Avoided Cost Calculations of

Natural Gas Energy Efficiency Programs

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1. Introduction

Avoided costs of natural gas are calculated for six end-uses, which are representative of the measures offered through Energy Efficiency Services (EES) programs. The avoided costs of natural gas are calculated on an annual basis before being converted in a present value for inclusion in the benefit-cost assessments.

Because the measures offered by EES save energy at different times throughout the year, the avoided costs of natural gas are calculated separately for each of the six representative end-uses. Not only do energy costs vary through the year[i], making the avoided costs dependent upon the timing of savings, but measures which save energy on the peak day avoid additional pipeline demand charges and distribution capacity costs.

Total avoided costs of natural gas are calculated using the following inputs:

1. Weighted average annual market prices of natural gas
2. Avoided pipeline demand charge
3. Avoided pipeline variable transportation charge
4. Avoided pipeline fuel reimbursement charge
5. Avoided distribution capacity costs

Unlike the avoided cost of electricity, there are no regulatory guidelines on applying the conservation credit to natural gas costs. Therefore to be consistant with the 2011 IRP, Puget Sound Energy (PSE) did not apply the conservation credit to the avoided costs of natural gas.

2. Weighted Market Price of Natural Gas

To calculate the weighted average annual market price of gas for years 2012 through 2041, PSE calculated the weighted average annual market price of natural gas over the years 2012 through 2031, for each of the six representative end-uses. PSE then inflated the price in year 2031 by 2.5%[ii] to estimate a weighted average annual market price of natural gas for years 2032 through 2041.

To calculate the weighted average annual market price of natural gas for years 2012 through 2031, the estimated average monthly natural gas prices[iii] and the monthly gas load shapes[iv] were obtained from the 2011 IRP. To obtain a weighted average annual price of natural gas for all six representative end-uses, the sum of the product of the monthly Sumas prices and the load shapes were calculated.

Calculation

For year 2012 though year 2031:

$$WAAMPG_{j_y} = \sum_{m=1}^{12} (load_{j_m}) * (price_{m_y})$$

Where:

$load_{jm}$: Percent of one therm used in month m for end-use j

$Price_{hy}$: Price of natural gas in month m of year y

$WAAMPG_{jy}$: Weighted average annual price of gas for end-use j in year y

3. Avoided Pipeline Demand Charge

The inclusion of a pipeline demand charge in avoided costs of natural gas is to account for potential avoided contract costs with the Northwest Pipeline. These contract costs are paid to reserve pipeline capacity for peak demand. When there is large demand for natural gas, PSE first utilizes the natural gas in PSE owned storage facilities and other available PSE peaking resources. However, to the extent that PSE's demand at peak outweighs PSE's ability to meet that demand with current peaking resources, PSE must buy gas from other sources.

Because PSE purchases natural gas from sources which are not directly connected to the PSE owned distribution systems, PSE has to purchase pipeline capacity from the Northwest Pipeline so that natural gas can be moved from the point of purchase (typically Sumas) to PSE owned pipes. When PSE buys capacity on the Northwest Pipeline, PSE reserves the capacity year around. Therefore, each year PSE purchases enough capacity to meet forecasted peak demand. Capacity is paid on a per day charge, year-round, even on days when PSE does not need the full amount of reserved capacity on the pipeline.

To the extent that gas efficiency programs mitigate peak demand, the efficiency programs assist PSE in avoiding some of the pipeline capacity costs. A portion of the pipeline capacity costs are avoided because PSE can purchase a smaller amount of capacity on the Northwest Pipeline when energy efficiency programs reduce peak demand.

The 2011 IRP indicates that PSE has enough capacity on the Northwest Pipeline to meet future demands though 2015. In 2016, PSE will need to begin purchasing additional capacity on the pipeline at $0.45 per dekatherm of capacity per day, or $164.25 per year, per dekatherm of capacity.

In 2017, the cost per dekatherm on the pipeline will increase by five percent, costing PSE $0.4725 per dekatherm of capacity per day, or $172.4625 per year, per dekatherm of capacity. That cost will remain flat for the five year contract and will increase by five percent every five years.

3.1. Calculation of Estimated Peak Savings by end-use

Because load shapes for the natural gas end-uses are not provided on a daily basis, PSE must estimate peak savings for each end-use, j, by multiplying the inverse of the load factor of end use j by the average load of end-use j. The explanation of the load factor, along with the calculation, is explained in sections 3.1.1 and 3.1.2.

PSE calculated peak savings with two different methodologies. For weather-sensitive end-uses, PSE used the gas forecast to estimate the load factor. For non-weather-sensitive end-uses, PSE utilized individual end-use load shapes to estimate the load factor.

An alternative option to estimate the load factor for weather-sensitive end-uses would be to utilize the individual load shapes, making the calculation of load factors for weather-sensitive measures consistent with the methodology used to calculate load factors for non-weather-sensitive measures. However, the PSE avoided cost team believed that a better estimate of load factor would be derived if the forecast was used.

It is not possible to use the forecast information to estimate the load factor for non-weather-sensitive loads (end-uses) unless the analyst assumed loads for non-weather-sensitive end-uses are completely flat. Therefore individual load shapes for non-weather-sensitive end-uses were used to estimate the load factor for those end-uses.

3.1.1. Peak savings for weather sensitive end-uses

To calculate the percentage of savings which occur coincident with system peak, the analyst first estimated a load factor, which is simply the average daily load for weather sensitive end-uses divided by the load of weather sensitive end-uses on peak day by customer class (residential or non-residential).

The load factor is defined below:

$$LF_c = ADLW_c / PDLW_c$$

Where:

LF_c: Load factor for customer class c, either residential or non residential

$ADLW_c$: Average daily load for weather sensitive end-uses for customer class c

$PDLW_c$: Peak day load for weather sensitive end-uses for customer class c

Next, the inverse of that load factor, which provides a percent of the average daily load which occurs on peak day, is multiplied by the average daily load for weather sensitive measures (one dekatherm spread evenly over a year) to obtain peak demand savings.

Estimated peak savings are defined below:

$$PDSW_c = [(PDLW_c)/(ADLW_c)]*(1/365) \quad \text{OR} \quad PDSW_c = (1/LF_c)*(1/365)$$

Where:

PDSWc: Peak savings, percent of weather sensitive load which occurs on peak day for class c (residential or non-residential)

PDLWc: Peak day load for weather sensitive end-uses in customer class c

ADLWc: Average daily load for weather sensitive end-uses in customer class c

The peak savings is then multiplied by the yearly demand charge to obtain the avoided cost of pipeline demand charges for end-use j in year y.

The peak demand charge is defined below:

$$PDC_{j_y} = (PDSW_{j_c})*(PDC_y)$$

Where:

PDC_{jy} : Avoided pipeline demand charge for end-use j in year y.

$PDSW_{jc}$: Peak demand savings for weather-sensitive end-use j in customer class c

PDC_y: Avoided pipeline demand charge for year y

3.1.2. Calculation of peak savings for non-weather sensitive loads

For non-weather sensitive loads, peak savings were calculated by estimating a percent of one dekatherm of savings which occurs on peak, using individual end-use load shapes; not using the gas forecast.

To calculate this percentage, the load factor is calculated as the average daily load for the non-weather sensitive end-use, j, divided by the peak load of end-use j.

The load factor is defined below:

$$LF_j = ADLNW_j / PDLNW_j$$

Where:

LF_j: Load Factor for end-use j

$ADLNW_j$: Average daily load for non-weather sensitive end-use j

$PDLNW_j$: Peak day load for non-weather sensitive end-use j

Next, the inverse of that load factor is calculated to provide a percent of the average daily load which occurs on peak day, for end-use j. This percentage is multiplied by the average daily load for end-use j (one dekatherm spread over a year) to obtain peak demand savings.

Peak savings are defined below:

$$PDSNW_j = [(PDLNW_j)/(ADLNW_j)]*(1/365) \text{ OR } PDSNW_j = (1/LF_j)*(1/365)$$

Where:

$PDSNW_j$: Peak savings for non-weather sensitive, percent of load for end-use j, which occurs on the peak day for end-use j.

$PDLNW_j$: Peak day load for non-weather sensitive end-use j.

$ADLNW_j$: Average daily load for non-weather sensitive end-use j.

The peak savings is then multiplied by the yearly demand charge to obtain the avoided cost of pipeline demand charges for end-use j in year y.

$$PDC_{j_y} = (PDSNW_j)*(PDC_y)$$

Where:

PDC_{jy}: Avoided pipeline demand charge for end-use j in year y.

$PDSNW_j$: Peak savings for non-weather sensitive end-use j

PDC_y: Pipeline demand charge for year y

4. Avoided Pipeline Variable Transportation Charge

The avoided pipeline variable transportation charge, which is included in the avoided cost calculations, represents the operation and maintenance costs on the pipeline. These costs vary by volume of flow on the pipeline, and the costs are independent of the time of flow. That current charge is $0.0319 per dekatherm. When PSE saves a dekatherm of gas at a customer location, PSE avoids paying the pipeline variable transportation charge on that dekatherm of gas.

Because the charge of $0.0319 per dekatherm is spent for every dekatherm of gas, the avoided pipeline variable transportation charge does not vary by end-use. In addition, the price is held constant over the course of the 30 year timeframe for avoided cost calculations. The charge is a negotiated charge and, at the time of the 2012-2013 avoided cost calculations, it was presumed that the majority of suppliers would lobby to hold this cost constant for the foreseeable future. Therefore, it is held constant for all years in the avoided cost calculations.

5. Pipeline Fuel Reimbursement

The avoided costs of pipeline fuel reimbursement are included in the avoided cost calculations to account for the additional savings on the fuel used by the compressors which move natural gas though the pipelines. As natural gas moves though the pipeline system, a small portion of the natural gas is consumed as fuel for the compressor systems that move the natural gas from various points in the pipeline. The pipeline reimbursement rates vary every 6 months, but generally range in the 2-3%. PSE applied a 2.9 %[v] rate for fuel reimbursement when calculating the 2012-2013 avoided costs.

Every time a PSE program saves a dekatherm of natural gas at a PSE customer location, PSE avoids both purchasing that unit of natural gas and purchasing additional 2.9% of that unit to fuel the compressors which move that natural gas to the customer location.

Calculation of Pipeline fuel reimbursement charge

$$PFRC_{j_y} = WAAMPG_{j_y} * 0.029$$

Where:

$PFRC_{jy}$: Avoided Pipeline Fuel Reimbursement charge for end-use j in year y.

6. Deferred Distribution Capacity Cost

The deferred pipeline distribution capacity cost is included in the calculations of the avoided cost of natural gas to account for the deferred cost of pipeline reinforcements. When peak demand increases, pipelines need to be reinforced to support the additional flow of natural gas. In as much as energy efficiency projects reduce peak demand, PSE can defer pipeline reinforcement projects.

The 2010 gas utilization business case was used to estimate the cost of pipeline reinforcements in years 2012 through 2041. The 2010 business case estimated a cost of $9,650,000 (high and intermediate pressure projects) would be spent from the capital budget for each 1% of load growth.

Upon receiving a cost estimate for distribution capacity projects in 2010 dollars, the PSE analyst estimated project costs though 2041 by inflating the cost in the year previous by 2.5%[vi] .

Because the reinforcement costs on a pipeline are a onetime cost- and those costs are simply differed, not necessarily avoided by EES programs-the yearly avoided costs of pipeline distribution capacity costs are represented as an avoided payment, or the yearly value of a levelized cost. The levelized payments were calculated over a 35 year timeframe as advised by the gas planning group. At the time the 2012-2013 avoided costs were calculated, the gas planning group believed that 35 years was the best estimate for the life of distribution upgrades. Each year 2012 though 2041 has a unique deferred payment, which is based on the payment for that year's estimated distribution capacity costs.

7. Calculation of Avoided Cost of Natural Gas

For inclusion in the benefit cost calculations, the avoided cost of natural gas is calculated as the present value of the stream of avoided cost over the life of the measure being assessed. The present value of the stream of avoided costs in each year contains the present value of avoided cost in that year and in every year previous. To calculate the present value of the stream of avoided costs, PSE first calculates the nominal avoided cost of energy for each year, 2012 though 2041.

Upon completion of the nominal cost calculations, PSE obtains a present value of avoided cost for each year, y, in 2012 dollars. After calculating the present value per year, PSE calculates the stream of avoided costs by summing the present value of avoided costs for each year, y, and every year previous. All present value costs are in calculated to the beginning of year 2012.

7.1. Nominal Avoided Cost of Natural Gas

The nominal avoided cost of natural gas is calculated by summing the values for the weighted average annual market price, the value of the pipeline distribution charge, the pipeline variable transportation charge, the pipeline fuel reimbursement charge, and the deferred value of the distribution capacity cost.

The nominal avoided cost of natural gas is defined below:

$$TCG_{j_y} = WAAMPG_{j_y} + PDC_{j_y} + PVTC + PFRC_{j_y} + DCC_{j_y}$$

Where:

TCG_{jy}: Total nominal avoided cost of natural gas for end-use j in year y.

$WAAMPG_{jy}$: Weighted average annual market price of natural gas for end-use j in year y.

PDC_{jy}: Avoided pipeline demand charge for end-use j in year y.

PVTC: Pipeline variable transportation charge, which is constant for all years and end-use types.

$PFRC_{jy}$: Pipeline fuel reimbursement charge for end-use j in year y.

DCC_{jy}: Avoided cost of distribution capacity

7.2 Present Value of Avoided Cost of Natural Gas

Once the nominal avoided cost of natural gas are calculated, for years 2012 through 2041, the present value of the avoided cost of natural gas, for year 2012 though 2041, are obtained. The present value is calculated to set all avoided costs to 2012 dollar values. All dollar values need to be in the same time period so correct comparisons of costs can be made. For present value calculations, PSE's weighted average annual cost of capital (WACC) is used as the discount rate. The WACC is currently 8.1%. This rate is adopted from the commission-approved cost of capital structure from the 2009 General Rate Case and is utilized in the 2011 IRP[vii].

The present value of the total avoided cost of natural is defined below:

$$PVG_{j_y} = TCG_{j_y} \Big/ (1+I)^y$$

Where:

PVG_{jy} : Present value of year y's avoided costs of energy for end-use j.

TCG_{jy}: Total avoided cost of energy for end-use j in year y.

I: Interest rate used for discounting, PSE weighted average annual cost of capital (8.10%).

7.2. Present Value of the Stream of Avoided Costs of Natural Gas

The present value of the stream of avoided costs is important in calculating the total benefits of avoided costs of natural gas over the life of the measure being assessed. The present value of the stream of avoided costs are calculated for years 2012 through 2041for the life of the measure and are equal to the sum of avoided costs for each year, y, and all years previous.

The calculation of the present value of the stream of avoided costs is below:

$$PVSACG_j = \sum_{y=1}^{N} TCG_{j_y} \Big/ (1+I)^y$$

Where:

$PVTACG_j$: Present value of the avoided

TCG_{jy}: Total avoided cost of natural gas for end-use j in year y.

I: Interest rate used for discounting money, PSE weighted average annual cost of capital (8.10%).

N: Measure life

I. PSE assumes the load shape for energy savings is identical to the load shape of the end-use.

[II] 2.5% is the assumed inflation rate in the 2011 IRP.

[iii] Market Prices: For the 2012-2013 Avoided Costs calculations, the estimated monthly market prices of natural gas, from Sumas, were used as a base to calculate a weighted average annual price of natural gas. Monthly gas prices were only available though 2031A.D. The estimated Sumas prices are contained in *Appendix B6*.

[iv] Load shapes: Natural gas monthly load shapes, for the six end-uses, are provided as a distribution of one therm of natural gas over an entire year, which provides the portion of therm used in each month throughout a typical year. Therefore, the sum of each of the load shapes is one. The Load shapes used in the most recent IRP are contained in *Appendix B6***.**

[v] This percentage was based on recommendations from Bill Donahue- PSE Manager, Natural Gas Resources.

[vi] 2.5% was used as a price inflator because it is the assumed inflation rate in the IRP.

[vii] Each time avoided costs are updated, the analyst conducting the analysis is required to update the discount rate to reflect the rate used in the most recent IRP. This rate should also correlate to the most recent commission-approved cost of capital before the finalization of the IRP. The Resource Planning Group provides the base WACC for the most recent IRP. To obtain a breakout of the WACC for equity, long-term debt, and short-term debt, speak with the Manager of the Cost of Service in the Rates Department, currently Jon Piliaris.