Commercial PV Site Assessment Report

Prepared For:

MS&S Inc.
1234 Main Street
Stevens Point, WI 54482

Prepared By:

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1.0 Executive Summary

To Mason and Ron of MS&S Inc.,

Thank you for the opportunity to work with you to analyze your business's energy usage and to explore how a grid tied solar electric system will impact your overall energy billing. The home office site gives little ground space for a PV array, but there are multiple buildings with wide-open roof space. You have given us permission to size the PV array with any of the available roof space.

The home office site on Main Street is serviced by one meter on Wisconsin Public Service (WPS) rate schedule CG-20. Annually, MS&S Inc. consumes 377,880 kWh of energy, accounting for $18,779 in charges from WPS in the past 12 months. However, this is only 48.9% of your energy bill. Your bill has a second major component – a demand charge. Over the past 12 months you have been charged $18,464 in demand charges, or 48.1% of your overall 12-month energy billing. Based on the past 12 months, and your business's typical energy use pattern, you use relatively little energy March through July (8.4% of the years energy consumption during these 5 months), then increase your usage from August through February (91.5%).

The first project option we propose will offer 32.8% reduction in annual energy billing (50.5% reduction in energy costs and 23.6% reduction in demand charges) or $10,193. The system we propose would be mounted to the potato storage shed. The south facing roof plane can support 352 PV modules, for a combined DC rating of 114.4 kW. This system would generate an estimated 148,613kWh of energy (37.2% of kWh use) in the first year of operation. The proposed system may be installed at an initial cost of $273,917, but the project will qualify for $2,400 from Wisconsin's Focus on Energy program, the 30% Federal Investment Tax Credit ($81,455 value), and will be able to utilize an accelerated depreciation schedule (worth $64,759). After these tax credits, your net project cost will be $125,303. Applying historical energy escalation rates, we anticipate this investment to return in 12.3 years.

Option #1 Financial Summary

Metric	Value
Annual energy (year 1)	148,613 kWh
Capacity factor (year 1)	14.7%
Energy yield (year 1)	1,291 kWh/kW
Performance ratio (year 1)	0.86
Battery efficiency	96.85%
Levelized COE (nominal)	9.79 ¢/kWh
Levelized COE (real)	7.74 ¢/kWh
Electricity bill without system (year 1)	$30,572
Electricity bill with system (year 1)	$20,379
Net savings with system (year 1)	$10,193
Net present value	$-7,997
Payback period	12.3 years
Net capital cost	$273,917
Equity	$273,917
Debt	$0

The second project option we propose would be to mount a PV array on the southern wall of the potato storage shed. As this wall is at a 70-degree pitch, the array will maximize fall and winter sun and minimize energy generated during the summer. This report will show how this may more directly address your energy consumption profile. Unfortunately, space is limited to 240 modules and from the data presented, there is not enough volume to overcome the lack of energy generated.

Option #2 Financial Summary

Metric	Value
Annual energy (year 1)	122,600 kWh
Capacity factor (year 1)	17.8%
Energy yield (year 1)	1,562 kWh/kW
Performance ratio (year 1)	0.80
Battery efficiency	0.00%
Levelized COE (nominal)	7.53 ¢/kWh
Levelized COE (real)	5.96 ¢/kWh
Electricity bill without system (year 1)	$30,572
Electricity bill with system (year 1)	$22,352
Net savings with system (year 1)	$8,220
Net present value	$-24,519
Payback period	13.1 years
Net capital cost	$174,223
Equity	$174,223
Debt	$0

In summary, the first option is the most cost effective design.

Bob Smith
PV Installers
March 22, 2016

2.0 Client Contact Information

Business Name	MS&S Inc.
Point of Contact (POC)	Ron - Plant Manager
POC Phone	715.555.6666
POC Cell Phone	715.555.7777
POC Email	Ron@gmail.com
Site Address	6213 County Highway HH
City	Stevens Point
State	WI
Zip Code	54482
Municipality	Township of Stockton
County	Portage
Electric Utility Provider	Wisconsin Public Service Corporation (WPSC)
Initial Date Of Contact	March 2015

Project Summary:

Ron contacted us looking to reduce MS&S Inc.'s annual energy bill and take advantage of the incentives and tax credits. Ron is unaware of how much energy PV could generate, what the investment might be like, or what the cost recovery might be. They have four large buildings and hope that we can use them. Ground arrays are not an option as the buildings are tight on the property, and there is large machinery driving throughout the yard.

The business would plan on paying for the system with cash reserves.

3.0 Client Profile

Business Type (For Profit, Non-Profit, Municipality, etc.)	For Profit Corporation (Inc.)
Property Ownership (Owned, Leased, Rented (by whom))	All property is owned by MS&S Properties Inc. and leased to MS&S Inc.
Client Goals (Criteria for a successful project)	Reduction of monthly energy costs. Want to learn if solar is a cost effective way to achieve energy savings.
Project Timeline	No timeline.
Preferred Array Location	There are 4 buildings within the home office site.
Decision Makers • Who decides? • How will they choose? • When will they choose?	Mason is the President of MS&S Inc. He will make the final decision with input from sons Curt, Mark, and Bruce, as well as plant manager Ron.
Project Financing	Cash reserves of MS&S Inc.
Obstacles to Implementation	Ron believes that ROI will ultimately be important, but monthly cash flow improvement is also important.
For Roof Mount Option • Gather information for roof loading questions. • Will builder provide written certification of roof loading?	Central States Builders constructed the largest potato storage shed. Other building contractors would need to be investigated. Need to make contact with builder.
Additional Client Goals • Does client want array to be visible? List any obstacles. • Will system be used for Marketing or Education? • Does client want to monitor system performance? • Others goals?	None.
Utility Account Manager • Identify name and contact information.	Cory at WPSC
Energy Storage (back-up)**?** Discuss critical loads	Not right now.

Project Opportunities and Challenges Analysis:

The potato shed roof loading may be an issue. This must be further investigated early in the process. Other buildings will work, but the east/west roof planes at 9 degrees will be more challenging to utilize. Flush mounted systems on these gradually-sloped roofs will experience

significant snow shading December through March, our target months for energy generation. In addition, a sawtooth configuration will significantly reduce overall roof capacity.

4.0 Client Energy Profile

Past 24 months energy bills (copies)	Attached. 12 months account data.
Meter Number	N/A
Account Number(s)	0402045638-00020
Current Rate Schedule	CG-20
Current Energy Rate	On peak: 6.448 ¢/kWh Off peak: 3.935 ¢/kWh
Current Demand Rate	Customer Demand: $1.689/kW (Based on Max demand over 11 months) System Demand: $9.272/kW Winter On Peak $13.905/kW Summer On Peak
Post PV Installation Electric Rate Schedule	PG-2A: No net metering. Excess generation during peak hours will be credited at 3.476 ¢/kWh and 2.555 ¢/kWh during off peak hours.
Number/Type(s) of Service Entrances	One; Behind potato shed (see drawing)
Single or Three Phase Power?	Three Phase.
Panel Make, Model, and Amperage	See Images Below.
PV System Disconnect Location	Not required.
Potential Interconnection location(s)	See diagram for load center interconnection.
Future Energy Projections (Increase/Decrease estimates)	MS&S Inc. anticipates steady energy use. No specific increases are expected.

Energy Analysis:

Usage History

Month/ Year	Energy On Peak (kWh)	Energy Off Peak (kWh)	Customer Demand (kW)	System Demand (kW)	TOTAL $*
Jan -16	14,640	32,880	198	146	$4,002
Feb - 16	16,680	32,880	198	150	$4,126
March -15	2,280	4,920	231	33	$1,156
April -16	2,640	7,680	231	40	$1,344
May -16	1,440	3,360	231	30	$951
June -16	1,800	3,360	231	30	$990
July- 16	1,920	2,400	231	33	$868
August -16	14,400	18,960	231	150	$4,210
Sept -16	27,600	32,160	231	198	$6,254
Oct -16	25,920	31,200	205	190	$5,730
Nov -16	18,600	31,440	198	166	$4,411
Dec -16	16,320	32,400	198	169	$4,332
Past 12 Months	144,240	233,640			$38,379

*Does not reflect entire energy bill. Meter fees, tax, and other non-kWh or kW fees have been excluded.

The energy and demand curves will not correspond well to the available solar resource. MS&S Inc. uses considerable energy beginning in August and maintains that level of energy and demand through February. During these seven months, they will consume 91.6% of their annual consumption. The demand curve follows the same as the energy curve, high in August through February.

Excess energy generation in March through July we will need to be considered. WPS will not net-meter over 20kW, so there will be significant amounts of energy valued at wholesale rates. While sizing this system to a 20 kW (AC) system would insure full retail price for all excess generation, it will only provide a 6% reduction in energy costs, a very small offset.

Steeper array pitch on the roof may be helpful but will cause roof loading concerns.

The south ‘wall’ of the potato shed may offer some opportunity. The wall is pitched to 70 degrees and could provide some closer energy generation to load mirroring. The analysis for this system will be completed in option #2.

5.0 Utility Profile

Electric Utility Provider	Wisconsin Public Service Corporation
Distributed Generation Contact • Name • Phone • Email	Cory 715.555.4444 cory@gmail.com
Can utility provide demand data?	Yes
Potential rate schedules post PV installation	Rate Schedule PG-4: Grid tied PV systems under 20 kW AC; net monthly excess generation at avoided cost (currently 3.92 ¢/kWh) Rate Schedule PG-2A: Over 20 kW AC but under 2,000 kW AC grid-tied systems; On peak exported energy 3.476 ¢/kWh Off peak exported energy 2.555 ¢/kWh Rate schedules are provided in the addendums.
Electrical Installation Requirements • NEC enforced • Local licensing	No metering or external disconnects required. Meter will need to be reprogrammed by WPSC before commissioning.
What is the transformer size that feeds the property?	
Will a study be required? What will be the cost?	PV systems at 20 kW AC or less per meter, no study required. Over 20 kW requires a WPSC review and could result in a possible study.
What is the utility's interconnection application process?	Under 20 kW – Submit a DG6027 and DG6029 with associated insurance documentation and single line diagram. Over 20 kW – submit a DG6028 and DG6030. Email to cory@gmail.com.

Utility Opportunities and Challenges Analysis:

Based on MS&S Inc.'s energy savings goals, they will qualify for the PG-2A rate schedule. Due to the uneven energy load described in Section #4, under either scenario, PG-4-or PG-2A, a good portion of the energy generated in March through July will be valued at avoided cost.

6.0 Site Profile

General Site Description	The home office site for MS&S Inc. has four large buildings and acres of growing fields adjoining the home office property. There is large, heavy machinery driving through the property, so ground arrays may be a concern for potential damage. The target roof plane is the only south pitched roof surface.
Future Property Use Considerations	No future building projects are planned for the property.
Potential Array Sites Show aerial imagery below. For ground arrays, note buried obstacles.	Target Roof Plane Processing Plant Office/Warehouse Outdoor Storage

Aerial View of MS&S Main Office

Building dimensions

Site Opportunities and Challenges Analysis:

Target roof plane features the only south facing roof (15 degrees) and steeply pitched south wall (70 degrees).

7.0 Authority Having Jurisdiction (AHJ) Profile

Authorities Having Jurisdiction (AHJ)	Town of Stockton
AHJ Contact • Name • Phone Number Email	Mike 715.555.3333 mike@gmail.com
Required Permits, Requirements, and Fees	Electrical Permit ($150 project cost) Portage County has jurisdiction over zoning. The subject property is not in a wetland, so county permit is not required.
Property Lines/Roof Setbacks	N/A if we install on the roof.
Required Inspections • Who? • What? • When?	Mike will inspect electrical system after commissioning.
Is Professional Engineering required?	Will be dependent on if roof drawings can be found. If not, yes, the roofs without drawings will require PE stamp.
Other organizations with governance (business park association, franchise requirements, historical preservation, etc.)	None identified
What is the permitting process?	According to Mike, submit electric permit application at least 1 week before commencement of work.

AHJ Opportunities and Challenges Analysis:

- Required town permit is attached to the end of this report.

No challenges noted.

8.0 Available Incentives/Grants/Tax Credits

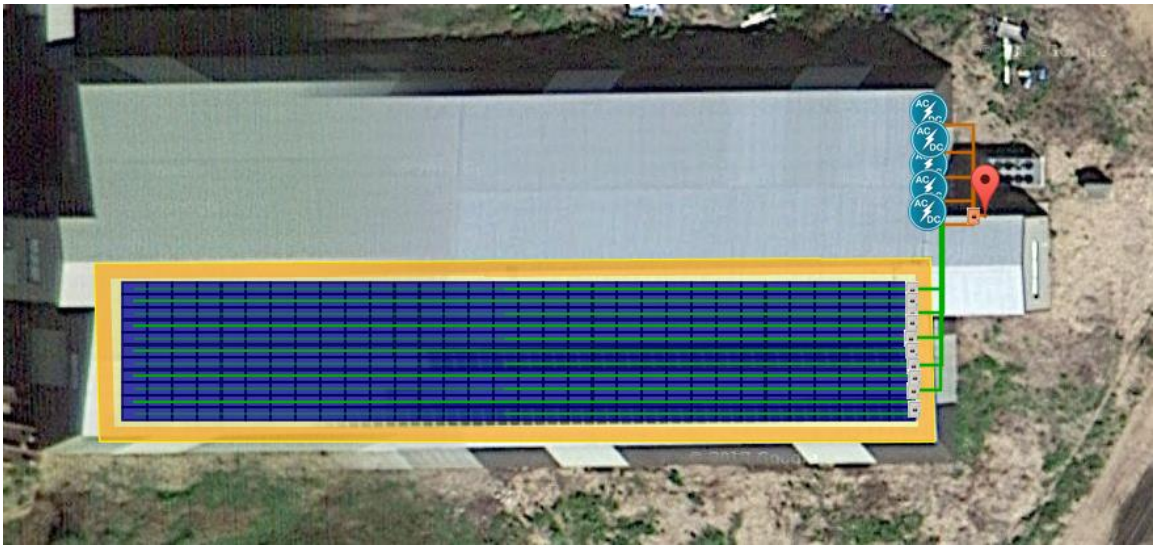
Utility Incentives/Grants	None Available
State Incentives/Grants	Focus On Energy – $2,400
Federal Investment Tax Credit	Yes
MACRS Depreciation	Yes
Other Grants	MS&S Inc.'s average annual gross receipts exceed the maximum for eligibility to apply for USDA REAP grant.
Financing Options	Not needed.

9.0 PV Array Options

PV Array Option #1

Utilize the south pitched roof and fill with modules.

Total system:
114.4 kW (DC), 100 kW (AC)
352 SolarWorld 325 Watt modules and 5 SMA Sunny Tri-Power 20,000 Watt inverters
Interconnected to Account 0402045638-00020.
Inverters located on outside of east wall next to service entrance.



Helioscope Aerial View of MS&S Potato Shed with Modules and Inverters

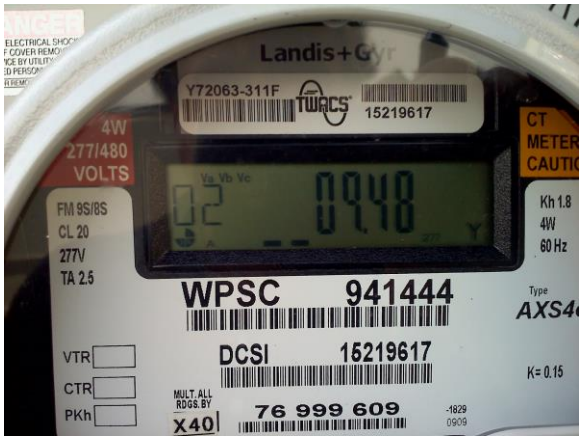
Array Description – Option #1

Site Layout	See above.
Ground Arrays • Identify soil types and depths.	N/A
Ground Arrays • Identify trench obstacles	N/A
Ground Arrays • Setback Issues	N/A
Roof Arrays • Dead Load/Wind Loading Issues	We have secured a PE stamped drawing from Keith at Central States Builders.
Roof Arrays • Fastening/ballasting issues	Fastening to Z-perlin will require through bolting or a Rivnut nutsert.
Roof Arrays • Setback Issues	4’ Minimum per Mike @ Town of Stockton
Solar Resource	No issues
Azimuth	180
Array Tilt	12.04
% Annual Energy Offset	37.2%

Interconnection/BOS - Option #1

Inverter Make and Model	SMA Sunny Tri-Power 20,000TL
Inverter Location	Outside on east wall (see image below)
Method Of Interconnection (Supply or Load side connection?)	Line side interconnection
Monitoring	None provided, none requested.

MS&S Main Meter and Load Center



MS&S Main Meter

Financial Analysis – Option #1

Metric	Value
Annual energy (year 1)	148,613 kWh
Capacity factor (year 1)	14.7%
Energy yield (year 1)	1,291 kWh/kW
Performance ratio (year 1)	0.86
Battery efficiency	96.85%
Levelized COE (nominal)	9.79 ¢/kWh
Levelized COE (real)	7.74 ¢/kWh
Electricity bill without system (year 1)	$30,572
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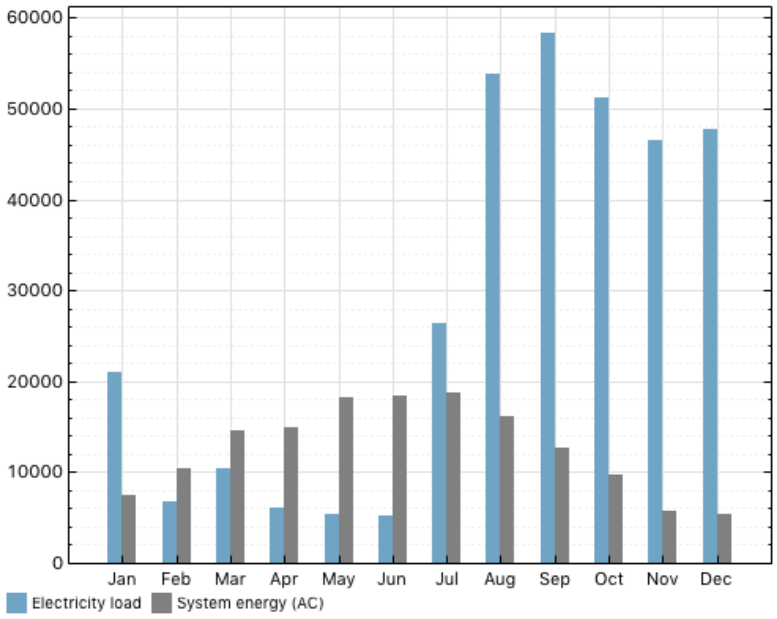
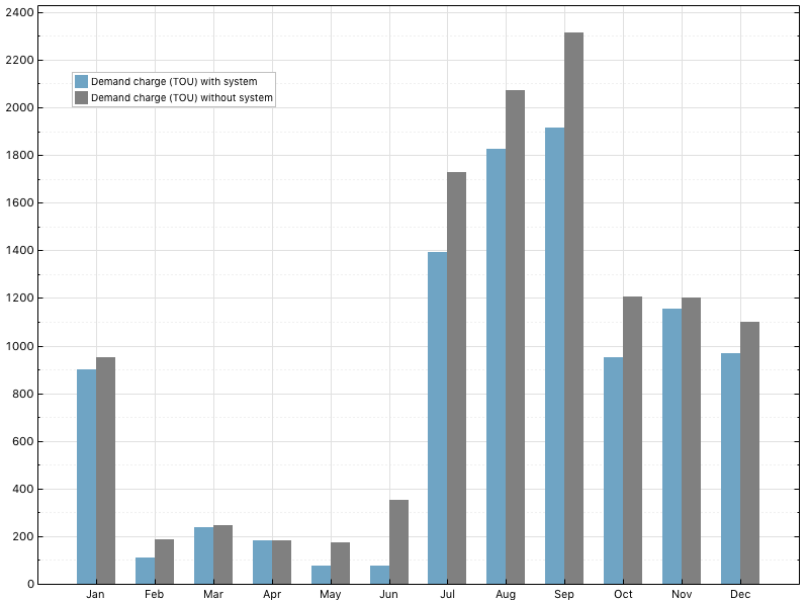
Net savings with system (year 1)	$10,193
Net present value	$-7,997
Payback period	12.3 years
Net capital cost	$273,917
Equity	$273,917
Debt	$0

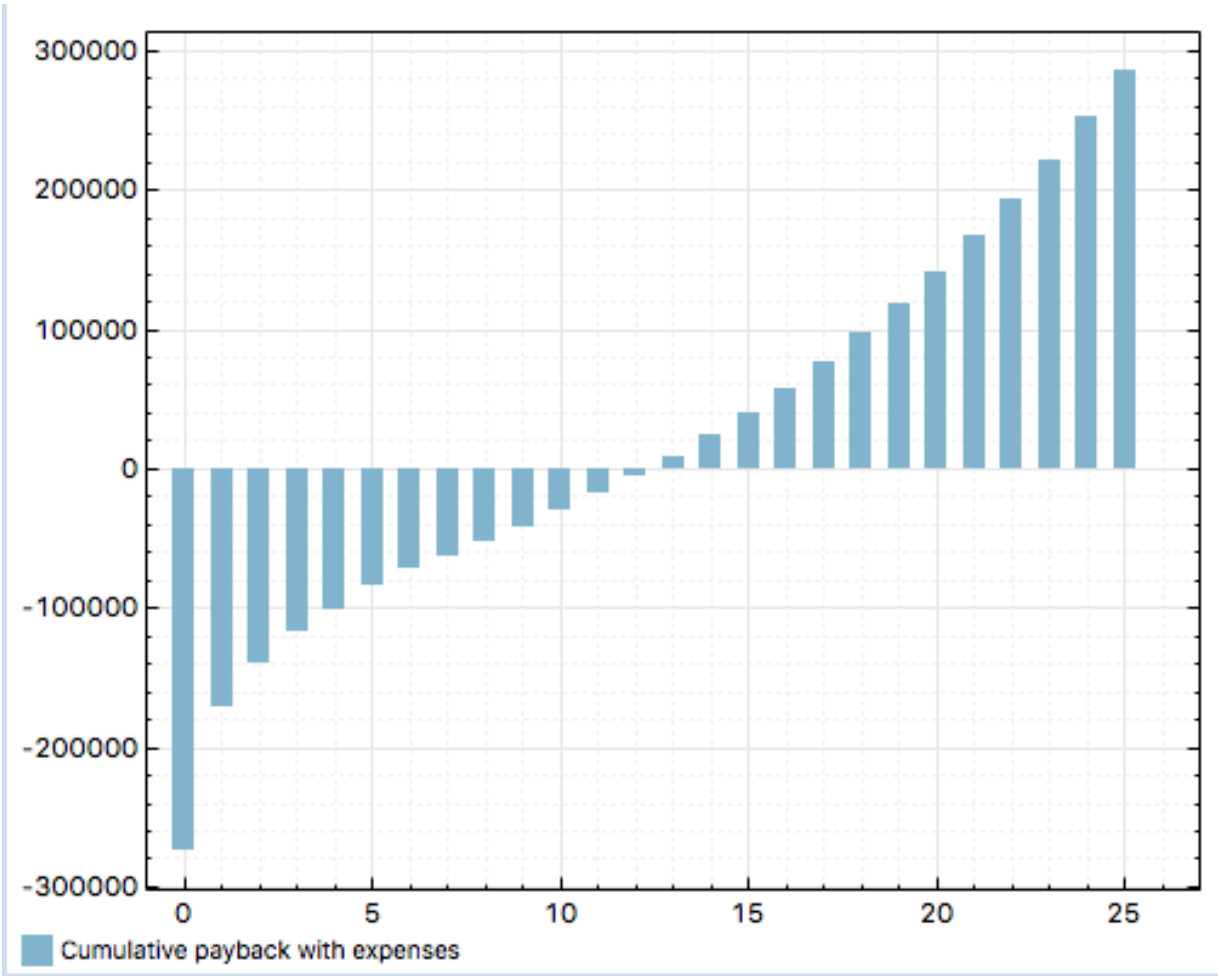
PV Energy Generation v. Current Energy Usage – Option #1



Demand Reduction by Month – Option #1



Cash Flow with Expenses – Option #1



Non-Financial Benefits – Option #1

PV FINANCE MODEL: ENVIRONMENTAL BENEFITS Revised: **3/16/15**

Environmental Factors per 1,000 kWh of Electricity Produced Each Year by a PV System:

1,000 kWh of Electricity Produced Each Year by a PV System Avoids:

burning	900	lbs of coal burned at a coal-fired power plant (1)
emitting	2,240	lbs of CO2 emitted by a coal-fired power plant (2)
emitting	1,630	lbs of CO2 emitted by non-baseload electric generation (3)

1,000 kWh of Electricity Produced Each Year by a PV System Avoids the Equivalent of:

burning	27.3	gallons of gasoline (4)
produced from	1.44	barrels of crude oil (5)
which would emit	535	lbs of CO2 (6)
while driving	642	miles in a car @ 23.5 mpg (2010) (7)

1,000 kWh of Electricity Produced Each Year by a PV System is Equivalent to:

having	0.833	acres of forest offset the CO2 emitted by a coal-fired power plant (8)

RESULTS:

During the First Year, a PV System **114.40** **kW in size, producing** **56,982** **kWh/year:**

Avoids burning	**41,284**	lbs of coal
and avoids emitting	**51,640**	lbs of CO2 by a coal-fired power plant
Avoids emitting	**55,881**	lbs of CO2 by non-baseload electric generation

If all the electricity produced by this PV System were used to charge an electric vehicle, it would:

Avoid burning	**4,286**	gallons of gasoline
produced from	**226.1**	barrels of crude oil
and avoid emitting	**83,985**	lbs of CO2 from burning gasoline
while driv	**00,782**	miles in a car with a U.S. average mileage of 23.5 mpg (2010)

The electricity produced by this PV System is equivalent to having:

	130.8	acres of forest offset the CO2 emitted by a coal-fired power plant

Data from the Midwest Renewable Energy Association.

PV Array Option #2

Utilize the south pitched wall and fill with modules to more closely match MS&S energy use and demand charges.

Total system:
78.0 kW (DC), 80 kW (AC)
240 SolarWorld 325 Watt modules and 4 SMA Sunny Tri-Power 20,000 Watt inverters
Interconnected to Account 0402045638-00020.
Inverters located on outside of east wall next to service entrance.

MS&S Potato Shed Aerial View from Helioscope with Modules on South Wall

MS&S Potato Shed – View from the south

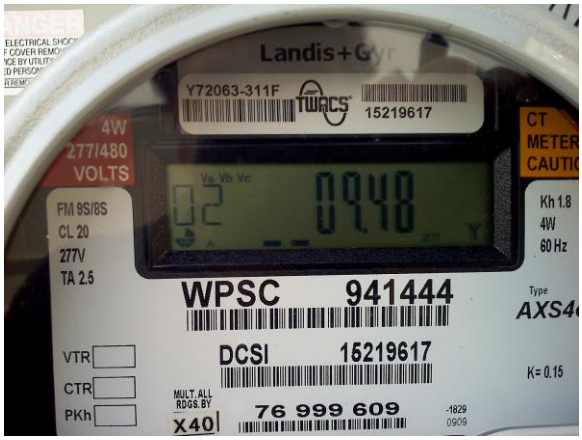
Array Description – Option #2

Site Layout	On 70 degree pitched south wall
Ground Arrays • Identify soil types and depths.	NA
Ground Arrays • Identify trench obstacles	NA
Ground Arrays • Setback Issues	NA
Roof Arrays • Dead Load/Wind Loading Issues	None : Per Keith @ Central States Builders
Roof Arrays • Fastening/ballasting issues	Fastening to Z-purlin will require through bolting or a Rivnut nutsert.
Roof Arrays • Setback Issues	None : According to Mike @ Town of Stockton, we can treat this as a wall.
Solar Resource	None
Azimuth	180
Array Tilt	70
% Annual Energy Offset	32.4%
Value of Energy	$8,220

Interconnection/BOS - Option #2

Inverter	SMA Sunny TriPower 20000-TL
Inverter Location	Outside on East Wall, next to service entrance
Method of Interconnection (Supply or Load side connection?)	Supply side interconnection
Monitoring	None

MS&S Main Electric Meter and Load Center

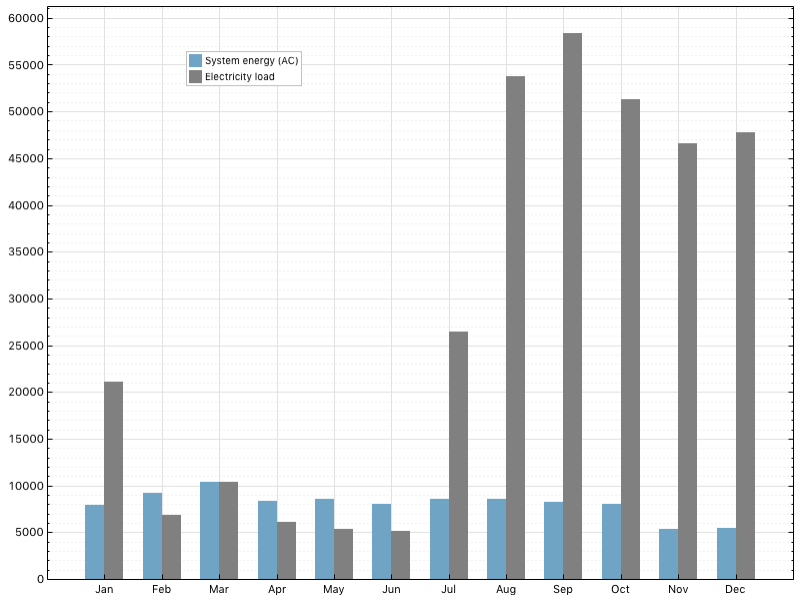


MS&S Main Electric Meter

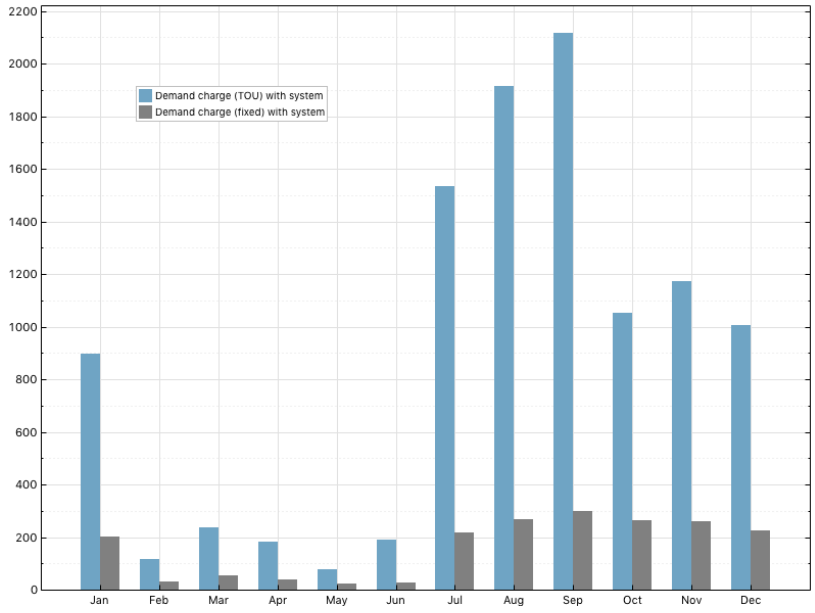
Financial Analysis – Option #2

Metric	Value
Annual energy (year 1)	122,600 kWh
Capacity factor (year 1)	17.8%
Energy yield (year 1)	1,562 kWh/kW
Performance ratio (year 1)	0.80
Battery efficiency	0.00%
Levelized COE (nominal)	7.53 ¢/kWh
Levelized COE (real)	5.96 ¢/kWh
Electricity bill without system (year 1)	$30,572
Electricity bill with system (year 1)	$22,352
Net savings with system (year 1)	$8,220
Net present value	$-24,519
Payback period	13.1 years
Net capital cost	$174,223
Equity	$174,223
Debt	$0

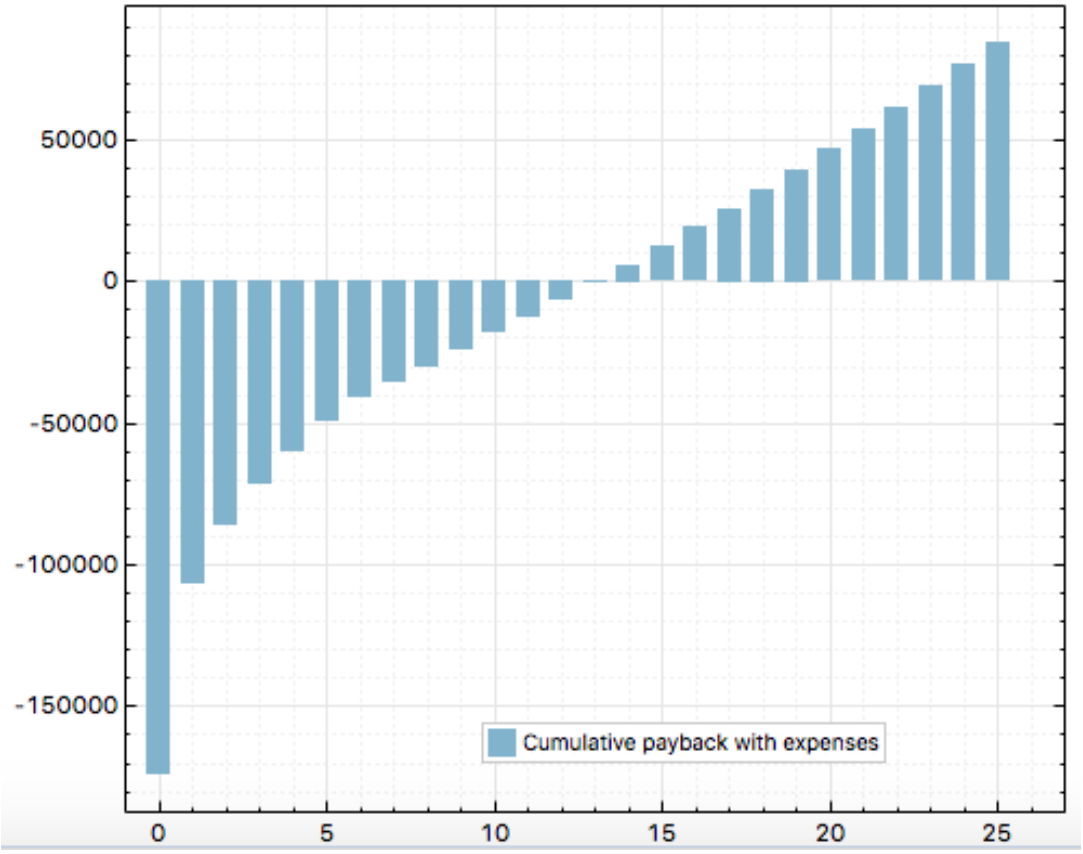
PV Energy Generation v. Current Energy Usage – Option #2



Demand Reduction by Month – Option #2



Cash Flow with Expenses – Option #2



Non-Financial Benefits – Option #2

PV FINANCE MODEL: ENVIRONMENTAL BENEFITS Revised: **3/16/15**

Environmental Factors per 1,000 kWh of Electricity Produced Each Year by a PV System:

1,000 kWh of Electricity Produced Each Year by a PV System Avoids:

burning	900	lbs of coal burned at a coal-fired power plant (1)
emitting	2,240	lbs of CO2 emitted by a coal-fired power plant (2)
emitting	1,630	lbs of CO2 emitted by non-baseload electric generation (3)

1,000 kWh of Electricity Produced Each Year by a PV System Avoids the Equivalent of:

burning	27.3	gallons of gasoline (4)
produced from	1.44	barrels of crude oil (5)
which would emit	535	lbs of CO2 (6)
while driving	642	miles in a car @ 23.5 mpg (2010) (7)

1,000 kWh of Electricity Produced Each Year by a PV System is Equivalent to:

having	0.833	acres of forest offset the CO2 emitted by a coal-fired power plant (8)

RESULTS:

During the First Year, a PV system	**78.00**	**kW in size, producing** **22,600** **kWh/year:**
Avoids burning	**10,340**	lbs of coal
and avoids emitting	**74,624**	lbs of CO2 by a coal-fired power plant
Avoids emitting	**99,838**	lbs of CO2 by non-baseload electric generation

If all the electricty produced by this PV system were used to charge an electric vehicle, it would:

Avoid burning	**8,347**	gallons of gasoline
produced from	**176.5**	barrels of crude oil
and avoide emitting	**65,591**	lbs of CO2 from burning gasoline
while driv	**78,709**	miles in a car with a U.S. average mileage of 23.5 mpg (2010)

The electricity produced by this PV system is equivalent to having:

102.1	acres of forest offset the CO2 emitted by a coal-fired power plant

Data from the Midwest Renewable Energy Association.

10.0 PV Project Summary and Recommendations

After identifying the heavy energy and demand during the fall and winter months, we wanted to compare the financial benefits between an array mounted to the 10-degree roof of the potato shed and the 70-degree south wall. The analysis was to asess if a system with energy generation skewed towards the winter months would have a strong enough financial impact to outperform perform an array that would make more energy year round, but not necessarily target the needed relief months.

The results of these two designs show that option #1, the 114.4 kW array mounted to a 10-degree pitch demonstrated a 12.3 year cost recovery period. This was slightly better than the 78 kW array mounted to a 70-degree pitch, which yielded a cost recovery of 13.1 years.