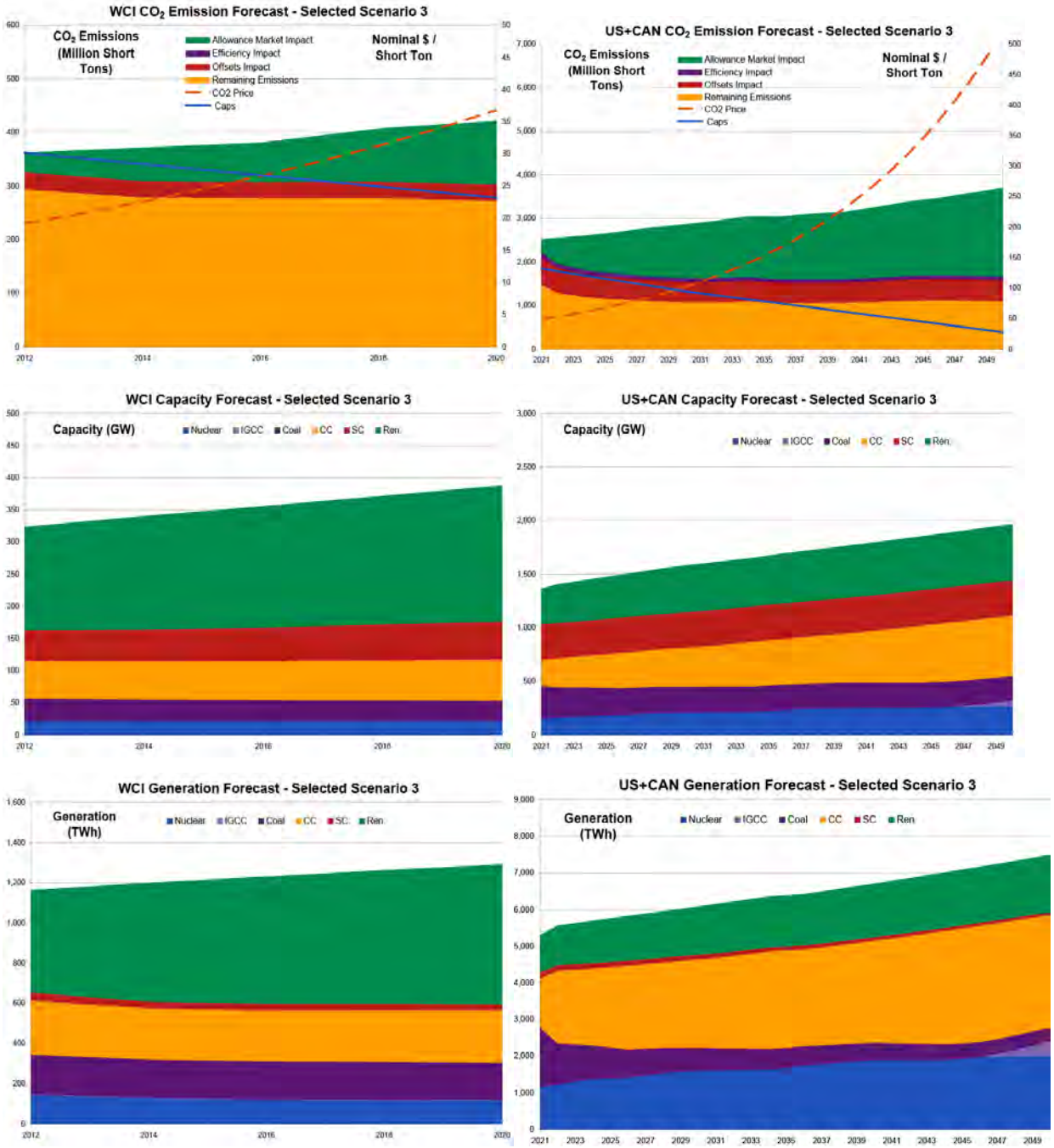
Figure 16.0 - Selected Scenario 3 - Forecast Generation and CO_2 Prices



5.6.2.4 Low Global Growth – Regional/National Action: Scenario 4

Scenario 4 is the second of two scenarios in which the Western Climate Initiative is assumed to govern CO_2 emissions in British Columbia until 2020 at which time a national program for both Canada and the U.S., like Waxman-Markey, is assumed to be enacted. Electric loads are assumed to be level in this scenario, the electric industry is assumed to get its full load ratio share of offsets, and natural gas prices are assumed to be low as well, all of which contribute to low CO_2 prices. Nuclear additions, renewable penetration and efficiency

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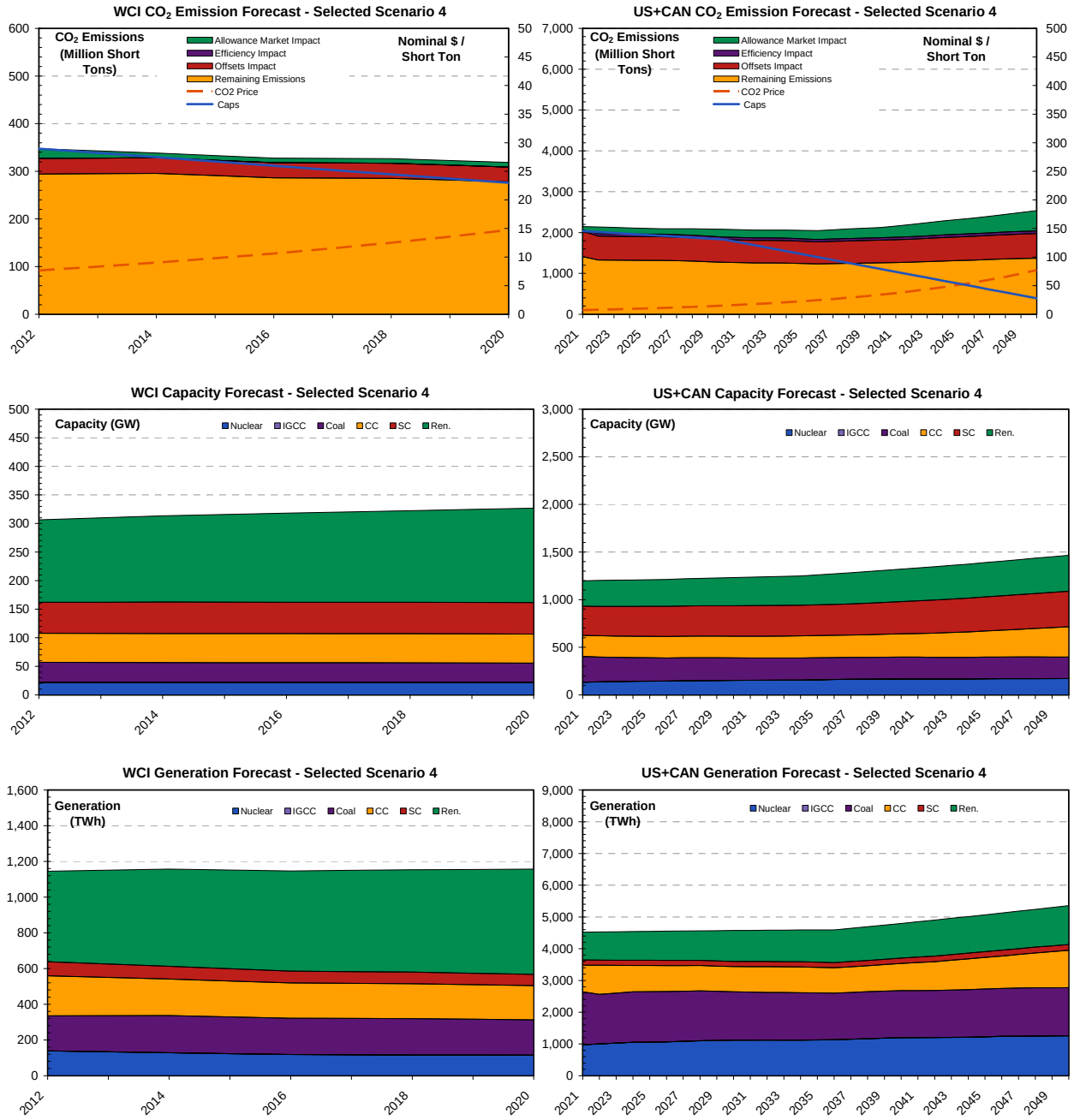
forecasts are forecast to be low which contribute to higher CO_2 prices. Finally, CCS costs are assumed to be 25% higher than the expected case. From Figure 17.0 we see that CCS is really not used in the future mix, making its cost of no significance. Under the Western Climate Initiative, prices start at $8/tonne in 2012 and escalate at 8.5% and then reset at $7 per tonne when Waxman-Markey takes over in 2021.

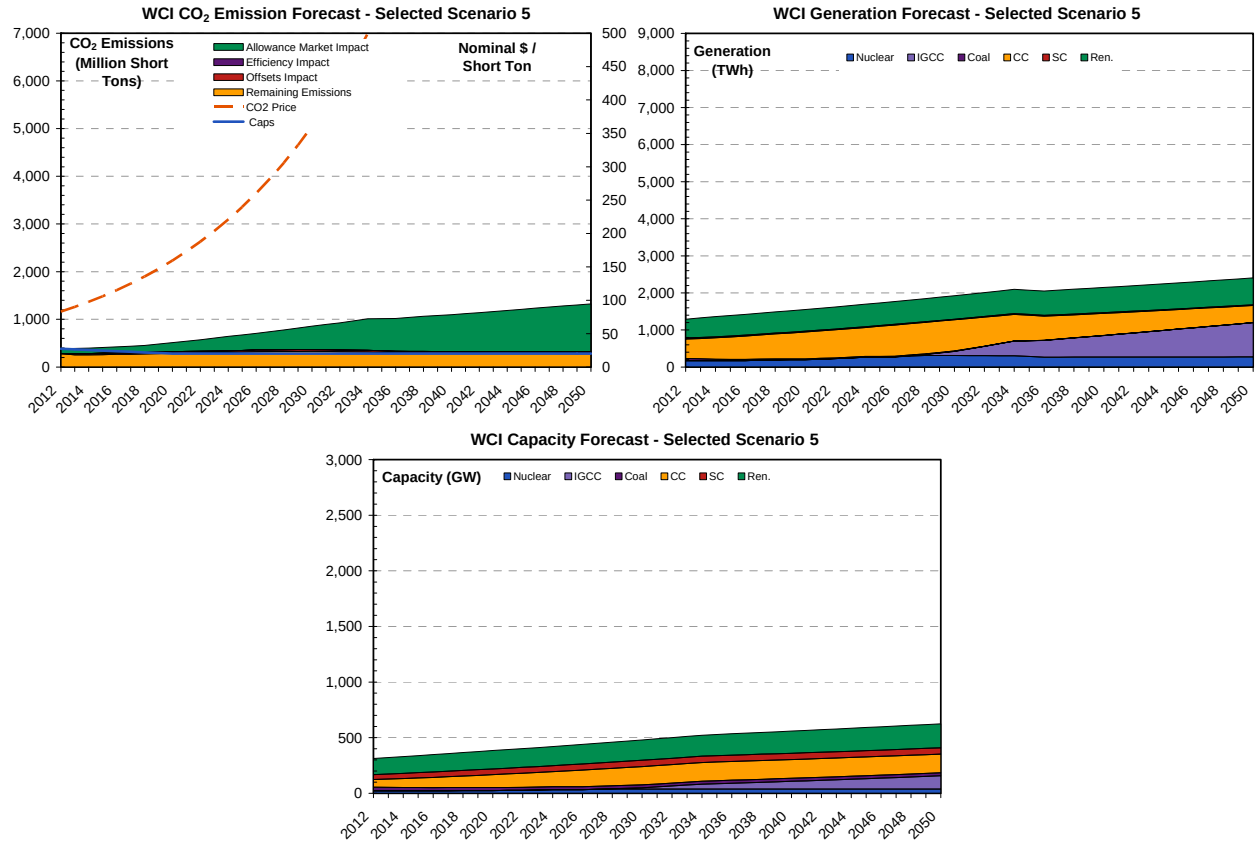
Figure 17.0 - Selected Scenario 4 - Forecast Generation and CO_2 Prices



5.6.2.5 High Global Growth – Regional Action: Scenario 5

Selected Scenario 5 assumes the Western Climate Initiative governs CO_2 prices in British Columbia under a cap and trade program throughout the forecast period. This scenario assumed high load growth in addition to an 8% increase in electric demands in the western climate region to serve electric vehicle loads. Expected forecasts of gas prices and renewable generation additions are assumed. A 15% target reduction in CO_2 is assumed and the use of 10% offsets is also assumed in accordance with the Western Climate Initiative proposal. CCS costs are assumed to increase by 50% in this scenario, delaying its economic addition until the mid 2020s. The resulting 2012 price for CO_2 is $83/tonne based on the cost to finance construction of new IGCC plants with CCS. The lack of existing coal generation in the WCI region makes it very expensive to achieve even a 15% reduction in emissions. Forecast capacity and generation mix, emission reduction sources and resulting CO_2 prices for Scenario 5 are shown in Figure 18.0.

Figure 18 - Selected Scenario 5 - Forecast Generation and CO_2 Prices



As discussed earlier, in all forecasts of CO_2 prices described above, an 8.5% nominal escalation in allowance prices is implied. This escalation rate compares to the 7.5% and 10% escalation assumptions used by EIA. In Scenarios 3 and 5, the 8.5% escalation in Western Climate Initiative prices applies until the Waxman-Markey provisions apply at which time there is an adjustment in price to reflect Waxman-Markey. Then the 8.5% rate applies to prices thereafter.

5.6.3 Summary for Five Scenarios

The carbon price forecasts generated by the Black & Veatch carbon model for the five scenarios are summarized in nominal and real terms the following Figure 19.0 and in Tables 2.0 and 3.0 below. From these

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figures and tables, Scenarios 1 through 3 yield very similar CO_2 price forecasts. Scenario 2 is close to Black & Veatch's expected case scenario for forecast CO_2 prices. The impact of electric vehicle loads pushing prices up is closely offset by assumptions of higher efficiency and renewable penetration.

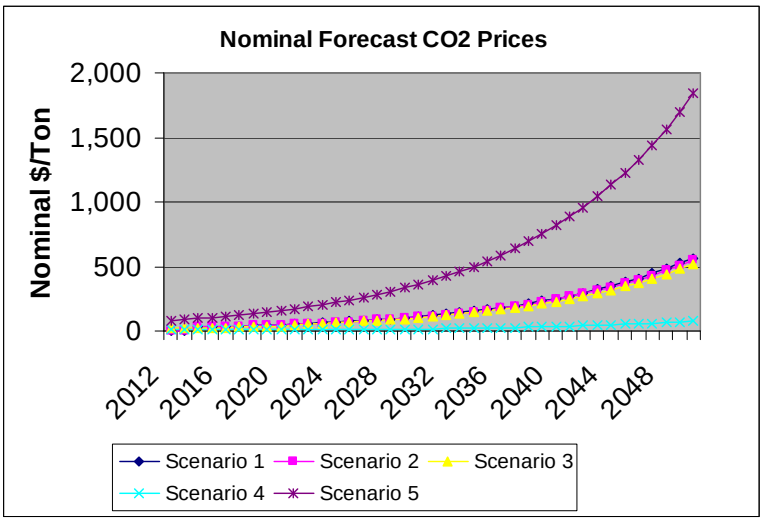
In addition for Scenario 1, it appears that the upward push on prices from high loads, gas prices and reduced nuclear penetration is offset by higher efficiency and renewable penetrations and the assumption that the electric industry gets its full load ratio share of offsets.

In Scenario 3, the delayed controls in much of the United States and Canada that result from the delay of Waxman-Markey produce a significant increase in the 2021 CO_2 price. However, the increased renewable and nuclear penetrations and full offsets tend to push the price down while the load from electric cars and IGCC costs that are 25% more expensive push the price higher. The net effect is a forecast very close to that of Scenarios 1 and 2.

In Scenario 4, the assumption of level loads and full load ratio share of offsets results in no need for IGCC and much lower CO_2 prices.

Finally, while Scenario 5 assumes CO_2 caps are applied to only the Western Climate Initiative area, the lack of existing coal generation in that region necessitates a reliance on the idea that combined-cycle capacity will be replaced by IGCC capacity that is assumed to cost 50% more than the baseline assumption. In spite of the lower cap, the reliance on very expensive IGCC capacity produces an extremely high CO_2 price forecast for the Western Climate region.

Figure 19 - Forecast CO_2 Prices



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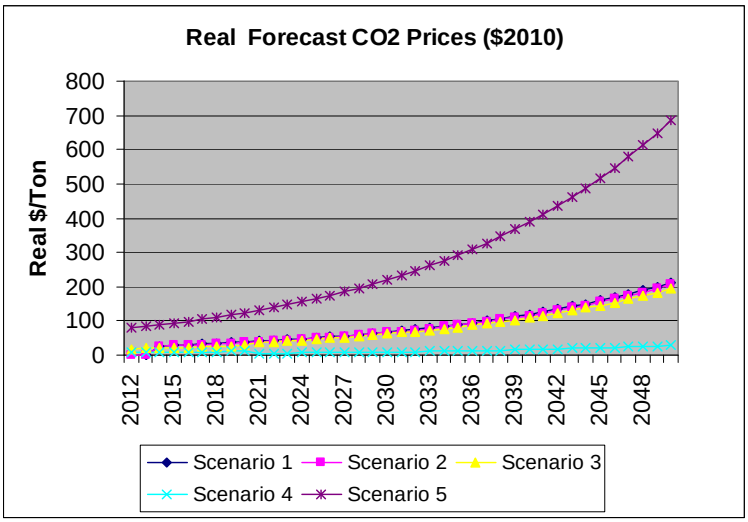

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Table 2.0 Forecast CO_2 Prices (Nominal $)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
2012	-	-	19.16	7.66	83.02
2013	-	-	20.79	8.32	90.08
2014	30.07	29.24	22.55	9.02	97.73
2015	32.63	31.73	24.47	9.79	106.04
2016	35.40	34.42	26.55	10.62	115.05
2017	38.41	37.35	28.81	11.52	124.83
2018	41.67	40.52	31.26	12.50	135.44
2019	45.21	43.97	33.91	13.57	146.96
2020	49.06	47.70	36.80	14.72	159.45
2021	53.23	51.76	48.83	7.23	173.00
2022	57.75	56.16	52.98	7.85	187.71
2023	62.66	60.93	57.48	8.52	203.66
2024	67.99	66.11	62.36	9.24	220.97
2025	73.77	71.73	67.66	10.02	239.76
2026	80.04	77.83	73.42	10.88	260.14
2027	86.84	84.44	79.66	11.80	282.25
2028	94.22	91.62	86.43	12.80	306.24
2029	102.23	99.41	93.77	13.89	332.27
2030	110.92	107.86	101.74	15.07	360.51
2031	120.35	117.03	110.39	16.35	391.15
2032	130.58	126.97	119.78	17.74	424.40
2033	141.68	137.77	129.96	19.25	460.48
2034	153.72	149.48	141.00	20.89	499.62
2035	166.79	162.18	152.99	22.66	542.08
2036	180.96	175.97	165.99	24.59	588.16
2037	196.34	190.92	180.10	26.68	638.16
2038	213.03	207.15	195.41	28.95	692.40
2039	231.14	224.76	212.02	31.41	751.25
2040	250.79	243.87	230.04	34.08	815.11
2041	272.10	264.59	249.60	36.98	884.39
2042	295.23	287.08	270.81	40.12	959.57
2043	320.33	311.49	293.83	43.53	1,041.13
2044	347.56	337.96	318.81	47.23	1,129.63
2045	377.10	366.69	345.90	51.25	1,225.64
2046	409.15	397.86	375.31	55.60	1,329.82
2047	443.93	431.68	407.21	60.33	1,442.86
2048	481.66	468.37	441.82	65.45	1,565.50
2049	522.61	508.18	479.37	71.02	1,698.57
2050	567.03	551.38	520.12	77.06	1,842.95

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Table 3.0 Forecast CO_2 Prices (Real 2010 dollars)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
2012		-	18.24	7.29	79.02
2013	-	-	19.30	7.72	83.65
2014	27.24	26.49	20.43	8.17	88.54
2015	28.84	28.04	21.63	8.65	93.72
2016	30.52	29.68	22.90	9.16	99.21
2017	32.31	31.42	24.24	9.69	105.02
2018	34.20	33.26	25.65	10.26	111.17
2019	36.20	35.21	27.16	10.86	117.67
2020	38.32	37.27	28.75	11.50	124.56
2021	40.57	39.45	37.21	5.51	131.85
2022	42.94	41.76	39.39	5.84	139.57
2023	45.46	44.20	41.70	6.18	147.74
2024	48.12	46.79	44.14	6.54	156.39
2025	50.93	49.53	46.72	6.92	165.54
2026	53.91	52.43	49.45	7.33	175.23
2027	57.07	55.50	52.35	7.76	185.49
2028	60.41	58.74	55.41	8.21	196.35
2029	63.95	62.18	58.66	8.69	207.84
2030	67.69	65.82	62.09	9.20	220.01
2031	71.65	69.68	65.73	9.74	232.89
2032	75.85	73.75	69.57	10.31	246.52
2033	80.29	78.07	73.65	10.91	260.95
2034	84.99	82.64	77.96	11.55	276.23
2035	89.96	87.48	82.52	12.23	292.40
2036	95.23	92.60	87.35	12.94	309.51
2037	100.80	98.02	92.46	13.70	327.63
2038	106.70	103.76	97.88	14.50	346.81
2039	112.95	109.83	103.61	15.35	367.11
2040	119.56	116.26	109.67	16.25	388.60
2041	126.56	123.07	116.09	17.20	411.34
2042	133.97	130.27	122.89	18.21	435.42
2043	141.81	137.90	130.08	19.27	460.91
2044	150.11	145.97	137.69	20.40	487.89
2045	158.90	154.51	145.75	21.59	516.45
2046	168.20	163.56	154.29	22.86	546.68
2047	178.05	173.13	163.32	24.20	578.68
2048	188.47	183.27	172.88	25.61	612.56
2049	199.50	193.99	183.00	27.11	648.41
2050	211.18	205.35	193.71	28.70	686.37

6 MARKET SIMULATION ANALYSIS

For Scenarios 1, 3, and 4, Black & Veatch completed detailed hourly power market simulations to assess the expected impact upon energy prices for BC Hydro. These simulations were completed for the 2012 through 2034 time period, using the PROMOD IV market simulation model.

6.1 Description Of PROMOD Model; Appropriateness for this Analysis

PROMOD IV is an integrated electric generation and transmission market simulation system, recognized in the industry for its flexibility and the breadth of its technical capability. It incorporates extensive details on generating unit operating characteristics and constraints, transmission constraints, generation analysis, unit commitment and operating conditions, and market system operations. PROMOD IV uses an hourly chronological dispatch algorithm that minimizes costs (or bids) while simultaneously adhering to a wide variety of operating constraints.

PROMOD IV has two methodologies for considering transmission constraints: a transportation-type model and a linearized AC load flow ("DC load flow"). The simulation can use a transportation model to represent the transmission system. This option allows users to capture the high level impacts of area-to-area transmission constraints without requiring detailed bus-level transmission data and in-depth knowledge of the transmission system. Black & Veatch used the transportation module in completing the market simulations for BC Hydro.

Black & Veatch routinely utilizes PROMOD IV in completing market simulation engagements. Black & Veatch also uses PROMOD IV to develop is Energy Market Perspective long-term forecasts of energy and capacity prices in each of the U.S. and Canadian market regions. PROMOD IV is well-suited to develop long-term detailed projections of energy prices, as it accurately models generator unit commitment and dispatch decisions, including the impact of CO_2 emissions allowance pricing.

6.2 Scope of PROMOD Runs

PROMOD IV market simulations were completed using Black & Veatch's Fall 2009 WECC Energy Market Perspective as the base case. The simulations were completed for the period of 2010 through 2034. In addition to the base case, additional market simulations were completed for Scenarios 1, 3 and 4 described above. Relative to the base case assumptions for Energy Market Perspective, the scenarios included the following major changes:

6.2.1 Scenario 1 – High Case

- Reflects federal CO_2 regulation policies only, with allowance pricing beginning in 2014. Under Scenario 1, CO_2 prices throughout the forecast period are higher than under the Black & Veatch Energy Market Perspective base case.
- Scenario 1 calls for a an increased level of renewable penetration in the WECC than assumed in the Black & Veatch Fall 2009 Energy Market Perspective in the early years of the study.
- Scenario 1 has higher demand growth throughout the WECC, with assumed 2% annual growth in electricity demand. We have adjusted the resource mix to include additional peaking resources in order to satisfy resource adequacy requirements and to eliminate un-served energy from the simulations. Scenario 1 also includes an 8% increase in energy demand in 2020 and later study years, to reflect anticipated demand growth from electric cars. The vehicle demand is allocated to off-peak periods only, which results in an increase in off-peak energy demand approaching 18%.
- Natural gas prices are higher under Scenario 1 compared to the market perspective base case.
- Scenario 1 has modest IGCC entry in the 2022 and later time period.

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6.2.2 Scenario 3 – Mid-Range Case

- Scenario 3 is a combination of WECC and then federal CO_2 regulation policies. As such, CO_2 pricing begins in 2012 under a WECC regulatory regime, and then switches over to assumed federal regulation in 2020. Under Scenario 3, CO_2 pricing begins in 2012 which is two years earlier than in the EMP base case. CO_2 prices in the 2014 through 2019 period are similar under the two forecasts, and then CO_2 prices are higher post 2020 under Scenario 3.
- In the 2012-2020 timeframe, Scenario 3 calls for a greater level of renewable penetration in the WECC than assumed in the Black & Veatch Fall 2009 Energy Market Perspective. As such, power prices under Scenario 3 are lower than the market perspective base case during that period, except in 2012 and 2013, where the earlier introduction of CO_2 pricing more than offsets the impact of increased renewables.
- In the 2020 and later time period, annual energy demand is 8% higher in Scenario 3 due to assumed penetration of electric vehicles. The increased energy demand is assumed to occur exclusively in off-peak periods, which translates into actual increases in off-peak energy demand of around 18%.
- Scenario 3 also has increased IGCC entry in 2022 and later.

6.2.3 Scenario 4 – Low Case

- Scenario 4 is also a combination of WECC and then federal CO_2 regulation policies. CO_2 pricing begins in 2012 under a WECC regulatory regime, and then switches to assumed federal regulation in 2020. CO_2 pricing begins in 2012 which is two years earlier than in the Energy Market Perspective. CO_2 prices throughout the forecast period are much lower under Scenario 4 than under the market perspective base case.
- In the 2012-2020 timeframe, Scenario 4 calls for a reduced level of renewable penetration in the WECC than assumed in the Black & Veatch Energy Market Perspective. In addition, electricity demand levels in the WECC region remain relatively flat throughout the study period, as do natural gas prices.
- There is no increased off-peak demand for plug-in electric vehicles in Scenario 4, in contrast to Scenarios 1 and 3.
- Scenario 4 has modest IGCC entry in the 2022 and later period.

6.3 Support for Major Assumptions

Black & Veatch developed its Energy Market Perspective, which uses an Integrated Market Modeling process to prepare its integrated long-term view of energy markets. In order to arrive at this market perspective, Black & Veatch draws on a number of commercial data sources and supplements them with its own view on key market drivers, for example, power plant capital costs, environmental and regulatory policies, natural gas exploration and development costs, and gas pipeline expansions.

Black & Veatch uses these data in a series of vendor-supplied and internally-developed energy market models to arrive at its proprietary market perspective; vendor-supplied models include PROMOD (part of the PowerBase Suite).

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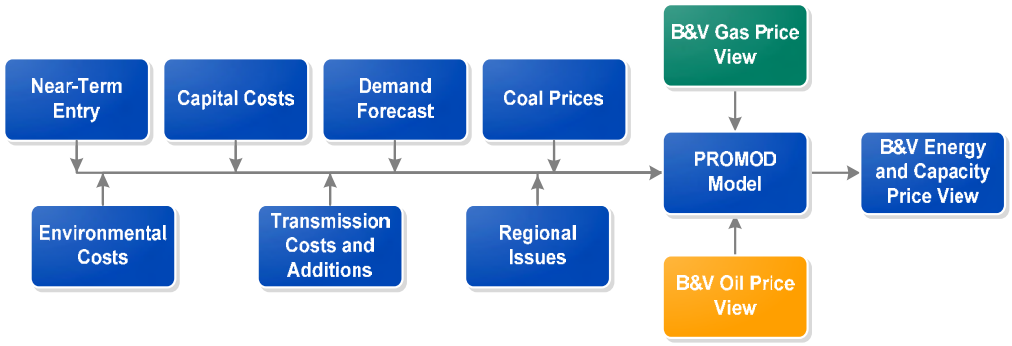
Figure 20 - Black & Veatch Integrated Market Modeling Process



From the Integrated Market Modeling process, Black & Veatch has developed an independent forecast of the WECC wholesale electricity market. This analysis incorporates the results of Black & Veatch's assessment of market-based capacity additions and retirements, the impact of potential greenhouse gas legislation, and the inter-zonal transmission transfer capabilities implicit in the existing transmission system, as well as the new transmission lines needed to facilitate renewables development in the western United States.

Black & Veatch's market perspective considers the resource adequacy value of capacity in the WECC with a "Net Cost of New Entry" process. To the extent that forecasted energy prices are insufficient to induce reliable levels of generation, Black & Veatch calculates the equivalent of a capacity price forecast that "fills the gap" between energy market net operating revenues and new entrant revenue requirements.

In the course of preparing its Energy Market Perspective, Black & Veatch validates its WECC modeling by comparing the near-term results of its energy price forecast to recent historical values. Figure 21 provides a comparison of historical and forecast energy prices for the Mid-C market area. As shown, historical electricity prices have exhibited considerable variability.

Black & Veatch's forecast Mid-C prices exhibit real price escalation in early years, as natural gas prices rise, and as supply/demand balances tighten. There is a permanent jump in 2014 with assumed implementation of greenhouse gas emission regulations, and formal pricing of CO_2 emissions allowances. Longer term, forecast energy prices continue to rise as both natural gas and CO_2 emissions allowances both exhibit strong real price escalation.

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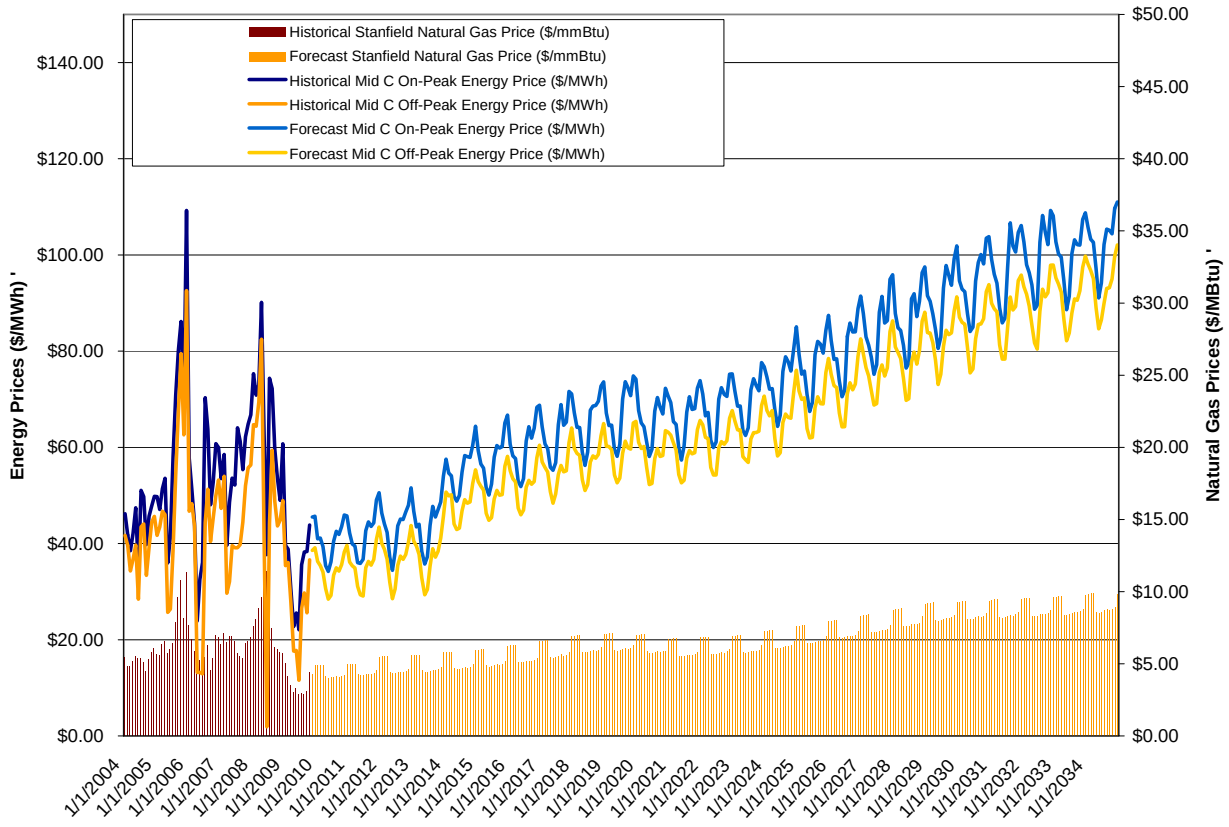
Figure 21 – Black &Veatch Energy Market Perspective – Mid-C Historical and Forecast Energy Prices (2009 dollars)



Because natural gas prices tend to exhibit substantial variability, Black & Veatch believes it is also important to compare historical and forecast results on a spark spread and market heat rate basis, which removes an element of natural gas price volatility from the comparison. Figure 22 illustrates that comparison. As shown, the Black & Veatch EMP forecast results are in line with recent historical spark-spread and market heat rate levels. As would be expected in a deterministic structural model, the forecast data is less volatile than historical levels. As shown in both Figures 20 and 21, historical power and natural gas prices have exhibited substantial price volatility.

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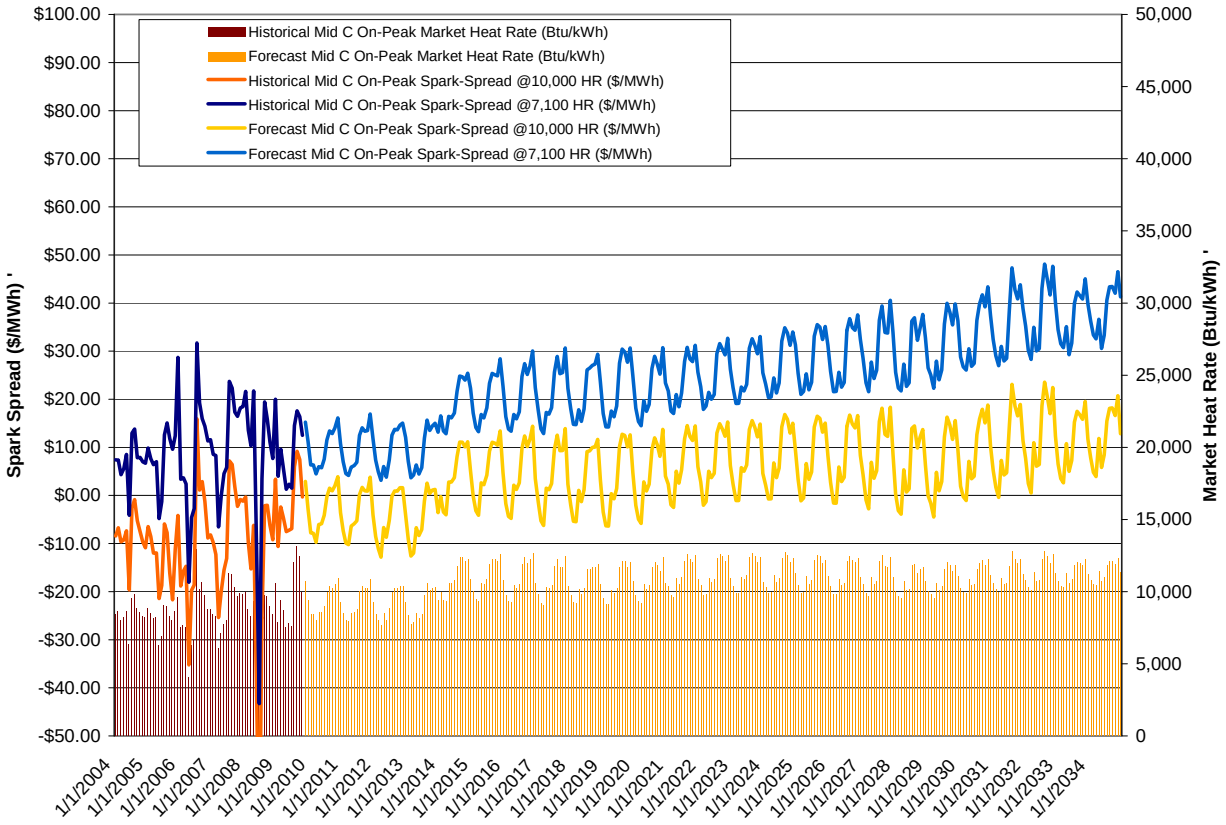
Figure 22 – Black &Veatch Energy Market Perspective – SP15 Spark-Spread and Market Heat Rate (2009 dollars)



6.4 Black & Veatch Fall 2009 Energy Market Perspective – Major Assumptions

The Black & Veatch Energy Market Perspective is a fundamental forecast, built up from base assumptions about supply and demand characteristics governing regional energy markets. There are a number of key assumptions that influence the results and price forecasts. Among the most important assumptions are the underlying forecasts for supply, demand, and natural gas prices, policy assumptions about greenhouse gas emissions regulation, and projections of new renewable and thermal generating capacity.

The Energy Market Perspective is developed as a zonal power price forecast, which means that the region is divided into a number of separate supply/demand zones, with load and generation assigned within each. Generation is dispatched within each zone to meet hourly demand, but the zones are also connected through existing transmission links, so that economic energy transfers occur between zones in the hourly dispatch. Figure 23 shows the 24 pricing zones reflected in the Energy Market Perspective, including transmission capacity levels connecting each zone. Under the zonal pricing approach, transmission capacity between zones is generally static, and does not vary with loadings of particular generators. Economic transfers are scheduled between zones up to the amount of transmission capacity. The approach produces reasonable electricity price projections, particularly over the long-term, but the transmission modeling is less detailed than a nodal modeling approach, or than the current operation of the California Independent System Operator locational marginal pricing markets.

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Figure 23 – WECC Market Zones

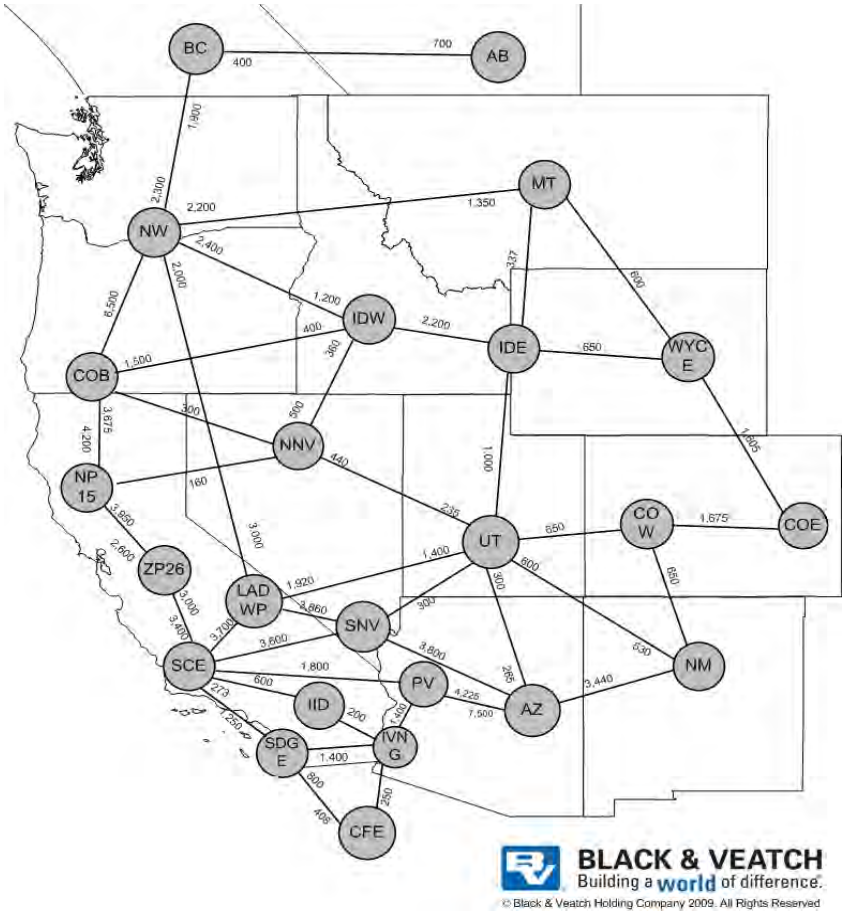

Table 4.0 provides a summary of current supply and demand in the WECC, with generators grouped by major technology. As shown, there is currently 4,516 MW of pumped storage capacity operating in the WECC. Total projected supply is 219,132 MW with wind generation at full rated capacity. With wind de-rated to 10% to reflect its expected capacity contribution during the peak hour, total WECC supply is projected at 208,370 MW. With August non-coincident peak demand projected at 163,091 MW, the WECC region has a projected reserve margin of 28% in 2010.

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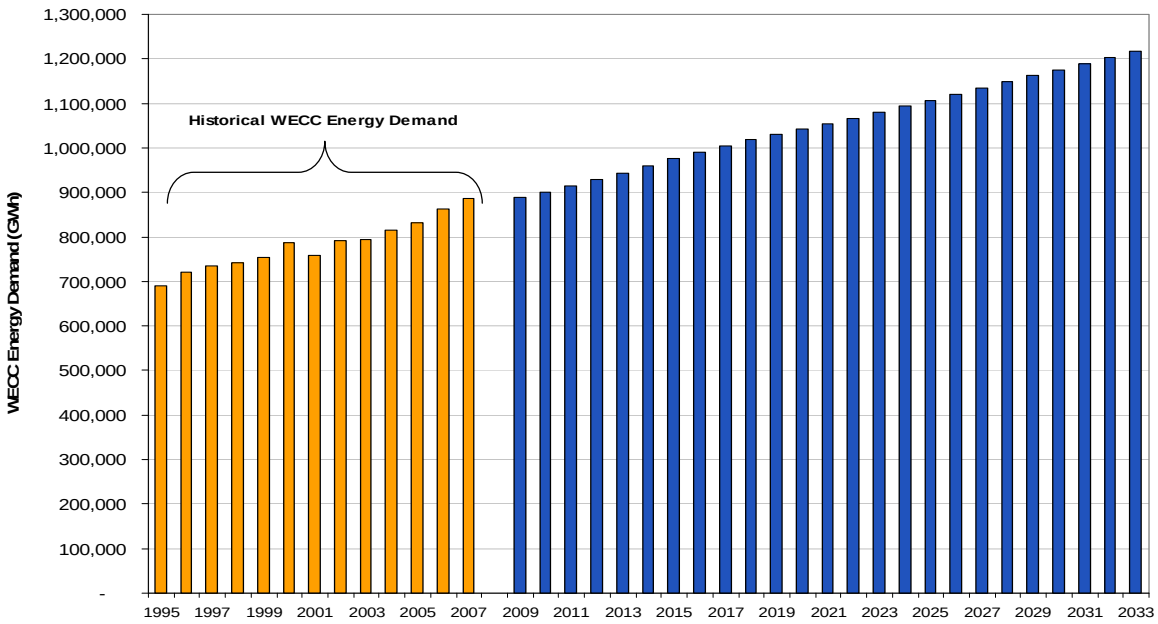
Table 4.0 – WECC 2010 Supply and Demand Summary

WECC Resources (MW)	2010
Biomass	1,452
Coal	36,446
Combined Cycle	47,781
Combustion Turbine	17,114
Geothermal	3,442
Hydro	64,963
IGCC	
Nuclear	9,552
Other	3,065
Pumped Storage	4,516
Renewable	11,957
Steam Turbine	18,845
Total Capacity (100%) Wind	219,132
Total Capacity (10%) Wind	208,370
August Non-Coincident Peak (MW)	163,091
Winter Non-Coincident (MW)	141,040
Average Energy Load (MW)	102,901
Total Capacity Resources (MW)	208,370
WECC 2010 August Reserve Margin	28%

The demand forecast underling the Black & Veatch Fall 2009 Energy Market Perspective reflects projections developed by each of the load-serving entities. The forecast reflects near-term conditions arising from the 2008-2009 economic recession. Figure 24 provides an illustration of the WECC energy demand forecast. Peak demand is projected to grow at 1.6% annually, and energy demand at 1.5% annually.

Figure 24 – WECC Energy Demand Forecast



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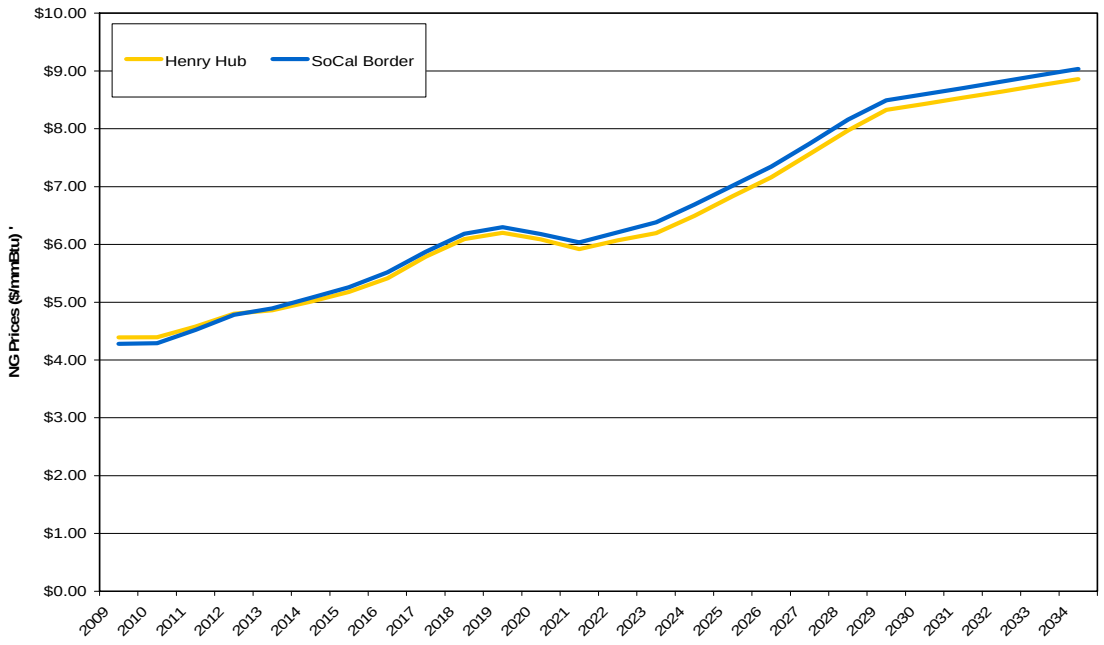
Natural gas prices play a substantial role in determining energy prices in the WECC, because natural gas-fueled resources are typically marginal over 90% of the time. As such, the natural gas price forecast is a key component in developing long-term electricity price projections. Figure 25 provides an illustration of the natural gas price forecast used in developing the Energy Market Perspective.

Figure 25 – Black & Veatch Fall 2009 Natural Gas Price Forecast



Major considerations underlying the Black & Veatch natural gas price forecast include:

6.4.1 Short-term (2009 - 2011)

- Demand weakens with global economic climate.
- North American natural gas production decreases with lower prices, credit constraints, and reduced drilling activity.

6.4.2 Medium-term (2011 – 2019)

- Natural gas prices track upward to an average of $5.50/MMBtu.
- Unconventional gas (gas shales, Rockies tight gas and coal bed methane production) and LNG imports keep pace with natural gas demand.

6.4.3 Long-term (2019 – 2030)

- Power sector demand pushes new consumption.
- Alaskan gas enters market in 2020 softening prices for a few years.
- Prices then rise as Western Canadian Sedimentary Basin (WCSB) decline accelerates and current unconventional gas plateaus.

WECC projected power prices are also influenced by policy initiatives designed to reduce the environmental impact of power generation, including renewable energy portfolio standards, and anticipated federal legislation to reduce greenhouse gas emissions. Black & Veatch, in its Fall 2009 market perspective, reflected current requirements for the development of renewable energy resources in the WECC, and also assumed that

federal greenhouse gas legislation will pass, with the pricing of CO_2 emissions allowances beginning in 2014. Each of those assumptions has a significant influence upon long-term electricity price projections.

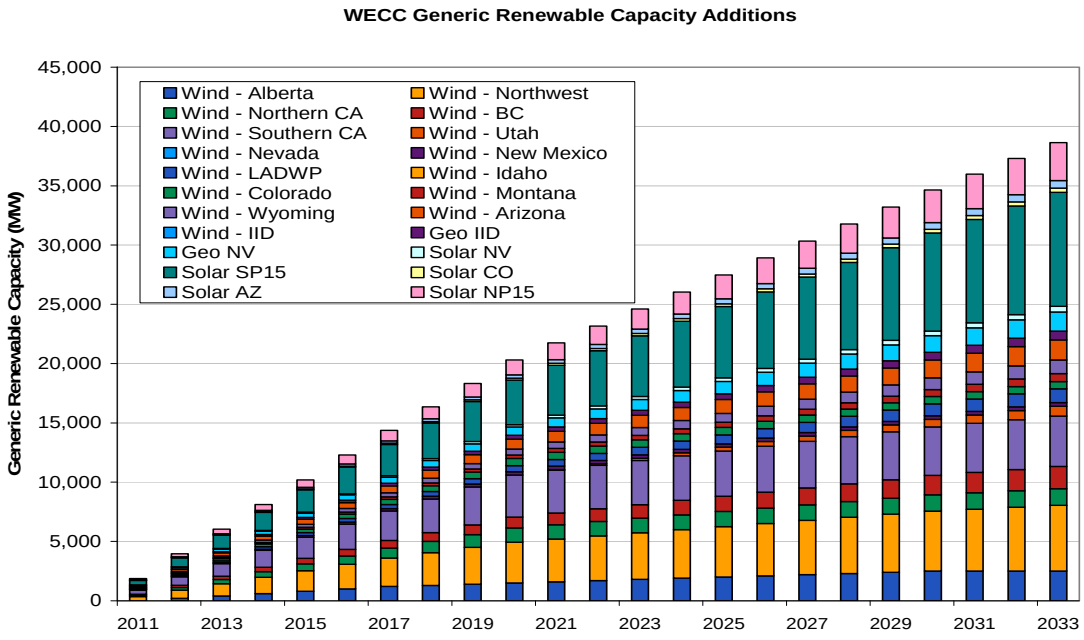
Table 5.0 outlines the current renewable generation requirements in the WECC, as a percent of energy demand.

Table 5.0 – WECC Renewable Energy Portfolio Standards (% of Energy Demand)

RPS %	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
California		20%	20%	20%	20%	23%	23%	26%	26%	30%	30%	33%	33%	33%	33%	33%	33%
Colorado	5%	5%	10%	10%	10%	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%
Montana	5%	10%	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Nevada	12%	12%	15%	15%	18%	18%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
New Mexico			10%	10%	10%	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%
Oregon			5%	5%	5%	5%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	25%
Washington				3%	3%	3%	3%	9%	9%	9%	9%	15%	15%	15%	15%	15%	15%

Based upon those renewable portfolio requirements, Black & Veatch included a substantial expansion of renewable energy capacity in developing the Energy Market Perspective. The balance of renewable expansion continues to use wind technology, but the solar contribution becomes increasingly meaningful through time. Figure 11 illustrates renewable energy expansion underlying the Black & Veatch forecast. As shown, current renewable portfolio requirements suggest cumulative renewable additions approximating 10,000 MW by 2015, 20,000 MW by 2020, 27,000 MW by 2025, and 38,000 MW by 2033. The introduction of those levels of renewable energy influence WECC energy prices, due to the low variable cost of renewable technologies and the expected time-of-day and seasonal generation profiles of those resources. Because the renewable resources have limited dispatch flexibility, energy from those resources is typically bid as price-taking, and has influence upon which thermal resources are marginal price-setting units in the respective market pricing zones.

Figure 26 – WECC Renewable Energy Resource Expansion



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One of the key policy uncertainties underlying power markets throughout the U.S., concerns whether greenhouse gas regulations will be enacted, and the exact form of such regulations if they are enacted. As of this writing, there is major greenhouse gas legislation in front of Congress, and passage of such legislation has strong support from the Obama Administration.

In recent months, significant legislative attention has been focused on the Waxman-Markey bill. The U.S. House of Representatives passed the bill on June 26, 2009. The Senate has not yet passed a companion bill, although bills have been introduced. This legislation is intended to reduce domestic emissions of greenhouse gases, and contains four main mechanisms for reducing greenhouse gas emissions in the economy:

- A cap and trade emissions trading system geared at the electric utility sector and large emitters of greenhouse gases.
- EPA enforced equipment performance standards for all other CO_2 emitters.
- A mandatory federal renewable electricity standard requiring electric utilities to generate 20% of their power from renewable sources and through efficiency gains by 2020.
- Various energy efficiency standards for buildings, equipment, and appliances.

The legislation has targeted reductions in greenhouse gas emissions of 17% by 2020 compared to 2005 levels; 42% by 2030, and 83% by 2050. Eighty-five percent of greenhouse gas allowances will be allocated to retail electric companies and generation owners, and 15% will be auctioned.

In developing the Fall 2009 Energy Market Perspective, Black & Veatch assumed that major elements of the Waxman/Markey legislation will pass, with implementation of CO_2 allowance pricing delayed to 2014, rather than 2012 as proposed in the current legislation. Black & Veatch assumed that international offsets would be available as a compliance mechanism in reducing greenhouse gases, consistent with the proposed legislation. That element plays a significant role in determining expected prices for CO_2 allowances.

Figure 27 provides an illustration of projected prices for CO_2 allowances based on the assumed legislative provisions of Waxman/Markey. These allowance prices are implemented in the Energy Market Perspective beginning in 2014, and cause a significant increase in projected energy prices beginning in that year.

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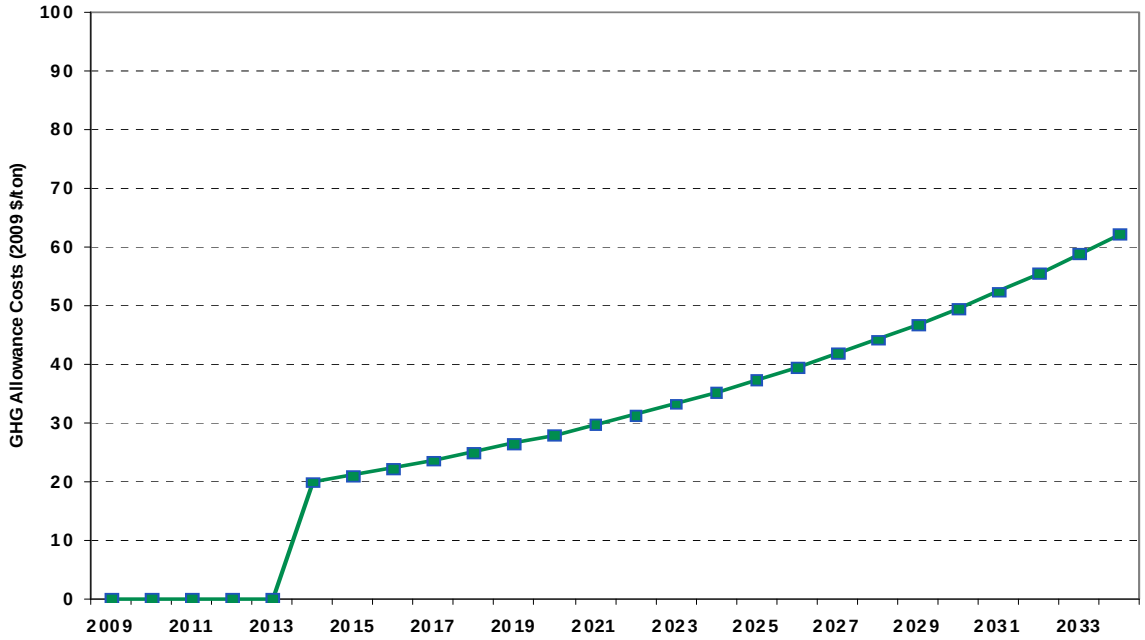
Figure 27 – Projected CO_2 Emission Allowance Prices



6.5 Summary of PROMOD Modeling Results

Implementation of Scenarios 1, 3 and 4 has significant impact upon forecast electricity prices.

Figure 28 provides an illustration of forecast energy prices for BC Hydro under Scenario 1, in comparison to the Energy Market Perspective base case. A comparison of projected CO_2 prices is also shown in Figure 28.

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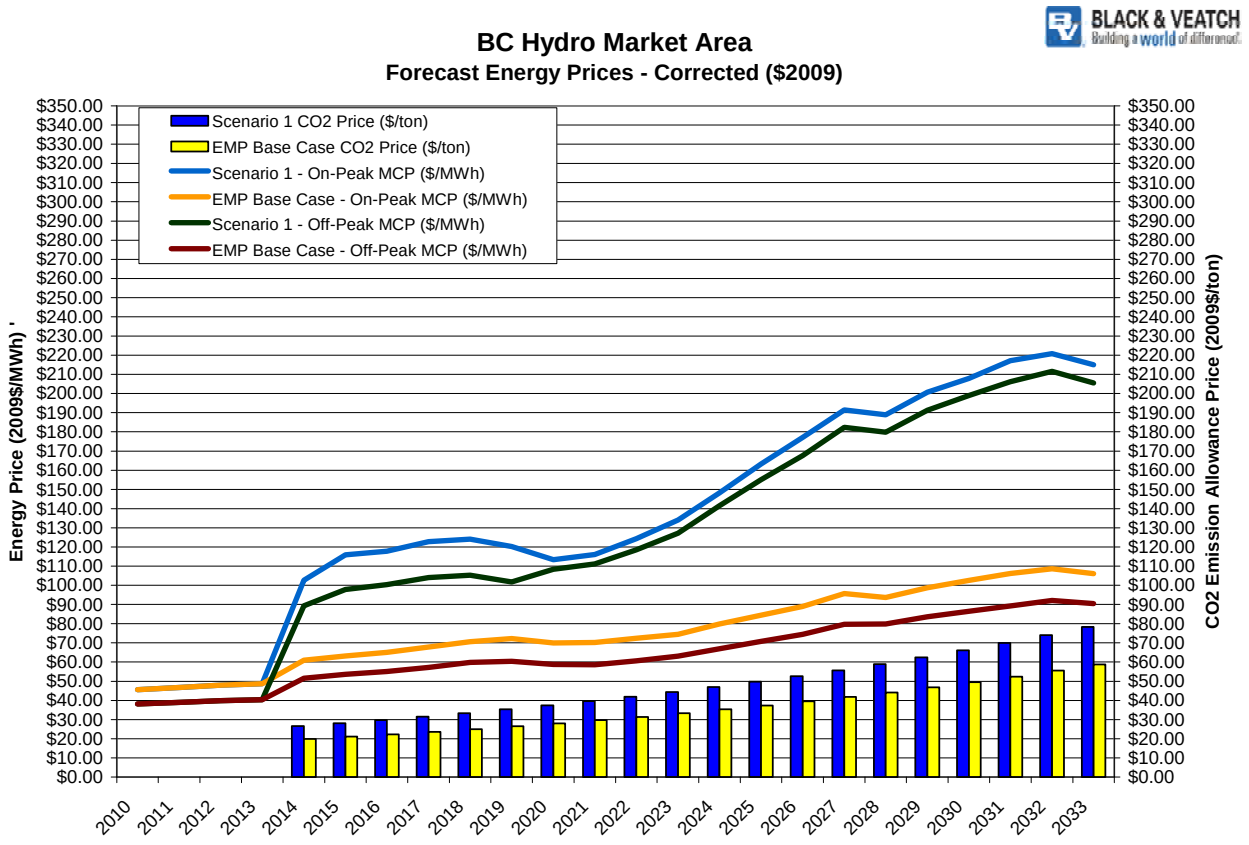
Figure 28 – Comparison of BC Hydro Forecast Energy Prices – Scenario 1 and EMP Base Case

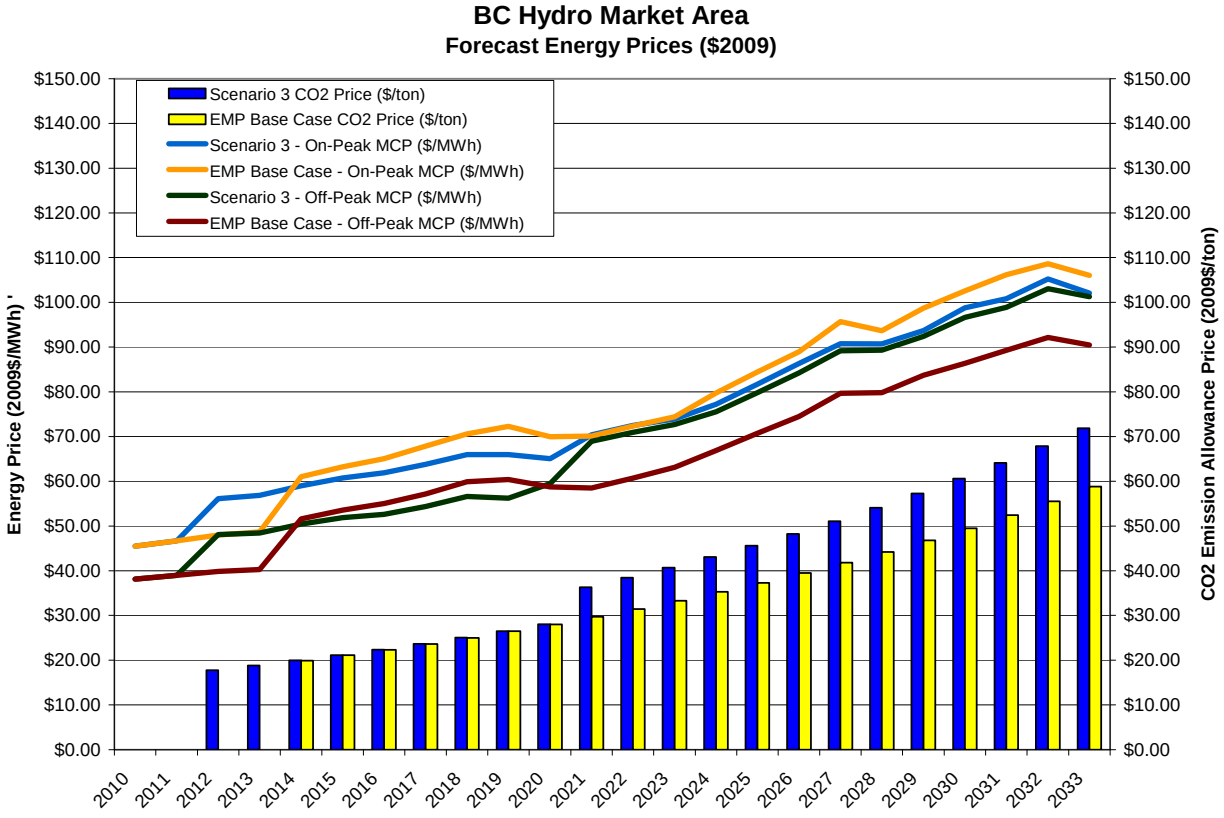


As shown in Figure 28, forecast energy prices are considerably higher under Scenario 1 than under the base case. This is driven by both higher projected CO_2 prices, and also by higher projected growth in electricity demand and natural gas prices. After 2020, the projected spread between on-peak and off-peak power prices is lower under Scenario 1, which is driven by assumed increases in off-peak demand from penetration of plug-in electric vehicles.

Figure 29 provides a comparison of projected BC Hydro energy prices for Scenario 3 and the Energy Market Perspective base case.

MARKET SIMULATION ANALYSIS

Figure 29 – Comparison of BC Hydro Forecast Energy Prices – Scenario 3 and EMP Base Case



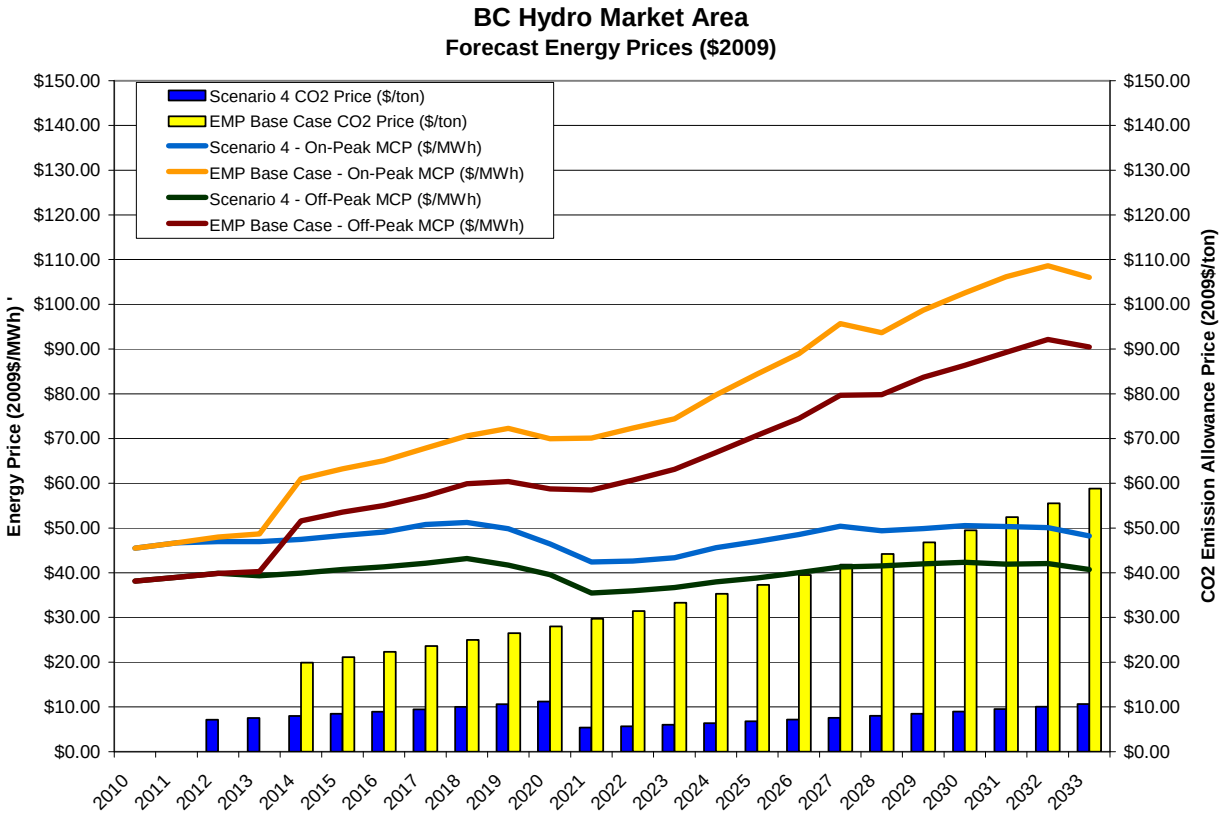
As shown in Figure 29, forecast power prices are higher in Scenario 3 in 2012 and 2013, due to the assumption that greenhouse gas pricing begins two years earlier than assumed in the base case, and under a WECC regulatory regime rather than under a federal program. In the 2014-2020 timeframe, Scenario 3 calls for a greater level of renewable penetration in the WECC than assumed in the Black & Veatch Fall 2009 Energy Market Perspective, and comparable CO_2 pricing. As such, power prices under Scenario 3 are lower than the market perspective base case during that period. In the 2020 and later time period, annual energy demand is 8% higher in Scenario 3 due to assumed growth in the fleet of electric cars. The increased energy demand is assumed to occur exclusively in off-peak periods, which translates into actual increases in off-peak energy demand of around 18%. In addition, CO_2 prices are higher under Scenario 3 beginning in 2021, with assumed implementation of the federal greenhouse gas program.

The overall impact upon energy market prices is mixed under Scenario 3 in the 2020 and later period. On-peak power prices are close between the two cases in the 2021 through 2023 period, and then lower in later years under Scenario 3, as the increased renewable and IGCC entry offsets the impact of higher CO_2 prices. In off-peak periods, power prices are considerably higher under Scenario 3, with the higher CO_2 prices and with the increases in off-peak demand due to electric vehicles.

Figure 30 provides an illustration of projected BC Hydro energy prices under Scenario 4.

MARKET SIMULATION ANALYSIS

Figure 30 – Comparison of BC Hydro Forecast Energy Prices – Scenario 4 and EMP Base Case



As shown in Figure 30, projected power prices are generally equivalent or lower under Scenario 4 throughout the study period. Scenario 4 has modest CO_2 pricing beginning two years prior than under the Black & Veatch market perspective base case but, beginning in 2014, projected CO_2 prices are substantially lower under Scenario 4. Scenario 5, however, also has relatively flat natural gas prices and electricity demand throughout the forecast period. The impact of lower natural gas prices and electricity demand more than offsets the impact of CO_2 prices in the 2012 through 2013 period, so that projected on-peak power prices are lower under Scenario 4, and off-peak prices are equivalent to the Energy Market Perspective base case. Beginning 2014, when higher CO_2 prices are included in the base case, both on-peak and off-peak power prices are considerably lower under Scenario 4. The spread between the two cases increases throughout the study period, with higher natural gas prices, electricity demand, and CO_2 prices in the base case driving the increasing power price spread.

APPENDIX A

7 APPENDIX A

7.1 Introduction

This section of the report is designed primarily to assist in the development of future greenhouse gas policy scenarios for modeling potential carbon prices and their impact on future operations. Black & Veatch reviewed the current status of established and emerging greenhouse gas policies, legislation and regulations that affect the jurisdictions into which BC Hydro sells electricity. Specifically, Black & Veatch researched and summarized the status of national greenhouse gas policies in Canada and the United States, regional policies in the WECC being developed under the Western Climate Initiative, and individual policies of British Columbia and all U.S. states in the WECC. Reviews of each program are provided in the following sections.

Due to the varying degrees and extent of greenhouse gas policy initiatives being undertaken in the different jurisdictions, the review was focused on summarizing those policies and programs that could have the most significant impact on BC Hydro's future operations and energy sales. Where applicable, the review of each jurisdiction outlines the reduction targets, implementation mechanisms, regulated sectors, and reporting requirements. Where policies include the implementation of an emission trading program, the geographic boundaries, distribution of allowances, use of offsets, allowable compliance mechanisms, cost controls, and linkage to other programs are summarized. Brief summaries of any relevant economic analyses performed for these trading programs are referenced as well. Related polices for clean and renewable energy requirements, such as renewable portfolio standards, are also reviewed for each jurisdiction.

7.2 Canada Federal

7.2.1 Regulatory Framework for Air Emissions

The government unveiled its *Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution* on April 26, 2007.[3] Rather than relying solely on voluntary measures used in the past, this plan sets out an approach for reducing greenhouse gas emissions through mandatory and enforceable actions across a broad range of sectors. The plan outlines a framework for achieving total absolute reductions of 20% below 2006 greenhouse gas emission levels by 2020, increasing to a 60% to 70% reduction by 2050.

The Action Plan outlines several policies for achieving these goals, including:

- A regulatory framework for industrial emissions of greenhouse gases and air pollutants.
- Development of a mandatory fuel-efficiency standard for automobiles, beginning with the 2011 model year, as well as action to reduce emission from the rail, marine, and aviation sectors, and from on-road and off-road vehicles and engineers.
- Implementation of new energy performance standards to strengthen existing energy-efficiency standards for a number of products that consume electricity.

Greenhouse gas reductions are to be implemented by regulations promulgated under the Canadian Environmental Protection Act of 1999 (CEPA).[4] Regulations are to be developed to mandate reductions in the sectors of electricity generation, oil and gas (upstream oil and gas, downstream petroleum, oil sands and natural gas pipelines), forest products (including pulp and paper and wood products), smelting and refining (including aluminum, alumina, and base metals), iron and steel, iron ore palletizing, potash, cement, lime, and chemical production.

[3] Minister of Environment, *Regulatory Framework for Air Emissions* (April 26, 2007), *available at* http://www.ec.gc.ca/doc/media/m_124/report_eng.pdf.
[4] Canadian Environmental Protection Act, S.C. 1999, c. 33.

APPENDIX A

The Regulatory Framework for Industrial Greenhouse Gas Emissions was issued in March 2008.[5] The framework sets a 2010 implementation date for regulated sectors to achieve emissions-intensity reduction targets. For existing facilities, the emission-intensity reduction target for each sector is based on an improvement of 6% each year from 2007 to 2010 (resulting in a total reduction of 18% by 2010). Every year thereafter a 2% continuous emission intensity improvement will be required. New facilities (those who's first year of operation is 2004 or later, including major expansions and transformations of existing facilities) will get a three-year grace period on emission reductions, after which they must make the same 2% annual improvement as set for existing facilities through 2020.

Clean fuel standards will also be used to determine targets for new facilities in specific sectors. A fuel-specific standard for the electricity sector will be equivalent to the emission-intensity performance of supercritical technology for coal-fired generation, natural gas combined cycle technology for gas-fired generation, and oil-fired gas turbine for oil-fired generation. Additionally, where carbon capture and storage is a viable option for reducing emissions, new facilities designed to be "capture ready" can defer compliance with the applicable cleaner fuel standard until 2018. The government is also developing targets based on carbon capture and storage for upgrader and in-situ facilities in the oil sands sector, and for new coal-fired electricity generation facilities that begin operation in 2012.

Regulated sectors will be required to achieve mandated reductions on either a facility-specific, sector-wide, or corporate level. Electricity generation facilities of 10 MW capacity or more will be regulated at the corporate level, which will provide incentives for investment in new non- and low-emitting power generation within their generation fleet. Under this approach, electricity companies can reduce their emission intensity by replacing high-emission intensity facilities (for example, coal and other fossil fuels) with non-emitting or lower emission intensity facilities (such as wind and hydro). Natural gas pipelines, petroleum refining and upstream oil and gas must use the facility-specific approach, while the lime, pulp and paper, aluminum and alumina, and cement sectors will use the sector-wide approach to achieve the targeted reductions.

Regulated sources have several options to achieve their reduction obligations, including:

- Reducing their own emissions through abatement actions.
- Contributing to a technology fund, which would be established to promote the development, deployment, and diffusion of technologies that reduce emissions of greenhouse gass across industry. From 2010 to 2012, contributions to the fund would be at a rate of $15/tonne of CO_2 equivalent (CO_2e). In 2013, the contribution rate would be $20/tonne. Thereafter, the rate would escalate yearly at the rate of growth of nominal GDP to 2017.
- Use emissions trading, including domestic inter-firm trading (baseline-and-credit), domestic emission reduction credits (offsets) from non-regulated activities, and certain limited types of credits from the Kyoto Protocol's Clean Development Mechanism (CDM credits limited to no more than 10% of compliance obligation). Environment Canada is developing an offset system that was scheduled to be finalized by the end of 2009.
- Use of verified credits from early action greenhouse gas reductions achieved between 1992 and 2006 (maximum of 15 million tonnes to be allocated, with no more than 5 million tonnes to be used in any one year).

The 2008 Regulatory Framework asserts that the government still intends to transition from emission-intensity targets to fixed emissions caps in the 2020-2025 period (as announced in its October 2006 *Notice of intent to develop and implement regulations and other measures to reduce air emissions),*[6] and that any decision in Canada on the transition to a fixed-cap regime for greenhouse gas emissions would take into

[5] Catalogue no. En84-60/2008, ISBN 978-0-662-05525-9
[6] Available at http://www.canadaagazette.gc.ca/partI/2006/20061021/pdf/g1-14042.pdf

account developments occurring in other countries, especially the United States, with the aim of establishing a North American emissions trading system once the United States implements a greenhouse gas regulatory system.

In 2009, the government announced that it continues to examine the feasibility of linking with emissions trading systems such as the Western Climate Initiative. Canada will set its own cap and trade market, one that is designed for specific Canadian industrial sectors, but in a way that will be easily integrated into a North American market. Over time, as national and regional carbon markets become more mature and the markets become more global in nature, with robust emission reduction verification systems, Canadian companies will have increased access to international trading markets for purposes of compliance with Canadian regulations.

The federal government also plans to work to reach equivalency agreements with those provinces that set provincial emissions standards that are at least as stringent as the federal standards. When an equivalency agreement has been reached, the Governor in Council can suspend the application of the specified federal regulations in the signing province, so that only the equivalent provincial regime applies.
Regulations implementing the Turning the Corner program were scheduled to be finalized by January 1, 2020. However, in a speech on November 17, 2009, from Copenhagen, Environment Minister Jim Prentice announced that Canada would not finalize greenhouse gas reduction regulations until global and North American climate change deals are reached. He indicated that these outcomes must be known before Canada tables any regulations to dictate how much Canadian companies will need to cut their own emissions. This announcement reflects Prime Minister Stephen Harper's position that Canada cannot impose carbon caps until it knows whether the United States, its largest trading partner, will impose its own reductions.

7.2.2 Renewable Electricity / Portfolio Standards

Canada does not have a federal renewable energy standard or requirement. In Canada, similar to the U.S., the only mandates for generating electricity from renewable energy sources or technology are imposed at the provincial level.

7.3 British Columbia

British Columbia has adopted an aggressive climate action plan that incorporates legislated reduction targets, revenue-neutral carbon tax, emissions trading system, carbon-neutral public sector, partnerships with other jurisdictions, and reduction actions focused on each of the province's major economic sectors. The key elements of this plan are being implemented through a number of significant climate-action legislation and policies. Some of the key legislation and regulation directly affecting BC Hydro are outlined below.

7.3.1 Greenhouse Gas Reduction Targets Act

Introduced as Bill 44, the Greenhouse Gas Reduction Targets Act (GGRTA) was given Royal Assent in November 2007 and brought into force on January 1, 2008.[7] It establishes provincial goals of reducing greenhouse gas emissions by at least 33% below 2007 levels by 2020, and ultimately 80% reduction below 2007 levels by 2050. British Columbia has also accepted the recommendations of its Climate Action Team for interim greenhouse gas targets of 6% below 2007 levels by 2012 and 18% by 2016.

GGRTA also establishes the government's commitment to a carbon-neutral public sector by 2010. Carbon neutrality involves public sector reporting of baseline emissions, reducing greenhouse gas emissions to the extent practicable, and offsetting remaining emissions by investing in emission offset projects. The carbon-neutral requirement for government business travel took effect in 2008, and is scheduled to apply to all

[7] Greenhouse Gas Reduction Targets Act, S.B.C. 2007, c. 42.

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emissions from government operations by 2010, including operations of schools, colleges, universities, health authorities, Crown corporations and other public sector organizations.

Pursuant to the Emission Offsets Regulation, which received Royal Assent on December 3, 2008, public sector organizations acquiring offsets under the GGRTA will be required to purchase offsets from the "Pacific Carbon Trust", a Crown corporation intended to facilitate carbon neutrality.[8] Some of the key requirements for offset projects to be recognized under the Act include having all greenhouse gas reductions verified in a project report, transfer of ownership of offsets to the Pacific Carbon Trust, and providing assurance that the reductions have been previously recognized by another greenhouse gas reduction program.

The Pacific Carbon Trust has published a draft document designed to provide an overview of the BC Emission Offsets Regulation along with the process required to submit offset project proposals to the Trust.[9] Currently, offset credits can be quantified by selecting a recognized protocol from another program and adapting it to the provincial context. Over time, an optional list of approved protocols will be developed and made available to project proponents. Ultimately, the director of the Climate Change Branch of the Ministry of Environment will establish mandatory protocols for the selection, determination of baseline scenarios, quantification of greenhouse gas reductions, and monitoring of sequestration sinks, and reservoirs. The act further provides that offset project validations will expire 10 years after the date of the statement of assurance unless otherwise ordered by the director of the Climate Change Branch.

The provincial government and BC Hydro have also entered into an agreement to significantly increase energy conservation and expand the use of alternative-energy options across the 6,500 public sector buildings in British Columbia, including Crown corporations, education and health-care facilities, office buildings, social housing and other government operations. This Public Sector Energy Conservation Agreement will be in place from 2008 through 2020, is based on three cooperative pillars: achieving aggressive conservation targets of reducing electricity consumption by 55 GWh in 2010 and ultimately lowering government-wide consumption 20% below baseline use by 2020; completing an enhanced energy management assessment and audit program and broadening government employees' energy management expertise by 2010; and supporting accelerated development and use of alternative energy technologies and innovations.

7.3.2 Energy Plan and Greenhouse Gas Reduction (Emissions Standards) Statutes Amendment Act

On February 27, 2007, Energy Minister Richard Neufeld introduced the Energy Plan: *A Vision for Clean Energy Leadership* which, among other highlights, outlined the following greenhouse gas emissions reduction goals and measures:

- All new electricity projects developed in British Columbia to have zero net greenhouse gas emissions, and all existing thermal generation power plants to reach zero net greenhouse gas emissions by 2016.
- Elimination of all routine flaring at oil and gas producing wells and production facilities by 2016 with an interim goal to reduce flaring by 50% by 2011.
- Prohibition against nuclear power.
- Zero greenhouse gas emissions requirement for coal-fired electricity generation.
- Continue to have clean or renewable electricity generation account for at least 90% of total generation. (See subsection 6.3.5 below).
- BC Hydro to meet half of its new electricity needs through conservation by 2020.[10]

[8] Emission Offsets Regulation, B.C. Reg. 393/2008.
[9] Pacific Carbon Trust, *Guidance Document v.1.0* (2009), available at http://www.pacificcarbontrust.ca/Publications/PCTGuidanceDocument/tabid/158/Default.aspx.
[10] British Columbia Ministry of Energy, Mines and Petroleum Resources, *The BC Energy Plan, A vision for Clean Energy Leadership* (February 2007), available at http://www.energyplan.gov.bc.ca/PDF/BC_Energy_Plan.pdf.

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By 2008, several of the Energy Plan's electricity related goals were codified in the Greenhouse Gas Reduction (Emissions Standards) Statutes Act. To achieve zero greenhouse gas emissions, coal-fired electricity generation facilities are required to capture and sequester greenhouse gas emissions from the combustion of coal. Electricity generation facilities that use other fossil fuels must achieve "net zero" emissions through a combination of emission reductions and offsets. New electricity generation facilities and expansions to existing facilities became subject to this "net zero" requirement when the law took effect, while existing facilities are being given until 2016 to achieve "net zero" emissions.

In addition to imposing greenhouse gas reduction requirements on specific industrial operations, the Amendments Act also encourages development of bioenergy sector projects, such as capturing methane from landfills or sewage treatment for use in generating energy. The provincial government is also advancing a Bioenergy Network initiative that funds research and development of wood-waste cogeneration and biofuel and wood pellet production. Efforts are also underway to expand electrification of ports and development of plug-in truck stops within British Columbia.

7.3.3 Greenhouse Gas Reduction (Cap and Trade) Act

Enacted on April 3, 2008, the British Columbia Cap and Trade Act established the framework by which the province would take part in the regional greenhouse gas cap-and-trade system developed through the Western Climate Initiative, discussed in detail in Section 5.0 below.[11] In the spring of 2007, British Columbia joined the climate initiative, a multi-jurisdictional partnership launched in February 2007 to address climate change.

Under the Act, the provincial government will establish the cap for designated large emitters by issuing a limited number of tradable emissions allowances – also called compliance units — for given periods of time. Each designated emitter will then be required to obtain a number of allowances equivalent to the amount of regulated greenhouse gas emissions it releases within the specified period. These units must then be surrendered to the government as proof of compliance.

A British Columbia allowance will be equal to one tonne of carbon dioxide or its equivalent – the same measuring unit in use by existing systems, and expected to be adopted by the regional cap and trade system under development by the Western Climate Initiative. The act identifies three different kinds of allowances, or compliance units:

- Allowance Units issued by the provincial government according to the cap specified in a given compliance period).
- Emissions Reduction Units or offset credits from approved emission reduction or removal projects in British Columbia.
- Recognized Compliance Units from other cap and trade systems, such as those established by the Western Climate Initiative.

The Act also authorizes the creation of a compliance unit tracking system for the banking, transfer and surrender of compliance units.

As with all enabling legislation, the Act must ultimately be implemented through regulations that will, among other things, establish reporting rules, create compliance units, and establish an offset system. The first regulation under the Act, the Reporting Regulation, was issued November 25, 2009, and came into force on January 1, 2010.[12]

[11] Greenhouse Gas Reduction (Cap and Trade) Act, S.B.C. 2008, c. 32.
[12] Reporting Regulation, B.C. Reg. 302/2009.

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7.3.4 Revenue Neutral - Carbon Tax Act

On July 1, 2008, the *Carbon Tax Act* came into force, which phases in a "revenue neutral" carbon tax to encourage individuals and businesses to make more environmentally responsible choices by reducing their use of fossil fuels and related greenhouse gas emissions.[13] The tax is intended to provide monetary incentive to consumers to reduce greenhouse gas emissions through any combination of reducing usage, increasing efficiency, changing fuels, or adopting new technologies without directly favoring any specific option or approach. The tax generally applies to purchases of fuels from vendors, transfers of fuels, and the importation of fuels into British Columbia. The Act also imposes a tax on the use of fuels if the fuel was not otherwise taxed by one of the three mechanisms just mentioned.

The carbon tax applies to virtually all fossil fuels, including gasoline, diesel, natural gas, coal, propane, and home heating fuel. The carbon tax started at a rate based on $10 per tonne of associated carbon — or carbon-equivalent emissions from its assumed combustion — and then will rise gradually by $5 a year for the next four years until reaching $30 per tonne by 2012. This works out to 2.41 cents per liter for gasoline in 2008, rising gradually to 7.24 cents a liter by 2012. For diesel and home heating oil, it works out to 2.76 cents per liter, rising to 8.27 cents over the same five-year period. Revenue from this tax will be returned to taxpayers by reductions in other provincial taxes. The government will present an annual plan to the legislature demonstrating how all of the carbon tax revenue will be returned to taxpayers by corresponding tax reductions.

7.3.5 BC Energy Plan (Clean or Renewable Energy)

The BC Ministry of Energy, Mines and Petroleum Resources released an Energy Plan in 2007 that sets out goals for the province's future energy policy. These include a policy action to ensure that clean or renewable electricity generation continues to account for at least 90% of total generation in the province. The plan also includes a goal of utilizing pine beetle kill wood for renewable energy generation and establishes a bioenergy strategy to encourage the development of this resource.

At this time, 90% of BC's power generation is from renewable resources, including large hydroelectric power. British Columbia considers both large and small hydroelectric power resources as a qualified renewable energy resource in the plan, which aims to maintain this generation resource mix. In order to maintain this 90% goal, the province will need to procure additional renewable energy as load grows and as resources are retired.

7.4 United States Federal

There have been several bills proposed in Congress over the last six years to regulate greenhouse gas emissions and establish renewable electricity and renewable portfolio standards. Of the 73 bills introduced in the current 111th Congressional session (as of December 28, 2009) addressing greenhouse gases and 149 addressing climate change, to date only one bill has been successfully passed by the chamber – the Waxman-Markey bill (officially, the American Clean Energy and Security Act; House Bill 2454). This bill is currently in the Senate for consideration and debate and, as of the time of writing, provides the most likely framework for any future regulatory program that may be implemented nationwide in the United States. Of the bills that have been introduced in the Senate, one energy bill (S1462) and one greenhouse gas reduction bill (S1733) have managed to be passed by one committee, but have yet to proceed to a full floor debate. Additionally, the U.S. Environmental Protection Agency (EPA) has recently taken steps towards regulating greenhouse gas emissions through direct promulgation of regulations under authority of the current Clean Air Act.

The following outlines the key elements and status of these developments at the United States federal level.

[13] Carbon Tax Act, S.B.C. 2008, c. 40.

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7.4.1 American Clean Energy and Security Act

Waxman-Markey was passed by the U.S. House of Representatives on June 26, 2009. It seeks to achieve economy-wide greenhouse gas emission reductions of approximately 20% below 2005 levels by 2020, and ultimately more than 80% in reductions by 2050. It calls for regulation of emissions of the six greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) currently recognized by the Intergovernmental Panel on Climate Change, as well as nitrogen trifluoride (NF_3) and black carbon emissions in the United States.[14] EPA is directed to issue regulations (within six months of its final enactment) to require entities that emit, produce, import or manufacture more than 10,000 tonnes of CO_2e to report their greenhouse gas emissions to a federal registry.

The primary mechanism to achieve these reductions is a cap-and-trade program designed to reduce aggregate greenhouse gas emissions for all covered entities 3% below their 2005 levels in 2012, 17% below 2005 levels in 2020, 42% below 2005 levels in 2030, and 83% below 2005 levels in 2050. Commercial production and imports of HFCs are addressed under a separate cap established in Title VI of the existing Clean Air Act. Sources subject to the cap-and-trade program ("covered entity" under the bill)[15] include:

- Any electricity source (stationary source with fossil fuel-fired utility unit).
- Large stationary sources emitting more than 25,000 tonnes per year of CO_2 equivalent (CO_2e) including a separate category for emitters of NF_3.
- Stationary sources in specified industrial, chemical and petrochemical sectors emitting more than 25,000 tonnes per year CO_2e.
- Fossil fuel combustion device (such as a boiler) emitting more than 25,000 tonnes per year CO_2e.
- Fuel producers (such as refineries) and importers of all petroleum based or coal based liquid fuels, pet-coke or natural gas liquid which will emit more than 25,000 tonnes per year CO_2e.
- Industrial gas producers and importers of more than 25,000 tonnes per year CO_2e of CO_2, N_2O, PFC, SF_6 or other fluorinated gases.
- Distributors of natural gas to residential, commercial and small industrial users (i.e. local gas distribution companies).
- Producers of "F-gases" (hydrofluorocarbons or HFCs, perfluorocarbons or PFCs and sulphur hexafluoride or SF6 gases).
- Geologic sequestration sites.

The primary currency of the cap-and-trade program is called an "allowance." One allowance authorizes the emission of one tonne of CO_2e emissions. Reductions of one tonne of greenhouse gas emissions achieved by a source or activity not regulated under the cap-and-trade program, called an "offset," can also be used for program compliance purposes.

7.4.2 Allowance Distribution

Based on baseline 2005 emissions of 7,206 million tonnes CO_2e, the bill specifies how many allowances will be issued each year of the program from 2012 through 2050 to achieve the program goals.[16] In the initial years of the cap-and-trade program, most of the allowances will be allocated for free, with as few as 20% of allowances to be auctioned in 2016. The percentage of auctioned allowances increases over time to approximately 75% by 2035 and beyond. Altogether, sources within the electricity sector, natural gas sector, domestic fuel producers, energy intensive industries, carbon capture & sequestration projects, clean vehicle manufacturers & component suppliers, early actors, research and development and various federal and state agencies are allocated allowances for varying periods, with more allowances being auctioned over time. A

[14] Title III Part B Sec. 711, and Title VIII Part E
[15] Title VII Subpart E Sec. 700
[16] Title III Part C Sec. 721

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summary of the percentages of allowances allocated to each sector or governmental entity under Waxman-Markey is included in Appendix A of this report.

The basis and periods of allocations to sources the electricity and natural gas sectors are as follows:

7.4.2.1 Electricity Sector 2012 through 2029[17]

- Electricity local distribution companies (LDCs) based on historic CO_2 emissions (50%) and sales (50%).
- Merchant coal generators based on electricity generation and average CO_2 emissions generated in 2006-2008.
- Generators with long-term power agreements based on emissions associated with such agreements.
- Small Electricity LDCs (delivering >4,000,000 MWh /year) ratably amongst all small LDCs based on historic emissions.

7.4.2.2 Natural Gas Sector 2016 through 2029[18]

- Natural gas local distribution companies (LDCs) based on natural gas deliveries from 2006-2008.

Auctioning of allowances will be held four times a year, with each auction (except for those held in 2011) to include a portion of allowances from future vintage years, up to four years in advance.[19] The auctions will follow a single-round, sealed-bid, uniform price format. A minimum reserve price will be established each year (beginning with $10 in 2012) based on the previous year's minimum reserve price increased by 5% plus the rate of inflation.

The bill also creates a strategic allowance reserve auction to be held quarterly each year in which only covered entities will be eligible to purchase allowances. The bill sets an initial minimum price level $28 for the 2012 auction, to rise at 5% plus inflation for the 2013 and 2014 auctions. Beginning in 2015, the reserve auction trigger price would be 60% above the three year rolling average of the market price of allowances.

7.4.2.3 Compliance Mechanisms

A covered entity may hold (bank) allowances for compliance use in any future year subsequent to the vintage year of the allowance (unlimited banking) without any penalty of discounted value. A covered entity may use vintage allowances from the preceding calendar year without penalty (unlimited next year borrowing). Covered entities can also satisfy up to 15% of their compliance obligation with allowances from vintage years borrowed up to 5 years in the future – but must prepay interest on such borrowed allowances according to an established rate formula (0.8 x number of years ahead).

Up to 2 billion tonnes of offsets — 1 billion from domestic sources and 1 billion from international sources — can be used for compliance in the cap-and-trade program. If the domestic supply of offsets is insufficient, EPA can raise the international limit up to 1.5 billion, but the 2 billion total still applies. The President can recommend to Congress that the limits on offsets be increased or decreased. Title V of HR 2454 establishes an offset program specific to domestic agriculture and forestry sources to be administered by the Secretary of Agriculture.

For international offsets, beginning in 2018, 1.25 offset credits would be required to be surrendered for each tonne of emissions compliance, but there is no such discount for domestic offsets. The EPA would oversee international offsets, as well as all domestic offsets not covered under Title V, such as those derived from projects that capture methane from landfills and coal mines.

[17] Title III Part H Sec. 783
[18] Title III Part H Sec. 784
[19] Title III Part H Sec. 791

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Compliance must be demonstrated on a two-year rolling basis. The Bill provides for unlimited banking of allowances for future use. The two-year rolling compliance period provides for unlimited next year borrowing. The bill allows for additional borrowing of up to 15% of a compliance obligation from years 2-5 beyond the current calendar year (with interest).

Initial compliance obligations are staggered for activities of different covered entities. Electricity sources, fuel producers and importers, industrial gas producers and importers, NF_3 sources and geologic sequestration sites must begin complying in 2012. Compliance obligations for industrial stationary sources and fossil fuel fired combustion devices begin in 2014, and natural gas local distribution companies begin in 2016.

Any covered entity that fails to hold sufficient allowances or offsets will have to pay a penalty equal to the number of allowances it failed to hold by the deadline multiplied by twice the fair market value of allowances issued for the year in which the allowances were due. Additionally, the entity will also have to offset its excess emissions by an equal quantity of emission allowances during the following year.[20]

7.4.2.4 Cost Containment and Market Oversight

Waxman-Markey dictates the distribution of allowances and use of revenue from the sale of allowances to a significant extent in an effort to mitigate and cushion the economic burden and impact of its implementation. It attempts to provide initial aid (through free allocation of allowances) to those energy intensive industries that will be burdened with costs of complying with the reduction mandates. The banking, borrowing, and the two-year rolling compliance period provisions, along with the strategic reserve, offers covered entities with some economic flexibility to meet annual compliance obligations. The ability to use up to 1 billion domestic and international offsets actually provides the greatest measure of overall program cost containment.

The revenue from the sale of these emissions allowances is intended to offset the cost impact to consumers and workers, to aid business in transitioning to clean energy technologies, to support technology development and deployment, and to support activities aimed at building communities that are more resilient to climate change (adaptation). Consumers are protected from higher energy prices by providing allowances to electricity and natural gas local distribution companies with specific mandates to use the value/revenues of these allowances are used for the benefit of customers. Low and moderate income households will also receive a refundable tax credit or rebate.

Waxman-Markey provides for allowance trading market oversight by putting the Federal Energy Regulatory Commission in charge of the cash market in emissions allowances and offsets, and assigns the Commodity Futures Trading Commission responsibility for regulation and oversight of carbon allowance futures and other derivatives unless the President decides otherwise. The bill includes a suite of new controls over derivatives trading in both carbon and other energy commodity markets, including a ban on loosely regulated over-the-counter trading.

7.4.2.5 Renewable Energy and Energy Efficiency Standard

The bill mandates that retail electricity suppliers[21] meet 20% of their electricity demand through renewable energy[22] and energy efficiency by 2020, and continue to meet this standard through 2040. From 2012 to 2039 retail electricity suppliers must submit federal renewable energy credits or document electricity savings that,

[20] Title III Part B Sec. 723
[21] "Retail electric suppliers" includes those electric utilities that sold at least 4 million megawatt hours of electric energy to electric consumers for purposes other than resale during the preceding year.
[22] "Renewable energy" is defined as electricity generate from a renewable energy source, including wind energy; solar energy; geothermal energy; renewable biomass, biogas or biofuels; qualified hydropower; marine and hydrokinetic renewable energy; landfill gas, wastewater treatment gas, coal-mine methane, and qualified waste-to energy.

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in total, are equal to the following percentages of their electricity sales (excluding electricity from current hydropower, new nuclear power, and generation coupled with carbon capture and storage).[23]

Calendar Year	Required Annual Percentage
2012	6.0
2013	6.0
2014	9.5
2015	9.5
2016	13.0
2017	13.0
2018	16.5
2019	16.5
2020	20.0
2021 – 2039	20.0

Renewable energy must constitute at least three-fourths of the compliance each year; however the governor of a given state can petition the Federal Energy Resource Commission (FERC) to allow suppliers to use documented electricity saving for up to two-fifths of their compliance.

Utilities with annual sales above 4 million MWh must meet at least 75% of their Renewable Energy Standard (RES) requirements using federal renewable energy credits (RECs), which are defined as 1 MWh of energy generated by qualified renewable sources. The remaining 25% may be met by energy efficiency credits. The bill also allows for alternative compliance payments of $25/MWh to be made in lieu of RECs.

Waxman-Markey will not count hydroelectric capacity that came online before January 1, 1988, toward a utility's renewable generation portfolio. However, that capacity, which is not considered "qualified hydropower," will be removed from the baseline net generation that makes up the denominator in the renewable percentage calculation, thus making it easier for utilities with hydroelectric capacity to meet the RES mandate.

7.4.2.6 Economic Impact Assessments

Governmental economic analyses of the bill have been released by the U.S. EPA, Congressional Budget Office (CBO), and the Department of Energy's Energy Information Administration (EIA). A multitude of assessment reports have also been released by industry groups and other non-governmental entities.

The CBO released two separate cost analyses. The first analysis, examined the effect of the bill on the federal government.[24] The second analysis dated June 19 focused on the average cost per household, as well as how that cost would be spread amongst households with different levels of income in 2020.[25] Taking into account only those elements designed to mitigate electricity price hikes, the CBO concluded that it would impose costs of about $175 per household by 2020, with households in the lowest fifth of annual income receiving a net benefit of $40 annually, and those in the highest fifth accruing $245 in annual costs. The impacts would come primarily from increases in costs as energy-intensive industries pass costs on to consumers.

EPA's analysis, performed by their Office of Atmospheric Programs, found that the cost per household would be lower than those estimated by the CBO. EPA estimated that the average household would see an increase ranging from $80 to $111 per year, and further estimated that allowances would cost $13 to $15/tonne CO_2e in

[23] Title I Subtitle A Sec. 101
[24] Congressional Budget Office Cost Estimate, *H.R. 2454 American Clean Energy and Security Act of 2009* (June 5, 2009) available at http://www.cbo.gov/doc.cfm?index=10262.
[25] Letter from Douglas W. Elmendorf, Director, Congressional Budget Office to Dave Camp, Ranking member of U.S. House of Representatives Committee on Ways and Means (June 19, 2009) available at http://energycommerce.house.gov/Press_111/20090620/cbowaxmanmarkey.pdf.

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2015 rising to around $16 to $19/tonne CO_2e in 2020.[26] EPA's analysis foresees the share of zero- and low-carbon primary energy (including nuclear, renewables, and CCS) rising to 18% by 2020, 26% by 2030 and 38% by 2050. EPA forecasts renewables powering about 65% of all new plants built by 2025, and estimates that 25 gigawatts of new and retrofitted power plants with carbon capture will come online between 2015 and 2020. The EPA analysis noted that use of emissions offsets from both domestic and international projects are essential for containing the costs of the bill.

It is worth noting that the CBO and EPA analyses only assess certain provisions of an earlier version of Waxman-Markey, and use different base assumptions. Another key difference is that CBO's costs were calculated in 2010 dollars while EPA's are calculated in 2005 dollars.

Key Features of the American Clean Energy and Security Act

- *Geographic Range* – All U.S. states.
- *Reduction Targets* – 17% to 20% below 2005 levels by 2020, 83% by 2050.
- *Regulated Sectors & Thresholds* – Cap-and-trade program covers electricity sources; large stationary sources (including specified sources in the industrial, chemical and petrochemical sectors) emitting more than 25,000 tonnes per year CO_2e; fossil fuel combustion devices (such as a boiler) emitting more than 25,000 tonnes per year CO_2e; fuel producers (refineries) and importers of all petroleum-based or coal-based liquid fuels, pet-coke or natural gas liquid which will emit more than 25,000 tonnes per year CO_2e; industrial gas producers and importers of more than 25,000 tonnes per year CO_2e of CO_2, N_2O, PFC, SF_6 or other fluorinated gases; distributors of natural gas to residential, commercial and small industrial users; producers of "F-gases"; and geologic sequestration sites.
- *Implementation Mechanism* – Nationwide cap-and-trade program and renewable portfolio standard.
- *Timeline* – EPA to issue reporting regulations within six months of enactment; auctioning of allowances begins in 2011; trading begins in 2012 for electricity sources, fuel and industrial gas producers and importers, NF_3 sources and geologic sequestration sites; 2014 trading begins for industrial stationary sources and fossil fuel combustion devices; 2016 trading begins for natural gas distribution companies. Renewable energy and energy efficiency standards take effect in 2012.
- *Allowance Distribution* – Detailed allowance allocation established with increasing auctioning over time. Electricity sector allocations from 2012 through 2029, with local distribution companies' allocations based 50% on historical emissions and 50% on sales. Natural gas sector allocated allowances from 2016 to 2019 based on deliveries in 2006-2008. Auctioning to be held quarterly each year, with additional strategic reserve auction for regulated sources only.
- *Compliance Mechanisms* – Two year rolling compliance periods, offsets allowed (1.25:1 for international offsets after 2017) unlimited next year borrowing, 15% of compliance obligation from next five years with some penalty. Up to 25% of renewable energy portfolio standard can be satisfied by energy efficiency/electricity savings.
- *Offsets* – Up to 2 billion tonnes (1B domestic and 1B international). Department of Agriculture to determine eligibility of domestic farm and forest offsets credits, EPA to determine eligibility for all other offset credits. Beginning in 2018, international offsets only worth 0.8 tonnes CO_2e
- *Clean & Renewable Energy Requirements* – National renewable portfolio standard of 6% beginning in 2012, increasing to 20% by 2020 and beyond. Energy efficiency goals for national energy productivity (measured in GDP per unit of energy input) of at least 2.5% per year by 2012 and through 2030.

[26] Environmental Protection Agency, *EPA Analysis of the American Clean Energy and Security Act of 2009, HR 2454 in the 111th Congress* (June 23, 2009)*, available at* http://www.epa.gov/climatechange/economics/economicanalyses.html#hr2454.

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- *Interaction with Other Policies* – Imposes a moratorium on all state and regional cap-and-trade programs from 2012 through 2017. Exempts greenhouse gas from regulation as a criteria air pollutant, hazardous air pollutant, or under the prevention of significant deterioration provisions of the federal Clean Air Act.

The EIA study released on August 4th predicted that enactment of the bill would cause the U.S. economy (gross domestic product) to lose $566 billion between 2012 and 2030.[27] Average loss to household consumption during this period would be $83 a year under a "basic case" scenario in which low-emission technology is developed on schedule and offsets are not constrained. It predicted the drag on consumption will rise as utilities lose free emission allocations, with household consumption decreasing by $134 (2007 dollars) in 2020, and $339 in 2030 when it estimates electricity prices will rise to around 12 cents per kilowatt-hour.

The Congressional Research Service released a report on September 14, 2009, that summarized the findings of the EPA, CBO and EIA economic impact analyses, along with others by the National Association of Manufacturers, National Black Chamber of Commerce, Heritage Foundation, and the Massachusetts Institute of Technology.[28] Figures from this report comparing projected allowance prices, impacts to residential electricity bills, and impacts to natural gas rates of these analyses are included in Appendix B of this report.

7.4.3 Senate Bills

While the Waxman-Markey has been passed by the House of Representatives and delivered to the Senate, consideration of similar bills sponsored by senators are currently being given priority within that chamber. To proceed to enactment, any Senate bill must be approved by all committees with subject matter jurisdiction and then clear the Senate's unique 60-vote cloture rule before it can be officially debated on the floor. If after debate the bill is finally approved by majority vote, it must then be sent to a joint House-Senate committee to be reconciled with Waxman-Markey where a compromise bill will be drafted for submittal to each chamber for its approval. If both chambers approve the compromise bill by majority vote, it will be sent to the President for either signing into law or veto back to Congress.

7.4.3.1 Kerry-Boxer Bill

The most heralded bill to date is the Clean Energy Jobs and American Power Act (S 1733), sponsored by Senators John Kerry (D–MA) and Barbara Boxer (D-CA). Introduced on September 30, 2009, it proposes a "pollution reduction and investment" (cap-and-trade) program to achieve 20% reductions of greenhouse gas emissions from 2005 levels, and ultimately 83% reductions by 2050.

Overall, the initial draft of S 1733 mirrors much of the provisions of the final HR 2454, but does differ in several respects. While it also allows for use of up to 2 billion tonnes of offsets annually, it limits the share of international offsets to no more than 25% annually (unless domestic offsets are not sufficiently available). Originally, S 1733 did not specify how allowances were to be distributed – a detail that was intentionally left to work out in committee hearings and floor debates. However, a subsequent "chairman's mark" version introduced on October 23, 2009, proposed to allocation allowances largely in line with the scheme set forth in Waxman-Markey. However, because S 1733 provided for significantly more revenue from auctioning of allowances to go toward deficit reduction (10% from all allowances from 2012-2029, 22% from 2030-2039 and 25% from 2040-2050), overall fewer allowances are available for distribution.

[27] Energy Information Administration, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009* (August 2009), available at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf
[28] Congressional Research Service, *Climate Change: Costs and Benefits of the Cap-and-Trade Provisions of H.R. 2454* (September 14, 2009), available at http://opencrs.com/document/R40809/

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Other significant differences from Waxman-Markey include:

- *Offsets Oversight* - Offsets Integrity Advisory Board to be established by the President (instead of EPA), and Office of Offsets Integrity to be established within Department of Justice.
- *Cost Control* – Establishes $28 allowance price trigger for releasing additional allowances from strategic reserve in 2012. Trigger price increases by 5% plus inflation from 2013 through 2017, and thereafter 7% plus inflation.
- *Nuclear Power* — Increases funding for training skilled workers for nuclear facilities, and for waste management and disposal R&D.
- *Clean Air Act* – No provision for exempting or pre-empting concurrent regulation by EPA under the Clean Air Act.
- *State and Regional Programs* – Moratorium would begin in 2012 or nine months after first allowance auction (whichever comes first) and extend through 2017.

S 1733 was passed out of the Senate Environment and Public Works Committee in a controversial vote on November 5, 2009, when all seven Republican committee members were absent. The bill is still being considered by other committees, including the Agriculture, Finance, Commerce, and Energy and Natural Resource committees.

In an effort to build more bi-partisan support, the bill's sponsor John Kerry has since joined with Senators Lindsey Graham (R-SC) and Joe Lieberman (I-CT) to craft a "blueprint" framework for evolution of S 1733 to improve its chances to clear the 60-vote cloture hurdle. The framework calls for a near term pollution reduction target of about 17% below 2005 levels (down from the original 20%) and a long-term reduction target of 80% (down from the original 83%). It promotes increased nuclear power plant development through friendlier financing and licensing provisions, and supports increased offshore oil and gas drilling to secure greater national energy independence.

The bipartisan blueprint also outlines several key provisions deemed critical to assuring its passage, including providing transitional assistance to households and businesses to ease the shift to a low-carbon economy; rapid development and deployment of clean coal technology including carbon capture and sequestration; assistance and financial incentives to manufactures to improve efficiency and avoid carbon leakage overseas; offset projects and incentives that will enable farmers to develop new income streams; vigilant carbon market oversight; and long-term financing to assist developing countries adapt to climate change, generate clean energy and reduce emissions from deforestation.

The degree to which any of these recommendations are incorporated into subsequent versions of S 1733 will be determined by the various committees.

7.4.3.2 Other Senate Bills

A bill introduced by Sens. Maria Cantwell (D-WA) and Susan Collins (R-ME) in December 2009 would establish a "cap-and-dividend" approach wherein a price would be set on fossil fuels' carbon dioxide emissions and revenue would be returned to consumers. Producers and importers of fossil fuels would bid in monthly auctions for "carbon shares". Seventy-five percent of the resulting revenue would be refunded to consumers to help compensate for increased energy costs. The remaining 25% would be deposited in a Clean Energy Reinvestment Trust Fund to be applied toward energy efficiency initiatives and clean energy research and development. The bill has garnered attention as a bipartisan alternative to S 1733.

A comprehensive energy bill entitled The American Clean Energy Leadership Act (S 1462) was approved by the Senate Energy and Natural Resources Committee on June 17, 2009. This bill would require electric utilities to increase their use of renewable sources of energy and energy efficiency measures to eventually meet 15% of their customer's electricity needs by 2021. It also provided for integrated national transmission

grid development planning, expedited siting approval for lines rated at 345 kV and above, establishing equitable cost allocation methodologies for national and regional transmission projects, and increased federal authority to deal with cyber security threats to the power grid. The bill also includes measures designed to facilitate large-scale demonstration and early deployment of carbon capture and storage technologies, and would establish a new Clean Energy Deployment Administration to offer credit support for breakthrough clean energy technologies.

Other Senate bills that may ultimately influence the outcome of any national climate change regulatory program include:

- Senate Clean Air Subcommittee Chairman Tom Carper's (D-DE) bill S 575 that would set aside 10% of any allowance auction for state and local transportation projects that reduce greenhouse gas emissions such as mass transit and passenger rail, sidewalk and bicycle train construction, and community anti-sprawl planning.
- Senators Dianne Feinstein (D-CA) and Olympia Snowe (R-ME) bipartisan S 1399 that would consolidate regulation of primary allowance, emissions and derivatives carbon markets under the Commodity Futures Trading Commission.
- Senator John Kerry's (D-MA) International Climate Change Investment Act that would authorize the Department of Agriculture to establish a program to preserve and rebuild forests in developing countries, and establish a strategic interagency board to monitor U.S. investments in greenhouse gas reduction programs in developing countries.

7.4.4 Direct EPA Regulation

The EPA has recently taken steps towards regulating greenhouse gas emissions through direct promulgation of regulations under authority of the current Clean Air Act. Regulations in the United States are authorized by and limited to within the bounds of their enabling legislation – here the current Clean Air Act. Therefore, successful enactment of Congressional climate change legislation (such as described in subsections 4.1 and 4.2 above) could allow, limit or pre-empt any regulatory programs established by the EPA.

7.4.4.1 Background

In 1999, several environmental and renewable energy organizations filed a petition with the EPA requesting the agency to issue standards under Section 202(a) of the Clean Air Act for emissions of four greenhouse gases (CO_2, CH_4, N_2O and HFCs) from new motor vehicles and engines. Section 202(a) of the Clean Air Act sets forth a two-step test wherein the EPA must decide (1) whether the air pollution under consideration may reasonably be anticipated to *endanger public health and welfare*, and (2) whether emissions of an air pollutant from new motor vehicles *cause or contribute to this air pollution*, before it can issue the requested standards.

EPA denied this petition in August 2003 on various grounds which were challenged by the petitioners but upheld by the federal D.C. Circuit Court of Appeals. In April 2007, the U.S. Supreme Court reversed that court's decision and held that EPA had improperly denied the petition.[29] Finding that the subject greenhouse gases fit the Clean Air Act's "sweeping definition of 'air pollutant'", the Supreme Court held that EPA's decision whether or not to grant the petition must relate to "whether an air pollutant 'causes or contributes to air pollution which may reasonably be anticipated to endanger public health or welfare.'" The Court directed EPA to either make this determination or provide some reasonable explanation as to why it cannot or will not do so.

EPA responded to the 2007 U.S. Supreme Court ruling by releasing its final "endangerment finding" on December 7, 2009. EPA's finding technically determined that greenhouse gas emissions from motor vehicles

[29] Massachusetts v. EPA, 127 S. Ct. 1438 (2007)

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cause or contribute to pollution that endangers public health and welfare. The legal effect of this action now initiates the process for making greenhouse gases regulated pollutants under the federal Clean Air Act, and authorizes the EPA to proceed to regulate greenhouse gas emissions from both mobile (vehicles) and stationary sources (industry) under the Clean Air Act.

7.4.4.2 Next Steps

While EPA has now fulfilled the 2007 Supreme Court directive, it is not immediately subject to any court mandate or timetable to begin a rulemaking process to implement greenhouse gas requirements, and therefore it is up to agency discretion as to when and how to proceed. When EPA will take the next step is not completely clear at this time. Meanwhile, the political, legal and regulatory implications of its endangerment finding will likely play out in the coming year.

Politically, EPA's finding puts pressure on Congress to craft and pass greenhouse gas legislation that would provide more flexible market-based compliance options that would be less harmful to the U.S. economy. Congress is considering different greenhouse gas cap-and-trade proposals as described previously. Congressional legislation, if enacted, would likely pre-empt direct EPA regulation.

Several organizations have vowed to challenge the endangerment finding in the federal D.C. Circuit Court of Appeals. In the interim, EPA has been working on a new rulemaking with the Transportation Department's National Highway Traffic Safety Administration to control vehicle greenhouse gas emissions, which once finalized (possibly as soon as by spring of 2010) will open the door to regulating greenhouse gas emissions from stationary sources such as power plants and refineries.

Both the Obama Administration and the EPA acknowledge that the Clean Air Act is not particularly suited for addressing the more global nature of greenhouse gas pollution, and would prefer to defer to legislative solutions to address climate change. Nevertheless, they have made it clear EPA is willing to proceed with developing a regulatory regime under the Clean Air Act if Congress fails to pass greenhouse gas legislation.

7.4.4.3 Legal Authority & Implications

Because EPA's authority is legally limited to only what is allowed under the Clean Air Act, any future regulatory requirements it may establish may have to be based on command-and-control requirements such as new source performance standards, best available control technology (BACT), and vehicle emissions standards. EPA's authority to establish a more flexible and cost effective emissions trading program is currently in question, as a result of a court decision remanding the Clean Air Interstate Regulation (CAIR) cap-and-trade program for NO_X and SO_2 emissions. Additionally, any such EPA program would not prevent or pre-empt individual states from implementing their own greenhouse gas regulatory programs (such as the Western Climate Initiative).

EPA has already finalized a rule which subjects stationary sources and fuel suppliers to mandatory greenhouse gas emissions monitoring and reporting requirements beginning on January 1, 2010.[30] EPA has also proposed a "tailoring rule" to adjust Clean Air Act thresholds to subject only larger sources of greenhouse gas emissions to regulation.[31] The proposed tailoring rule would raise the threshold for triggering prevention of significant deterioration (PSD) permitting requirements to only those sources that emit more than 25,000 tonnes of carbon dioxide-equivalent greenhouse gas emissions annually. Currently the "major source" PSD thresholds are set at 250 tonnes per year or less.

PSD requirements mandate that major sources obtain permits and incorporate BACT when constructing new facilities or modifying existing ones in some significant way. How EPA may choose to define BACT for

[30] 40 CFR Parts 86, 87, 89 et al. 74 Fed. Reg. 56260.
[31] 40 CFR Parts 51, 52, 70, et al. 74 Fed. Reg. 55292.

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greenhouse gas emissions is unknown, and currently subject to extensive speculation. It will likely involve a wide range of options, including energy and process efficiency improvements; ultra-supercritical and/or combined heat and power boiler designs; switching to lower carbon content fuels; or carbon capture and sequestration. Considerations of energy demand reduction and response programs or even purchase of carbon offsets may be even required, although such actions would extend beyond what traditionally has been addressed in BACT reviews. Since most states actually administer the Clean Air Act program within their jurisdictions, there could likely be a patchwork of interpretations of what BACT requirements should apply to each source.

The future of greenhouse gas regulation under the Clean Air Act is uncertain at this time. The endangerment finding was officially published in the *Federal Register* on December 15, 2009[32], and took effect on January 14, 2010. Beyond that, EPA does not appear to be in any hurry to finalize its proposed PSD tailoring rule, and has convened stakeholder groups to explore how best to define sources, consider the kinds of technologies that may be used to control greenhouse gas emissions, and discuss how states will administer the program. Due to procedural requirements, regulatory proposals typically take at least a year to finalize, and almost always are then challenged in the courts. Whatever requirements and programs may ultimately be upheld will take several years to be fully adopted and implemented by the states.

In any event, these programs will not apply to British Columbia sources unless Canada and the United States sign a treaty to harmonize emission standards or control technology requirements. However, it is important to note that the Clean Air Act only authorizes EPA to regulate emissions of air pollutants from sources and facilities, rather than their products and services (such as exported electricity). Accordingly, in the absence of a harmonization treaty or similar BACT requirements being imposed on British Columbia generation sources, the cost of electricity they generate may indeed be more competitive than some new power plants or modified existing plants in the United States that are required to install BACT under an EPA Clean Air Act regulatory program. However, the degree of uncertainty regarding the number of such sources, the type and costs of BACT that may be installed, and differential in generated electricity costs resulting from direct EPA regulation under the current Clean Air Act precludes any meaningful estimation of potential impacts to BC Hydro at this time.

7.5 Western Climate Initiative

Originally established by the Western Governor's Association in February 2007, the Western Climate Initiative is a collaborative effort by seven western states (Arizona, California, Montana, New Mexico, Oregon, Utah and Washington) and four Canadian provinces (BC, Manitoba, Quebec and Ontario) to reduce emissions of six greenhouse gases (SO_2, CH_4, N_2O, HFCs, PFCs and SF_6) from their power generation, industrial, petrochemical and transportation sectors to 15% below 2005 levels by 2020. The primary mechanism for achieving this reduction would be through a regional cap-and-trade program.

7.5.1 Program Framework

The Western Climate Initiative released its design recommendations for implementing a regional cap-and-trade program in September 2008.[33] Under this draft plan, entities and facilities annually emitting 10,000 tonnes or more of the regulated greenhouse gases, measured in CO_2 equivalents, will have to begin reporting their 2010 emissions in early 2011. The cap-and-trade program will begin in 2012 for power generation, industrial and petrochemical companies emitting 25,000 tonnes or more of CO_2e each year. Regulation of transportation sector emissions will not begin until 2015. A final model trading rule is due to be released in 2010.

[32] 40 CFR Chapter 1, 74 Fed. Reg. 66496.
[33] Western Climate Initiative, *Design Recommendations for the WCI Regional Cap-and-Trade Program*, (September 2008), available at http://www.westernclimateinitiative.org/component/remository/func-startdown/14/

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The proposed reach of the emissions trading program would extend outside of the partner state boundaries to include regulation of "first deliverers" of electricity into the region, but would exclude sources that burn biomass or biofuels. Regulated sources would have three-year compliance periods in which to retire allowances equal to their CO_2e emissions.

The 2012 regional cap is to be set at the best estimate of expected actual annual emissions from those sources covered in initial year of the cap-and-trade program. In 2015, the regional cap will include expected actual emissions from transportation fuels as well as residential, commercial and industrial fuels. The total number of allowances that comprise the cap for covered sectors will decline on a straight line basis from the year of initial coverage (2012 or 2015) through 2020.

7.5.2 Distribution and Use of Allowances

The annual apportionment of allowances to each member state and province will be determined prior to the start of the program in 2012. The individual allowance budgets for each member jurisdiction are to be based on the best estimates of expected emissions from covered sources (derived from best available data, including annual reporting) considering projected population growth and economic growth, and adjusted for production and consumption of electricity (in MWh) within each jurisdiction.

Each WCI partner will decide how best to distribute allowances to regulated entities within its own jurisdiction. A minimum of 10% of allowances must be auctioned in the first compliance period beginning in 2012, increasing to 25% in 2020. Auctions are to be undertaken in a coordinated regional process, the design of which is to be developed by the end of 2009. The first 5% of allowances auctioned by any jurisdiction will have a reserve price or minimum price. Allowances not sold at the reserve price will mostly be retained for auction in later compliance periods, and a remaining fraction of these unsold allowances will be permanently retired. Auction proceeds are to be directed towards energy efficiency and renewable energy development and incentives, research and development of carbon capture and storage, promotion of reductions and carbon sinks in agriculture forestry and other unregulated sectors, and human and natural adaptation to climate change impacts.

7.5.3 Compliance Mechanisms

Offsets from reductions achieved outside of the regulated program may be used for up 49% of total emission reductions from 2012 to 2020. Each jurisdiction will have the discretion to set lower percentage limits. Offset credit criteria are to be jointly established to assure offsets are real, surplus/additional, verifiable and permanent. This is to be enforced by jurisdiction issuing the credit, and credits are to be verified by each individual jurisdiction accepting it.

Individual jurisdictions may approve or certify offset projects located anywhere in the United States, Canada or Mexico, and may accept credits through the Kyoto Protocol Clean Development Mechanism (from developing, non-Annex I countries). Offset project types may include (1) agricultural (soil sequestration and manure management), (2) forestry (afforestation/reforestation, forest management, forest preservation / conservation, forest products) and (3) waste management (landfill gas and wastewater management).

Emission reductions in sectors covered by cap-and-trade program are not eligible for generating offsets. However, each member jurisdiction will have discretion to award credits for early actions undertaken between January 1, 2008, and January 1, 2012. Common eligibility criteria are to be jointly established by the end of 2009, and all early reduction allowances will be issued in 2012. All early reduction credits issued will come out of that member jurisdiction's allowance budget.

Each covered facility or entity must surrender sufficient allowances by July 1 of the year following the end of each three-year compliance period. Banking of allowances and credits for future use will be unrestricted,

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however borrowing from the future will not be allowed. Any regulated facility or entity that fails to surrender sufficient allowances to cover its emissions for the previous compliance period will be required to obtain and surrender three allowances for every tonne of CO_2e not covered by an allowance. Each member jurisdiction will be responsible for enforcement within its state or province, and may impose additional penalties for non-compliance.

Key Features of the Western Climate Initiative

- *Geographic Range / Participants* – signatory parties include seven western states - Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington - and four Canadian provinces - BC, Manitoba, Quebec, and Ontario. Does *not* currently include "observer" jurisdictions of Idaho, Nevada, Wyoming, Colorado, Kansas, Alaska, Saskatchewan, Baja California, Chihuahua, Coahuila, Nuevo Leon, Sonora, and Tamaulipas.
- *Reduction Targets* - 15% below 2005 levels by 2020
- *Regulated Sectors & Thresholds* - Facilities in sectors of electricity generation (including "first jurisdictional deliverers" of imported electricity to the region); industrial and commercial fossil fuel combustion; industrial process emissions (including oil and gas process emissions); distributors of residential, commercial and industrial combustion fuels (at point of entry into WCI commerce); and blenders and distributors of gasoline and diesel transportation fuels (at point of entry into WCI commerce). Reporting threshold is annual emissions of 10,000 tonnes CO_2e; cap-and-trade applicability threshold is annual emissions of 25,000 tonnes CO_2e.
- *Implementation Mechanism* – Region-wide cap-and-trade program
- *Timeline* – Measurement and monitoring of all six greenhouse gases to commence in January 2010 for covered facilities/entities, and annual reporting 2010 emissions in early 2011. Regulation/trading begin in 2012 for power generation, industrial and petrochemical companies. Regulation of transportation sector emissions does not begin until 2015.
- *Allowance Distribution* – Budgets to be established for each member jurisdiction by 2012. Each member decides within its own jurisdiction if and how to allocate allowances to covered facilities and entities. Recommends minimum percentage to be auctioned (10% in 2012 and 25% in 2025), proceeds to be directed towards energy efficiency and renewable energy development, CCS R&D, promoting reductions and carbon sinks in agriculture forestry and other unregulated sectors, and climate change adaptation.
- *Compliance Mechanisms* - Three year compliance periods, early reduction credits, offsets up to 10%, unlimited banking, no borrowing from future.
- *Offsets* – Limited to no more than 49% of total emission reductions from 2012-2020 (each jurisdiction can set lower percentage limit). Offset criteria to be enforced by jurisdiction issuing the credit, and credits to be verified by each individual jurisdiction accepting it. Individual jurisdictions may approve or certify offset projects located anywhere in the United States, Canada or Mexico, and may accept credits through the Kyoto Protocol Clean Development Mechanism (from developing, non-Annex I countries). Project types include (1) agricultural (soil sequestration and manure management), (2) forestry (afforestation/reforestation, forest management, forest preservation/conservation, forest products) and (3) waste management (landfill gas and wastewater management). Emission reductions in sectors covered by cap-and-trade program are not eligible (except prior to beginning of program).
- *Clean & Renewable Energy Requirements* - None
- *Interaction with Other Policies* – Each participating jurisdiction must enact or adopt its own regulatory program to implement collaborative WCI program. WCI may seek bilateral and multilateral linkages with other government approved cap-and-trade systems. The program is designed to be integrated into, or implemented in conjunction with any federal programs that may be enacted by the United States or Canada in the future.

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7.5.4 Organization, Growth and Linkages

The fate of this effort will depend upon how successful the WCI is in keeping all its partner states and provinces fully committed to the regulatory regime design. The signatory members must now enact the requisite legislation and regulations to enable its participation in the WCI by 2012. These programs must be aligned with the design recommendations to the extent allowed under their individual laws.

With an additional six states, two Canadian provinces, and six Mexican states signed on as observers, the Western Climate Initiative has the potential to grow into a North American market for trading of greenhouse gas allowances and offset credits. New members can join the initiative once they have adopted an economy-wide greenhouse gas reduction goal for 2020 that is at least as stringent as the regional goal. Their joining will have to be regionally coordinated for a designated time, such as the beginning of a relevant compliance period.

The WCI will seek bilateral and multilateral linkages with other government approved cap-and-trade programs so that allowances will be fully fungible between the various programs. The WCI program is purposely designed to be integrated into, or implemented in conjunction with, any federal programs that may be enacted by the United States or Canada in the future.

7.5.5 Recent Developments

By the end of 2009, the Western Climate Initiative had committed to (1) setting the regional cap, (2) adopting a reporting rule for 2012 covered sources, (3) developing and approve protocols for an initial set of offset projects, and (4) developing criteria for acceptable early reduction credits. While none of these commitments has been fully completed, as of November 1, 2009, the WCI has released a final Essential Requirements for Mandatory Reporting (ERMR) that includes general provisions governing all reporters; requirements for third-party verification; and greenhouse gas monitoring, reporting and record keeping methodologies for 14 specific source categories.[34]

7.5.6 Renewable Electricity / Portfolio Standards

The WCI currently does not have any specific goals defined for how renewable energy will play a role in the greenhouse gas reduction target. However, the Western Governor's Association has recently been at the forefront of developing infrastructure for greater renewable energy development through its Western Renewable Energy Zones project. The study was undertaken by the U.S. Department of Energy and the governor's association to identify areas of the WECC that have both the potential for large scale development of renewable resources and low environmental impacts. The study engaged a diverse range of stakeholders to make decisions about the study direction and the details of the technical and economic analysis. Decisions were approved first by small technical working groups and then by various renewable energy zone leadership committees. This work defined the areas that were best suited to future renewable energy development.

Provinces and states have also agreed on a common renewable energy tracking method, the Western Renewable Energy Generation Information System (WREGIS). This system assures that renewable energy being counted by one locality for policy compliance is not also counted elsewhere. Most renewable portfolio standard policies require that eligible generators register with WREGIS and those entities that must comply with the portfolio rules to obtain renewable energy credits through WREGIS. This type of system makes obtaining credits from other provinces or states (if allowed per individual renewable portfolio guidelines) easy to obtain and track.

[34] Western Climate Initiative, *Final Essential Requirements of Mandatory Reporting*, (July 15, 2009), available at http://www.westernclimateinitiative.org/component/remository/func-startdown/118/

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7.6 California

7.6.1 Global Warming Solutions Act

The Global Warming Solutions Act, also known as AB32, was signed into law in September 2006. [35] AB32 required the state's major industries - such as power generation utilities, oil and gas refineries, and cement kilns - to reduce their current CO_2 and other greenhouse gas emissions approximately 20% by 2020, starting in 2012. The act authorizes the California Air Resources Board (CARB) to measure the amount of CO_2 and other gases coming from the regulated industries and then set limits for each facility and industry sector that would take effect by 2012.

Initially, AB32 directed CARB to determine what the statewide greenhouse gas emissions were in 1990 and establish this as a statewide cap to take effect in 2020. CARB must then identify "market-based compliance mechanisms" that might be used as part of its plan to drive reductions to reach the established limit, which could likely include a cap-and-trade program that will allow businesses to buy, sell, and trade emission credits with other companies. The regulatory program must be adopted by 2011 and be effective and implemented by the beginning of 2012.

In accordance with the mandates of AB32, CARB established the 1990 baseline of state greenhouse gas emissions at 427 million tonnes of CO_2e and adopted regulations for mandatory reporting of greenhouse gas emissions beginning in April 2009. [36] Regulated sources emitting more than 25,000 tonnes of CO_2 annually are required to report their direct and indirect CO_2, CH_4, and N_2O emissions based on best available data, which should be based on fuel consumption for power generation facilities and electricity importers with a capacity of 1 MW or greater. Reporting will become more rigorous and be subject to third-party verification in 2010.

CARB initiated efforts to develop the main strategies to be used to reduce greenhouse gas emissions, including considerations of alternative compliance mechanisms, monetary and non-monetary incentives, voluntary actions, and market-based mechanisms such as a cap-and-trade program. CARB released its recommendations in a proposed Scoping Plan in October 2008,[37] which was approved by the board in December 2008.[38] The key elements of this approved plan include:

- Developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system.
- Expanding and strengthening existing energy efficiency programs as well as building and appliance standards.
- Achieving a statewide renewables energy mix of 33%.
- Establishing targets for transportation-related greenhouse gas emissions for regions throughout California, and pursuing policies and incentives to achieve those targets.
- Adopting and implementing measures pursuant to existing state laws and policies, including California's clean car standards, goods movement measures, and the Low Carbon Fuel Standard.
- Creating targeted fees, including a public goods charge on water use, fees on high global warming potential gases, and a fee to fund the administrative costs of the State's long term commitment to AB 32 implementation.

These recommendations are to be developed into regulations to take effect by January 1, 2012.

[35] Cal. Health & Safety Code § 38570 et seq. (2009).
[36] Cal. Code Regs. Tit. 17, § 95100 to 95133 (2009).
[37] California Air Resources Board, *Climate Change Proposed Scoping Plan, a framework for change*, (October 2008), available at http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf
[38] California Air Resources Board, *Climate Change Proposed Scoping Plan, a framework for change*, (December 2008), available at http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

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7.6.2 Cap-and-Trade Program Framework

The approved Scoping Plan anticipates California participating in the regional Western Climate Initiative cap-and-trade program, and therefore recommends designing the state program to integrate into the WCI. Nevertheless, AB32 mandates specific requirements for a California program, regardless of its participation or linkages to other programs.

According to AB32, regulations to implement the cap-and-trade program need to be developed by January 1, 2011. The proposed trading program would include up to 85% of the state's emission sources by 2020, covering the electricity, transportation fuels, natural gas, and industrial sectors. Overall, the cap represents a 147 tonne CO_2e reduction from the projected business-as-usual emissions from the covered sources.

AB32 requires that the program account for and regulate emissions from all electricity produced and consumed in the state, including electricity from both in-state and out-of-state generation. The California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) have jointly provided recommendations to CARB for regulating the electricity sector under AB32, including a "first jurisdictional deliverer" point of regulation similar to the WCI scheme. Emissions or energy use from most of the covered sectors would also be subject to other regulatory measures such as performance standards and efficiency programs.

CARB will establish the details of allowance distributions within the general guidelines of the WCI framework. Free allocation of allowances may be based on environmental performance standards, historical emissions, or other relevant metrics. The CPUC and CEC have recommended a transition to 100% auction for the electricity sector by 2016. While CARB generally agrees with transition to full auction, but has stated that the timing of this transition must account for the potential for emissions leakage, effect on regulated vs. unregulated sectors, impacts to consumers, and strategic use of auction revenues.

Trading under AB32 is to begin in 2012 when in-state electric generating facilities, imported power, and large industrial facilities that emit more than 25,000 tonnes per year CO_2e become subject to the program. In 2015, upstream treatment of industrial fuel combustion at facilities with emissions at or below 25,000 tonnes per year CO_2e, as well as all commercial and residential fuel combustion and transportation fuels regulated where the fuel enters into commerce in California (or the WCI).

CARB will work together with other WCI participants to develop an offsets program. Ultimately, CARB must establish a quantitative limit on offsets to ensure that a majority of the required emissions reductions come from within the capped sectors. The final approved Scoping Report recommends that CARB establish an offsets program without geographic restrictions, so long as it has sufficiently stringent criteria for creating offset credits to ensure the overall program integrity. It further recommends consideration of limiting acceptance of offsets from the developing world to only those countries that pledge to achieve greenhouse gas intensity targets in certain carbon intensive industries.

7.6.3 Renewable Electricity / Portfolio Standards

California has the most aggressive requirements for renewable energy production in the United States. The current requirement is that utilities must meet a standard of 20% renewables by 2010 and 33% renewables by 2020. An executive order signed by the governor on September 15, 2009, made the 33% requirement apply to all utilities, including municipal and rural electric cooperatives, not just the previously regulated investor owned utilities (IOU). To meet the requirements, out-of-state qualifying electricity, not just RECs, must be delivered to the state.

There are application forms for eligibility of hydro and out-of-state resources which can be found at the California Energy Commission website. Hydro generation facilities must be under 30 MW capacity and have different requirements based on when the facility was placed in service.

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7.6.4 Greenhouse Gas Performance Standard

California enacted another key greenhouse gas regulatory measure in 2006, Senate Bill 1368 (SB1368).[39] This prohibits an electricity provider from entering into long term power purchase agreements unless the baseload generation complies with greenhouse gas emission performance standards. A standard of 1,100 pounds of CO_2 per megawatt hour was adopted by the CPUC in January 2007, followed by the same standard being adopted by the CEC in May 2007. The CEC standard applies to all baseload generation owned by, or under long-term contract to publicly owned utilities. The CPUC standard applies to all new long-term commitments for baseload generation to serve California consumers. "New long-term commitment" refers to new plant investments (new construction), new or renewal contracts with a term of five years or more, or major investments by the utility in its existing baseload power plants.

7.6.5 Economic Impact Analyses

In its 2007 Economic Analyses of California Climate Initiatives, the Electric Power Research Institute (EPRI) modeled 20 different policy scenarios to predict the economy-wide impacts of specific climate policies, particularly on the electricity sector.[40] In examining its Pure Trade case (based on AB32), EPRI found that the carbon price in California would amount to $128 per tonne of carbon in 2015 (the end of the first modeling period following initial implementation of AB 32) and rises to $403 per tonne of carbon by 2035. The carbon price declined somewhat thereafter as assumed technological advances help ameliorate the demand for permits. On a sectoral basis the largest reductions from baseline emissions come from electricity generation, which reduces its emissions by 88 million tones of CO_2 (68%) in 2020. The economic impact of the Pure Trade scenario was a $229 billion welfare reduction (discounted present value of the consumption of all goods and services plus leisure from 2010-2050, or in other words the amount of money that the people in the state would require in order to be as well off as it would be without any greenhouse gas limits).

Key Features of California Global Warming Solutions Act and SB 1368

- *Geographic Range* – California, including importers of electricity. May integrate with Western Climate Initiative..
- *Reduction Targets* - reduce current greenhouse gas emissions 20% by 2020, 80% by 2050.
- *Regulated Sectors & Thresholds* - Electricity generation (including “first jurisdictional deliverers” of imported electricity to the state), and large industrial sources emitting more than 25,000 tonnes per year CO_2e and refineries of fuels burned in California that emit over 10,000 tonnes per year CO_2e.
- *Implementation Mechanism* – Cap-and-trade program, energy efficiency, renewable energy, transportation and fuels standards, emissions performance standards, fees on water and high warming potential gases.
- *Timeline* – 2009 adopt plan, 2010 early actions, 2011 finalize regulations and the market mechanism, 2012 electricity and large industrial sectors begin trading, 2015 upstream fuel suppliers begin trading.
- *Allowance Distribution* – To be determined by CARB.
- *Compliance Mechanisms* - To be determined by CARB.
- *Offsets* – To be determined by CARB.
- *Renewable Portfolio Standard* – 20% renewables by 2010 and 33% by 2020.
- *Performance Standard* – 1100 lbs CO_2/MWh long term commitments for baseload generation.

[39] Cal. Pub. Util. Code §8340 and 8341 (2009).
[40] Electric Power Research Institute, *Program on Technology Innovation: Economic Analysis of California Climate Initiatives: An Integrated Approach, Volume 2: Full Report*, (December 13, 2007), available at http://my.epri.com/portal/server.pt?Abstract_id=000000000001014862

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7.7 Washington

Reduction Targets - In February 2007, Govenor Christine Gregoire issued an executive order establishing a goal of reducing statewide greenhouse gas emissions to 1990 levels by 2020 (approximately 10 million tonnes below 2004 levels), and then achieving a 50% reduction below 1990 levels by 2050 (for a total of 50 million tonnes below 2004 levels).[41] Less than three months later, she signed into law Senate Bill 6001 (SB6001) which essentially codified these goals with some slight modifications, and further imposed an emissions performance standard on all baseload electric generation sources supplying power to the state.[42]

On December 22, 2008, the state Department of Ecology released "Growing Washington's Economy in a Carbon-Constrained World: A Comprehensive Plan to Address the Challenges and Opportunities of Climate Change."[43] The plan includes policies to meet the state's emission reduction targets of 1990 levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050. The WDOE recommends that in addition to participating in the WCI, Washington should adopt policies to improve building efficiency, reduce Vehicle Miles Traveled through increased public transportation, and to foster compact and transit-oriented development.

Reporting - On March 13, 2008, Govenor Gregoire signed into law H.B. 2815, which required the Department of Ecology to develop a system for greenhouse gas emissions reporting, and requiring entities emitting more than 10,000 tonnes per year CO_2e to begin reporting by 2010.[44] Both the Energy Facility Site Evaluation Council (EFSEC) and the Department of Ecology have adopted rules for reporting annual emissions of CO_2, N_2O and CH_4 to the appropriate air quality permitting authorities.[45]

Performance Standard - The EFSEC, which regulates fossil fuel plants that produce 350 megawatts or more, began drafting CO_2 emission mitigation standards and siting requirements in 2003. By 2004, mitigation requirements were enacted requiring new power plants to offset a certain portion of their anticipated CO_2 emissions through one or a combination of payment to a third party, direct purchase of permanent carbon credits, or investment in an applicant-controlled carbon dioxide mitigation projects.

With the enactment of SB6001, all new plants sited within the state are now required to limit their greenhouse gas emissions to no more than 1,100 lbs/MWh, and further to sequester all their emissions within five years of beginning operations. If the emissions can't be sequestered, mitigation must be achieved by paying for an older plant in the western electricity grid to shutdown. Additionally, utilities entering into long-term financial commitments for power supply from all baseload generation sources, whether located inside or outside of the state, must demonstrate that these sources meet the 1,100 lbs/MWh performance standard – essentially equivalent to greenhouse gas emissions from a gas-fired combined cycle plant. This standard took effect on July 1, 2008 as a result of regulations being adopted by both EFSEC and the Department of Ecology, which regulates plants with capacities less than 350 MW.

WCI - Washington is one of the participating states..

Renewable Portfolio Standard - The voters of Washington State passed a renewable portfolio standard requirement by a ballot initiative process in 2006. The goal is 15% renewables by 2020. The standard applies to virtually all utilities in the state. Utilities are subject to an inflation adjusted $50/MWh penalty for failure to comply.

[41] Exec. Order No. 07-02, Wash. St. Reg. 08-05-054 (February 7, 2007).
[42] Wash. Rev. Code Ann. § 80.80.005 et seq. (2009).
[43] State of Washington Department of Ecology, *Growing Washington's Economy in a Carbon-Constrained World, A Comprehensive Plan to Address the Challenges and Opportunities of Climate Change*, (December 2008), available at http://www.ecy.wa.gov/climatechange/2008CompPlan.htm
[44] Wash. Rev. Code Ann. §70.94.151, § 70.94.161, §28B.50.272, §47.01.440, §43,330,310, §70.235.005 et seq. (2009).
[45] Wash. Admin. Code § 173-407-230 and § 463-85-230 (2009).

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Hydroelectric projects are eligible for compliance if the incremental electricity produced is from efficiency improvements, if the improvements were made after March 31, 1999, and:

- Hydro projects are owned by a utility subject to the RPS and the project is located in the Pacific Northwest, or
- Hydro generation for irrigation pipes and canals located in the Pacific Northwest as long as there are no new impoundments or water diversions.

By statute, "Pacific Northwest" largely means "the area consisting of the States of Oregon, Washington, and Idaho, the portion of the State of Montana west of the Continental Divide, and such portions of the States of Nevada, Utah, and Wyoming as are within the Columbia River drainage basin."

Key Features of Washington Greenhouse Gas Policies

- *Reduction Targets* – 1990 levels by 2020, 25% below 1990 by 2035, 50 % by 2050.
- *Implementation Mechanism* – Participation in WCI cap-and-trade program.
- Renewable Portfolio Standard – 15% renewables by 2020.
- *Performance Standard* – 1100 lbs CO_2/MWh for baseload generation, CCS mitigation plan >25 MW, offset 20% emissions over 30 years.

7.8 Oregon

Reduction Targets – Governor. Ted Kulongoski appointed an advisory group in 2004 that released a report entitled Oregon Strategy for Greenhouse Gas Reduction[46] the following year that initially established statewide greenhouse gas emission targets that were finally officially established in August 2007 when House Bill 3543[47] was enacted, directing the state to stop the growth of greenhouse gas emissions by 2010; and then to reduce greenhouse gas emissions to 10% below 1990 levels by 2020 and to 75% below 1990 levels by 2050.

Reporting - In October 2008, the Oregon Environmental Quality Commission adopted a greenhouse gas emission reporting mechanism for entities that release more than 2,500 tonnes of carbon dioxide equivalent gases annually.[48] Designed to be implemented in two phases, Title V sources and entitles with an air discharge permit are required to start reporting 2009 emissions in 2010, and all other sources must start reporting 2010 emissions in 2011. In 2009, the Oregon legislature passed Senate Bill 38 that expanded the state greenhouse gas emissions reporting requirements to out-of-state sources of imported electricity, natural gas, and transportation fuel.

Performance Standards – In 1997, HB 3283 created standards for baseload gas power plants, non-baseload power plants, and nongenerating energy facilities that emit carbon dioxide.[49] These entities must reduce their net carbon dioxide emissions 17% below the most efficient baseload gas plant in the United States. HB 3283 allows covered utilities to offset their emissions by implementing carbon dioxide offset projects either directly or through a third party. Alternatively, they may provide funds (corresponding to their carbon dioxide emissions) to The Climate Trust, a non-profit organization established to implement projects that reduce or sequester carbon dioxide emissions.

SB 101, signed in July 2009, applied a different performance standard to all baseload power plants. Generators of baseload power must have emissions equal to or less than 1,100 pounds of carbon dioxide per

[46] Governor's Advisory Group on Global Warming, *Oregon Strategy for Greenhouse Gas Reductions* (December 2004), available at http://www.oregon.gov/ENERGY/GBLWRM/docs/GWReport-FInal.pdf
[47] Or. Rev. Stat. §468A.200 et seq. (2009).
[48] Or. Admin. R. §320-214-0010 et seq. (2009).
[49] Or. Rev. Stat § 469.310, § 469.370, § 469.407, § 469.409, § 469.501, and § 469.503 to § 469.505 (2009).

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megawatt-hour, and utilities may only make long-term purchase agreements for baseload power with generators that meet this standard. This bill addresses all baseload power, including coal plants, whereas HB 3283 applied only to baseload gas plants and other non-baseload facilities. It is also less flexible in terms of compliance: while generators were able to purchase offsets for compliance under HB 3283, SB 101 does not have any provisions for compliance through offsets.

WCI - Oregon is a participant.

Renewable Portfolio Standard - Oregon's Renewable Energy Act of 2007 established an renewable portfolio standard that varies with a utility's size. Large utilities, representing the majority of the load in the state, must have renewables represent 25% of their load by 2025. The largest Oregon utilities are required to show compliance by purchasing RECs through WREGIS. RECs used for compliance may be bundled or unbundled with electricity; that is, they may accompany power used in the state or be separate purchases of renewable power attributes without taking physical delivery of the power. RECs not bundled with electricity are limited to 20% of the compliance amount. The legislation also includes a goal that 8% of Oregon's electric load by 2025 would come from sources smaller than 20 MW.

To be eligible, a facility must have been operational after January 1, 1995. An Oregon Department of Energy document titled *"Summary of Oregon's Renewable Portfolio Standard"* includes a four-page summary of all pertinent RPS details.

The definition of renewable energy sources in Oregon statute ORS 469A.025 contains the following language concerning eligible hydro:

> *Electricity generated by a hydroelectric facility may be used to comply with a renewable portfolio standard only if:*
>
> *(a) The facility is located outside any protected area designated by the Pacific Northwest Electric Power and Conservation Planning Council as of July 23, 1999, or any area protected under the federal Wild and Scenic Rivers Act, Public Law 90-542, or the Oregon Scenic Waterways Act, ORS 390.805 to 390.925; or*
> *(b) The electricity is attributable to efficiency upgrades made to the facility on or after January 1, 1995.*

Key Features of Oregon Greenhouse Gas Policies

- *Reduction Targets* – 10% below 1990 levels by 2020, 75% below by 2050.
- *Implementation Mechanism* – Participation in WCI cap-and-trade program.
- *Renewable Portfolio Standard* – 25% of load from renewables by 2025 (large utilities).
- *Performance standard* – 1,100 lbs CO_2/MWh for new coal-fired power plants.

7.9 Arizona

Reduction Targets - A Climate Advisory Group was established by executive order in February 2005.[50] Tasked with producing an inventory of state greenhouse gas emissions and developing recommendations to reduce these emissions, the advisory group released a final report in August 2006 analyzing various policy recommendations, including cap-and-trade programs, offsets and performance standards.[51] Following the release of this final report, Governor Janet Napolitano issued Executive Order 2006-13 on September 7, 2006,

[50] Exec. Order No. 2005-02 (February 2, 2005).
[51] Arizona Climate Change Advisory Group, *Climate Change Action Plan*, (August 2006), available at http://www.azclimatechange.gov/download/O40F9299.pdf

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which established a statewide goal to reduce Arizona's greenhouse gas emissions to 2000 levels by 2020, and 50% below 2000 levels by 2040.[52]

WCI - Arizona is one of the founding members of the WCI.

Renewable Portfolio Standard - The Arizona Corporation Commission in 2006 adopted final rules to expand the state's RPS to 15% by 2025, with 30% of the energy from distributed generation. Only RECs bundled with electricity deliverable to the state are eligible. Hydro generation from facilities installed before January 1, 1997, must either be used to firm intermittent renewables or be the result of hydro power plant efficiency improvements. Hydro installed after January 1, 2006 must be less than 10 MW. The state provides multipliers for some forms of in-state generation, impacting the amount of out-of-state generation that may be used to comply with future regulations.

Key Features of Arizona Greenhouse Gas Policies

- *Reduction Targets* – 2000 emission levels by 2020, 50% reduction from 2000 levels by 2040.
- *Implementation Mechanism* – Participation in WCI cap-and-trade program.
- *Renewable Portfolio Standard* – 15% by 2025, with 30% from distributed generation.

7.10 New Mexico

Reduction Targets - On June 9, 2005, Governor Bill Richardson issued Executive Order 05-033, which set statewide greenhouse gas emission reduction targets of 2000 emission levels by 2012, 10% below 2000 levels by 2020, and 75% below 2000 emission levels by 2050.[53] EO-05-033 also established a Climate Change Advisory Group to provide specific, measurable proposals to reduce greenhouse gas emissions. The advisory group issued a final report in October 2006 that in addition to 69 recommendations included an inventory of state greenhouse gas emissions. [54] Shortly thereafter, Governor Richardson issued Executive Order 06-69 that among other things directed the Environmental Improvement Board (EIB) to adopt a greenhouse gas emissions registry and reporting mechanism no later than January 1, 2008.[55]

Reporting - The EIB adopted rules in October 2007 requiring all electric generating units of 25MW capacity or higher, petroleum refineries, and cement manufacturing plants to report 2008 emissions of CO_2 in 2009.[56] Methane emissions from 2009 were to be added to the 2010 report, and in subsequent years data for annual N_20, SF_6, HFC and PFC emissions were to be reported. The rule had proposed to require commercial operations to report annual greenhouse gas emissions exceeding 10,000 tonnes per year CO_2e, and for all entities emitting more than 25,000 tonnes per year CO_2e to have a third-party verify the accuracy of the data. However, after the U.S. EPA issued its final mandatory reporting rule in September 2009, New Mexico withdrew its proposed rule in October 2009. [57]

WCI - New Mexico is a participant. In April 2009 the EIB issued a 3-1 decision declaring that greenhouse gas emissions qualify as air pollutants under the Arizona Air Quality Control Act, and therefore are subject to rulemaking by the board. This decision was intended to confirm the board's authority to establish regulations to implement programs for participating in the WCI emissions trading program.

[52] Exec. Order No. 2006-13 (September 7, 2006).
[53] Exec. Order No. 05-033 (June 9, 2005).
[54] New Mexico Climate Change Advisory Group, *Final Report* (2006), available at http://www.nmclimatechange.us/
[55] Exec. Order No. 06-069 (December 28, 2006).
[56] N.M. Admin. Code tit. Environmental Protection, § 20.2.73 and § 20.2.87 (2009).
[57] New Mexico Environment Department, *Environment Department Announces Effort to Harmonize State Greenhouse Gas Reporting Rules with New Federal Requirements* (October 16, 2009), available at http://www.nmenv.state.nm.us/OOTS/documents/PR-greenhousegasReporting-10-16-09.pdf

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Renewable Portfolio Standard - New Mexico's RPS, enacted in 2007, covers investor owned utilities and requires them to generate 20% of retail sales with renewably generated electricity by 2020. Rural electric cooperatives are required to use 10% renewables by 2020 with an interim goal of 5% by 2015 and a 1% annual escalation to 2020. Compliance RECs must be registered with the WREGIS. To be eligible, facilities must have been brought online after July 1, 2007. Hydro resources must also have been brought into service after July 1, 2007.

Key Features of New Mexico Greenhouse Gas Policies

- *Reduction Targets* – 2000 emission levels by 2012, 10% reduction from 2000 levels by 2020, and 75% reduction by 2050.
- *Implementation Mechanism* – Participation in WCI cap-and-trade program.
- *Renewable Portfolio Standard* – 20% of retail sales from renewables by 2020 (IOUs) and 5% by 2015 rising to 10% by 2020 (rural electric cooperatives).

7.11 Utah

Reduction Targets - On June 20, 2008, the Utah Department of Environmental Quality (DEQ) announced a goal of reducing statewide greenhouse gas emissions to 2005 levels by 2020.[58] The reductions will be achieved using several policy tools, including increased reliance on renewable energy sources, policies to reduce energy demand and increase efficiency, mass transit policies, and participation in the Western Climate Initiative cap-and-trade program. Utah DEQ estimated that if all the recommended policies are implemented, that state's 2020 CO_2 emissions will be 28% below business-as-usual levels projected levels.

WCI - Utah is a participant in the Western Climate initiative and joined The Climate Registry voluntary greenhouse gas reporting program.

Renewable Portfolio Standard - Utah's RPS, 20% by 2020, is defined as a goal, rather than a utility mandate. The law includes a clause that only requires a utility to use renewable energy when cost-effective to do so. Also, there are no interim targets for years before 2025, although progress reports must be periodically submitted.

In calculating the RPS requirement, nuclear, carbon-sequestered generation, and demand-side management are deducted from the total hours of retail sales before the renewable percentage is calculated. Plants have to have been in operation after January 1, 1995. Only certified low-impact hydro or efficiency upgrades to existing hydro are eligible.

Key Features of Utah Greenhouse Gas Policies

- *Reduction Targets* – 2005 emission levels by 2020.
- *Implementation Mechanism* – Participation in WCI cap-and-trade program.
- Renewable Portfolio Standard (Goal) – 20% by 2020.

7.12 Montana

Reduction Targets - In December 2005, Governor Brian Schweitzer directed the Montana Department of Environmental Quality to establish a Climate Change Advisory Committee (CCAC). Under this initiative, the CCAC evaluated state-level greenhouse gas reduction opportunities in various sectors of Montana's economy while taking into consideration the governor's charge to develop policy recommendations that would "save money, conserve energy, and bolster the Montana economy." The CCAC issued a final report and Climate

[58] Utah Department of Environmental Quality, *Utah's Greenhouse Gas Goal* (2000), available at http://www.deq.utah.gov/Climate_Change/greenhouse gas_goal.htm

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Change Action Plan in November 2007 that outlined 54 agreed upon policy recommendations designed to help reduce Montana's emissions of greenhouse gas to 1990 levels by the year 2020.[59]

Performance Standard - On May 14, 2007, Governor. Schweitzer signed HB 25, which includes provisions for an emissions performance standard for new coal plants.[60] The Public Service Commission may not approve applications for new plants constructed after January 2007 that are primarily fueled by coal unless the plant captures and stores at least 50% of its carbon dioxide emissions. HB 25 also requires natural gas plants build after the same date to implement "cost-effective offsets" through "any combination of certified actions taken to reduce CO_2 emissions or that increase the absorption of CO_2 which collectively do not increase the cost of electricity produced annually on a per mega-watt basis more than 2.5%."

WCI - Montana participates in the WCI. In his December 2007 application letter to the WCI, Governor Schweitzer officially established the state greenhouse gas reduction goal of 1990 emission levels by 2020 recommended by the CCAC in its final report.

Renewable Portfolio Standard - Montana's Renewable Power Production and Rural Economic Development Act created a renewable portfolio standard in 2005 of 15% by 2015. RECs may be used to comply, but they must be verified by either WREGIS or the Midwest Renewable Energy Tracking System (MRETS). Municipal utilities and rural electric co-operatives are exempt from the state requirements, but, if they have 5,000 customers or more, they must create a standard that recognizes the "intent of the legislature…while taking into consideration the effect of the standard on rates, reliability and financial resources."

The standard includes the use of hydropower, but only in the case of a hydroelectric project that:

- Does not require a new appropriation, diversion, or impoundment of water and that has a nameplate rating of 10 megawatts or less; or
- Is installed at an existing reservoir or on an existing irrigation system that does not have hydroelectric generation as of April 16, 2009, and has a nameplate capacity of 15 megawatts or less.

Key Features of Montana Greenhouse Gas Policies

- *Reduction Targets* – 1990 levels 2020.
- *Implementation Mechanism* – Participation in WCI cap-and-trade program.
- Renewable Portfolio Standard – 15% by 2015.
- *Performance Standard* – 50% CO_2 capture for new coal-fired power plants, offsets for natural gas power plants.

7.13 Colorado

Reduction Targets - On April 22, 2008, Governor. Bill Ritter issued Executive Order D-004-08, which sets the statewide greenhouse gas emissions goal at 20% below 2005 levels by 2020 and 80% below 2005 levels by 2050.[61] It further directs the Colorado Department of Public Health and Environment (CDPHE) to develop regulations mandating the reporting of greenhouse gas emissions, and requests the Public Utilities Commission to require each utility under its jurisdiction to submit electric resource plans that include an analysis showing how the utility could achieve a 20% reduction in its greenhouse gas emissions from 2005 levels by 2020.

[59] Montana Climate Change Advisory Committee, *Montana Climate Change Action Plan, Final Report for the Governor's Climate Change Advisory Committee* (2007), available at http://www.mtclimatechange.us/ewebeditpro/items/O127F14041.pdf
[60] Mont. Code Ann. § 15-72-103, § 15-72-104, § 36-19-102, § 69-1-114, § 69-8-103, § 69-8-201, § 69-8-210, § 69-8-311, § 69-8-402, § 69-8-403, § 69-8-411, § 69-8-419, § 69-8-420, § 69-8-421, § 69-8-426, § 69-8-602, § 69-8-603, and § 69-8-1004 (2009).
[61] Exec. Order No. D 004 08 (April 22, 2008).

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WCI – Colorado is an observer member and therefore has no commitments or obligations to participate in its future greenhouse gas cap-and-trade program.

Renewable Portfolio Standard - Colorado's Renewable Portfolio Standard came into being via a ballot initiative process when voters approved Amendment 37 in November 2004. The main target is 20% renewables by 2020. For investor owned utilities, at least 4% of the RPS must be met with solar technologies which would have the effect of lowering the total percentage which could be met with other technologies. In-state technologies are favored with a 125% compliance credit, potentially lowering the use of out-of-state generation. "Community-based" projects that are in Colorado and are 30 MW or less are given a 150% compliance credit in meeting municipal and co-operative targets. Hydro resources are limited to new hydroelectricity with a nameplate rating of 10 megawatts or less, and hydroelectric generation in existence on January 1, 2005, with a nameplate rating of 30 megawatts or less.

Key Features of Colorado Greenhouse Gas Policies

- *Reduction Targets* – 20% below 2005 levels by 2020, 80% by 2050.
- Implementation Mechanism – TBD.
- *Renewable Portfolio Standard* – 20% renewables by 2015, 4% solar for IOUs.

7.14 Nevada

The state Climate Change Advisory Committee provided its final report to Nevada Governor Jim Gibbons in July 2008.[62] The committee, which had been working on the report for more than a year, reached consensus on 28 recommendations to forward to Governor Gibbons.

WCI – Nevada is an observer member of the WCI, and therefore has no commitments or obligations to participate in its greenhouse gas future cap-and-trade program.

Renewable Portfolio Standard - Nevada's RPS was revised in 2009 to increase the target to 25% renewables by 2025. Up to 25% of the RPS can be met with energy efficiency improvements, and the compliant entities must have 6% of their retail load from solar by 2016. There are compliance credit multipliers for photovoltaics and efficiency measures which may have the effect of reducing the amount of other renewables used to meet the standard. Compliance is by using the Nevada Public Utility Commission's system of "portfolio energy credits" which may be purchased from energy providers.

Hydroelectric power is eligible to qualify for portfolio energy credits if under 30 MW in size.

Key Features of Nevada Greenhouse Gas Policies

- Reduction Targets – None.
- Implementation Mechanism – TBD.
- *Renewable Portfolio Standard* – 25% renewables by 2025, 6% of retail load from solar.

7.15 Wyoming

Wyoming has not enacted any legislation, promulgated any rules, or issued any executive orders addressing greenhouse gas emission reductions. Its only official greenhouse gas related action to date was its joining. The Climate Registry voluntary greenhouse gas reporting program.

However, Wyoming has emerged as perhaps the leading state in enacting geologic sequestration legislation. In 2008 Governor Dave Freudenthal signed HB 90[63] that granted the Wyoming Department of Environmental

[62] Nevada Climate Change Advisory Committee, *Governor Jim Gibbons' Nevada Climate Change Advisory Committee Final Report* (2008), available at http://gov.state.nv.us/CLIMATE/FinalReport/ClimateChangeReport.pdf

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Quality the authority to regulate long-term storage of CO_2, and H.B. 89[64] which recognizes surface owners control the underground spaces where CO_2 could be sequestered and further provided for a regulatory regime to protect those rights. This year, Governor Freudenthal signed three more bills addressing ownership and liability issues. H.B. 57[65] grants priority to mining and drilling rights over geologic sequestration activities. H.B. 58[66] provides that the ownership and liability for sequestered CO_2 and all other materials injected during the sequestration process belong to the injector. H.B. 80[67] establishes a procedure for unitizing geologic sequestration sites, whereby pore space rights from multiple parties would be aggregated for the purposes of a carbon storage project as long as 80% of the parties approve the project. The Wyoming Oil and Gas Conservation Commission will oversee the unitization of these sites.

WCI – Wyoming is an observer member of the WCI, and therefore has no commitments or obligations to participate in its future greenhouse gas cap-and-trade program.

Renewable Electricity / Portfolio Standards - Wyoming does not have an RPS mandate or goal.

7.16 Idaho

On May 16, 2007, Governor C.L. Otter issued Executive Order No. 2007-05[68] that directed the state Department of Environmental Quality to develop a greenhouse gas emission inventory and provide recommendations on how to reduce greenhouse gas emissions in Idaho, recognizing Idaho's interest in continued growth, economic development and energy security. Idaho joined the Climate Registry in August 2007.

WCI – Idaho is an observer member of the WCI, and therefore has no commitments or obligations to participate in its future greenhouse gas cap-and-trade program.

Renewable Electricity / Portfolio Standards - Idaho does not have an RPS mandate or goal.

[63] Wyo. Stat. Ann. § 30-4-501, § 35-11-103, and § 35-11-313 (2009).
[64] Wyo. Stat. Ann. § 34-1-152 and § 34-1-202(e) (2009).
[65] Wyo. Stat. Ann. § 34-1-152(e) (2009).
[66] Wyo. Stat. Ann. § 34-1-153 (2009).
[67] Wyo. Stat. Ann. § 35-11-314 to § 35-11-317, § 30-5-104(d), 35-11-313 (2009).
[68] Exec. Order No. 2007-05, Idaho Admin Bulletin V. 07-7, pg 14 (July 4, 2007).

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American Clean Energy and Security Act (H.R. 2454) Allowance Distribution (in millions)

Recipients		USAID	Electricity Sector		Natural Gas Sector	States	EPA Auction	Industry	Utilities	States		Research & Development Entities		MFGs & Suppliers	Domestic Fuel Producers		EPA Auction	States & Indian Tribes	EPA Auction	States	EPA Auction	US State Department	US State Department	Early Actors	Departments of Agriculture & Energy				
Year	Total Allowances Allocated (millions)	Supplemental Reductions (w/ carryover)	Electricity LDCs & Merchant Coal	Small Electricity LDCs Energy Efficiency, Renewable & Low Income Ratepayer Assistance	Natural Gas Consumers (LDCs)	Home Heating Oil & Propane	Low Income Consumers	Trade Vulnerable Industries (w/ carryover)	Carbon Capture & Sequestration Technology Deployment (w/ carryover)	Energy Efficiency & Renewable Energy Investment (States)	304 ECPA & 202 ACES	Energy Innovation Hubs	Advanced Energy Research	Clean Vehicle Technology	Petroluem Refineries	Small Business Refiners	Investment in Workers Adjusment Assistance & Training	Domestic Adaptation	Health Protection & Promotion Fund	Wildlife & Natural Resource Adaptation	Natural Resources Climate Change Adaptation Fund	Intl Adpatation	Intl Clean Technology Deployment	Early Actors	Supplemental Agriculture & Renewable Energy (w/ carryover)	Strategic Reserve		Overall Allocation	Overall Auction
		§781	§782(a)(1)&(3)	§782(a)(2)	§782(b)	§782(c)	§782(d)	§782(e)	§782(f)	§782(g)(1)	§782(g)(2 &(3)	§782(h)(1)	§782(h)(2)	§782(i)	§782(j)(1)	§782(j)(2)	§782(k)(1)&(2)	§782(l)(1)	§782(l)(2)	§782(m)(1)	§782(m)(2)	§782(n)	§782(o)	§782(t)	§782(u)	§726			
2012	4627	5	44.1	0.5		1.875	15	2.000		9.5	0.55	0.45	1.05	3			1.25	0.9	0.1	0.385	0.615	1	1	1	0.28	1		67.590	32.410
2013	4544	5	43.75	0.5		1.875	15	2.000		9.5	0.55	0.45	1.05	3			1.25	0.9	0.1	0.385	0.615	1	1		0.28	1		66.240	33.760
2014	5099	5	35	0.5		1.67	15	15.000	1.75	9.5	0.55	0.45	1.05	3	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1		0.28	1		74.285	25.715
2015	5003	5	35	0.5		1.67	15	14.718	1.75	9.5	0.55	0.45	1.05	3	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1		0.28	1		74.003	25.997
2016	5482	5	35	0.5	9	1.5	15	14.441	1.75	6.5	0.55	0.45	1.05	3	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1		0.28	1		79.556	20.444
2017	5375	5	35	0.5	9	1.5	15	14.159	1.75	6.5	0.55	0.45	1.05	3	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1			1		78.994	21.006
2018	5269	5	35	0.5	9	1.5	15	14.159	4.75	5.5	0.53	0.45	1.05	1	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1			1		78.974	21.026
2019	5162	5	35	0.5	9	1.5	15	14.159	4.75	5.5	0.53	0.45	1.05	1	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1			1		78.974	21.026
2020	5056	5	35	0.5	9	1.5	15	14.159	5	5.5	0.53	0.45	1.05	1	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1			2		79.224	20.776
2021	4903	5	35	0.5	9	1.5	15	14.159	5	5.5	0.53	0.45	1.05	1	2	0.25	0.5	0.9	0.1	0.385	0.615	1	1			2		79.224	20.776
2022	4751	5	35	0.5	9	1.5	15	14.159	5	1	0.53	0.45	1.05	1	2	0.25	1	1.9	0.1	0.77	1.23	2	2			2		78.109	21.891
2023	4599	5	35	0.5	9	1.5	15	14.159	5	1	0.53	0.45	1.05	1	2	0.25	1	1.9	0.1	0.77	1.23	2	2			2		78.109	21.891
2024	4446	5	35	0.5	9	1.5	15	14.159	5	1	0.53	0.45	1.05	1	2	0.25	1	1.9	0.1	0.77	1.23	2	2			2		78.109	21.891
2025	4294	5	35	0.5	9	1.5	15	14.159	5	1	0.53	0.45	1.05	1	2	0.25	1	1.9	0.1	0.77	1.23	2	2			2		78.109	21.891
2026	4142	3	28	0.4	7.2	1.2	15	9.628	5	4.5	0.53	0.45	1.05		2	0.25	1	1.9	0.1	0.77	1.23	2	2			2		66.878	33.122
2027	3990	3	21	0.3	5.4	0.9	15	8.244	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			2		60.814	39.186
2028	3837	3	14	0.2	3.6	0.6	15	6.937	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			2		50.307	49.693
2029	3685	3	7	0.1	1.8	0.3	15	5.710	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			2		39.880	60.120
2030	3533	3					15	4.562	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		29.532	70.468
2031	3408	2					15	3.521	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		28.491	71.509
2032	3283	2					15	2.544	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		27.514	72.486
2033	3158	2					15	1.631	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		26.601	73.399
2034	5033	2					15	1.300	5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		26.270	73.730
2035	2908	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2036	2784	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2037	2659	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2038	2534	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2039	2409	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2040	2284	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2041	2159	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2042	2034	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2043	1910	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2044	1785	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2045	1660	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2046	1535	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2047	1410	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2048	1285	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2049	1160	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030
2050	1035	2					15		5	4.5	0.53	0.45	1.05				1	3.9	0.1	1.54	2.46	4	4			3		24.970	75.030

APPENDIX C

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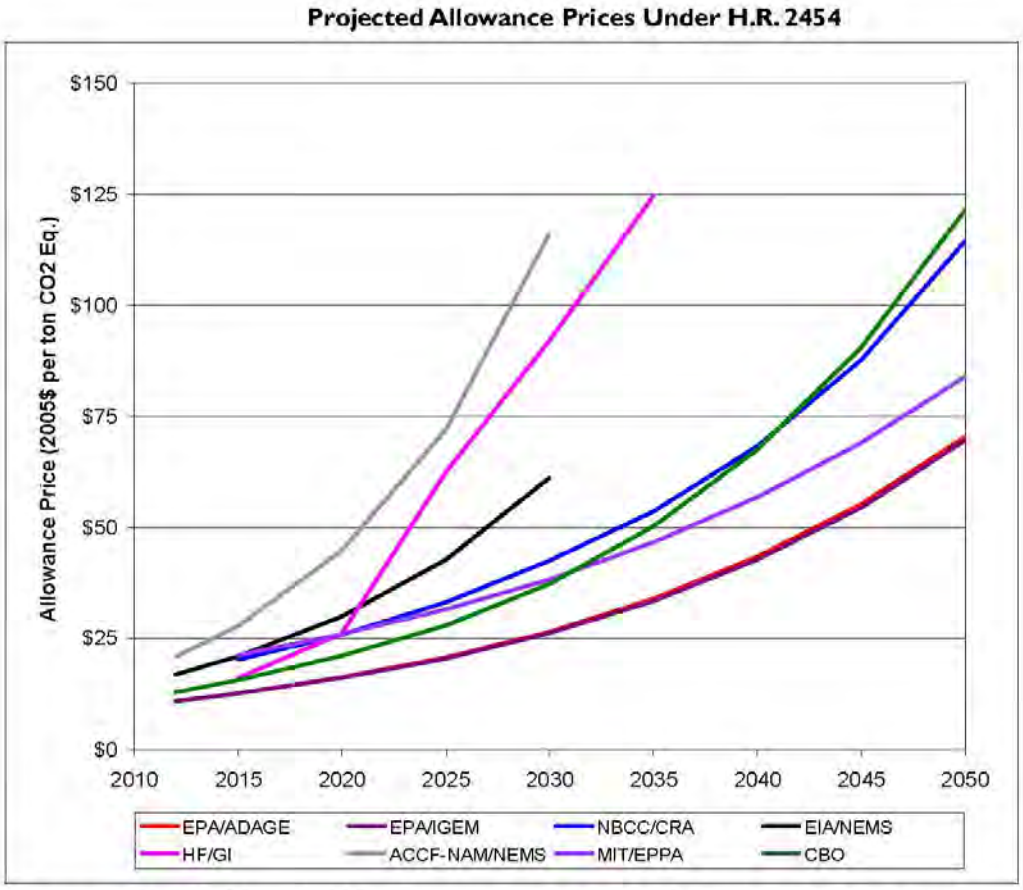

Sources: EPA/ADAGE and EPA/IGEM: "Data Annex" available on the EPA website at http://www.epa.gov/climatechange/economics/economicanalyses.html MIT/EPPA: Sergey Paltsev, et al., "Appendix C" of Paltsev et al., *The Cost of Climate Policy in the United States*, MIT Joint Program on the Science and Policy of Global Change (2009). EIA/NEMS: EIA, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009*, (August 2009). ACCF-NAM/NEMS: SAIC, *Analysis of The Waxman-Markey Bill "The American Clean Energy and Security Act of 2009" (H.R. 2454) Using The National Energy Modeling System (NEMS)*, report by the ACCF and NAM (2009). NBCC/CRA: CRA International, *Impact on the Economy of the American Clean Energy and Security Act of 2009 (H.R. 2454)* (May 2009). CBO: CBO, *CBO Cost Estimate: H.R. 2454 American Clean Energy and Security Act of 2009 As ordered reported by the House Committee on Energy and Commerce*, (June 5, 2009). HF/GI: The Heritage Center for Data Analysis, *The Economic Consequences of Waxman-Markey: An Analysis of the American Clean Energy and Security Act of 2009* (August 5, 2009).

Note: Estimates converted to 2005$ using GDP implicit price deflator.

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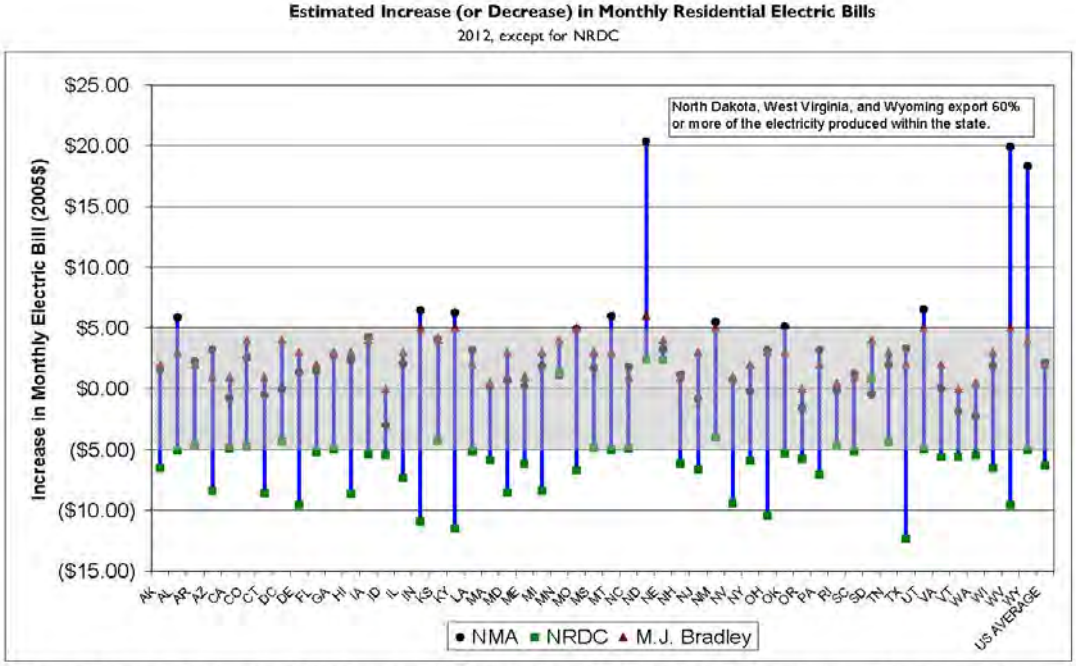

Source: CRS analysis of data from: National Mining Association, "Most States Lose Under H.R. 2454," (2009); M.J. Bradley and Associates, "Change in Monthly Average Residential Electricity Bills in 2012 under the Waxman-Markey Bill," (2009); Natural Resources Defense Council, "Climate Bill Cuts Electric Bills: H.R. 2454 saves Americans an average of $6 per month" (2009).

Table 14. Selected Estimates of Natural Gas Rate Impacts from H.R. 2454

	2020 (percentage over/under baseline levels)	2030 (percentage over baseline levels)	Allowance Costs Included in Price?	Consumer Rebate Included?
ACCF-NAM/NEMS Residential Rates	-3%	56%	Probably	not stated
ACCF-NAM/NEMS Industrial Rates	33%	87%	Probably	not stated
NBCC/CRA Residential Rates	14%	16%	Yes	No
EIA/NEMS Residential Rates	3%	17%	Yes	Yes
EIA/NEMS Industrial Rates	13%	23%	Yes	Yes
EPA/ADAGE Average Rates	9%	10%	Yes	Yes
HF/GI Residential Rates	not stated	55% in 2035	Yes	No

Source: EPA/ADAGE: "Data Annex" available on the EPA website at http://www.epa.gov/climatechange/economics/economicanalyses.html. EIA/NEMS: EIA, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009*, (August 2009). ACCF-NAM/NEMS: SAIC, *Analysis of The Waxman-Markey Bill "The American Clean Energy and Security Act of 2009" (H.R. 2454) Using The National Energy Modeling System (NEMS)*, report by the ACCF and NAM (2009). NBCC/CRA: CRA International, *Impact on the Economy of the American Clean Energy and Security Act of 2009 (H.R. 2454)* (May 2009. HF/GI: Heritage Foundation, *Son of Waxman-Markey: More Politics Makes for a More Costly Bill* (June 16, 2009).

Notes: "Probably" is based on ACCF-NAM's use of the ACCF-NAM/NEMS model for estimates.

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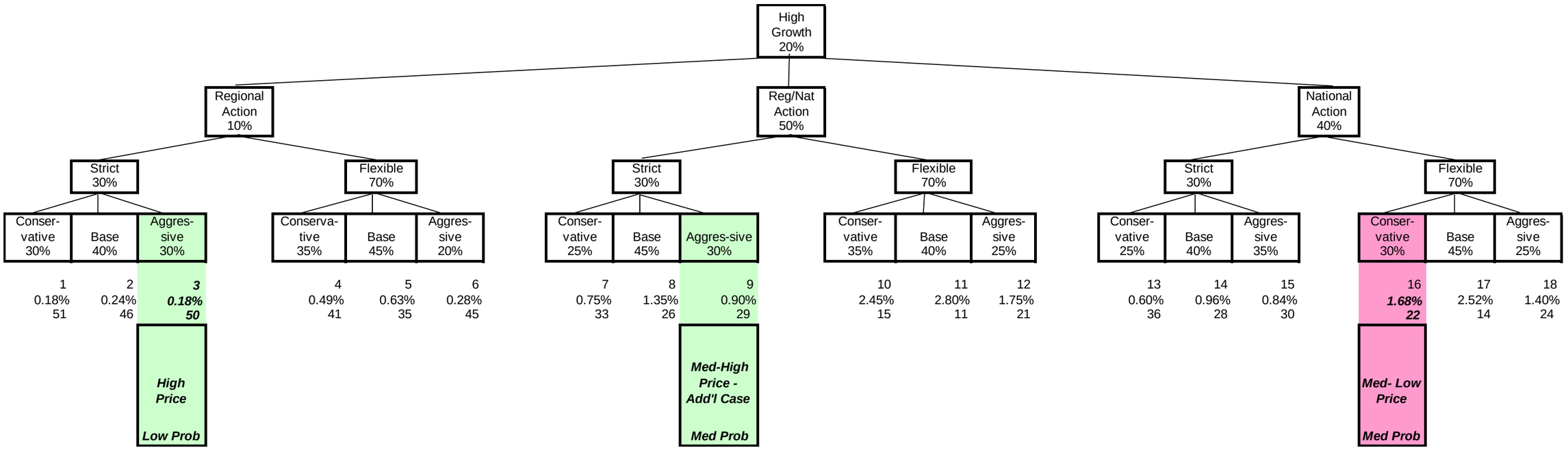
Probability Tree for Case Selection from Scenarios - Page 1 of 3



= Expected higher price case
= Expected medium price case
= Expected lower price case

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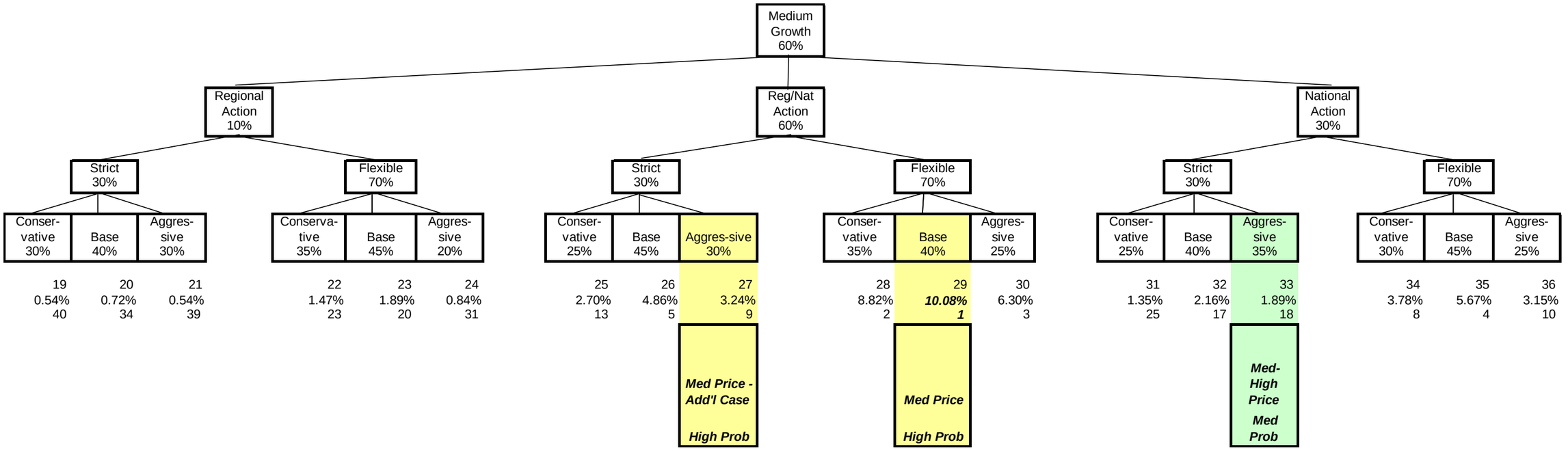
Probability Tree for Case Selection from Scenarios - Page 2 of 3



= Expected higher price case
= Expected medium price case
= Expected lower price case

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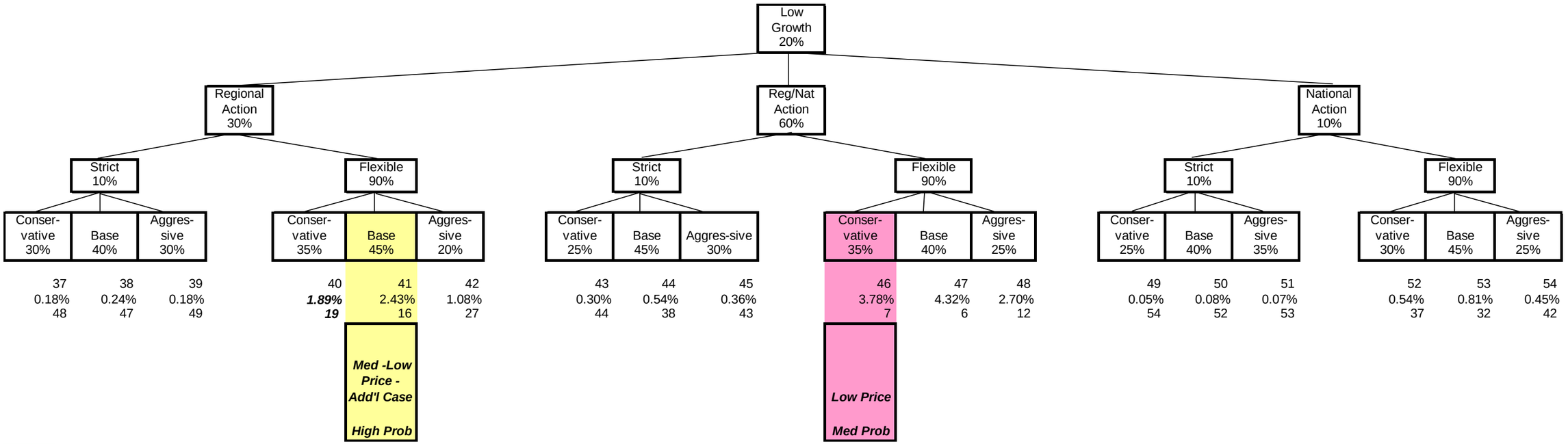
Probability Tree for Case Selection from Scenarios - Page 3 of 3



= Expected higher price case
= Expected medium price case
= Expected lower price case

APPENDIX D

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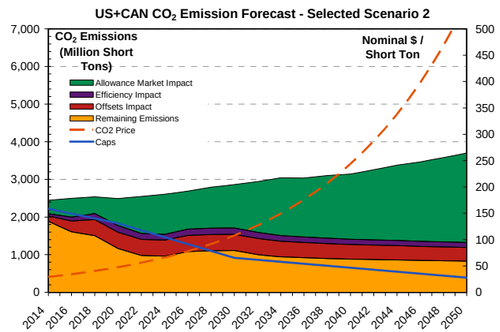
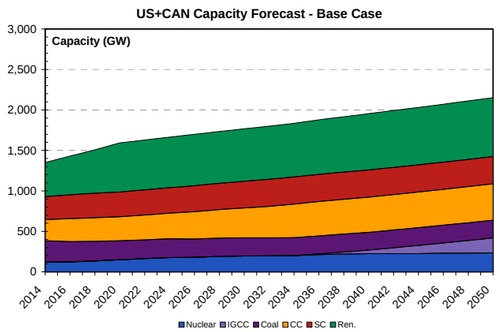
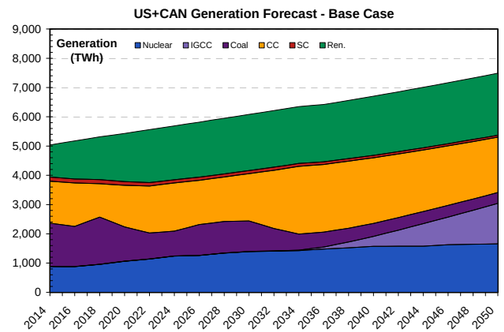
BC Hydro: Forecast of CO_2 Price – Sensitivities

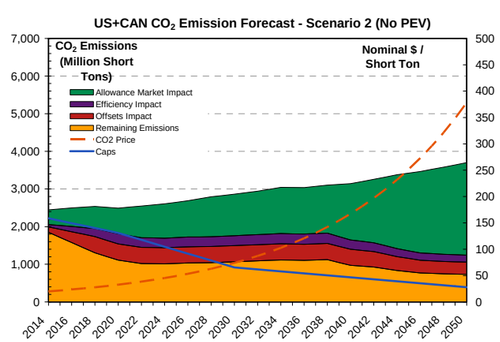
Scenario 2 - Original

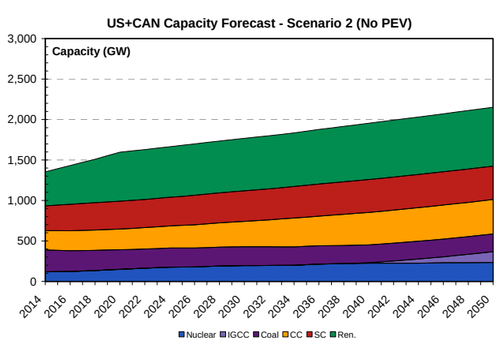


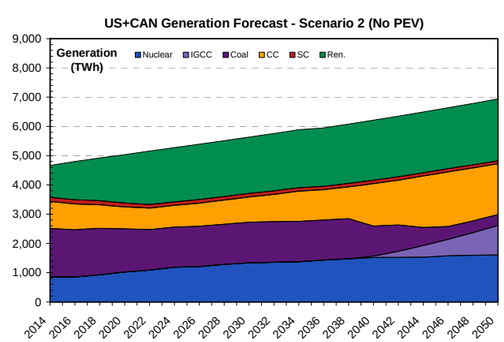




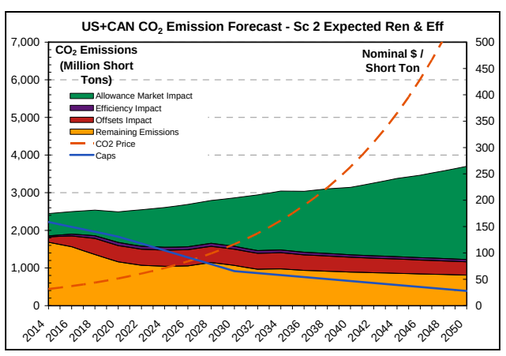
Scenario 2 -No PEV

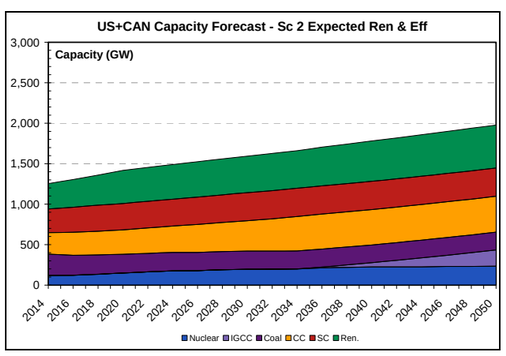


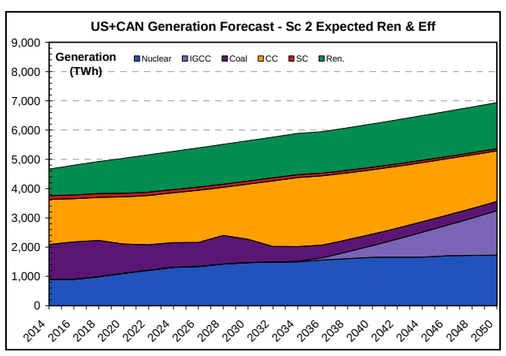




Scenario 2 -No PEV, Expected Renewables & Efficiency







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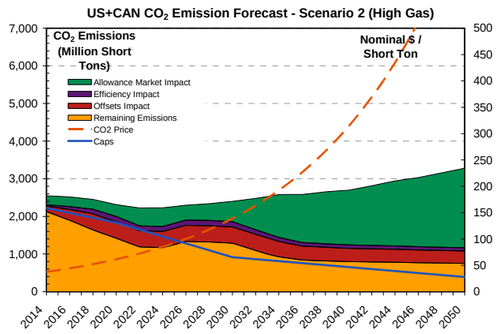
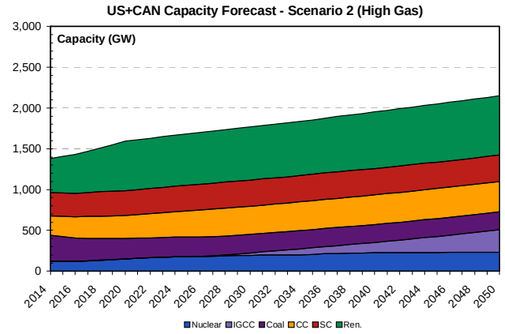
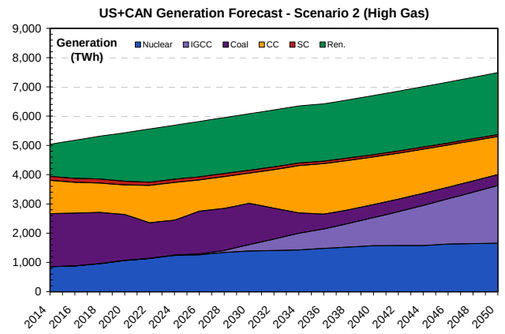
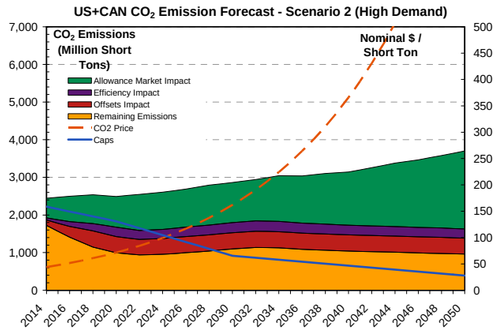
Scenario 2 -High Gas

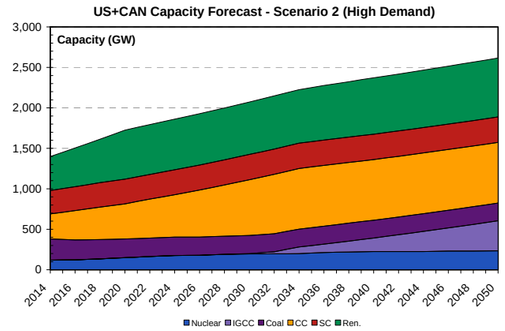


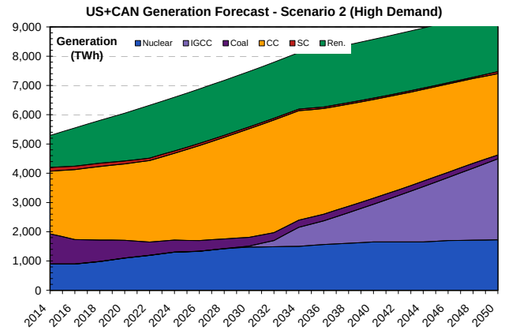




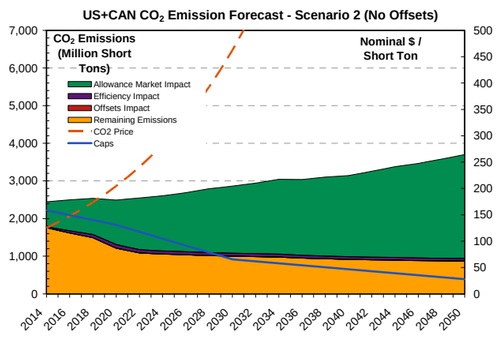
Scenario 2 -High Demand

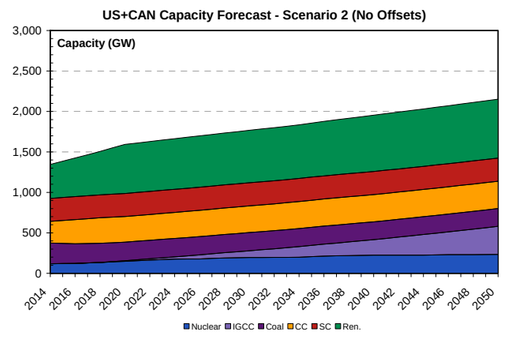


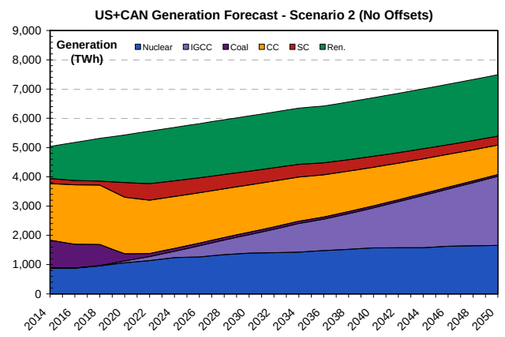




Scenario 2 -No Offsets







APPENDIX D

BC Hydro: Forecast of BC Hydro Energy Prices – Sensitivities

Table 1 - Comparison of BCHydro Scenario 1 and B&V Base Case Energy Prices

BC Hydro Market Area - Annual Energy Prices - Corrected ($/MWh)

	BC Hydro Scenario 1			B&V EMP Base Case			Difference (Scenario 1 minus EMP)		
	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)
2010	$45.48	$38.16	$41.66	$45.48	$38.16	$41.66	$0.00	$0.00	$0.00
2011	$46.70	$38.96	$42.66	$46.70	$38.96	$42.66	$0.00	$0.00	$0.00
2012	$48.00	$39.83	$43.71	$48.00	$39.83	$43.71	$0.00	$0.00	$0.00
2013	$48.68	$40.27	$44.25	$48.68	$40.27	$44.25	$0.00	$0.00	$0.00
2014	$102.72	$89.33	$95.78	$61.03	$51.58	$56.06	$41.69	$37.74	$39.72
2015	$115.95	$97.79	$106.44	$63.21	$53.58	$58.17	$52.74	$44.21	$48.27
2016	$117.79	$100.35	$108.70	$65.06	$55.01	$59.82	$52.72	$45.34	$48.88
2017	$122.80	$104.03	$112.96	$67.84	$57.14	$62.24	$54.96	$46.89	$50.72
2018	$124.01	$105.23	$114.15	$70.57	$59.87	$64.95	$53.44	$45.36	$49.20
2019	$120.28	$101.73	$110.49	$72.31	$60.38	$66.02	$47.97	$41.34	$44.46
2020	$113.36	$108.33	$110.73	$69.95	$58.74	$64.09	$43.41	$49.59	$46.64
2021	$116.07	$111.22	$113.55	$70.12	$58.50	$64.06	$45.95	$52.72	$49.49
2022	$124.32	$118.49	$121.27	$72.33	$60.68	$66.25	$51.99	$57.81	$55.02
2023	$134.06	$127.21	$130.49	$74.42	$63.13	$68.51	$59.65	$64.08	$61.98
2024	$148.20	$141.44	$144.63	$79.76	$66.87	$72.97	$68.45	$74.57	$71.67
2025	$163.20	$155.13	$158.97	$84.42	$70.74	$77.23	$78.78	$84.39	$81.75
2026	$177.16	$167.60	$172.17	$88.99	$74.48	$81.40	$88.18	$93.12	$90.77
2027	$191.49	$182.38	$186.72	$95.70	$79.65	$87.37	$95.79	$102.73	$99.35
2028	$188.84	$179.86	$184.14	$93.62	$79.81	$86.39	$95.22	$100.05	$97.75
2029	$200.72	$191.27	$195.73	$98.71	$83.67	$90.81	$102.01	$107.60	$104.91
2030	$207.98	$198.98	$203.22	$102.56	$86.39	$94.04	$105.41	$112.60	$109.18
2031	$217.07	$206.15	$211.34	$106.21	$89.25	$97.30	$110.86	$116.90	$114.04
2032	$220.84	$211.54	$215.96	$108.63	$92.17	$100.07	$112.20	$119.37	$115.89
2033	$215.06	$205.53	$210.06	$106.02	$90.46	$97.91	$109.04	$115.07	$112.15

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Table 1 - Comparison of BCHydro Scenario 3 and B&V Base Case Energy Prices

BC Hydro Market Area - Annual Energy Prices ($/MWh)

	BC Hydro Scenario 3			B&V EMP Base Case			Difference (Scenario 3 minus EMP)		
	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)
2010	$45.48	$38.16	$41.66	$45.48	$38.16	$41.66	$0.00	$0.00	$0.00
2011	$46.70	$38.96	$42.66	$46.70	$38.96	$42.66	$0.00	$0.00	$0.00
2012	$56.13	$48.08	$51.90	$48.00	$39.83	$43.71	$8.13	$8.25	$8.19
2013	$56.85	$48.42	$52.40	$48.68	$40.27	$44.25	$8.17	$8.16	$8.16
2014	$59.01	$50.44	$54.50	$61.03	$51.58	$56.06	-$2.02	-$1.14	-$1.56
2015	$60.75	$51.85	$56.09	$63.21	$53.58	$58.17	-$2.45	-$1.72	-$2.08
2016	$61.86	$52.64	$57.04	$65.06	$55.01	$59.82	-$3.20	-$2.37	-$2.78
2017	$63.76	$54.37	$58.84	$67.84	$57.14	$62.24	-$4.08	-$2.77	-$3.40
2018	$65.94	$56.59	$61.03	$70.57	$59.87	$64.95	-$4.63	-$3.28	-$3.92
2019	$65.99	$56.22	$60.86	$72.31	$60.38	$66.02	-$6.32	-$4.17	-$5.16
2020	$65.08	$59.51	$65.54	$69.95	$58.74	$64.09	-$4.87	$0.78	$1.45
2021	$70.42	$68.93	$69.64	$70.12	$58.50	$64.06	$0.30	$10.43	$5.58
2022	$72.48	$70.96	$71.70	$72.33	$60.68	$66.25	$0.15	$10.28	$5.45
2023	$73.94	$72.69	$73.29	$74.42	$63.13	$68.51	-$0.48	$9.56	$4.78
2024	$77.21	$75.51	$76.30	$79.76	$66.87	$72.97	-$2.55	$8.64	$3.34
2025	$81.72	$79.81	$80.69	$84.42	$70.74	$77.23	-$2.70	$9.07	$3.47
2026	$86.34	$84.24	$85.24	$88.99	$74.48	$81.40	-$2.64	$9.76	$3.84
2027	$90.77	$89.16	$89.95	$95.70	$79.65	$87.37	-$4.93	$9.51	$2.59
2028	$90.68	$89.31	$89.98	$93.62	$79.81	$86.39	-$2.94	$9.50	$3.59
2029	$93.72	$92.39	$93.01	$98.71	$83.67	$90.81	-$4.99	$8.72	$2.20
2030	$98.76	$96.63	$97.61	$102.56	$86.39	$94.04	-$3.80	$10.24	$3.57
2031	$100.81	$98.88	$99.78	$106.21	$89.25	$97.30	-$5.40	$9.63	$2.48
2032	$105.22	$103.06	$104.09	$108.63	$92.17	$100.07	-$3.41	$10.89	$4.02
2033	$102.05	$101.24	$101.64	$106.02	$90.46	$97.91	-$3.97	$10.78	$3.74

APPENDIX D

BLACK & VEATCH
Building a world of difference.

Table 1 - Comparison of BCHydro Scenario 4 and B&V Base Case Energy Prices

BC Hydro Market Area - Annual Energy Prices ($/MWh)

	BC Hydro Scenario 4			B&V EMP Base Case			Difference (Scenario 4 minus EMP)		
	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)	On-Peak ($/MWh)	Off-Peak ($/MWh)	Average ($/MWh)
2010	$45.48	$38.16	$41.66	$45.48	$38.16	$41.66	$0.00	$0.00	$0.00
2011	$46.70	$38.96	$42.66	$46.70	$38.96	$42.66	$0.00	$0.00	$0.00
2012	$46.93	$39.90	$43.23	$48.00	$39.83	$43.71	-$1.07	$0.07	-$0.47
2013	$46.94	$39.34	$42.94	$48.68	$40.27	$44.25	-$1.74	-$0.93	-$1.31
2014	$47.43	$39.94	$43.49	$61.03	$51.58	$56.06	-$13.60	-$11.65	-$12.57
2015	$48.36	$40.73	$44.37	$63.21	$53.58	$58.17	-$14.85	-$12.85	-$13.80
2016	$49.08	$41.34	$45.03	$65.06	$55.01	$59.82	-$15.99	-$13.67	-$14.79
2017	$50.76	$42.13	$46.24	$67.84	$57.14	$62.24	-$17.08	-$15.01	-$16.01
2018	$51.22	$43.16	$46.99	$70.57	$59.87	$64.95	-$19.35	-$16.71	-$17.96
2019	$49.84	$41.71	$45.58	$72.31	$60.38	$66.02	-$22.46	-$18.67	-$20.44
2020	$46.45	$39.60	$42.88	$69.95	$58.74	$64.09	-$23.50	-$19.14	-$21.21
2021	$42.40	$35.47	$38.78	$70.12	$58.50	$64.06	-$27.72	-$23.03	-$25.28
2022	$42.63	$35.95	$39.15	$72.33	$60.68	$66.25	-$29.70	-$24.73	-$27.11
2023	$43.36	$36.67	$39.85	$74.42	$63.13	$68.51	-$31.05	-$26.46	-$28.66
2024	$45.59	$37.93	$41.57	$79.76	$66.87	$72.97	-$34.17	-$28.94	-$31.40
2025	$47.01	$38.85	$42.74	$84.42	$70.74	$77.23	-$37.41	-$31.89	-$34.48
2026	$48.53	$40.05	$44.10	$88.99	$74.48	$81.40	-$40.46	-$34.43	-$37.30
2027	$50.39	$41.28	$45.63	$95.70	$79.65	$87.37	-$45.31	-$38.37	-$41.73
2028	$49.38	$41.54	$45.25	$93.62	$79.81	$86.39	-$44.24	-$38.27	-$41.14
2029	$49.87	$41.94	$45.71	$98.71	$83.67	$90.81	-$48.84	-$41.72	-$45.10
2030	$50.51	$42.31	$46.20	$102.56	$86.39	$94.04	-$52.06	-$44.08	-$47.84
2031	$50.31	$41.91	$45.90	$106.21	$89.25	$97.30	-$55.90	-$47.34	-$51.40
2032	$50.09	$42.07	$45.90	$108.63	$92.17	$100.07	-$58.55	-$50.10	-$54.16
2033	$48.26	$40.74	$44.33	$106.02	$90.46	$97.91	-$57.76	-$49.72	-$53.58

APPENDIX E

11 APPENDIX E

Summary of Black & Veatch WECC Energy Market Perspective

The Black & Veatch *WECC Energy Market Perspective* is a fundamental-based view of natural gas, oil, and power markets in the WECC. Black & Veatch has developed a detailed, comprehensive, unbiased view of all the important energy issues. The *WECC Energy Market Perspective* covers the entire WECC footprint.

Features of the *WECC Energy Market Perspective* include:

- An integrated assessment of oil, coal and natural gas prices, including outlooks on new resource development and infrastructure implications.
- Electricity Load Growth in WECC of 1.3% per year on average over 25 years.
- A 25-year forecast (2009-2033) of monthly and hourly electric prices for 24 market areas in the WECC, delivered in electronic format.
- Co-optimized commodity price forecasts for energy, capacity, natural gas, coal, and oil.
- Forecasted impact of a national GHG tax based primarily on the Waxman-Markey legislation that passed the US House of Representatives (but has not yet become law).
- A detailed regional resource expansion plan, including significant amounts of renewable capacity sufficient to ultimately meet state RPS requirements.