Technoeconomic Analysis of Pacific Steel Energy Bills

Sep16, Oct16, Nov16, Dec16 (power conditioner pre-installation)

compared to

Sep17, Oct17, Nov17, Dec17 (power conditioner post-installation)

B.D. Erickson II
President
Satic USA
7151 Kestrel Dr.
Missoula, MT 59808

Dear Mr. Erickson:

It is my pleasure to present to you this technoeconomic analysis of the energy bills for Pacific Steel[1] for the final four months of 2016 prior to the installation of Satic™ power conditioners and the final four months of 2017 subsequent to their installation.

The purpose of this analysis is to provide Satic with a fully disclosable document to share with Pacific Steel, as well as other potential clients wishing to estimate financial payback parameters of their investment in Satic™ power conditioners.

Kindly note that this document bears my Professional Engineering Seal. If you have remaining questions prior to sharing this analysis with your numerous customers, please do not hesitate to contact me.

Sincerely,

Bradley E. Layton

Bradley Layton PhD PE

Human Powered Future PLLC
Missoula, MT

[1] NorthWestern Energy Account Number: 0646870-6; Customer Name: Pacific Hide and Fur

Executive Summary

After a thorough analysis of eight [8] separate charges on eight [8] separate energy bills for Pacific Steel, I have concluded that the total savings on metered electrical service for the four months analyzed compared to the previous year was $1,047. Working under the approximation that Sep, Oct, Nov and Dec are typical operating months for Pacific Steel, this four-month savings extrapolates to an annual savings of $3,140, which coincidently is nearly equal to the (discounted) sale price of $3,174, indicating a simple payback of 1.01 years.

Notable in the bills is that taxes suddenly appeared on the 2017 bills that were absent from the 2016 bills. I will raise a question regarding the justification for this discrepancy during my next conversation with NorthWestern Energy regarding the Pacific Steel account.

Also notable in my discovery and analysis is that two key charges, the Electric Delivery GS-1 Distribution Demand Charge, and the Electric Delivery GS-1 Transmission Demand Charge both decreased by 22% between 2016 and 2017. This decrease is largely attributable to the decrease in the Delivery Service portion of the Electric Service charge. After running a financial simulation using the 2016 (more expensive) rates and the 2017 actual usages, a substantial annual savings of $282 was still predicted, 100% of which appears to be attributable to the installation of the power conditioners, which was the only differing independent variable that I found in my review of demand rates.

During my next phone call to NorthWestern Energy I will inquire about their demand rate policies and whether rates are driven by customer habits or are fixed and independent of customer behavior and power factor.

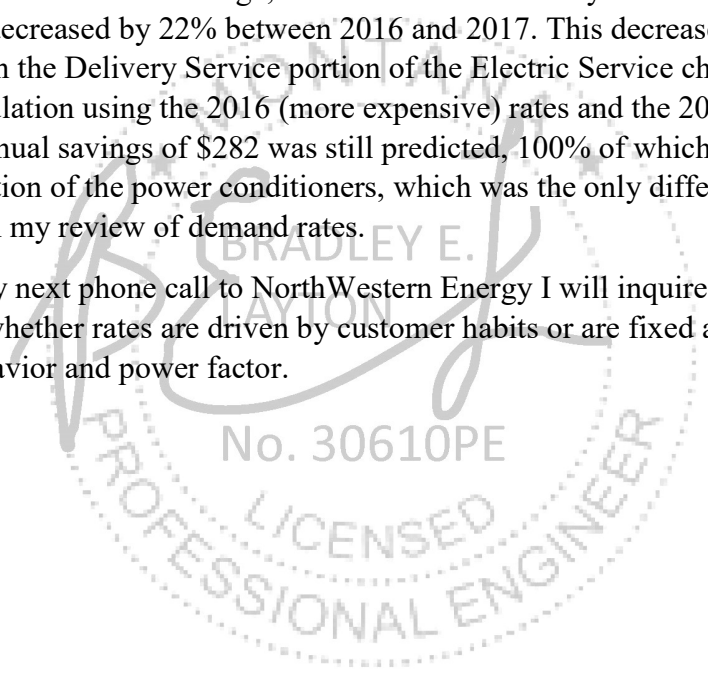

***Table 1**. Symbols used for analysis. All rates are taken directly from a typical NorthWestern Energy monthly energy bill.*

Symbol	description	units
C_{demand}	demand charge	$/month
$C_{\text{ES\_DS}}$	delivery service charge for electrical service	$/month
$C_{\text{ES\_DS\_DelC}}$	delivery charge portion of demand charge of electrical service	$/month
$C_{\text{ES\_DS\_DemC}}$	demand charge for electric delivery service	$/month
$C_{\text{ES\_DS\_SC}}$	service charge for electric service delivery (fixed at $7.35/month)	$/month
$C_{\text{ES\_SS}}$	supply service charge for electrical service	$/month
$C_{\text{US\_DS}}$	delivery service charge for unmetered electrical service	$/month
$C_{\text{US\_SS}}$	supply service charge for unmetered electrical service	$/month
C_{monthly}	monthly cost of all services, taxes included	$/month
$C_{\text{NGS\_DS}}$	delivery service charge for natural gas	$/month
$C_{\text{NGS\_SS}}$	supply service charge for natural gas	$/month
$C_{\text{SLT\_DS}}$	state and local taxes on distribution service charge for energy	$/month
$C_{\text{SLT\_SS}}$	state and local taxes on supply service charge for energy	$/month
DR	demand read	kW
DS	delivery service	Figure 1
DU	demand usage	kW
E_{E}	electrical energy metered monthly	kWh/month
MM	Meter Multiplier	none
P_{DemUsage}	power demand usage	kW
$R_{\text{CTC-QF}}$	competitive transition charge for qualifying facilities	$/kWh
$R_{\text{ES\_USBC}}$	universal service benefits charge	$/kWh
R_{DistDem}	electric delivery distribution demand rate	$/kW
$R_{\text{ES\_DistDel}}$	electrical service distribution delivery rate	$/kWh
R_{TransDem}	electric delivery transmission demand rate	$/kW
SS	supply service	Figure 1

Background

As several of the billing categories on the Pacific bills were initially unfamiliar to me, I engaged NorthWestern Energy over the telephone on Thursday, February 15, 2018, and spoke with Deborah in the Butte call center at 888-467-2669. One of the first thing we clarified is that the four categories of monthly charge, 1) electrical, 2) unmetered electrical, 3) natural gas, and 4) taxes are subdivided into two fundamental categories of Delivery Service, and Supply Service.

Deborah confirmed that Delivery Service is the charge for getting electricity (or natural gas) **TO** the customer: NWE → Meter, and that Supply Service is the charge for getting energy, in the form of electricity (or natural gas) **FROM** primary sources: Supply = Primary → NWE (Figure 1).

Figure 1. *Supply Service is the charge that NorthWestern Energy charges its customers for purchasing primary energy from generating facilities such as hydro dams, windfarms, solar farms, coal-fired power plants, nuclear plants, gas-fired plants, etc. Delivery Service is the portion of the charge that NorthWestern energy charges its customers for getting electricity (or natural gas) to the customer's meter.*

Analysis

The eight (8) separate charges, all of which are described Table 2 and which comprise the monthly charge are as follows:

$$C_{\text{monthly}} = C_{\text{ES\_DS}} + C_{\text{ES\_SS}} + C_{\text{US\_DS}} + C_{\text{US\_SS}} + C_{\text{NGS\_DS}} + C_{\text{NGS\_SS}} + C_{\text{SLT\_DS}} + C_{\text{SLT\_SS}}. \quad (1)$$

Substituting actual values of each of these charges from the Dec17 bill results in

$$\$2{,}187.31 = \$812.42 + \$774.23 + \$28.72 + \$20.24 + \$100.54 + \$83.66 + \$319.01 + \$48.49.$$

Figure 2. *The eight [8] charges from the Dec17 Pacific Steel energy bill. As can clearly be seen, the Electric Service Delivery Service Charge, C_{ES_DS} comprises, 37% of the total bill.*

Total Amount Due			$ 2,187.31
SUMMARY OF CURRENT CHARGES			
	Delivery Service	Supply Service	TOTAL
Electric Service	$ 812.42	$ 774.23	$ 1,586.65
Unmetered Service	$ 28.72	$ 20.24	$ 48.96
Natural Gas Service	$ 100.54	$ 83.66	$ 184.20
State and Local Taxes	$ 319.01	$ 48.49	$ 367.50
Total Current Charges	$ 1,260.69	$ 926.62	$ 2,187.31

While Deborah was not 100% familiar with all of the twenty [20] distinct codes on the bill that are used to calculate (1), after she and I went through a few exercises on dissecting the Dec17 energy bill one item at a time, we deduced the following:

The Dec17 Electric Service Delivery Service Charge, C_{ES_DS} of \$812.42 is comprised of three components, one of which is fixed, one of which is based on power demand, and one of which is based on energy consumed. The first of these, $C_{ES\_DS\_SC}$, the fixed GS-1 Service Charge is \$7.35. The second of these, $C_{ES\_DS\_DemC}$, the Electric Service Delivery Service Demand Charge which is a function of maximum power draw was \$705.05, and the third charge which is a function of energy consumed, $C_{ES\_DS\_DelC}$, the Electric Service Delivery Service Delivery Charge, was \$100.02. This total C_{ES_DS} is calculated as:

$$C_{ES\_DS} = C_{ES\_DS\_SC} + C_{ES\_DS\_DemC} + C_{ES\_DS\_DelC} \quad (2)$$

$$\$812.42 = \$7.35 + \$705.05 + \$100.02$$

The Electric Service Delivery Service Demand Charge, $C_{ES\_DS\_DemC}$ which is the primary component of the bill that a power conditioner is designed to reduce, and which is the largest component of the Delivery Service, and indeed the entire monthly bill is calculated according to

$$C_{ES\_DS\_DemC} = (R_{DistDem} + R_{TransDem}) \bullet (P_{DemUsage}). \quad (3)$$

Making substitutions into (3) from the Dec17 bill yields:

$$\$705.05 = (\$4.9478300 / kW + \$2.4272180 / kW) \bullet (95.60\ kW)$$

The Electrical Service Delivery Service Delivery Charge, $C_{ES\_DS\_DelC}$ of \$100.02 is the product of the electrical energy metered monthly E_E, measured in kilowatt-hours, and three separate rates, the Competitive Transition Charge for Qualifying Facilities, $R_{CTC\text{-}QF}$,[2] the electrical service distribution delivery rate, $R_{DistDel,}$ and the universal service benefits charge, R_{ES_USBC}[3]

$$C_{ES\_DS\_DelC} = (R_{CTC\text{-}QF} + R_{ES\_DistDel} + R_{ES\_USBC}) \bullet E_E. \quad (4)$$

Making numeric substitutions from the Dec17 bill into (4) yields:

$$\$100.02 = (\$0.0032410 / kWh + \$0.0039240 / kWh + \$0.0011430 / kWh) \bullet 12{,}040\ kWh.$$

To reiterate, the Electric Service Delivery Service charge, C_{ES_DS} of \$812.42 is one of eight charges that comprise a typical monthly energy bill, and happens to be the most significant, comprising 37% of the total bill (Figure 3).[4]

During our conversation, Deborah and I also confirmed that the Demand Read, DR and Demand Usage, DU are related by the Meter Multiplier, MM, in this case 40, which is a technical necessity as the meter itself cannot accept the roughly average of approximately 30-40 amperes[5] with monthly peak averages of 200 amperes that flow through the facility.[6]

[2] CTC-QF Rate http://www.northwesternenergy.com/docs/default-source/documents/mt_rates/Electric/CTC-QF-1
[3] USBS Rate http://www.northwesternenergy.com/docs/default-source/documents/mt_rates/Electric/E-USBC-1
[4] Demand Charge https://www.northwesternenergy.com/docs/default-source/documents/E-Programs/E-demandcharges.pdf
[5] Average amp calculation: A_{ave} = kWh/mo × 1000 W/kW ÷ 24 h/d ÷ 30 d/mo ÷ 460 V.
[6] Max amperage calculation: $A_{max} = P_{max}$ × 1000 W/kW ÷ 460 V.

The unmetered service consists of the security light that is not behind Pacific Steel's meter, and represents only about 2% of the total bill. Since we cannot control this charge, we neglect it from our final analysis.

Table 2. *Full financial analysis of each of the eight costs associated with each of the eight months analyzed. As the Electrical Service costs were the only two under consideration, these are the only two summed.*

charge	SEP 16	SEP 17	$(v_1-v_2)/v_2$	$(v_2-v_1)/v_1$	Δ$
C_{ES_DS}	$ 1,005	$ 770	30%	-23%	$ 234
C_{US_DS}	$ 36	$ 29	26%	-20%	
C_{NGS_DS}	$ 20	$ 15	32%	-24%	
C_{SLT_DS}	$ -	$ 264	-100%	100%	
C_{ES_SS}	$ 970	$ 831	17%	-14%	$ 139
C_{US_SS}	$ 22	$ 20	11%	-10%	
C_{NGS_SS}	$ 0	$ -	100%	-100%	
C_{SLT_SS}	$ -	$ 52	-100%	100%	
$C_{monthly}$	$ 2,053	$ 1,980	101%	100%	
charge	OCT 16	OCT 17	$(v_1-v_2)/v_2$	$(v_2-v_1)/v_1$	Δ$
C_{ES_DS}	$ 1,045	$ 791	32%	-24%	$ 254
C_{US_DS}	$ 36	$ 29	26%	-20%	
C_{NGS_DS}	$ 38	$ 39	-5%	5%	
C_{SLT_DS}	$ -	$ 282	-100%	100%	
C_{ES_SS}	$ 905	$ 838	8%	-7%	$ 67
C_{US_SS}	$ 22	$ 20	10%	-9%	
C_{NGS_SS}	$ 13	$ 26	100%	103%	
C_{SLT_SS}	$ -	$ 52	-100%	100%	
$C_{monthly}$	$ 2,058	$ 2,077	101%	102%	
charge	NOV 16	NOV 17	$(v_1-v_2)/v_2$	$(v_2-v_1)/v_1$	Δ$
C_{ES_DS}	$ 1,145	$ 774	48%	-32%	$ 371
C_{US_DS}	$ 36	$ 29	26%	-20%	
C_{NGS_DS}	$ 54	$ 71	-23%	31%	
C_{SLT_DS}	$ -	$ 291	-100%	100%	
C_{ES_SS}	$ 726	$ 795	-9%	9%	$ (69)
C_{US_SS}	$ 22	$ 20	10%	-9%	
C_{NGS_SS}	$ 25	$ 56	100%	128%	
C_{SLT_SS}	$ -	$ 50	-100%	100%	
$C_{monthly}$	$ 2,009	$ 2,085	100%	102%	
charge	DEC 16	DEC 17	$(v_1-v_2)/v_2$	$(v_2-v_1)/v_1$	Δ$
C_{ES_DS}	$ 858	$ 812	6%	-5%	$ 46
C_{US_DS}	$ 36	$ 29	26%	-20%	
C_{NGS_DS}	$ 130	$ 101	30%	-23%	
C_{SLT_DS}	$ -	$ 319	-100%	100%	
C_{ES_SS}	$ 778	$ 774	1%	-1%	$ 4
C_{US_SS}	$ 22	$ 20	10%	-9%	
C_{NGS_SS}	$ 76	$ 84	100%	10%	
C_{SLT_SS}	$ -	$ 48	-100%	100%	
$C_{monthly}$	$ 1,902	$ 2,187	98%	105%	
four-month total **savings** on metered electric service					$ 1,047
extrapolated annual **savings** on metered electric services					$ 3,140
capital **cost** of power conditioners					$ 3,174
simple payback (years)					1.01

In an effort to give this client and other potential clients a clear picture of the total energy bill, I have plotted all eight [8] charges for all eight months analyzed. These are given in Figure 3. Please note that while the natural gas portion of the bill is not directly affected in any way by the performance of the power conditioner, the taxes are affected in direct proportion to the power conditioner's ability to increase power factor and thus diminish Electric Delivery charges.

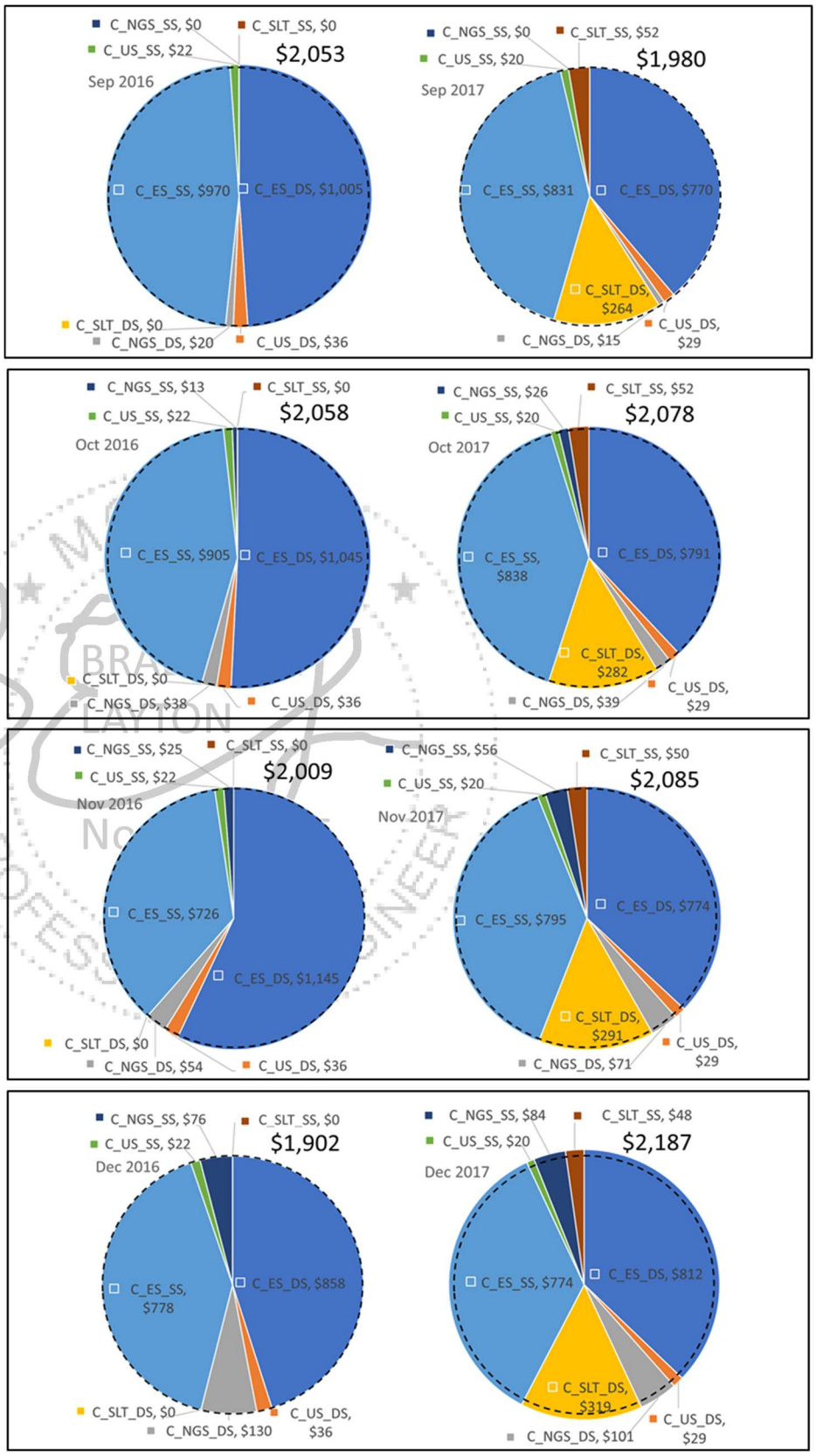

Figure 3. *Eight energy bills for Pacific Steel, Sep16, Oct16, Nov16 & Dec16 compared to Sep17, Oct17, Nov17 & Dec17. Notable is the appearance of state and local taxes on both the Supply Service, SS (top and left) and the Delivery Service, DS (bottom and right). Note that while the overall bill varies by only a few percentage points between corresponding months, the cost of electric supply (light blue) and electric delivery (dark blue), are significantly reduced. With one exception, (Nov SS) all eight [8] of the electrical service costs dropped in the four months examined for a total savings of $1,047. Extrapolated over a year, this represents an annual savings of $3,140. The dashed line seen at the circumference of each of the pie charts represents an area proportional to $2,000. For bills less than $2,000 the pie chart lies inside this dashed circle. Bills greater than $2,000 extend proportionately beyond the border.*