Avoided Cost Calculations of Natural Gas Energy Efficiency Programs

Using Assumptions from Puget Sound Energy's 2011 IRP

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1. Introduction

The intent of this paper is to provide a broad overview of how Puget Sound Energy (PSE) calculated the avoided costs of natural gas for the assessment of 2012-2013 gas efficiency programs, using inputs from the 2011 IRP. PSE utilizes information directly from the IRP to develop our avoided costs, rather than simply using Sendout. Although assumptions are consistent with assumptions in Sendout, we choose to itemize our cost-effectiveness to better understand how to augment our programs to make them as cost-effective as possible.

Because the measures offered by EES save energy at different times throughout the year, the avoided costs of natural gas were calculated separately for each of six end-uses, which are representative of the measures offered through Energy Efficiency Services (EES) programs. 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 requirements or guidelines on applying the 10% conservation credit to natural gas costs. This credit is an artifact of the Northwest Regional Power Act of 1980 and is applied by the Northwest Power and Conservation Council and by many utilities to electric avoided costs. To be consistent with the 2011 IRP, Puget Sound Energy (PSE) did not apply the conservation credit to the avoided costs of natural gas.

The components of the total avoided costs of natural gas are explained in the remainder of this paper. *Appendix B2: Avoided Cost Calculations* contains the present value calculations of the annual avoided cost for natural gas, derived from the 2011 IRP assumptions.

2. Weighted Market Price of Natural Gas

PSE calculated the weighted average annual market price of natural gas over the next 20 years (IRP period) for each of the six representative end-uses. PSE then used an inflation rate of 2.5%[ii] to estimate a weighted average annual market price of natural gas for the remaining 10 years.

To calculate the weighted average annual market price over the next 20 years, PSE used the estimated average monthly natural gas prices[1] (Sumas) and the monthly gas load shapes[iii] from the 2011 IRP. A weighted average annual price of natural gas was calculated for all six representative end-uses.

The calculations for the weighted average annual cost of natural gas, for years 2012 through 2031, is contained *Appendix B1: Monthly Gas Prices _ Weighted Annual Avoided Costs*. The calculated weighted average annual costs of natural gas in years 2032 through 2041 are contained in *Appendix B2: Avoided Cost Calculations*.

2.1 Calculation

For 20 years:

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

Where:

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

$Price_{my}$: 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*

[1] Our monthly Sumas price forecast is purchased from third part vendors, Kyodex and Wood Mac.

3. Avoided Pipeline Demand Charge

The pipeline demand charge is included in avoided costs of natural gas 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.

To calculate the avoided cost of pipeline demand charges, PSE must multiply the yearly pipeline demand charge by the measure savings which occur on peak. The calculations of avoided pipeline demand charges are contained in *Appendix B2:Avoided Cost Calculations*.

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.

For weather sensitive loads, PSE avoided cost team believed that a better estimate of load factor would be derived if the forecast in Sendout was used, rather than the end-use, because the load forecast better correlates with our actual peak.

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. The methodology used to calculate peak savings for weather sensitive end-uses is described in section 3.1.1; the methodology used to calculate peak savings for non-weather sensitive end-uses is described in section 3.1.2

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, divided by the load on peak day. These load factors were calculated for residential and non-residential customer class. 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*

Calculations of weather sensitive peak load, weather sensitive average loads, and the weather sensitive load factors are contained in *Appendix B3: Load Factor Weather Sensitive Load***.** Load factors were calculated using the 2011 IRP forecasts for the gas sendout.

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 to obtain peak demand savings.

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:

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

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

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

The calculation of the peak savings (percent of savings which occur on peak day) is contained in *Appendix B2: Avoided Cost Calculations***.** Within Appendix B2, the calculation of peak savings is contained in individual tabs for each of the six representative end-uses.

The peak demand 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*

The calculation of avoided pipeline demand charges to the avoided costs of natural gas use are contained in *Appendix B2: Avoided Cost Calculations***.** The application of the pipeline demand charge is contained in the individual tabs for each of the six representative end-uses.

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.

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*

Calculations of load factors for non-weather sensitive loads are contained in *Appendix B2*. The load factors are calculated in the Load Shape tab, row nineteen. The load factors, for the six representative end-uses, are then used in the calculation of peak demand savings.

The load factors, for the six representative end-uses, are then used in the calculation of peak demand savings.

The inverse of the load factor is then 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 calculations of the peak demand savings for these non-weather sensitive loads are contained in *Appendix B2*. Within *Appendix B2*, the calculation of peak demand savings is contained in individual tabs for each of the six representative end-uses

The peak demand 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

The application of avoided pipeline demand charges to the avoided costs of natural gas are contained in *Appendix B2: Avoided Cost Calculations*. The application of the pipeline demand charge is contained in the individual tabs for each of the six representative end-uses.

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.

The application of the pipeline variable transportation charge is contained in *Appendix B2: Avoided Cost Calculations*. The application of the variable transportation charge is contained in the individual tabs for each of the six representative end-uses.

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 %[iv] 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 gas to fuel the compressors.

Calculation of Pipeline fuel reimbursement charge

$$PFRC_{j_y} = WAAMPG_{j_y} * \mathrm{Re}imbursementRate$$

Where:

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

The application of the avoided pipeline fuel reimbursement charge is contained in *Appendix B2: Avoided Cost Calculations*. The application of pipeline fuel reimbursement charge is contained in the individual tabs for each of the six representative end-uses.

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%[v]. Those cost estimates are contained in *Appendix B5: Deferred Distribution Capacity Costs*.

Because the reinforcement costs on a pipeline are a onetime cost- and those costs are simply deferred, 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.

The calculation of deferred costs for distribution capacity projects is contained in *Appendix B5: Deferred 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. To calculate the present value of the stream of avoided costs, PSE first calculates the nominal avoided cost of energy for each year.

Upon completion of the nominal cost calculations, PSE obtains a present value of avoided cost for each year in today's 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.

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

The calculations for the nominal avoided costs, for each year y, are contained in *Appendix B2: Avoided Cost Calculations***.** Within Appendix B2, the calculation of the nominal avoided costs, for each year y, is located in column G of the individual end-use tabs.

7.2 Present Value of Avoided Cost of Natural Gas

For present value calculations, PSE's weighted average annual cost of capital (WACC) is used as the discount rate. This rate is adopted from the commission-approved cost of capital structure from the General Rate Case which was utilized in the most recent IRP[vi]. 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

The calculations for the nominal avoided costs, for each year y, are contained in *Appendix B2: Avoided Cost Calculations.* Within Appendix B2, the calculation of the nominal avoided costs, for each year y, is located in column H of the individual end-use tabs.

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 values of the stream of avoided costs are calculated for multiple years so that PSE can assess measures with various measure lives. These 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

N: Measure life

The calculations for the present value of the stream of avoided costs are contained in *Appendix B2***.** Within *Appendix B2*, the calculation of the stream of avoided costs, for each year y, is located in column I of the individual end-use tabs.

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 IRP.

[iii] 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.

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

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

[vi] 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.