LOS ALAMOS

Department of Public Utilities

Electric, Gas, Water, and Wastewater Services

County of Los Alamos, NM
Value of Solar

January 11, 2017

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Introduction

This report was prepared to provide guidance on the valuation of solar renewable generation for the County of Los Alamos, NM (Los Alamos). Utility Financial Solutions, LLC (UFS) used long-run marginal cost valuation considering a natural gas fired turbine generating unit as the next generation resource. Several customers are installing renewable generation to help off-set the cost of electricity and to produce power from carbon-free sources. The purpose of this report is to identify the value of solar for electricity produced by solar generation. The study focused on two solar scenarios*:

1. Residential roof top solar
2. Commercial roof top solar

*(All solar installs for this study are assumed to be fixed panel systems with no battery storage)

The Public Utility Regulatory Act passed by Congress in 1978, and required utilities to pay an "avoided cost" value for customer-generated electricity. The value was typically set at the marginal price of fuel and ignored the capacity value the customer generation provided. In the 1990's, many states approved net metering policies for Investor Owned Utilities (IOU) which credited the customer's production at the full retail cost of electricity. The methods used in the past typically did not produce a value of customer installed generation that properly reflect the long-term cost savings to the electric utility. This study used a theoretical long-run marginal cost valuation method.

The following items were considered in determining the value of photo voltaic (PV), (solar).

1. Energy savings – The marginal energy cost of producing a kWh of electricity.
2. Generation capacity savings - The reductions in capacity provided by the distributed generation. This is determined by the cost of capacity times the distributed generation's ability to reduce the peak demands of the Utility.
3. Loss savings – Losses occur as energy is transmitted over the lines of an electric utility. Placing the generation at the customer site reduces the utility's energy losses.
4. Transmission capacity savings – This is the ability of the distributed generating unit to reduce the cost of transmission from the point of production into the utility's local distribution system.
5. Environmental benefits – Reflect the savings from the reductions in carbon that occurs with solar generation units. Currently this is not a direct cost to Los Alamos and was not considered in this analysis.
6. Distribution system:
    a. Transformers, distribution lines, substations – Investments are made to reflect the peak demands of each customer and savings will occur in the long run if the distributed generation can reduce the required size of these facilities.
    b. Sub-transmission lines and substations – The investments in these facilities are to serve the peak demands of the system. Long term savings will occur if the distributed generation can reduce the impacts on the infrastructure designed to handle the peak demands of the system.

Summary Results

The results of the study are listed in the tables below. Los Alamos should consider a credit of $0.08388 per kWh for residential solar and $0.09427 per kWh for commercial solar. The commercial class has a usage pattern that more closely matches the system peak loads. Therefore, the commercial solar has a higher avoided cost credit than residential solar due to the difference in their energy usage pattern. The detail calculations and assumptions used in the analysis are listed in the subsequent sections of this report. Please see the Appendix for load and production characteristics. Solar production peaks and commercial load peaks more closely match therefore, the distribution savings are greater for commercial solar. **This study was conducted using Los Alamos supplied peak data and detailed hourly solar production data from NREL. Hourly load data was available for Los Alamos total system, residential and commercial classes. The value of solar for Los Alamos is within the top two highest values of solar that UFS has conducted studies for. The main factors are: relatively high solar production and relatively high solar production at the time of the system peak (mainly driven by Los Alamos National Laboratory).**

Solar Summary Avoided Cost

Residential Solar

No.		Long Run - Residential
1	Production Capacity Savings	0.03118
2	Energy Savings	0.03177
3	Transmission Savings	0.01691
4	Substation and Sub Transmission	0.00288
5	Distribution Savings	0.00113
	Total	**0.08388**

Commercial Solar

No.		Long Run - Commercial
1	Production Capacity Savings	0.03118
2	Energy Savings	0.03177
3	Transmission Savings	0.01691
4	Substation and Sub Transmission	0.00288
5	Distribution Savings	0.01152
	Total	**0.09427**

Assumptions / Project Approach

The long-run marginal cost valuation assumed Los Alamos would construct a natural gas fired turbine generating unit. The section that follows details the calculations and assumptions used to determine the value of solar distributed generation.

A natural gas fired turbine generating unit operates as a base load generating unit and the study used the average all-in cost on a per kWh basis. The all-in cost used in this analysis was $1,274/KW.

Transmission

Transmission savings were identified for long-run peak demand savings.

Transmission Charges			
Peak Demand	$	4.19	kW

Distribution

The cost of service study completed in 2014 by Leidos Engineering was used to attempt to identify the distribution savings for customer installed generation. Because the Leidos study was not broken down to the level of detail needed for the solar study, certain assumptions were made on a customer peak demand before and after the installation of solar. It was assumed there would be a 7% reduction in a customer's peak demand with the installation of an average solar unit.

Solar				
Distribution Cost	Rate	Factor	Adjusted Rate	Avoided Cost
Distribution	0.01527	93%	0.0142	0.0011
Transformer	0.00117	93%	0.0011	0.0001
Avoided Cost	**0.01644**			**0.001134**

The solar production was projected from NREL (National Renewable Energy Laboratory) historical irradiance data. The table below identifies the solar production would have an annual capacity factor of 19.94%. The generation was compared with system monthly peak loads to identify the potential reduction in the peaks. This study used a sample solar install of 50 KW. However, the average annual kWh solar production per KW of solar should be consistent across other sized fixed panel installations in Los Alamos service area. As a result, the 1,747 kWh average production can be applied to residential roof top as well as commercial roof top installations. Snow days were obtained from www.currentresults.com. This was used to more accurately calculate the average capacity factor for the Los Alamos service area.

Table of projected solar production compared with system and transmission peak load data

- **Effective Average Annual Fixed Panel Solar Production per KW of Installed Solar is 1,747 kWhs**
- **Effective Average Annual Capacity Factor for Fixed Panel Solar is 19.94%**
- **Capacity factor was also validated with an actual metered solar system from Los Alamos**

2015	Average Snow Days - Santa Fe NM	kW Unit	Days	Hours	Possible kWH	kWH Produced	Theoretical Capacity factor	Non Snow Days factor	kWH Produced reduced by Snow Days	Capacity factor reduced by Snow Days
1	1.9	50	31	744	37,200	5,852	15.73%	93.87%	5,494	14.77%
2	1.5	50	28	672	33,600	6,161	18.34%	94.64%	5,831	17.36%
3	1.3	50	31	744	37,200	7,728	20.78%	95.81%	7,404	19.90%
4	0.4	50	30	720	36,000	8,481	23.56%	98.67%	8,368	23.24%
5	0	50	31	744	37,200	9,236	24.83%	100.00%	9,236	24.83%
6	0	50	30	720	36,000	8,576	23.82%	100.00%	8,576	23.82%
7	0	50	31	744	37,200	8,712	23.42%	100.00%	8,712	23.42%
8	0	50	31	744	37,200	8,304	22.32%	100.00%	8,304	22.32%
9	0	50	30	720	36,000	7,334	20.37%	100.00%	7,334	20.37%
10	0.3	50	31	744	37,200	7,184	19.31%	99.03%	7,115	19.13%
11	0.8	50	30	720	36,000	5,969	16.58%	97.33%	5,810	16.14%
12	2.2	50	31	744	37,200	5,546	14.91%	92.90%	5,152	13.85%
	8.4		365	8760	438,000	89,084	20.34%	97.70%	87,336	19.94%
						1,782			87.34	
						89.08 MWh			Produced after snow	1,747 per kW
									-1.96%	

Solar savings and avoided cost

The solar savings considers savings in production capacity, transmission, energy, substation, sub transmission and distribution. This total is divided by the units produced to come up with an avoided cost per kWh. The average annual solar avoided cost is $0.08388 per kWh for residential solar and $0.09427 per kWh for commercial solar. The respective avoided cost numbers assume a “buy all sell all” approach to metering and billing. If using a more traditional “net metering” scenario, please see “residential net metering scenario” or “net billing scenario” on the following pages.

* Note: The average residential rate below was calculated from rate schedules provided by Los Alamos. This additional monthly charge per KW of installed solar calculation will need to be updated as the average residential rate changes and / or as the PCA (if applicable) changes.

Residential Net metering (with additional charge per KW of installed solar) scenario – Long-Run

Below only used if net metering vs. buy all sell all. Othewise just use avoided cost rate

Residential Charge per kW of Solar Installation		
Average Residential Rate *	$	0.11520
PCA	$	-
Average Net Rate (Residential and PCA)	$	0.11520
Avoided Cost Long-Run		0.0839
Lost Revenues per kWh		0.0313
Annual kWh production from 1 kW of Solar		1,747
Annual Under-Recovery from Solar	$	54.71
Additional Monthly Charge per kW of installed Solar	**$**	**4.56**

* Note: The commercial rate below was calculated from rate schedules provided by Los Alamos. This additional monthly charge per KW of installed solar calculation will need to be updated as the average commercial rate changes and / or as the PCA (if applicable) changes.

Commercial Net metering (with additional charge per kW of installed solar) scenario – Long-Run

Below only used if net metering vs. buy all sell all. Othewise just use avoided cost rate

Commercial Charge per kW of Solar Installation		
Average Commercial Rate *	$	0.11110
PCA	$	-
Average Net Rate (Commercial and PCA)	$	0.11110
Avoided Cost Long-Run		0.0943
Lost Revenues per kWh		0.0168
Annual kWh production from 1 kW of Solar		1,747
Annual Under-Recovery from Solar	$	29.40
Additional Monthly Charge per kW of installed Solar	**$**	**2.45**

Recommendations

1. Los Alamos should apply the following values in the determination of rate impacts to customers.

   Buy all sell all options

   a. Residential roof top solar - $0.08388 per kWh
   b. Commercial roof top solar - $0.09427 per kWh

   Net metering (with additional charge per KW of installed solar) options

   c. Residential Net metering (with additional charge per KW of installed solar) scenario - $4.56 additional monthly charge per KW of installed solar
   d. Commercial Net metering (with additional charge per KW of installed solar) scenario - $2.45 additional monthly charge per KW of installed solar

   Net billing options

   e. Residential roof top solar - $0.08388 per kWh
   f. Commercial roof top solar - $0.09427 cents per kWh

2. The analysis is based long-run marginal costs (avoided cost) and production data from the solar renewable units compared with system monthly peak data. Both the production data and load profile will change over time and Los Alamos should consider reviewing the value of solar periodically. The value of solar calculation, review and update should mirror the general rate review process (usually annually).
3. It was discussed with staff that the buy all sell all or theoretical buy all sell all options were best suited and the staff preferred this methodology.
4. Buy all sell all and theoretical buy all sell all methodologies both require a second meter for the solar production. Los Alamos currently has two meters on each solar installation. The meter installed to track the solar production may need to be read and integrated into the billing system.
5. It is recommended that Los Alamos hire UFS to conduct a "Right Sizing" analysis to help define future solar installation sizing guidelines. This is particularly critical for larger solar installations. Many utilities will limit the size of a solar install based on a number of factors:

   (Examples only)

   - Based on percent of original customer peak. Example customer monthly peak prior to solar = 6 KW * 90% = 5.4 KW name plate solar install allowed.
   - Based on percent of original annual customer kWh consumption. Example customer annual consumption 750 kWh per mo. * 12 months = 9000 kWh per year. 9000 / 1,186 kWh solar production per KW of installed solar = 7.5 KW. 7.5 * 75% = 5.6 name plate solar install allowed.
   - Based on a percentage of excess solar being pushed back to the grid. This requires detailed hourly customer load data. The customer load data is compared to the predicted hourly solar production to calculate the percentage of solar kept behind the meter vs. excess solar pushed to the grid.

Metering and billing options defined

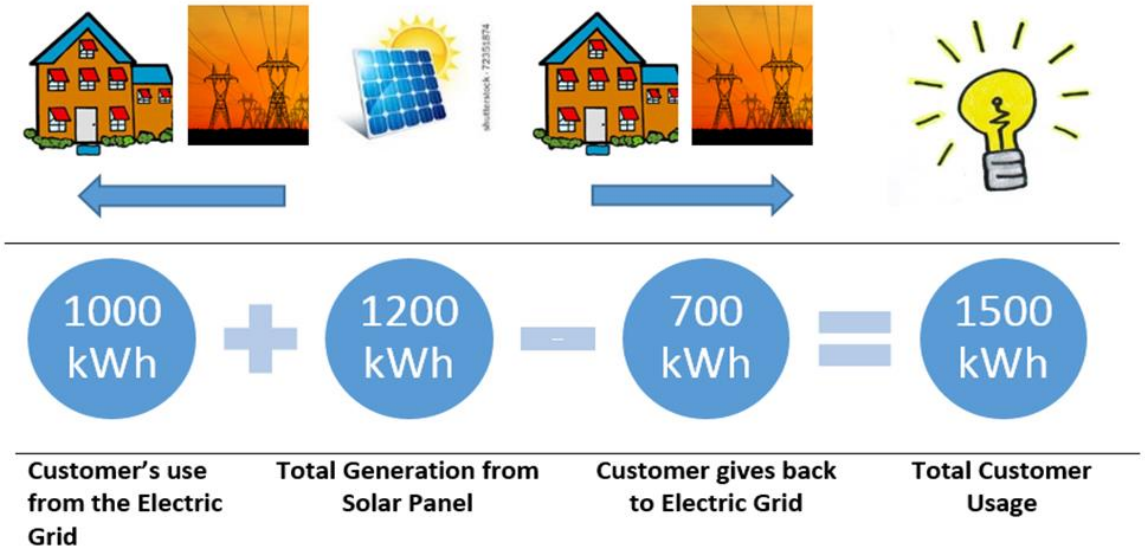
Buy all sell all

Under a buy all sell all metering and billing scenario two meters will be required. All power used by the customer will be supplied by the utility. The utility supplied power will be metered and billed at the current normal utility rates. The solar production will be metered by the second meter. All solar production will be credited to the customer at the Value of Solar rate currently in place at the time. This option is also recommended for community solar projects. **However, this option can also be done on a "Theoretical Buy all sell all" where the billing is netted on the customer bill. This allows the customer to keep as much of their solar production behind their meter as possible. (This is the recommended method for Los Alamos)**

Buy all sell all summary

Metering: Two meters are required with a buy all sell all scenario. One meter is for tracking power supplied by the utility to the customer and production sent back to the utility by the customer. A second meter is used for tracking solar production.
Solar Production: All solar production gets sent back to the utility. The customer only uses power supplied by the utility.
Billing: The utility sells all the power to the customer at the normal rate. The utility buys all the solar production at the avoided cost. (A and B above)

Buy all sell all example diagram & summary



Customer billed on total facilities electric usage - Utility credits customer on the total solar production @ $0.08388 (residential) or $0.09427 (commercial / general service) per kWh.
Metering required:

- Meter on facility
- Meter on solar unit

Metering and billing options defined

Net metering (with additional charge per KW of installed solar)

Under a net metering (with additional charge per KW of installed solar) scenario, only one meter will be required. Net metering can be done under two different metering options. The first option is a meter that "spins both ways". This type of meter will spin forward when power is being used from the utility and spin in reverse when excess solar production is being sent back to the utility. The second option is a meter that tracks the "in and out" separately (Bi-directional meter that normally tracks the kWh digitally for both in from Utility and out to Grid). The utility supplied power in and the solar production excess sent back to the utility is tracked separately. These two numbers can be netted for billing at the current normal utility rates. Under both metering options, the customer bill will be the same. At the end of the billing cycle the net usage will be billed at the current normal utility rates. If there is a billing cycle that there is more power sent back to the utility than power supplied by the utility, the excess solar production will be credited at the current normal utility rates. The customer is charged an additional monthly charge per KW of installed solar. This option is generally used for commercial and residential roof top solar customers. Some utilities will limit the dollar amount and/or number of months that an over production of solar will be allowed to be credited.

Net metering (with additional charge per KW of installed solar) summary

Metering: Only one meter is required with a net metering scenario. One meter is for power supplied by the utility to the customer. The same meter is used for solar production sent back to the utility by the customer. The two most typical single net metering options are a meter that spins both ways or a meter that tracks the "in and out" separately. Both meters should allow for the same customer bill to be calculated.

Solar Production: Only excess solar production gets sent back to the utility. The customer only uses power supplied by the utility when solar production does not meet their usage needs.

Billing: The utility sells all the power to the customer at the normal rate. The utility buys the excess solar production at the normal rate. (Net usage based on two metering options above). The customer is credited at normal rates if more solar production is sent to the utility then used from the utility. The customer is charged an additional monthly charge per KW of installed solar. (C and D above)

Metering and billing options defined

Net billing

Under a net billing scenario only one meter will be required. Net billing is typically done when the utility only has meters that spin both ways. (When the utility does not have bi-directional digital meters). This method may also be used when the Utility adopts demand based COS rates. At the end of the billing cycle, the net usage will be billed at the current normal utility rates. If there is a billing cycle that there is more power sent back to the utility than power supplied by the utility, the excess solar production will be credited at the current avoided cost. This option is generally used for commercial and residential roof top solar customers. Some utilities will limit the dollar amount and/or number of months that an over production of solar will be allowed to be credited.

Net billing summary

Metering: Only one meter is required with a net billing scenario. One meter is for power supplied by the utility to the customer. The same meter is used for solar production sent back to the utility by the customer. This typical single net meter option is a meter that spins both ways.

Solar Production: Only excess solar production gets sent back to the utility. The customer only uses power supplied by the utility when solar production does not meet their usage needs.

Billing: The utility sells all the power to the customer at the normal rate. The utility buys the excess solar production at the avoided cost. This only happens when there is a billing cycle that there is more power sent back to the utility than power supplied by the utility. (E and F above)

Appendix of Load Characteristics

The charts below are summaries of the load profiles used for Los Alamos system and solar generation. **This study was conducted using system monthly peak load data.**

Below is Los Alamos system load profile comparing mWh, peak demand of the system, date and time of the system load at the time of monthly peak. (2015 peak load data used).

System Load (2015)

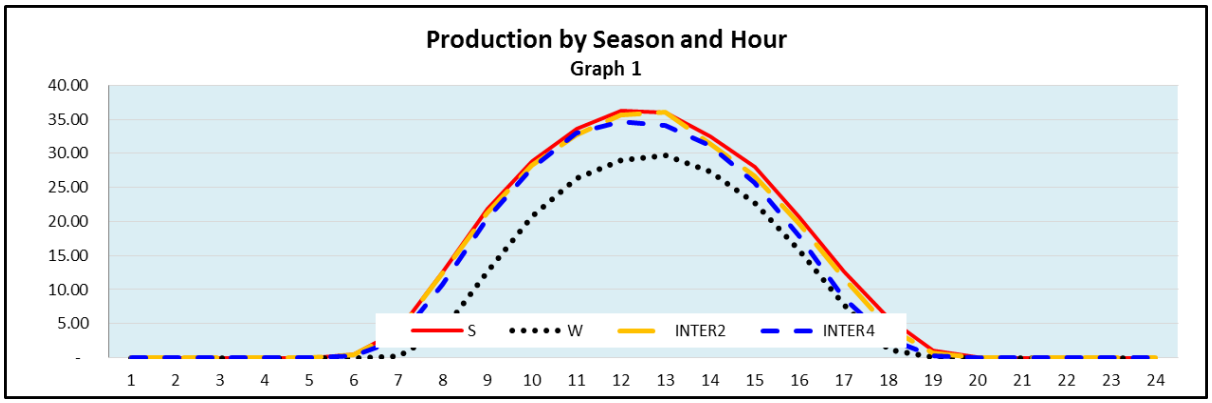
Demand Peak Summary

Month	Peak	Code	Peak Hour	Peak Date
January	84.00	January84	12	1/29/2015
February	91.00	February91	14	2/7/2015
March	79.00	March79	13	3/5/2015
April	58.00	April58	11	4/21/2015
May	58.00	May58	15	5/28/2015
June	69.00	June69	13	6/22/2015
July	72.00	July72	14	7/28/2015
August	83.00	August83	12	8/31/2015
September	85.00	September85	13	9/28/2015
October	87.00	October87	19	10/11/2015
November	84.00	November84	8	11/18/2015
December	88.00	December88	10	12/15/2015

NREL Irradiance per kW							
Month	kW Unit	Days	Hours	kWH	kWH Produced	Capacity factor	Production at time of System Peak
1	50	31	744	37200	5,494	14.77%	25.66
2	50	28	672	33600	5,831	17.36%	30.14
3	50	31	744	37200	7,404	19.90%	35.86
4	50	30	720	36000	8,368	23.24%	36.98
5	50	31	744	37200	9,236	24.83%	31.01
6	50	30	720	36000	8,576	23.82%	37.80
7	50	31	744	37200	8,712	23.42%	36.05
8	50	31	744	37200	8,304	22.32%	38.41
9	50	30	720	36000	7,334	20.37%	36.68
10	50	31	744	37200	7,115	19.13%	0.00
11	50	30	720	36000	5,810	16.14%	1.92
12	50	31	744	37200	5,152	13.85%	25.00
				438,000	87,335.66	19.94%	335.50

Appendix of Production Characteristics

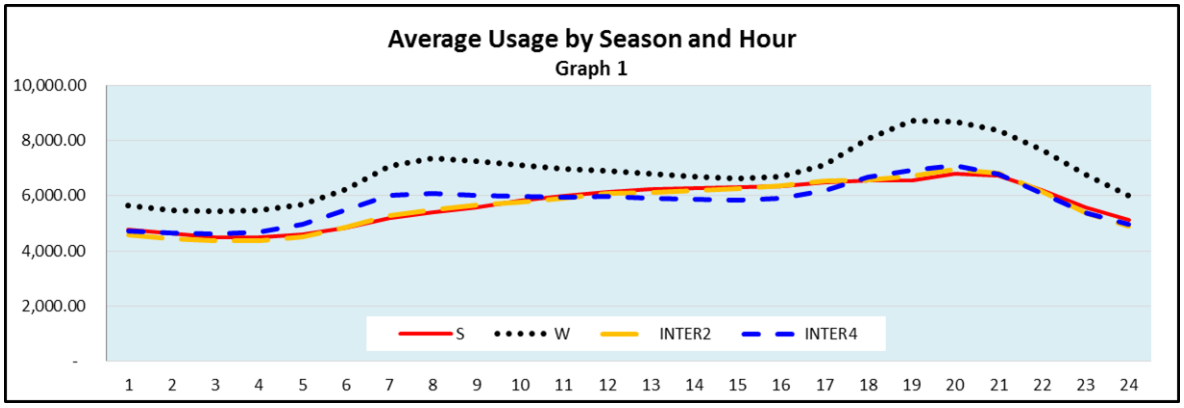
Sample Solar Production Characteristics



Appendix of Load Characteristics

The data shows that solar production peaks and residential load peaks are not as coincident. Therefore, the distribution savings are less for residential solar.

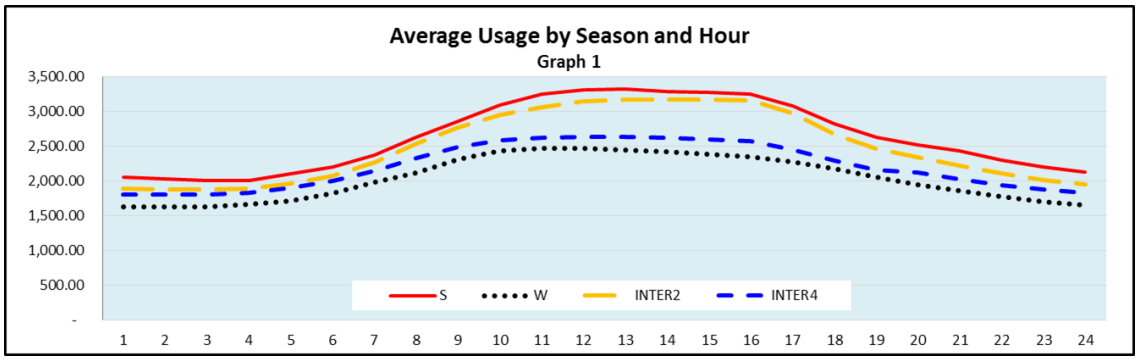
Sample Residential Load Characteristics



Appendix of Load Characteristics

The data shows that solar production peaks and commercial load peaks more closely match. Therefore, the distribution savings are greater for commercial solar.

Sample Commercial Load Characteristics



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ACCOUNTANT'S COMPILATION REPORT

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The purpose of this report is to assist management in determining the value of solar. This report should not be used for any other purpose.

The accompanying solar renewables valuation study for Los Alamos was compiled with system load data for the calendar year 2015. The load data used was supplied by Los Alamos. Solar production data used was from NREL (National Renewable Energy Laboratory).

Differences between historical (NREL production data used) and actual Los Alamos results will occur since some assumptions may not materialize and events and circumstances may occur that were not anticipated. Some of these variations may be material. Utility Financial Solutions, LLC has no responsibility to update this report after the date of this report. However, it is recommended that Los Alamos update this study as base assumptions used materially change.

This report is intended for information and use by management and the Board of Directors for the purposes stated above. This report is not intended to be used by anyone except the specified parties.

UTILITY FINANCIAL SOLUTIONS, LLC

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January 11, 2017