White Paper: The Difference in Investor-Owned Utility
Total Resource Cost Test Calculations for Ground Source Heat Pumps

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1.0 Introduction

South Dakota investor-owned utilities (IOUs) are not required to use a statewide method for calculating the Total Resource Cost (TRC) test when evaluating energy efficiency plans. Rather, each utility uses a method of calculating the TRC test that is consistent with energy efficiency plan evaluation requirements established in other states in which they operate. This is done in order to minimize administrative costs associated with energy efficiency plan evaluation, allowing each utility to rely on internal evaluation practices already established for other jurisdictions rather than establishing new evaluation practices for South Dakota. What results, however, are inconsistencies in benefits and costs included in the TRC test among South Dakota's utilities. This is due to the fact that utilities use different Technical Reference Manuals (TRMs) and input assumptions when calculating benefits and costs. This practice provides ratepayer economies, but it does make utilities' results comparisons difficult.

This paper highlights the differences in how South Dakota IOUs calculate their TRC scores for a single measure. This was done for simplicity. The calculations in this paper reflect the hypothetical installation of one residential Ground Source Heat Pump (GSHP) retrofit. Further, the paper covers the three electric IOUs that currently offer ground source heat pump rebates in South Dakota. The three electric IOUs are Otter Tail Power (Otter Tail or OTP), MidAmerican Energy (MidAmerican or MidAm), and Black Hills Energy (BHE).

The purpose of the paper is not to advocate for a standardized evaluation process in South Dakota. The purpose is to simply inform the Commission as to why TRC scores differ among IOUs. Developing a TRM specific to South Dakota would be a time-consuming and difficult undertaking for the Commission and South Dakota utilities. For energy efficiency program evaluation purposes in South Dakota, the benefit of being able to compare one utility's energy efficiency program to another's using a South Dakota-specific TRM may not justify the cost of developing the TRM.

2.0 Assumptions

The hypothetical used in this analysis consists of a residential GSHP retrofit. The following assumptions were made for the analysis:

1) The replacement of electric resistance heating and a central air conditioning system with a GSHP, and

2) The GSHP installed is a two-stage, four-ton ground loop system that has the following system ratings:
   a. Full Load Heating: 38,200 Btu/hr with a COP of 3.9
   b. Part Load Heating: 29,700 Btu/hr with a COP of 4.3
   c. Full Load Cooling: 49,000 Btu/hr with an EER of 17.1
   d. Part Load Cooling: 37,400 Btu/hr with an EER of 24.1

3.0 The Total Resource Cost Test

The TRC test is used by Staff and the Commission to measure the effectiveness of energy efficiency programs. In short, the TRC test answers the question: will the total cost of energy for the utility's rate payers decrease?[1] Below is a slide[2] from a presentation presented to the PUC by Snuller Price from Lawrence Berkley National Lab that identifies the typical benefits and costs included in the TRC test. After quantifying the benefits and costs, the TRC is then calculated by dividing benefits by costs.

Summary of costs and benefits components

- Each state adjusts these definitions depending on circumstances
- Details can significantly affect the type of energy efficiency implemented

Component	PCT	PAC	RIM	TRC	SCT
Energy and capacity related avoided costs	-	Benefit	Benefit	Benefit	Benefit
Other energy resource savings	-	-	-	Benefit	Benefit
Societal non-energy benefits (non-ratepayer benefit)	-	-	-	-	Benefit
Incremental equipment & install costs paid for by customer	Cost	-	-	Cost	Cost
Program administration overhead costs	-	Cost	Cost	Cost	Cost
Incentive payments paid by utility/program admin.	Benefit	Cost	Cost	-	-
Bill Savings	Benefit	-	Cost	-	-

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4.0 Benefits

Benefits typically included in the TRC test are avoided energy cost savings, avoided capacity cost savings, and avoided transmission and distribution (T&D) cost savings. In addition, one

[1] August 2013. Snuller Price. Background input on Energy Efficiency Cost Effectiveness – Presentation for South Dakota Public Utilities Commission. Slide 7. Located at: http://www.puc.sd.gov/commission/ee2013/backgroundinputonenergyefficiencycosteffectivenessprice.pdf

[2] Id. Slide 8

South Dakota IOU includes federal tax credits as a benefit and another IOU includes ancillary avoided costs as a benefit. There are two key drivers for quantifying the monetary value of benefits attributed to energy and capacity savings. First, one must calculate the amount of energy and demand savings that result from the installation of an energy efficient technology. This is done through algorithms that are typically sourced from a TRM. Second, the utility uses forecasted avoided cost prices to calculate the monetary value (i.e. avoided cost) of the energy and demand savings. A utility's avoided energy and capacity cost price forecasts are typically taken from its integrated resource planning process.

A TRM is developed by a state through a stakeholder process in order to establish a reasonable estimate of energy and demand savings for each energy efficiency measure. Algorithms and input assumptions for each measure are set through the TRM stakeholder process and drive the estimated energy and demand savings. TRMs are also updated periodically. As such, TRMs have different algorithms and input assumptions when compared to one another or when comparing the same TRM's current version with a past version. This results in the potential to have different calculated energy and demand savings for the same energy efficiency measure. Table 1 identifies the TRMs used by South Dakota's IOUs for calculating a ground source heat pump's energy and demand savings.

Table 1. TRMs Used By South Dakota Electric Utilities for Ground Source Heat Pump

TRM	OTP	MidAmerican	BHE
Minnesota	X		
Iowa		X	
Illinois			X

4.1 Energy Savings Calculations

Table 2 provides the results of the energy savings calculated for the hypothetical installation of a residential GSHP pump retrofit. The main drivers for the deviation in energy savings calculated are the input assumptions used for the baseline technology that the GSHP is replacing and the measure's estimated lifetime. Regarding the baseline technology, some TRMs identify the baseline as an air source heat pump (e.g. Iowa TRM), whereas another may identify the baseline as the currently installed technology being replaced (e.g. MN TRM). The Illinois TRM attempts to meet in the middle by assigning the currently installed system as the baseline for the first eight years and the air source heat pump as the baseline for the remaining 17 years. As shown in the table, the TRM and input assumptions used by each utility result in different calculated energy savings for the same GSHP system installation. The calculations for the energy savings reported in Table 2 are provided in Appendix A.

Table 2. Energy Savings (kWh) for a GSHP Retrofit							
Year	MN TRM	IA TRM	IL TRM		OTP[1]	MidAm[2]	BHE[3]
1	27,506	7,322	22,885		26,574	11,401	14,641
2	27,506	7,322	22,885		26,574	11,401	14,641
3	27,506	7,322	22,885		26,574	11,401	14,641
4	27,506	7,322	22,885		26,574	11,401	14,641
5	27,506	7,322	22,885		26,574	11,401	14,641
6	27,506	7,322	22,885		26,574	11,401	14,641
7	27,506	7,322	22,885		26,574	11,401	14,641
8	27,506	7,322	22,885		26,574	11,401	14,641
9	27,506	7,322	5,701		26,574	11,401	5,958
10	27,506	7,322	5,701		26,574	11,401	5,958
11	27,506	7,322	5,701		26,574	11,401	5,958
12	27,506	7,322	5,701		26,574	11,401	5,958
13	27,506	7,322	5,701		26,574	11,401	5,958
14	27,506	7,322	5,701		26,574	11,401	5,958
15	27,506	7,322	5,701		26,574	11,401	5,958
16	27,506	7,322	5,701		-	11,401	5,958
17	27,506	7,322	5,701		-	11,401	5,958
18	27,506	7,322	5,701		-	11,401	5,958
19	-	7,322	5,701		-	-	5,958
20	-	7,322	5,701		-	-	5,958
21	-	7,322	5,701		-	-	5,958
22	-	7,322	5,701		-	-	5,958
23	-	7,322	5,701		-	-	5,958
24	-	7,322	5,701		-	-	5,958
25	-	7,322	5,701		-	-	5,958
Lifetime	495,108	183,050	279,997		398,610	205,218	218,414

1) OTP's results differ from the MN TRM due to the utility modifying certain input assumptions to reflect its service territory.
2) MidAmerican's results differ from the IA TRM due to the utility modifying certain input assumptions to reflect its service territory. Further, for this analysis the calculations used for each utility was derived from each utility's most recent filing and IA has updated its TRM since MidAmerican's plan was approved in South Dakota.
3) BHE's results differ from the IL TRM because BHE assumes the system being replaced is an ASHP whereas the IL TRM captures the energy savings from replacing existing electric resistance heating.

4.2 Demand Savings Calculations

Table 3 provides the results of the demand savings calculated for the hypothetical GSHP installation. The main drivers for the deviation are similar to those identified in Section 4.1. As shown in the table, the TRM and input assumptions used by each utility result in different calculated demand savings for the same GSHP system installation. The calculations for the demand savings reported in Table 3 are provided in Appendix A.

Table 3. Demand Savings (kW) for a GSHP Retrofit							
Year	MN TRM	IA TRM	IL TRM		OTP	MidAm	BHE
1	1.28	1.60	2.83		1.96	1.63	2.13
2	1.28	1.60	2.83		1.96	1.63	2.13
3	1.28	1.60	2.83		1.96	1.63	2.13
4	1.28	1.60	2.83		1.96	1.63	2.13
5	1.28	1.60	2.83		1.96	1.63	2.13
6	1.28	1.60	2.83		1.96	1.63	2.13
7	1.28	1.60	2.83		1.96	1.63	2.13
8	1.28	1.60	2.83		1.96	1.63	2.13
9	1.28	1.60	1.16		1.96	1.63	0.46
10	1.28	1.60	1.16		1.96	1.63	0.46
11	1.28	1.60	1.16		1.96	1.63	0.46
12	1.28	1.60	1.16		1.96	1.63	0.46
13	1.28	1.60	1.16		1.96	1.63	0.46
14	1.28	1.60	1.16		1.96	1.63	0.46
15	1.28	1.60	1.16		1.96	1.63	0.46
16	1.28	1.60	1.16		-	1.63	0.46
17	1.28	1.60	1.16		-	1.63	0.46
18	1.28	1.60	1.16		-	1.63	0.46
19	-	1.60	1.16		-	-	0.46
20	-	1.60	1.16		-	-	0.46
21	-	1.60	1.16		-	-	0.46
22	-	1.60	1.16		-	-	0.46
23	-	1.60	1.16		-	-	0.46
24	-	1.60	1.16		-	-	0.46
25	-	1.60	1.16		-	-	0.46

4.3 Conversion to Net Present Value

After calculating the energy and demand savings that resulted from the GSHP installation, the IOU then determines the Net Present Value (NPV) of the energy and demand savings. This is done by applying a forecast of the utility's avoided energy cost and avoided capacity cost to the calculated energy and demand savings. Avoided energy and demand costs are typically taken from the utility's IRP. Table 4 provides the NPV of savings, with the calculations provided in Appendix B. The table also shows how utilities factor in different benefits. For example, MidAmerican includes the federal tax credit as a benefit and Otter Tail includes ancillary avoided costs.

Table 4. Benefits Included in TRC Calculation for GSHP Retrofit			
	OTP	MidAm	BHE
NPV of Avoided Energy	$ 15,935	$ 7,658	$ 5,251
NPV of Avoided Generation Capacity	$ 3,303	$ 1,774	$ 250
NPV of Avoided T&D*	$ 10,112	$ 907	
NPV of Ancillary Avoided Costs	$ 61		
Federal Tax Credit Benefit[1]		$ 8,200	
Total Benefits	$ 29,411	$ 18,539	$ 5,502

*T&D: Transmission and Distribution

1) Estimated - Reflects a 30% federal tax credit the participant receives, however the tax credits will not be available in 2017

5.0 Costs

When computing the TRC score, costs included are the actual program administrative costs and the incremental participant cost for the GSHP installation. Since program administrative costs vary among utilities and from year-to-year, it was decided to use $200 for the hypothetical as this is a reasonable estimate to use for a single GSHP installation based on review of past energy efficiency plan status reports filed by the IOUs. For incremental participant costs, each utility uses a different method for determining the cost amount. Table 5 provides a summary of the costs each utility would use in its TRC test for the same GSHP installation.

Table 5. Costs Included in TRC Calculation for GSHP Retrofit			
	OTP	MidAm	BHE
Administrative/Implementation Costs[1]	$ 200	$ 200	$ 200
Incremental Participant Cost[2]	$ 11,200	$ 10,992	$ 4,500
Total Costs	$ 11,400	$ 11,192	$ 4,700

1) Assumed to be $200 since this cost will vary based on actuals incurred

2) Based on each utilities method for determining the cost.

i) OtterTail uses a $11,200 for each installation

ii) MidAmerican uses the following algorithm: ($0.6262 x (Annual kWh - BACKUP) + $7,209.68

iii) BHE uses $4500 for each installation

6.0 TRC Calculation

Table 6 provides the results of the TRC calculation using the benefits and costs as calculated above. As shown in the table, the TRC score varies among the IOUs as a result of the benefits, costs, and avoided cost price forecasts used in each one’s program evaluation.

Table 6. TRC Calculation			
	OTP	MidAm	BHE
Total Benefits	$ 29,411	$ 18,539	$ 5,502
Total Costs	$ 11,400	$ 11,192	$ 4,700
TRC Score	2.58	1.66	1.17

7.0 Conclusion

Without having a standardized TRM, South Dakota relies on each IOU to justify its TRC test calculations by providing sources of algorithms and input assumptions used in order to make sure the equations and assumptions are reasonable. To perform this justification the IOUs then refer to a TRM or the Department of Energy (DOE). While price forecasts used to calculate the NPV of avoided costs are more easily vetted by Staff based on our understanding of current energy and demand prices, it is difficult for Staff to challenge the use of algorithms and input assumptions that are taken from a TRM or the DOE.

The establishment of a South Dakota TRM is a policy decision. Should the Commission wish to standardize algorithms and input assumptions for calculating energy and demand savings for energy efficiency measures, Staff is willing to work with the IOUs to develop a South Dakota TRM. However, the benefit gained from a South Dakota TRM may not outweigh the costs of developing the TRM. Finally, unless there is a South Dakota TRM in place it will continue to be difficult to compare one IOU's energy efficiency program results to another IOU's energy efficiency program results.