

UNION GAS LIMITED
INTERROGATORIES ON COUNCIL OF CANADIANS WRITTEN EVIDENCE

1. *Reference:* Exhibit L.EGD.COC.1

Preamble: The Environmental Research Letters journal published an article written by Nathan Hultman et al., titled “The greenhouse impact of unconventional gas for electricity generation” on December 15, 2011. This paper is referenced in Exhibit L.EGD.COC.1.

Question:

- a) Please provide this paper.

2. *Reference:* Exhibit L.EGD.COC.1

Preamble: Environmental Science & Technology Journal published a paper written by Christopher L. Weber and Christopher Clavin, titled “Life-Cycle Carbon Footprint of Shale Gas: Review of Evidence and Implications” on April 30, 2012. This paper compares the results of various studies completed on upstream carbon footprint estimates from shale gas and the methodologies used to estimate these emissions. One of the studies discussed is the information provided in the referenced exhibit.

Question:

- a) Is Dr. Ingraffea aware of this paper? Please provide this paper.

3. *Reference:* Exhibit L.EGD.COC.1

Preamble: The World Resources Institute developed a Working Paper entitled “Clearing the Air: Reducing Upstream Greenhouse Gas Emissions from U.S. Natural Gas Systems,” in April of 2013. This paper compares various studies completed on emissions from shale gas at each of the life cycle stages of the well. One of the studies discussed is the information provided in the referenced exhibit.

Question:

- a) Is Dr. Ingraffea aware of this paper? Please provide this paper.

4. *Reference:* Exhibit L.EGD.COC.1

Preamble: Environmental Science & Technology Journal published a peer-reviewed paper written by Andrew Burnham et al., titled “Life-Cycle Greenhouse Gas Emissions of Shale Gas, Natural Gas, Coal and Petroleum” on November 22, 2011. This paper is referenced in Exhibit L.EGD.COC.1.

Question:

a) Please provide this paper.

5. *Reference:* Exhibit L.EGD.COC.1, Schedule C-I Page 1

Preamble: The Abstract of Schedule C-I in Exhibit L.EGD.COC.1 identifies that the April 2011 paper prepared by Robert W. Howarth, Renee Santoro and Anthony Ingraffea was challenged by Cathles et al. (2012).

Question:

- a) Please provide a copy of the Cathles et al. (2012) challenge to the April 2011 report.
- b) Did Cathles et al. produce a review/challenge of Schedule C-I? If so please provide this document.

6. *Reference:* Exhibit L.EGD.COC.2

Question:

- a) Do the environmental issues noted in this evidence apply to the shale gas plays in Western Canada as well? If so, what is their impact on WCSB supply forecasts?

7. *Reference:* Exhibit L.EGD.COC.3, page 12 (Conclusion)

Question:

- a) What is your price forecast for Marcellus shale gas? Has this forecast been filed in any other regulatory proceeding? If so, which? How does the price forecast compare to projected prices for WCSB?

8. *Reference:* Exhibit L.EGD.COC.3

Question:

- a) Are the potential impacts described in the referenced evidence related to the US shale plays an issue for the WCSB shale? What is the potential impact to WCSB supplies going forward?

9. *Reference:* Exhibit L.EGD.COC.3

Preamble: In Union's Application Summary for the Brantford-Kirkwall/Parkway D Compressor Application (EB-2013-0074, Section 1 Page 1 of 7), Union states that "incremental demand for Dawn-Parkway transportation capacity and for transportation capacity downstream of Parkway for eastern markets" is supported by "increased access to the liquid market, diverse natural gas supplies and premium storage facilities at the Dawn Hub". The Dawn Hub has access to multiple supply basins throughout North America, of which the Marcellus/Utica shale is just one.

Question:

- a) Were the long term viability and prices of other supplies coming into Dawn evaluated, or just shale gas? Has it been filed in other regulatory proceedings, if so which?

10. *Reference:* Exhibit L.EGD.COC.3 Page 2: "High well decline rates, ranging from 77%-89% over three years with an average of 84%. This necessitates high levels of drilling and capital expenditure to maintain, let alone increase, production."

Question:

- i. For each shale play in North America, please provide the level of drilling and capital expenditures required to maintain gas production in light of the three year decline rates identified in your report.
 - a) Does this estimate fall within the bounds of feasibility in each shale region?
- ii. What is the trend in well cost per completion in shale gas wells from 2006 through 2012?
 - a) How will continued technological advancements affect future costs per well completion?

- iii. What is the trend in days required to drill an individual shale gas well for the period of 2006 to 2012?
 - a) What is the impact of fewer days required per well on the cost per well completion?
- iv. Has year over year Marcellus shale gas production increased from 2006 through 2012?
 - a) If yes, did the growth in production require increases in natural gas prices in the Marcellus region?

11. *Reference:* Exhibit L.EGD.COC.3 Page 2: “Four of five shale gas plays comprising 80% of shale gas production in the U.S. are in or near decline.”

Question:

- i. Please provide Estimated Ultimate Recovery (EUR) per well for the shale plays described in the above reference for the years 2006 through 2012.
 - a) How does technology improvement impact the EUR per well in shale gas development?
 - b) How has technology improvement affected the completions per well?
 - c) How has technology improvement affected the drilling and completion cost per well?
- ii. In the four shale plays that are at or near decline, please provide well completion totals for each year 2006 through 2012.
 - a) How did lower gas prices in 2010, 2011 and the extremely low gas prices in 2012 impact the level of production in the shale plays?
 - b) If so, what portion of the decline was attributed to changes in gas prices?
 - c) With the rebound in gas prices that has occurred in the first half of 2013, what will be the impact on well completion totals?

12. *Reference:* Exhibit L.EGD.COC.3 Page 4: “These sweet spots typically comprise 5 to 10 percent of a play’s total area and are drilled first.”

Question:

- i. Please provide the basis for the statement.
 - a) Please provide any and all published studies specific to shale development used to support the statement.
 - b) To what extent is the statement based upon analysis of non-shale resource development.
 - ii. To what extent has drilling required to hold acreage affected activity in the in the Marcellus and other shale resource areas?
 - a) Have wells been drilled in the Marcellus to hold acreage?
 - b) How many wells have been drilled in the Marcellus to hold acreage?
 - c) What is the source of that information?
 - d) Have wells been drilled to delineate the formation held by a production company?
 - e) How many wells have been drilled to delineate the formation held by a production company?
 - f) What is the source of that information?
 - iii. What have you assumed about the distribution of the decline in EUR per well as a function of distance from the “sweet spots”?
 - iv. Please describe the average potential EUR per well for the Marcellus formation as a whole.
 - a) What is the source of the estimate?
 - v. Assuming that the current density in the Marcellus region as a whole has been 2 wells drilled per pad, what are the implications of the potential to expanded to 8 to 10 wells per pad and expanding the number of completions per well on the cost per well completion? Please explain thoroughly.
13. *Reference:* Exhibit L.EGD.COC.3 Page 6: “The extent to which these sweet spots can continue to produce cheap natural gas depends on the number of available drilling locations, which are running out.”

Question:

- i. Please provide the statistical basis of the assertion that the number of available drilling locations are running out.
 - a) Please provide the spatial GIS analysis of the Marcellus formation used to support the conclusion.
 - b) If no spatial GIS analysis was performed, please describe the methodology used.
 - c) Please provide the any and all work papers supporting the conclusion.
14. *Reference:* Exhibit L.EGD.COC.3 Page 9: “If addressed by effective government measures, the cost of shale gas production is likely to greatly increase.”

Question:

- i. Please provide the production cost analysis (if any), including all work papers, used to support the statement.
 - a) What regulation other than those that have been promulgated by the U.S. EPA such as the New Source Performance Standards subpart OOOO and Oil and Gas Production NESHAPS are considered “effective government measures”?
 - b) Please provide any and all cost analysis conducted by Mr. Hughes that has been filed in a regulatory proceeding regarding the cost impacts of promulgated Bureau of Land Management (BLM).
 - c) Please provide any and all cost analysis conducted by Mr. Hughes that has been filed in a regulatory proceeding regarding the cost impacts of state environmental regulation of shale gas development.
 - d) Please provide citations to any and all testimony where you have examined increases in production costs driven by environmental regulation of shale gas development.
15. *Reference:* Exhibit L.EGD.COC.3 Page 10: “U.S. natural gas production has remained flat for the past six months, even as gas prices rose from historic lows.”

Question:

- i. During the period of the last six months, has Marcellus shale gas production increased?
- ii. During the past six months, has production from traditional gas resource formations (Non-shale and tight formations) in the United States and Canada decreased?

- iii. During the past six months, have increases in shale gas production offset the declines in traditional gas resource formations (Non-shale and tight formations) in the United States and Canada?
- iv. Does drilling activity increase instantaneously with increases in gas prices or is there a lag in the drilling response?
 - a) Assuming that there is a lag in the drilling response, typically how long is the lag (expressed in months)?
- v. How has the production of associated gas that is being developed with natural gas liquids and shale oil affected gas production over the last six months?