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**2012 Integrated Resource Plan**

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**Appendix**

**4B**

**Low Natural Gas Price Forecast Report**

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BUILDING A WORLD OF DIFFERENCE®

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# **Low Natural Gas Price Scenario: Technological Success in Shale Production in a Stagnant Demand Environment**

**November 2010  
Final Report**

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## Low Natural Gas Price Scenario

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In conducting our analysis and in forming an opinion of the value and estimated future revenues summarized in this report, Black & Veatch has made certain assumptions with respect to conditions, events, and circumstances that may occur in the future. The methodologies we utilize in performing the analysis and making these projections follow generally accepted industry practices. While we believe that such assumptions and methodologies as summarized in this report are reasonable and appropriate for the purpose for which they are used; depending upon conditions, events, and circumstances that actually occur but are unknown at this time, actual results may materially differ from those projected.

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### 1.0 SCOPE OF ANALYSIS

As part of its Integrated Resource Planning effort, BC Hydro requested Black & Veatch to perform analysis that supported a potential low price scenario for natural gas prices in North America during the 2011-2020 time period. There is meaningful uncertainty in the projected natural gas prices during this analysis period influenced by key drivers such as the availability and cost of supply and demand projections for natural gas going forward. This analysis used a fundamental model of the North American natural gas market to incorporate assumptions of supply and demand that could lead to a low price environment for natural gas during the analysis period.

### 2.0 SCENARIO DESCRIPTION

Natural gas production is currently outpacing natural gas demand growth due to the emergence of abundant shale resources in combination with a slow post-recession demand recovery. These fundamental factors have placed downward pressure on natural gas prices across North America and reduced market price projections for the near term. The average annual Henry Hub price has declined by more than \$4.00/MMBtu since 2008, and current NYMEX price expectations range from \$3.85/MMBtu to \$4.59/MMBtu over the next year.

Current market fundamentals have provided strong indications of a supply overhang in the North American market. Lower 48 production has outpaced demand growth since 2005. Lower 48 wellhead production has increased at 2.4% CAGR, while demand has only grown at 1.9% CAGR during this time period. Storage inventory has been at or above 5 year average highs for the last couple of winter seasons, dampening winter price spikes.

For purposes of this scenario, Black & Veatch assumes that continued growth of emerging shale production and relatively stagnant demand growth will continue to characterize the North American gas market through 2020. Shale production's share of total Lower 48 production has risen from 8% in 2007 to 20% in 2010. The analysis assumes that technological advances continue to increase shale resource availability and help to maintain low costs of production for shale gas.

Lower 48 demand in this scenario continues to remain stagnant due to efficiency gains in the residential and commercial sectors combined with modest growth in natural gas demand for power generation.

### 3.0 DEMAND ASSUMPTIONS

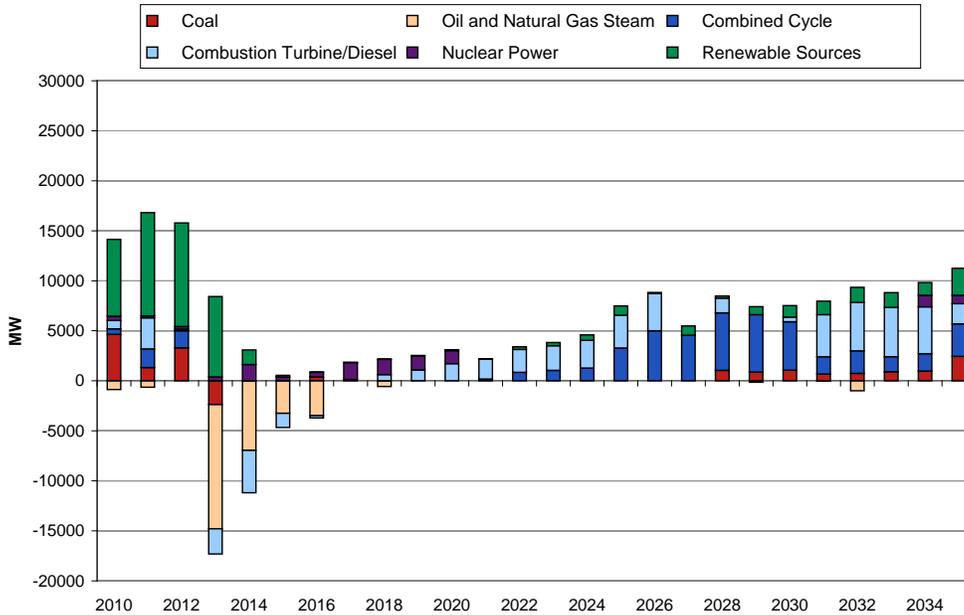
Black & Veatch adopted the Energy Information Administration (EIA) Annual Energy Outlook (AEO) 2010 demand assumptions for the purposes of this analysis. Under these assumptions, natural gas demand grows at a low average rate of 0.4% per annum from 2010 to 2035. This stagnant growth in overall demand is driven by several key EIA assumptions.

The most important of these assumptions is that potential greenhouse gas legislation is not included in the AEO 2010 Outlook. The EIA AEOs generally only includes legislation and regulations which have been enacted and have sufficient funding demonstrated. As a result of not incorporating any potential greenhouse gas legislation during its analysis period, the EIA AEO 2010 Outlook reflects comparatively few retirements of coal plant capacity, which inhibits growth in gas-fired generation capacity. The demand for gas-fired power generation grows at an average annual rate of 0.5% from 2010 to 2035. The EIA AEO 2010 also shows significant renewable capacity additions through 2013, related to the tax incentives and grants provided via the 2009 economic stimulus package (ARRA). An overview of Electric capacity additions assumed in the AEO 2010 is displayed in Figure 3-1.

# Low Natural Gas Price Scenario

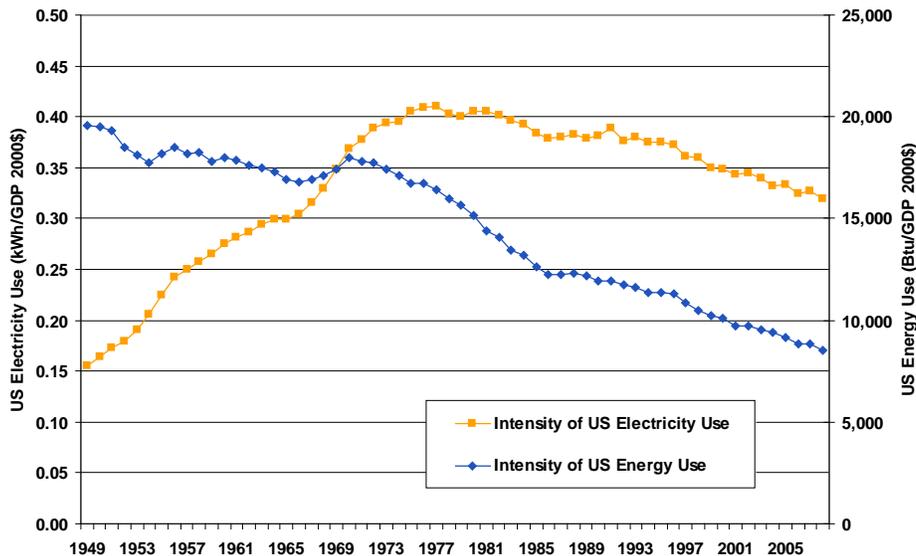
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**Figure 3-1-Total Nameplate Capacity Additions/Retirements - EIA AEO 2010**



Gains in energy efficiency and drops in energy intensity contribute to the stagnant demand growth assumed for the commercial and residential sectors. The energy efficiency of the US economy (or “intensity of use”) is quite dramatic when viewed in terms of consumption per dollar of GDP. In this measure (shown in Figure 3-2), it becomes clear that the energy efficiency of the U.S. economy has improved continually since WWII, and that electricity efficiency has been improving since 1970. Since 2000, average annual growth in electricity use has been 1.1% lower than the GDP growth during the same period.

**Figure 3-2 – U.S. Energy and Electricity Intensity of Use 1949-2008**

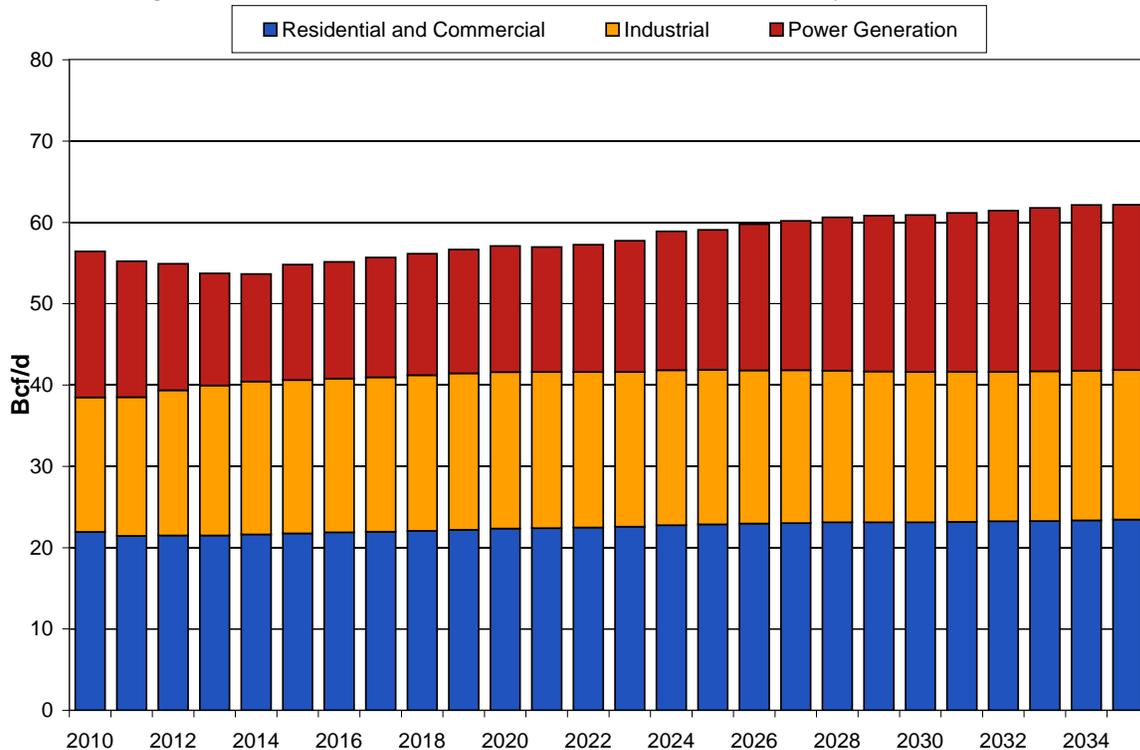


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The AEO 2010 assumes that this trend will continue into the future, with energy intensity declining at an average annual rate of 1.9% between 2008 and 2035. This decline in energy intensity may, for the most part, be attributed to a structural shift away from carbon intensive technologies, and to a lesser extent, attributed to efficiency gains in existing technology. The AEO 2010 assumes that residential per-capita natural gas consumption declines with efficiency improvements of existing appliances and limited introduction of natural gas-fired appliances while commercial consumption of natural gas declines with efficiency improvements in building and equipment stocks.

**Figure 3-3 - EIA AEO 2010 Lower 48 Natural Gas Demand Projections - 2010-2035**



The EIA AEO 2010 projection reflects a stagnant view of natural gas demand as shown in Figure 3-3. Total demand growth is only 0.4% CAGR from 2010 to 2035. Low growth in the residential and commercial sectors reflects both efficiency gains and declines in energy intensity. Gas demand for power generation initially declines due to new renewable capacity additions and the retirement of oil & gas steam generation capacity before increasing in the later part of the analysis period.

### 4.0 SUPPLY ASSUMPTIONS

On the supply side, the analysis assumes that shale resources continue to be abundant in North America during the analysis period and that the finding and development costs associated with these resources remain highly competitive when compared to conventional resources. While shale production costs may escalate as producers move from low cost “sweet spots” to higher cost resources, the analysis assumes that the escalation of shale production costs are mitigated due to technological gains.

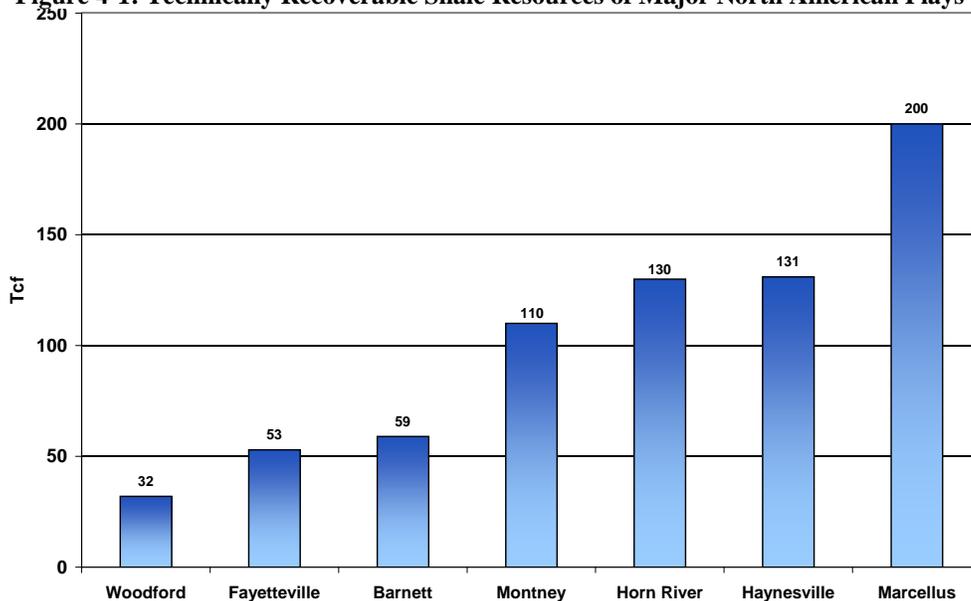
Estimates of shale resources have varied widely for the emerging shales in North America. Figure 4-1 shows the shale resource estimates used in this analysis. In the Lower 48, Marcellus and Haynesville Shale are the two largest resources in the Lower 48 and where most of the recent drilling activity has occurred. In the Marcellus Shale, natural gas production has risen from 200 MMcf/d in 2008 to 1,400 MMcf/d by 2010.

## Low Natural Gas Price Scenario

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Producers have been extremely active in developing both processing and midstream assets to bring the production to market, even during current market conditions.

**Figure 4-1: Technically Recoverable Shale Resources of Major North American Plays<sup>1</sup>**



Source: Kuuskraa & Stevens. "Worldwide Gas Shales and Unconventional Gas: A Status Report". December 2009.

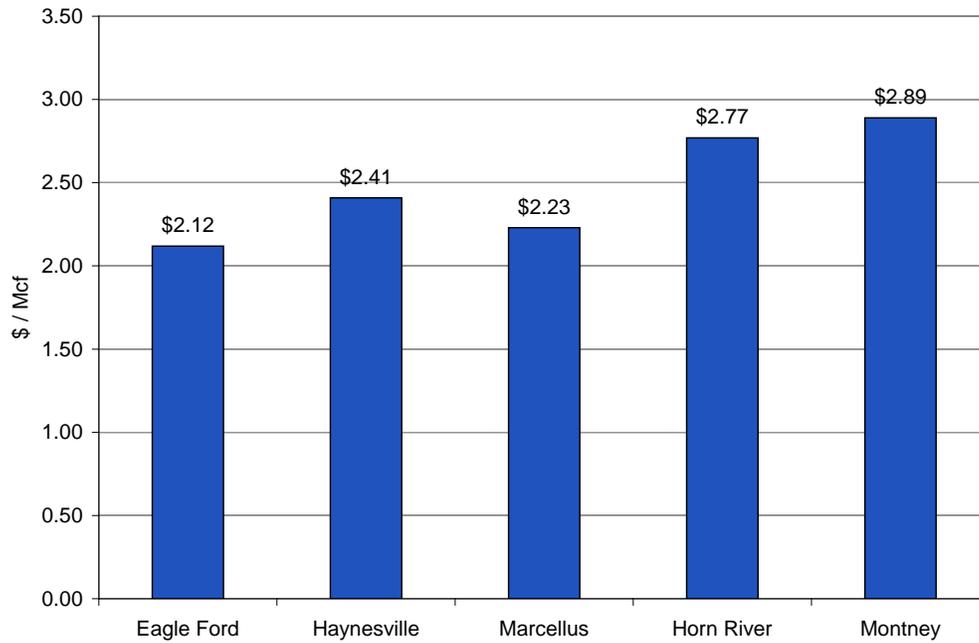
Black & Veatch reviewed the finding and development (F&D) costs reported by the independent producers for each of the major shale plays to develop F&D cost estimates for the analysis. For each play, the analysis weighted the F&D cost reported by each producer by their acreage holdings to obtain F&D cost estimates for the play as a whole. Figure 4-2 summarizes the initial expected F&D cost assumptions utilized by Black & Veatch in the low price scenario for the emerging shale plays considered. Due to limited reported F&D cost data for Horn River and Montney, Black & Veatch estimates are based on F&D cost estimates at other shale plays. It should be recognized that additional investments may be needed during drilling, hydrofracturing and wellhead operations in Horn River and Montney, and that initial data appears to indicate higher costs for these plays than those for the Lower 48 shales.

<sup>1</sup> The analysis referenced Advanced Resources International, Inc.'s (ARI's) natural gas shale recoverable resource estimates in this scenario. rARI utilizes a rigorous estimation methodology to derive its reserve estimates, accounting for various factors such as the geographic area, gas-in-place, well drainage, well spacing, well performance and success rates, field case studies, technical performance data, and the accessibility/productivity of various leases within a play.

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Figure 4-2- F&D Cost Assumptions by Shale Basin – Low Price Scenario



Source: Black & Veatch research

### 5.0 PRICE FORECAST

In the low price scenario, Henry Hub prices start at \$4.12/MMBtu in 2011 and reach \$5.28/MMBtu by 2020 as shown in Figure 5-1. In comparison to other estimates, the low price scenario is \$1.70/MMBtu below the EIA AEO 2010 price and \$1.52/MMBtu below the B&V Fall EMP price in 2020. Current NYMEX price expectations are \$5.39/MMBtu by 2020.

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**Figure 5-1- Low Natural Gas Price Forecast at Henry Hub**

