

September 10, 2018

United Laguna Wood Mutual at Laguna Woods Village

Attn: Ms. Juanita Skillman
24351 El Toro Road
Laguna Woods, CA 92637

Re: Year 1 Measurement and Verification Report
Energy Savings Performance Contract

Dear Ms. Juanita Skillman:

Attached please find the Year 1 Measurement and Verification (M&V) Report for the Energy Savings Performance Contract at the United Laguna Wood Mutual at Laguna Woods Village. This report covers the energy savings achieved during Year 1 Performance Period.

Due to soiled solar PV panels and trees obstructing sun lights during the winter season, Solar PV system produced 997,252kWh less than a forecasted projection of 1,158,256 kWh. Since the operation (cleaning and reducing tree shading impact) of the solar PV system is the customer's responsibility, the reported energy savings for the Solar PV is adjusted to 1,160,387 kWh.

Combining the energy saving for both ECM 1(solar PV system) and ECM 2(water heaters), the verified energy and O&M savings for Year 1 performance period is \$325,273, which is \$9,184 less than the Year 1 energy savings guarantee of \$334,457. Combined with the energy savings of \$86,325 achieved during the installation period, the Year-to-date accrued energy savings is \$411,598, which is \$77,141 greater than the total year-to-date energy guarantee.

Following your review and acceptance of this Report, please return a signed copy of the following letter to:

Johnson Controls, Inc.
5770 Warland Dr., Ste. A
Cypress, CA 90630

Sincerely,



Marcus J. Lee
Energy Solution Performance Engineer

**Measurement and Verification Report
Performance Year 1**

**United Laguna Wood Mutual Village
Performance Project**

Pursuant to the Measurement and Verification Report, dated 9/10/2018 and associated documents (collectively, the "Report") presented to me by Johnson Controls Inc., on 9/10/2018, I am in agreement that United Laguna Wood Mutual Village has realized certain project benefits (which may consist of, among other things, energy savings, potential revenue increase, rebates, capital contribution, and/or operational cost avoidance, all as set forth in additional detail in the Report) of **\$411,598** as of the end of the 1 year of the Performance Contract., as shown in the table below:

Year 1 Verified	Electricity kWh	\$ Electricity	\$ Non-Measured Benefit	\$ Total
FIM 2 Water Heaters	421,836	\$68,583	\$49,028	\$117,611
FIM 1 PV System	1,160,387	\$207,662		\$207,662
Total	1,582,223	\$276,245	\$49,028	\$325,273
			Construction Period Savings	\$86,325
			Total	\$411,598
			Year 1 Guarantee	\$334,457
			Surplus/(Shortfall)	\$77,141

The data contained in the Report show the calculations and savings data to support the savings numbers shown above.

Please sign below to indicate your acceptance of the Report for the Year 1 Performance Period. If this signed off acceptance letter is not received by 30 days after the date above it will be deemed that you accept the values in the Report.

Marcus J. Lee _____ Date _____
For: Johnson Controls, Inc.

_____ Date _____
For: United Laguna Wood Mutual Village

United Laguna Wood Mutual Village, California Performance Contract

**Year 1 M&V Report
July 1st, 2017 through June 30th, 2018**

Submitted under
Performance Contract, Dated July 6th, 2016
by Johnson Controls International Plc
September 2018

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1. EXECUTIVE SUMMARY

1.1 PROJECT BACKGROUND

The United Laguna Woods Mutual (United Mutual) and Johnson Controls, Inc. (JCI) entered into Savings Performance Contract to implement Facility Improvement Measures (FIMs) at the United Mutual village. This section provides a brief overview of the project.

- Performance Contract Signed: July 6, 2016
- Construction Commenced: July 6, 2016
- Substantial Completion and Acceptance: March 30th, 2017.
- Solar Interconnection with SCE: February 9, 2017
- Annual Performance Period: July 1st through June 30th.
- Number of Performance Years: 15 Years
- Number of M&V Services Years: 15 Years from Substantial Completion Date

1.2 BRIEF PROJECT AND ECM DESCRIPTIONS

1.2.1 Project Overview

JCI evaluated equipment and the facilities at the United Mutual. The FIMs in Table 1.2.1, were selected based on their individual and collective merit in supporting the United Mutual's objectives.

Table 1.2.1: United Mutual's FIMs

FIM #	ECM	ECM Description
FIM 1	Solar Carport Photovoltaic System	Installation of nominal 809 kWDC (As-built 797.5 kWDC) Solar Photovoltaic systems at Carport next to Laundry Buildings
FIM 2	Water heater Replacement	Replacement of existing (175) domestic hot water heaters for stand-alone laundries

1.3 GUARANTEED ENERGY AND COST SAVINGS VERSUS YEAR 1 EXPECTED.

Table 1.3.1 summarizes the proposed Savings and Cost Savings as documented in the Contract, adjusted for as-built Solar PV system size of 797.5 kWDC from nominal capacity of 809 kWDC. As such, the annual electricity from the Solar PV system was updated from 1,236,030 kWh and \$221,199 to 1,211,708 kWh and \$216,846 in energy cost savings.

Table 1.3.1: Guaranteed Energy Savings and Energy Cost Savings for Year 1

FIM #	FIM	Electricity (kWh)	Electricity (kWh \$)	Capital Cost Avoidance	Total
FIM 1	Solar PV system (As-built Capacity)	1,211,708	\$216,846		\$216,846
FIM 2	Electric Tank Water Heater	421,836	\$68,583	\$49,028	\$117,611
	Total	1,633,544	\$284,873	\$49,028	\$333,901

1.4 UTILITY RATES AND ANNUAL ESCALATIONS

Based on the contract Section 4, Schedule 2 -Baseline Calculations and Utility Rates (contract page 27), annual energy cost savings are calculated using the escalated utility rates. For this Post-Installation report, Year 1 utility rates were used to calculate the energy cost savings expected for Year 1.

Rates for FIMs will be escalated by the actual utility cost escalation, but such escalation shall not be less than the mutually agreed floor rates described in the contract, namely: the lessor of 5% escalated rates or the actual rates during the performance period.

The annual escalation rates are stipulated in the signed contract, as presented below in table 1.4.1.

Table 1.4.1 Utility Rates and Escalation Rates

Electricity Rates \$/kWh	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
FIM 1 Solar PV System	\$0.170	\$0.179	\$0.187	\$0.197	\$0.207	\$0.217
FIM 2 Electric Tank Water Heaters	\$0.158	\$0.166	\$0.174	\$0.183	\$0.192	\$0.202

1.5 CONSTRUCTION PERIOD SAVINGS

These are savings that were accrued as the FIMs were implemented. Construction Period savings were calculated based upon each FIM's percent completion during each month of the Construction Period.

For FIM 1 Solar PV system, the accrued energy cost savings are based on actual electrical production starting from January 2017 through March 2017. A monthly proration of the annual energy cost savings, for FIM 2 Water Heaters, (verified through Construction period Measurement and Verification) was derived by dividing the total annual savings by 12. The amount of each month's savings accrued was then multiplied by the percent of completed scope during the month as substantiated via Project Manager Documentation.

According to schedule 2, page 23 of the contract, "Any Project Benefits achieved during the Installation Period may, at JCI's discretion, be allocated to the Annual Project Benefits for the first year of the Guarantee Term."

Construction Period Savings started to accrue on July 1st, 2016 and ended on March 31st, 2017. The total accrued savings is \$86,325, as presented below in Table 1.5.1.

Table 1.5.1: Construction Period Savings Summary

#	FIM	Construction Period Total	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17
1	Solar PV System	\$32,420					\$822	\$8,272	\$23,326
2	Water Heaters	\$53,905	\$2,450	\$4,900	\$7,351	\$9,801	\$9,801	\$9,801	\$9,801
		\$86,325	\$2,450	\$4,900	\$7,351	\$9,801	\$10,623	\$18,073	\$33,127

1.6 SUMMARY OF MEASUREMENT AND VERIFICATION METHODS

The M&V methodologies used to verify annual savings are summarized in Table 1.6.1.

Table 1.6.1: Summary of M&V Options and Methods

FIM	M&V Option	M&V Method
Solar Photovoltaic Systems	B	Continuous Measurement of solar insolation and electrical power output & comparison to modeled energy production
Water Heaters	A	Based on collected data during the audit with savings calculation based on industry standard program

2. FIM 1: SOLAR PHOTOVOLTAIC SYSTEMS

2.1 SCOPE OVERVIEW

This measure is for the installation of photovoltaic (PV) systems which are connected to the existing site's electrical system and will generate usable electricity using solar energy. The PV system includes JA Solar multicrystalline silicon photovoltaic modules, Sunny Boy inverters, Unirac Panel racking system on the carport roofs, and Locus data acquisition and monitoring system. Table 2.1.1 below presents the location of the system and its installed DC capacity.

Table 2.1.1 – List of PV systems

Site/Location	As-Built DC Capacity
Carport Area with Laundry Buildings L23 and L24	90.7 kW + 90.7 kW
Carport Area with Laundry Buildings L50 and L52	105.8 kW + 94.5 kW
Carport Area with Laundry Buildings L88	105.8 kW
Carport Area with Laundry Buildings L90	102.1 kW
Carport Area with Laundry Buildings L91 and L92	102.1 kW + 105.8 kW

During the installation, the capacity of the solar PV system at laundry 52 was updated to 94.5 kWDC, and this changed the total capacity from 809 kWDC to 797.5 kWDC.

2.2 SAVINGS CALCULATION OVERVIEW

Industry standard software for the solar PV industry, PVsyst, was utilized to calculate the yearly energy production. Baseline Incident Radiation used in the model was based on TMY 3 data (Typical Meteorological Year based on last 30 years of history) for Laguna area. The primary concepts and terms involved in JCI savings calculations are as follows:

Guaranteed Energy = Modeled Energy x [Measured Incident Radiation / Baseline Incident Radiation] less adjustment for Production Factors.

Table 2.2.1 - Baseline Incident Radiation and Modeled Energy for Energy Year 1, with Size updated to 797.5 kWDC

Month	Baseline GHI Radiation (kWh/m2)	Modeled Energy for Energy Year 1 (kWh/kWp)
January	96.4	70.5
February	93.8	66.3
March	163.5	112.5
April	182.2	121.6
May	185.9	121.2
June	214.7	128.5
July	225.9	146.0
August	202.5	122.0
September	165.5	111.0
October	116.9	75.7
November	103.9	71.8
December	89.1	64.7
Annual Total	1,840.3	1,211.7

JCI will provide a Photovoltaic monitoring system during the Years that M&V is to be provided for the Photovoltaic System as described in Schedule 2. Modeled energy for each energy year reflects Photovoltaic array degradation of 0.5%/year of Year 1 modeled energy. The annual production by year is listed below in Table 2.2.2:

Table 2.2.2 - Modeled Energy with size adjustment to 797.5 kWDC

Energy Year	Modeled Energy (kWh/kWp)
1	1,211.71
2	1,205.60
3	1,199.60
4	1,193.59
5	1,187.59
6	1,181.68
7	1,175.77

Energy Year	Modeled Energy (kWh/kWp)
8	1,169.96
9	1,164.05
10	1,158.25
11	1,152.44
12	1,146.73
13	1,141.02
14	1,135.31
15	1,129.59

2.3 M&V ACTIVITIES

M&V Option B for this measure requires continuous measurement of solar insolation and electrical power output along with a comparison to the modeled energy production cited in the contract. Monitoring commenced with the successful commissioning and interconnection to the SCE grid starting January 2017.

JCI used Locus Monitoring system (www.locusenergy.com) to perform remote tracking and assess the system performance. The reporting generated by Locus is incorporated into savings recalculation methodology as described in the Contract, Schedule 2 M&V plan for this FIM.

2.4 YEAR 1 PERIOD PERFORMANCE

Presented is a summary of the solar PV system performance with adjustments. The electricity production was lower due to soiling of the Solar PV system and due to tree shading effect. The downloaded data from the LOCUS system is included in the appendix of the report, and also available on the LOCUS website portal.

Table 2.4.1- Summary of the PV production downloaded from LOCUS system

		A	B	C	D = C*B/A	E	F = D-E	G = F/E	H= (G - Max(Column G))* (Column D)	I = H + E
#	Year-Month	Measured Solar irradiation	Contracted Solar Irradiation	Measured Energy (kWh)	Adjusted Energy (based on ratio Solar Irradiance)	Contract Proposed/Baseline Energy (kWh)	Variance (kWh)	Variance %	Shading/Soiling Impact (kWh)	Reported Energy Output (kWh)
1	Jul-17	216.9	225.9	118,627.2	123,559.6	146,011.4	(22,451.9)	-15.4%	16,267.7	139,827.2
2	Aug-17	198.2	202.5	101,988.1	104,217.5	121,988.0	(17,770.4)	-14.6%	12,603.7	116,821.3
3	Sep-17	146.5	165.5	73,872.3	83,456.7	110,960.8	(27,504.1)	-24.8%	22,804.4	106,261.1
4	Oct-17	125.2	116.9	61,418.7	57,343.0	75,713.3	(18,370.3)	-24.3%	15,163.5	72,506.5
5	Nov-17	84.9	103.9	34,186.3	41,814.0	71,775.0	(29,961.0)	-41.7%	26,921.0	68,735.0
6	Dec-17	84.0	89.1	46,800.4	49,631.7	64,686.1	(15,054.4)	-23.3%	12,314.7	61,946.4
7	Jan-18	86.7	96.4	57,975.5	64,474.6	70,495.1	(6,020.5)	-8.5%	3,034.7	67,509.3
8	Feb-18	112.7	93.8	73,726.8	61,386.7	66,261.4	(4,874.7)	-7.4%	2,068.3	63,455.0
9	Mar-18	149.6	163.5	97,594.3	106,697.6	112,536.1	(5,838.5)	-5.2%	1,072.2	107,769.7
10	Apr-18	177.6	182.2	113,499.2	116,444.1	121,594.1	(5,150.0)	-4.2%	-	116,444.1
11	May-18	164.2	185.9	94,996.6	107,579.8	121,200.3	(13,620.5)	-11.2%	8,487.2	116,067.0
12	Jun-18	214.3	214.7	122,567.1	122,786.8	128,486.1	(5,699.3)	-4.4%	257.3	123,044.2
	Total	1,760.7	1,840.3	997,252.5	1,039,392.1	1,211,707.7	(172,315.7)		120,994.8	1,160,386.8

The downloaded data from LOCUS website portal was analyzed and compared to the field data. An additional adjustment was made to account for the loss of energy savings due to Soiling and Tree Shading/Solar Access effect.

We assumed that April 2017 was the best month out of the whole year, producing only 4.2% less than anticipated. This was used to estimate the potential electricity output (kWh) as if the solar panels were clean with minimal solar access impact, by applying the 4.2% reduction in all other months. The result of the calculation is Column H above, and the reported energy savings (as a result of the both irradiance and soiling, tree shading impact) are presented in Column I.

During the Year 1, problems with solar Panel PV cleaning and tree shading were noted and communicated to the staff at United Mutual. Presented below is a pictures taken during one of the numerous site visits and walkthrough by JCI.

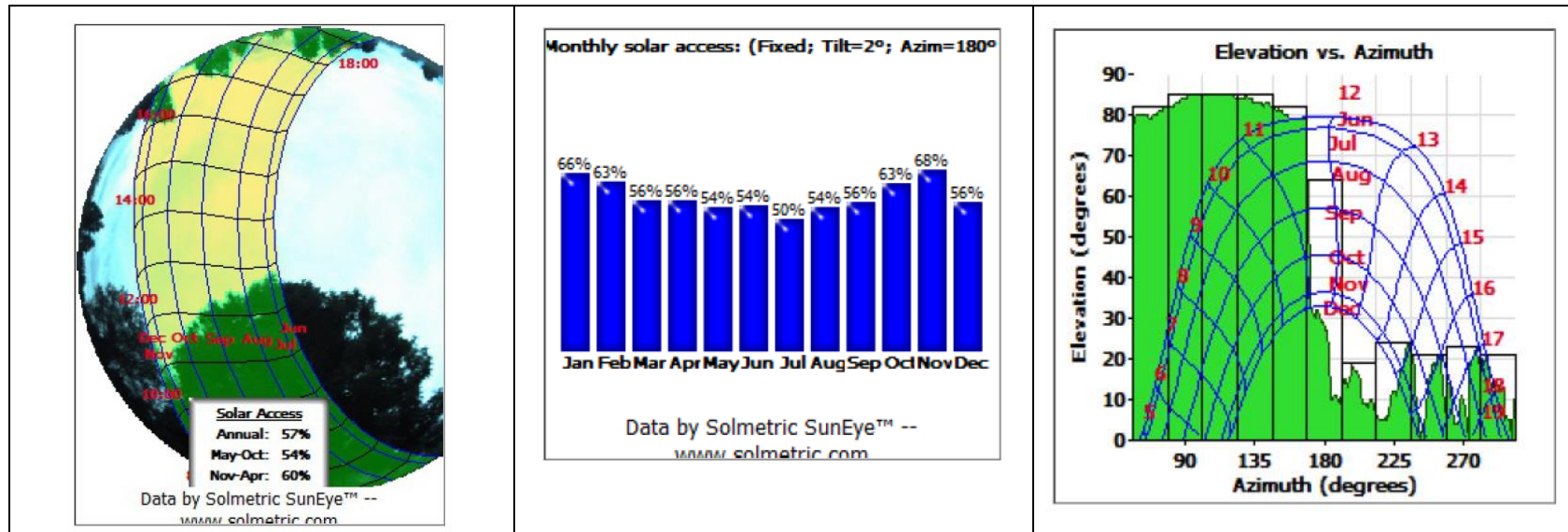
Picture 2.4.2: Picture Taken on 11/8/2017 at L88



The picture above shows Solar Panel in heavily soiled condition, in November 2017, and it matches with the November 2017 performance (-42%) as shown in the summary table 2.4.1. The customer is advised to use deionized water per contract, as tap water can leave behind calcium residue left on the solar panels. The solar panels were installed with 2 degree tilt, due to customer's directive during the development phase of this project, and thus any pooled water needs to be dried off in every wash.

In addition, some of the solar panels are still subject to significant tree shading, as shown below.

Field Analysis 2.4.3: Taken on 11/8/2017 at L90



The tree shading/solar access field analysis was conducted at L90 and at all other sites on 11/8/2017. At L90, many of the solar panels have direct access to sunlight around 57% throughout the year. A copy of the analysis is available on request.

2.5 VERIFIED SAVINGS

Presented below is the verified savings for Year 1 for the Solar PV System. It produced significantly less than anticipated during Year 1, as presented above in section 2.4. Per the contract, it is the customer's responsibility to operate and to manage solar PV systems, as such, the customer assumes the responsibility for the loss in energy generation.

Table 2.5.1: Verified Savings for FIM 1 – Solar PV

	Electricity (kWh)	Solar Irradiance Adjustment (kWh)	Soiling/Tree Shading Adjustment(kWh)	Total Reported Energy Output	Electricity Cost Savings (\$)
Contracted	1,236,030			1,236,030	\$221,199
As-Built	1,211,708			1,211,708	\$216,290
Measured	997,252	42,140	120,995	1,160,387	\$207,662
Variance					\$ (13,537)

3. FIM 2: DOMESTIC HOT WATER HEATER REPLACEMENT

3.1 SCOPE OVERVIEW

Domestic Hot Water Heaters for Stand-alone Laundries: This measure removed the existing electric domestic hot water heaters located at the Customer's laundry facilities and replaced them with new electric domestic hot water heaters.

Energy savings are achieved by installing newer and more efficient water heaters that have lower standby energy/heat losses, resulting in less need to re-heat water using electricity.

3.1.1 Savings calculation Overview

The energy savings for this FIM was developed using industry standard program, and the energy savings calculation is presented below.

Annual Energy Savings (kWh) =

*[(Heat Loss Rate (Existing DHW Heaters) x DHW Heater Surface Area in square feet)
(Existing DHW Heaters)) - (Heat Loss Rate (New DHW Heaters)) x DHW Heater
Surface Area in square feet) (New DHW Heaters)) / 3413 kW per Btu] x Annual Hours of
Standby Losses*

The energy savings and cost savings for this FIM will be revised, if the number and/or size of the existing water heaters are found to be different. Upon completion of the retrofit, energy savings and cost savings will be reported in the post-installation report.

3.2 M&V ACTIVITIES

As part of measurement and verification plan, annual visual site walkthrough was conducted at various laundries near solar PV system: Laundry Building #23, #24, #50, #52, #88, #90, #91, and #92, on 11/8/2018. The electric water heaters were visually found to be in good condition. In addition, JCI has yet to receive maintenance records from VMS, and it is presumed that the new electric water heaters are working as anticipated.

3.3 VERIFIED SAVINGS

Based on the M&V activities in section 3.3, presented below is the energy savings, which is the same as proposed in the contract.

Table 3.3.2: Verified Savings

Savings	Electricity (kWh)	Electricity (\$)	Capital Cost Savings(\$)	Total Cost Savings (\$)
Proposed	421,836	\$68,583	\$49,028	\$117,611
Verified	421,836	\$68,583	\$49,028	\$117,611
Variance	0	\$0	\$0	\$0

APPENDIX: FIM 1: DOWNLOADED SOLAR PV SYSTEM FROM LOCUS SYSTEM

Time-stamp	Laundry 23 - Measured AC Energy, sum, (kWh)	Laundry 24 - Measured AC Energy, sum, (kWh)	Laundry 50 - Measured AC Energy, sum, (kWh)	Laundry 52 - Measured AC Energy, sum, (kWh)	Laundry 88 - Measured AC Energy, sum, (kWh)	Laundry 90 - Measured AC Energy, sum, (kWh)	Laundry 91 - Measured AC Energy, sum, (kWh)	Laundry 92 - Measured AC Energy, sum, (kWh)	Laundry 88 - Weather Station - Measured Insolation Plane-of- Array
Jul-17	12,912	12,437	16,209	14,359	14,957	15,993	14,611	17,149	216,882
Aug-17	11,266	10,889	14,200	12,308	12,701	13,819	12,319	14,486	198,168
Sep-17	8,066	7,971	10,276	8,822	9,181	10,035	8,959	10,562	146,493
Oct-17	6,654	6,679	8,626	7,333	7,669	8,359	7,428	8,670	125,209
Nov-17	3,790	3,793	4,593	3,984	4,330	4,643	4,256	4,799	84,947
Dec-17	5,055	5,054	5,771	5,258	6,301	6,467	6,123	6,771	84,017
Jan-18	6,133	6,097	7,561	6,835	8,007	7,996	7,231	8,125	86,683
Feb-18	7,970	7,957	9,807	8,847	10,247	9,699	9,173	10,027	112,656
Mar-18	10,824	10,509	13,595	11,669	12,945	12,869	11,752	13,430	149,550
Apr-18	12,639	12,139	15,689	13,633	14,728	15,056	13,726	15,890	177,592
May-18	10,582	10,650	13,076	11,379	12,065	12,157	11,960	13,127	164,156
Jun-18	13,338	13,769	16,443	14,238	16,594	15,295	15,700	17,190	214,316