From: Paul Harrington
To: PHarrington@lowerchurchillproject.ca
Subject: Fwd: FINAL version of opinion memo - PLEASE CONFIRM RECEIPT
Date: Thursday, July 12, 2018 10:01:27 AM
Attachments: DRAFT_of_NALCOR_CPW_Opinion_FINAL.docx
Untitled attachment 00021.html

Sent from my iPad

Begin forwarded message:

From: "r_westney@[redacted]" <r_westney@[redacted]>
Date: 18 July 2012 at 18:56:27 GMT-2:30
To: pharrington@[redacted]
Cc: j_evans@westney.com, r_westney@[redacted] ebriel@[redacted]
k_clifton@westney.com
Subject: Re: FINAL version of opinion memo - PLEASE CONFIRM RECEIPT

Paul:
Attached please find the final version of the opinion memo with appendix. I have left it in Word format for now as I am not sure how you will use it but of course either you or I will need to put the final version in PDF.

We have spent some time polishing the text, but not much on the graphics in the Appendix. Depending on how you wish to use the graphics, you may want to tart them up a bit.

Jack and I decided on a very user friendly tone for the appendix - using an example that is simple but relevant and easy to understand, and seeking to explain the basics without talking down to the reader. Hope this is what you need.

We will not charge any more hours to this unless you ask us to. Jack's hours totalled 23.5, mine totalled 15. (I had estimated 40 in total). I will leave it to Kelly (copied on this email) and you to determine if you want to raise a new WTO to cover this.

Once you have reviewed this I would like to chat with you just to be sure we have met your needs - am interested in how you intend to use this.

Thanks again for the opportunity to work with you - always a pleasure - of course we are here for you as and when needed.

Best regards to you, Jason, Ed, and LC team.

DW

---------- Original Message ----------
From: pharrington@[redacted]
To: "r_westney@[redacted]" <r_westney@[redacted]>
Subject: Re: j_evans@westney.com; r_westney@[redacted] ebriel@[redacted]
Date: Tue, 17 Jul 2012 15:29:39 -0230

Dick
We only need the one appendix to explain the probability terminology used in the letter, you can drop the decision gate one
Regards paul

Paul Harrington

On 2012-07-17, at 5:26 PM, "r_westney@[redacted]
<r_westney@[redacted] wrote:

> Paul: thanks
> Just to be clear, I take it you want us to complete the two Appendices and stop at that point, possibly incorporating any feedback you and your team might have?
>
> (Anniversary meal went very well ... excellent bottle of French Bordeaux ensured that result).
>
> D
>
> From: pharrington@[redacted]
> To: "r_westney@[redacted] <r_westney@[redacted]
> Subject: Re: j_evans@westney.com; r_westney@[redacted]
> Date: Tue, 17 Jul 2012 14:09:36 -0230
>
> I was a bit tied up yesterday so could not get back to you. Many thanks for this I look forward to the appendices
> We do not need to go to the next phase, as always we appreciate the prompt and professional response. Hope your anniversary meal went well Dick and I did not disrupt Jacks vacation too much
> Best regards
> Paul
>
> Paul Harrington
>
> On 2012-07-16, at 7:43 PM, "r_westney@[redacted]
> <r_westney@[redacted] wrote:

paul - latest version of opinion letter - please confirm receipt
Appendices not ready yet

<DRAFT_of_NALCOR_CPW_Opinion_rev9.docx>

Observations on the Use of Price Forecasts to Determine the Current Present Worth of Nalcor's Muskrat Falls Generation and Labrador - Island Transmission Link Projects

Prepared by Richard Westney and Jack Evans, Westney Consulting Group Canada, ULC
July 18, 2012

Background

Nalcor is preparing Current Present Worth (CPW) analyses for use in Decision Gate 3, the decision to sanction and fund the Muskrat Falls Generation and Labrador - Island Transmission Link projects. PIRA Energy Group (PIRA), an energy consulting firm, has provided Nalcor with fuel oil price forecasts for use in the CPW calculations.

Four price forecasts for each type of fuel oil were provided; these are referred to as Low, Reference, High, and Expected Value. This raises the question: Which is the most reasonable price forecast to use in the CPW analyses at Decision Gate 3?

A well-established global provider of project risk management consulting services, Westney Consulting Group has been requested to provide an expert opinion on which of the PIRA forecasts is most reasonable for use in the CPW calculations.

Discussion

CPW analysis requires that prices be forecast many years into the future to help determine annual cash-flows; a discount rate is then applied to these future cash-flows to determine the project's present value. Therefore it is important that the most appropriate price forecast be used as the basis for CPW analysis.

We understand that PIRA developed specific scenarios on which the Low, Reference, and High price forecasts were based. They assigned probabilities to each of these scenarios, with the highest probability being assigned to the Reference scenario. PIRA describes the Reference scenario as its most likely view of how events will unfold, reflecting certain data and assumptions about various global financial and economic drivers. The Reference price forecast is based on the Reference scenario and has the same probability. Since it has the highest probability, it is analogous to the *mode* of a probability distribution, which is the value that represents the most likely outcome.

As might be expected, the difference between the Low price forecast and the Reference price forecast is smaller than the difference between the High and Reference price forecasts. This is not surprising; for example, it is quite possible for a future price to be 100% higher than a most likely value, but not possible for it to be 100% lower. Clearly, in such cases, the distribution of possible outcomes is asymmetrical, as it is here.

PIRA also provided an Expected Value price forecast, which was based on a probability-weighted average of the Low, Reference, and High price forecasts. Unlike the Low, Reference, and High price forecasts, which are based on specific scenarios, the Expected Value price forecast represents the full range of outcomes under all possible scenarios. It incorporates the potential outcomes of the three PIRA price forecasting scenarios into a single view, and is analogous to the *mean* of a probability distribution. The mean is a valuable measure in business decisions because it reflects both the full range of possible outcomes and their associated probabilities. When the distribution of possible outcomes is asymmetrical, as it is in this case, the Expected Value price forecast will typically be greater than the Reference price forecast.

Observations

CPW calculations are performed to support decision-making under a variety of circumstances. Decision-makers may wish to be conservative in some cases and less so in others; it depends on how the results of the CPW calculation will be used. Nalcor is currently performing CPW analyses in preparation for Decision Gate 3. This is a critical point in a project's life-cycle, when the financial stakeholders make the decision to commit to full funding.

Which of the price forecasts is most appropriate for Nalcor to use in its current CPW analyses: Reference or Expected Value? While this is a question only the project's decision-makers can answer, Westney's experience and methodologies in the probabilistic analysis of projects provides an independent perspective as to what might be considered the most reasonable choice.

In our opinion, the Expected Value price forecast is the one that represents the most reasonable choice at Decision Gate 3. We understand Nalcor's CPW analyses require forecasting the price of oil for the next 50 years. Since the Expected Value price forecast represents the full range of outcomes, we consider it to be a more appropriate basis for predicting prices over this long time horizon than one based on a specific scenario. Moreover, assuming PIRA's Expected Value price forecast is a reasonable analog for the mean value of future oil prices, it is likely that it will more closely track actual prices than the Reference price forecast will. As the years go by, actual outcomes would be more likely to cluster around the Expected Value price forecast than around the Low, Reference, or High price forecasts. Finally, we note that the use of the Expected Value price forecast is consistent with our experience with a variety of clients and conditions.

About the authors:

Richard (Dick) Westney founded Westney Consulting Group in 1978 to provide thought leadership and consulting services to organizations investing in major capital projects in the energy industry. Westney Consulting Group Inc., and its subsidiaries Westney Consulting Group Canada ULC, and Westney Consulting Group International LLC, provide project and risk management consulting on a global basis, focusing on due diligence, risk analysis, strategic planning, and organizational effectiveness.

An internationally recognized authority, Dick is the author of 5 books on project and risk management, and has served as visiting faculty for executive programs at Texas A&M and Stanford Universities, the Norwegian University of Science and Technology, the University of Houston, the University of Texas, and Moscow School of Management. A Fellow and Past-President of the Association for the Advancement of Cost Engineering (AACE Int'l.), he received that organization's highest honor, the Award of Merit. He currently serves on the Executive Advisory Board of the Engineering and Construction Contracting Association (ECC) and on the SPE Program Committee for the Offshore Technology Conference (OTC). Dick is a graduate of the City College of New York (BS Mechanical Engineering), Rensselaer Polytechnic Institute (MS Management Science), and Harvard Business School.

John (Jack) Evans is a Senior Executive Consultant with Westney Consulting Group where his focus is on probabilistic risk analysis and executive decision-making for investments in large capital projects. Prior to joining Westney in 2008, Jack held numerous management positions in the energy industry including serving as Treasurer of Amoco Canada as well as Risk Director of Amoco Energy Group North America. He holds a BS in Basic Engineering from Princeton University, and an MBA from the Amos Tuck School of Business Administration at Dartmouth College where he was an Edward Tuck Scholar.

APPENDIX: Discussion of Statistical Terms used in this Memo

This memo utilizes several terms that are associated with statistical and probability analysis. These are:

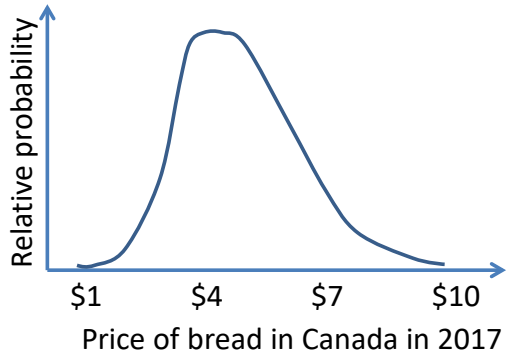
- Probability Distribution
- Mode
- Asymmetrical Probability Distribution
- Mean

A short description of each of these terms is provided below, as they apply to this discussion.

Probability Distribution

Suppose we were investing in a new bakery and wish to determine if our investment will be profitable. To answer this question, we need some way of predicting what the price of bread in Canada might be next year, and for many years into the future. Of course, many things determine the price of bread; labor costs will likely go up over time, the cost of the ingredients can go up or down (depending, for example, on crop yields and global weather patterns), and even the cost of the power needed to run our bakery will change over time. So, it would not be very helpful to predict a single value for the cost of bread in future years; the chance that we would get it right is virtually zero.

A better way is to recognize the uncertainty in any projection of a future price, and find a way to represent that uncertainty. Clearly, the price of bread will never be zero, and is extremely unlikely to be as low as $1.00. Likewise, it is extremely unlikely (although not impossible) that five years from now it will be $10.00. Between these extremes is a range of possible outcomes that we can use in our analysis.



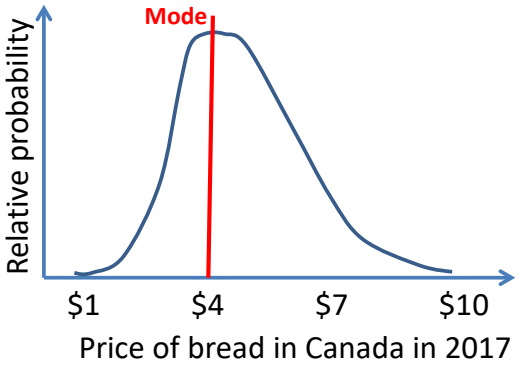
A probability distribution can help us understand what might happen. The height of the curve shows the relative probability that any given value of bread price will be seen in 2017, as illustrated here. We can see from this probability distribution that the relative probability of $1 bread is very low, as is $10 bread, while it is much more likely that the actual price in 2017 will be somewhere between $3 and $7.

Clearly, the probability distribution illustrates the full range of possible outcomes. One way to approximate the distribution is to develop scenarios: these might represent a low price scenario

(corresponding to a $1 price), a high price scenario (corresponding to $10), and a likely scenario (corresponding to $4).

Mode

Suppose we wanted to know the single value for the price of bread in Canada in 2017 that is more likely than any other value to occur. This is what we think the price will be if our likely scenario comes to pass. This value is called the mode; it is the peak of the probability distribution curve, and is illustrated here.



The mode answers the question: what is the price of bread that is more likely to occur in 2017 than any other price? Although the probability of the mode is higher than any other value, the probability that this specific value for the price of bread will occur is still relatively low.

Asymmetrical Probability Distribution

In addition to the mode, the probability distribution for the price of bread in 2017 suggests a range of possible outcomes from a minimum value of $1, to a maximum value of $10. We can see from the shape of the distribution that it is not symmetrical; the low value ($1), is $3 less than the most likely (mode) value, while the high value ($10), is $6 more. This form of asymmetry is called skewness, and this curve can be said to be skewed to the right. While many people think of a probability distribution as being symmetrical (a “bell curve”), in fact, many real-world variables are distributed in an asymmetrical way.

Mean

While the probability distribution and mode are helpful in understanding the possible future price of bread, we still need a single metric that represents the entire distribution. This is the mean, which is the average of all the values in the distribution weighted by their respective probabilities. Since it represents the full range of possible prices in 2017, the mean price will be useful in evaluating the potential profitability of our bakery. And, since the distribution of future bread prices is skewed to the right, the mean will be greater than the mode.