# Market Scenarios for the IRP Risk Framework

## OVERVIEW

### What are the Market Scenarios and Why are they Needed?
The financial impacts of different policy choices vary widely depending on what assumptions are made about the underlying future market conditions over a given planning horizon. Given the exposure of BC's electricity sector through extensive trade to the US market, these market conditions include both domestic and US influences.

Any single "best guess" of where prices may go in the future will surely be wrong. The Risk Framework is designed to encourage a wide enough range of possible future outcomes for a limited number of key variables that there is a good chance the future will unfold within these bounds and that the "best" policy options identified will be robust to different values within the broad ranges identified.

The tool used in the IRP to address the uncertainty around future market prices is "scenario analysis"[i]. Here, a scenario is defined as a specified collection of key uncertain variables. By letting these variables take on particular values (for instance, Scenario X might have: GHG prices are "hi", natural gas prices are "low", economic growth as "mid", etc), the scenario will describe a specific way in which the world might unfold. And by considering a number of different scenarios, then the scenario analysis will span some part of the spectrum of what might happen in the future.

The consideration of market prices is further complicated by the complex set of interrelationships among variables. This briefing note will lay out which variables were selected and how the market scenarios were constructed in order to create a diverse but small number of coherent views as to how future markets might unfold.

### Which Prices and What to Do With Them?
There are a large number of market variables that are of potential interest, but it is not possible to systematically examine all of these across their plausible ranges. What is important is to highlight a small number of the key variables. For the purposes of the IRP analysis, the four key price variables identified are:
- Natural Gas Prices
- Electricity Prices
- GHG Prices
- Renewable Energy Credit Prices

Even working with a set of four key variables, and simplifying their potential values to hi/mid/low, the number of possible market scenarios to examine would be too large. Moreover, many of these combinations would be unlikely to occur. The creation of scenarios is an attempt to think carefully and systematically about what external factors could be linked with and influence these variables and how these might be linked in order to create combinations of factors that are small in number, reasonable, and cover a wide range of what the world might look like.

### Influence Diagram for Market Scenarios
Figure 1 shows a simplified view of how a number of these market factors interact. This figure is just a schematic; the computer models used map these relationships in explicit detail. However, what the diagram shows are the other details that need to be taken into account when thinking about the future

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path of these four key prices. In particular, this highlights the need to have some internal logic so that consistent assumptions are being used across these relationships; this yields market scenarios that are internally coherent.

**Figure 1 – A simple influence diagram for market prices**
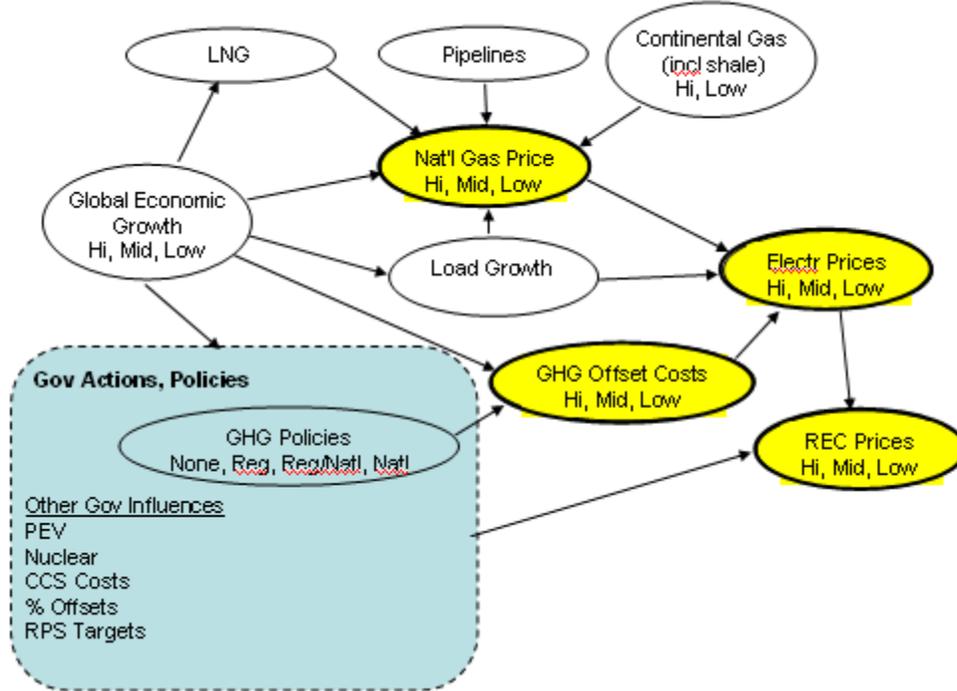


## Where Can I Find More Detailed Information About How These Four Key Prices Were Forecast?

The following briefing notes contain more explicit information about these market prices, including background, policy setting, modeling inputs and outputs. Please refer to these for more detailed information about these price forecasts, how they were derived and what their actual values are.

- Natural Gas Price Forecast
- Electricity Market Price Forecast
- Greenhouse Gas Price Forecast
- REC Price Forecast

The remainder of this note will address how these and other factors are assembled into market scenarios

## Creating Market Scenarios

The goal of creating market scenarios was twofold. First, it was important that a wide range of external factors describing how the world might unfold were considered. Here, these factors were: Global Economic Growth and a collection of Government Actions, Policies, most notably, the breadth of GHG policies in the US, including the stringency of reduction targets and the compliance flexibility allowed.

Secondly, a desired outcome was that the prices driven by these scenarios covered a wide (but plausible) range; wide enough that they would truly test the robustness of policy choices, but not so wide that they would be ruled as totally unrealistic.

Due to modeling, time, and cost constraints, it was decided that only five market scenarios would be considered for detailed analysis. A brief description of these has been excerpted from the GHG Gas Price Forecast briefing note and included here.

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

This scenario is characterized by high global economic growth driven by successful fiscal and monetary policies. Although the strong economy renews public and government interest in environmental impacts and issues, the costs of regulation are attenuated to some extent by increased government spending on R&D. A national RPS is assumed, and this combined with strong spending on R&D and high natural gas prices, drives significant development of renewable energy, lowering their costs.

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

With slower but promising economic growth, regional initiatives such as the WCI take the lead in establishing GHG regulatory markets, with national US and Canadian governments following suit by 2020. *Medium levels of growth soften governments ability to take on environmental initiatives.* Although there are delays in national renewable energy standards, development is strong in later years (post 2020).

**Scenario C – Low economic growth delays national GHG market development**

With slow economic growth and activity, this scenario envisions that GHG emissions start to fall worldwide, taking the urgency out of the climate change debate and lowering public and government interest in GHG regulation. Lower natural gas prices and low electricity load growth delay spending on renewable energy and RPS development. Investments in R&D in conservation are also down.

**Scenario D – Delayed high economic growth and lower international cooperation stifles national** environmental initiatives, leaving the regions to regulate.

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

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

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

## Do We Have the Right Market Scenarios?

If one of the objectives in creating the market scenarios was to cover a wide range of views as to how the world might unfold, then their adequacy can be judged by the extent to which this objective was met. Table 1 shows how these five scenarios are distributed across these two variables.

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**Table 1 – Diversity of input assumptions**

| | | Government Action on GHG Emissions | | |
|---|---|---|---|---|
| | | None / Low | Regional/National | National |
| Global Economic Growth | Hi | Scenario D | | Scenario A |
| | Mid | | Scenario B | |
| | Low | Scenario E | Scenario C | |

While not all nine combinations of factors shown in Table 1 were modeled, it is clear to see that the scenarios considered include the full range of the two key variables highlighted. Moreover, the two market scenarios that involved National GHG regulatory action but with mid or low economic growth trends were dropped from consideration because it seemed less likely to see aggressive action on GHG emissions unless there was a healthy economy. Another candidate scenario (Mid Economic Growth, Regional/National Government Action) wasn't considered because it only promised to give an outcomes partway between the two other High Growth Scenarios (D and A). Similarly, a Mid-Growth and Low/No Gov't GHG Action scenario was not used as it would just be an intermediary between the two other Low/No Gov't GHG Action scenarios (D and E). In sum, the market scenarios cover the wide range of input options while avoiding the less plausible and less information combinations of factors.

A second objective of the market scenarios was to land on ones that resulted in a wide range of market prices. Table 2 shows how these scenarios are distributed across the different market prices of interest. Note that these market prices, which in reality are price paths over the next decades, are simplified into hi/mid/low. The subject area briefing notes will show the actual outcomes. As well, the display is simplified by noting that gas and electricity prices move in tandem and so will be hi, mid, or low together.

**Table 2 – Diversity of Market Prices**

| | | Natural Gas Prices/Electricity Prices | | |
|---|---|---|---|---|
| | | Hi | Mid | Low |
| GHG Offset Costs | Hi | | Scenario D (with Low REC Prices) | |
| | Mid | Scenario A (with Low REC prices) | Scenario B (with Mid REC prices) | |
| | Low | | | Scenario C (with Hi REC prices) Scenario E (with Hi REC prices, zero GHG prices) |

As Table 2 shows, the full range of Natural Gas and Electricity prices, GHG prices and REC prices has been used. As well, since economic growth tends to influence both Natural Gas and GHG prices, the less

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plausible scenarios (top right and lower left) are avoided. So, while not all combinations were covered, the ones included in the market scenarios are diverse and have some internal consistency.

**Next Steps**

The final step in this process is to assign relative likelihoods to each of these five scenarios. This is *not* to be interpreted as the probability that the world will unfold this way. Rather, it is a subjective judgment, using the best current knowledge we have, as to which scenario is relatively more likely. This exercise is a mix of both art and science. As such, it will be important to do a sensitivity analysis on the results to ensure that the chosen policy direction is not sensitive to small changes in the assigned probabilities.

Once relative likelihoods are assigned to each market scenario, then these can be combined through the Risk Framework's 15-branch probability tree with the three Net Gap scenarios. This yields a total of 15 different views of how the world might unfold, and these will form the backdrop against which many of the key IRP questions will be tested.

**Results and Discussion**

For each policy question, the five market scenarios will allow possible answers to be tested across a wide range of potential futures. By pushing these scenarios to include a broad range of possible outcomes, the best policy can be shown to be robust against a wide range of possible futures. Moreover, if there is not one policy option that is best under all future conditions, then the relative likelihood judgments will give further guidance as to which is the best policy direction to follow.

## KEY REFERENCE DOCUMENTS

- *Renewable Energy Credit (REC) Price Forecast* summary brief
- *Greenhouse Gas (GHG) Price Forecast* summary brief
- *Natural Gas Price Forecast* summary brief
- *Electricity Spot Market Price Forecast* summary brief

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[i] Scenario analysis has also come to mean a slightly different approach to describing the future. Shell Oil pioneered the use of highly descriptive, non-mutually exclusive, qualitative scenarios to help stimulate thinking about broad corporate strategies. While this more qualitative approach used by Shell is interesting and useful in some situations, its non-numeric and non-systematic approach to creating these future worlds makes it less useful in highly detailed energy planning applications.