

Memorandum



DATE February 13, 2015

TO Housing Committee Members: Carolyn R. Davis, Chair, Scott Griggs, Vice-Chair, Monica Alonzo, Rick Callahan, Dwaine Caraway, and Philip Kingston

SUBJECT Solar Photovoltaic System: Residential Applications

On Tuesday, February 17, 2015, you will be briefed on residential use of solar panels: Solar Photovoltaic System: Residential Applications. This presentation will be given by representatives from Axium Solar. A copy of the briefing is attached.

Please let me know if you have any questions.



Theresa O'Donnell
Chief Planning Officer

c: The Honorable Mayor and Members of the City Council
A. C. Gonzalez, City Manager
Rosa A. Rios, City Secretary
Warren M.S. Ernst, City Attorney
Craig Kinton, City Auditor
Daniel F. Solis, Administrative Judge
Ryan S. Evans, First Assistant City Manager
Eric D. Campbell, Assistant City Manager
Jill A. Jordan, P. E., Assistant City Manager
Mark McDaniel, Assistant City Manager
Joey Zapata, Assistant City Manager
Jeanne Chipperfield, Chief Financial Officer
Sana Syed, Public Information Officer
Elsa Cantu, Assistant to the City Manager – Mayor and Council

Solar Photovoltaic System: Residential Applications

PRESENTED TO:

City Council Housing Committee

PRESENTER:

Andrew Whitehead – LEED AP, NABCEP PVI
Russell Speed – LEED AP, NABCEP PVTS

DATE:

February 17, 2015





AGENDA

- About Axium Solar
- Solar Photovoltaic Systems: Residential Applications
 - Installation – New Construction & Retrofit
 - Solar Basics: How Solar Works
 - Design Considerations & Best Practices (Case Study)
 - Solar Energy Generation
 - Cost of Going Solar
 - Upfront & Future Costs
 - Investment & Savings
 - Tax credits & Subsidies
 - Solar ROI & Lifetime Savings
 - Environmental Benefits



About Axium Solar

ABOUT AXIUM SOLAR

- North Texas based renewable energy Engineering, Procurement, & Construction company
- Specialized in the design and construction of grid connected solar electric systems for both commercial and residential clients
- Founded out of Axium Electric, (dba Automated Controls), a low voltage, building automation subcontractor serving the commercial market for the past 26 years
- 7.3 MW of Installed Capacity



ABOUT AXIUM SOLAR

- **Licensing and Certification**

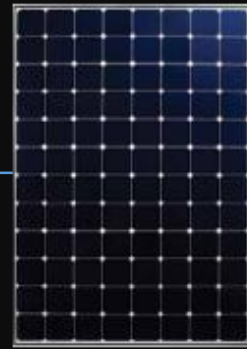
- NABCEP Certified PV installers
- Master Electricians
- NABCEP Certified PV Technical Sales Professionals
- LEED Accredited Professionals
- Texas Small Business: NCTRCA, HUB, SCTRCA





Solar Basics: How Solar Works

TECHNOLOGY





Solar Design: Best Practices

SOLAR DESIGN

Considerations & Best Practices

Orientation & Pitch

- Ideal Orientation is 180 degrees due south, also SE, SW, E, W
- Ideal Slope is Site Latitude +/- 5 degrees (5:12 – 10:12)

Shading

- Ideally no shading between 9 am and 3 pm

Setbacks & Access rows (IFC 2012)

- 3ft on pitched roofs, 4-6 ft on flat roofs

Age, Material, & Condition of Roof

- Under 10 years old preferred

Electrical Infrastructure

- 200A Service Panel on single family home preferred

SOLAR DESIGN

Considerations & Best Practices

Case Study:

5.4 kW DC PV System

(20) 270 watt solar panels

(1) 5000 watt AC solar inverter

Orientation = 178 degrees

Slope = 27 degrees (6:12)



SOLAR DESIGN

Azimuth

This chart compares the production of a 100 kWDC PV array at different azimuth degrees, all other variables being equal.

Direction	Azimuth	kWh Annual	Delta kWh from 180	% Efficiency From 180
NE	45	90,828	49,516	64.72%
E	90	113,473	26,871	80.85%
SE	135	132,183	8,161	94.19%
S	180	140,344	0	100.00%
SW	225	133,560	6,784	95.17%
W	270	115,270	25,074	82.13%
NW	315	92,049	48,295	65.59%

SOLAR DESIGN

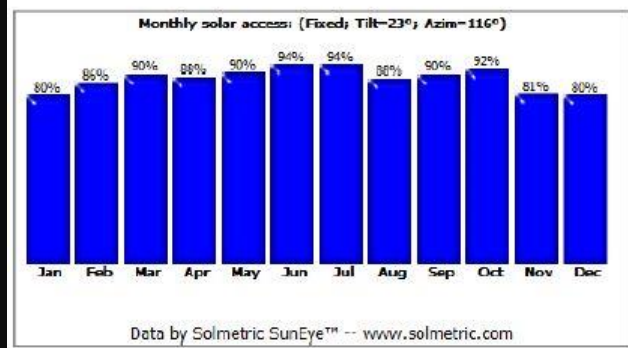
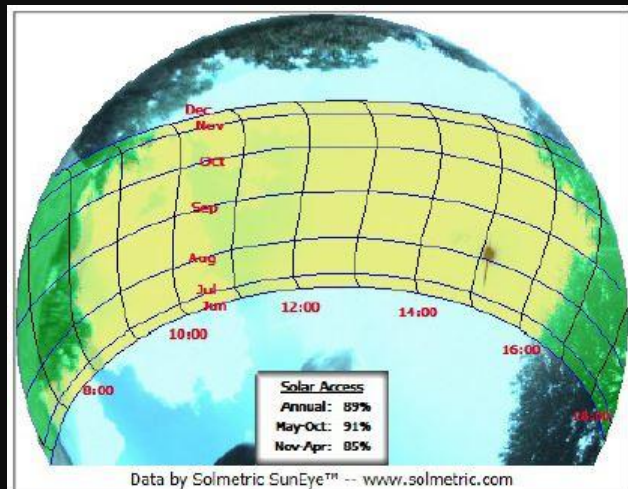
Pitch

This chart compares the production of a 100 kWDC PV array at different tilt angles, all other variables being equal.

Tilt	kWh Annual	Delta From Latitude	% Efficiency from Latitude
0	124,700	15,644	88.85%
5	129,569	10,775	92.32%
10	133,534	6,810	95.15%
15	136,560	3,784	97.30%
20	138,726	1,618	98.85%
25	140,028	316	99.77%
30	140,477	-133	100.01%
32.9	140,344	0	100%
35	140,046	298	99.79%
40	138,750	1,594	98.86%
45	136,539	3,805	97.29%

Case Study: 5.4 kW DC PV System

Shading impact of mature trees measured and accounted for in estimated energy generation



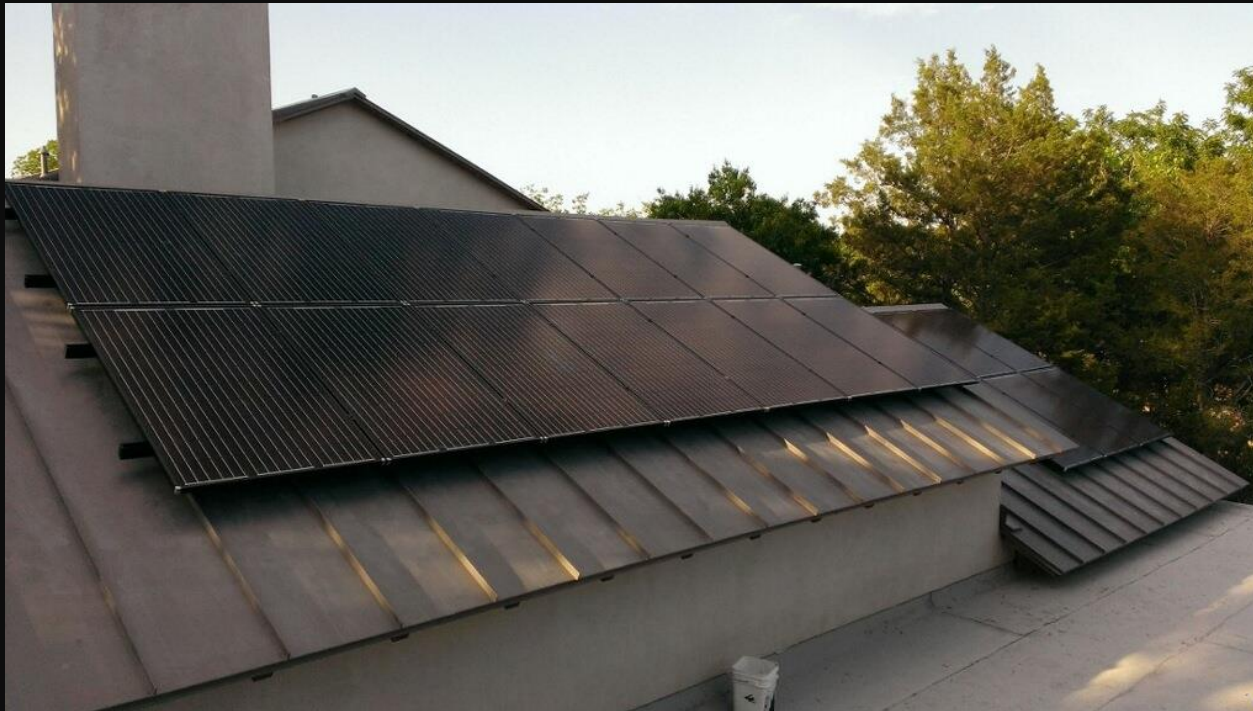
SOLAR DESIGN

Roof Material

Case Study: 5.4 kW DC PV System

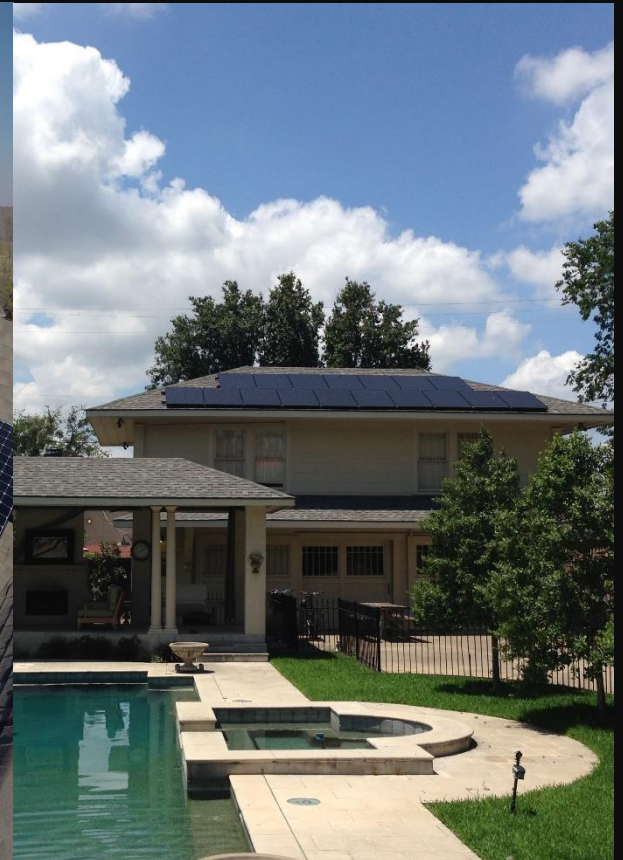
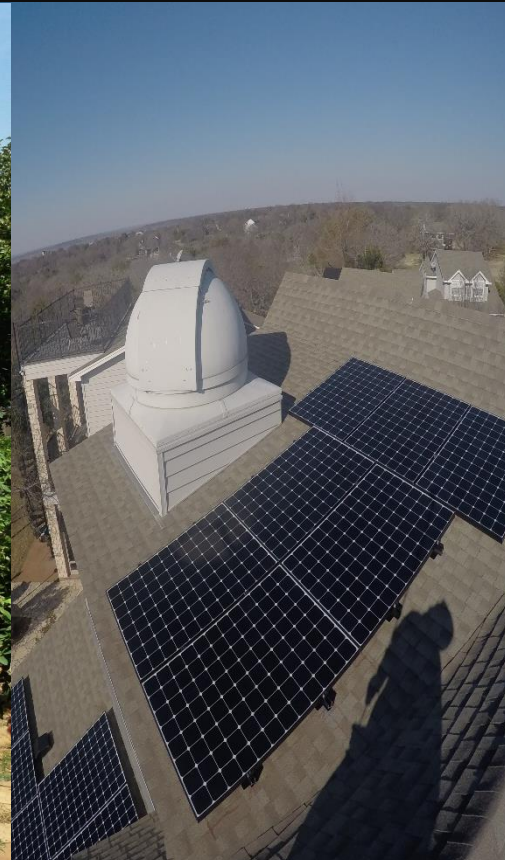
Standing Metal Seam Roof

No penetrations required to attach panels



ROOF MOUNT

Comp Shingle



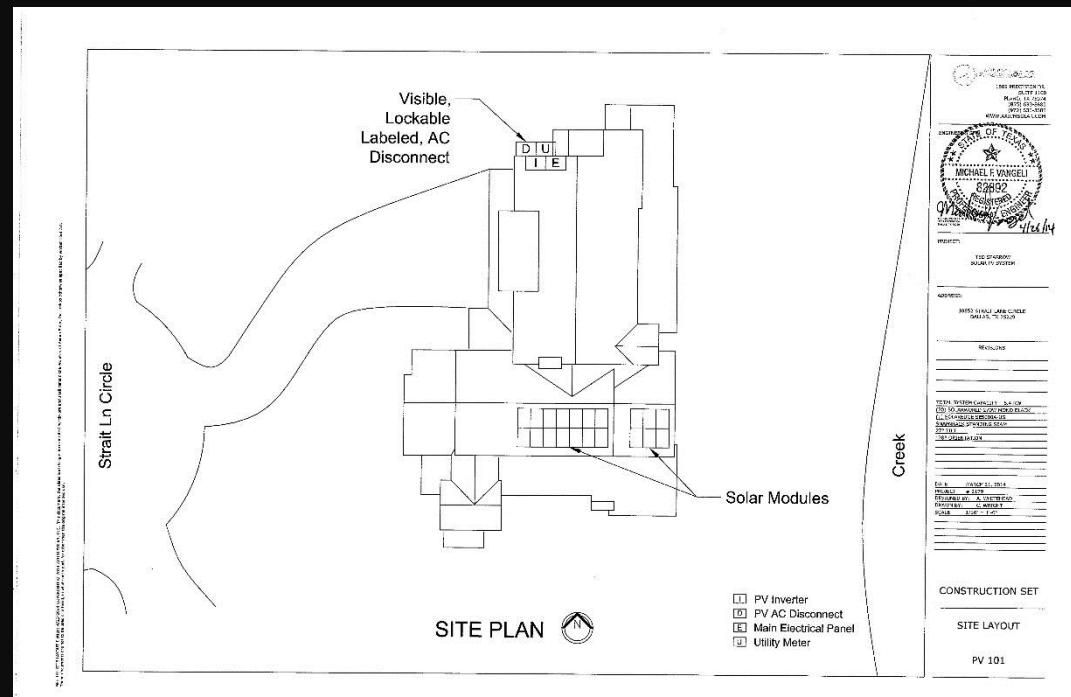
ROOF MOUNT

Metal Rooftops



Case Study: 5.4 kW DC PV System Required Setbacks

- Project permitted prior to adoption of 2012 IFC
- Current code requires 3' setback from ridgeline & 18" from valleys





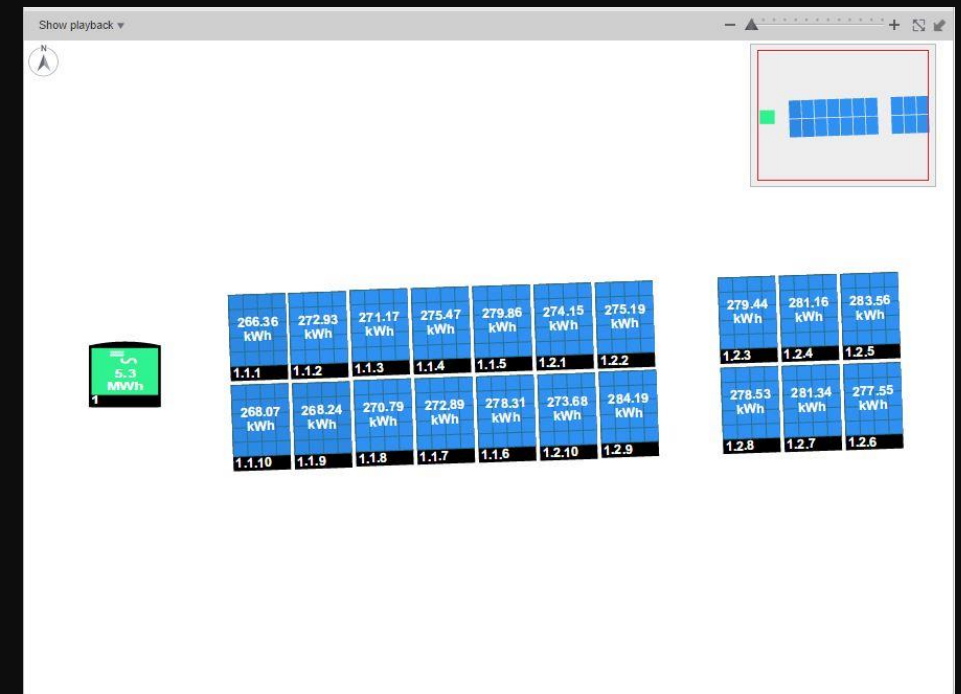
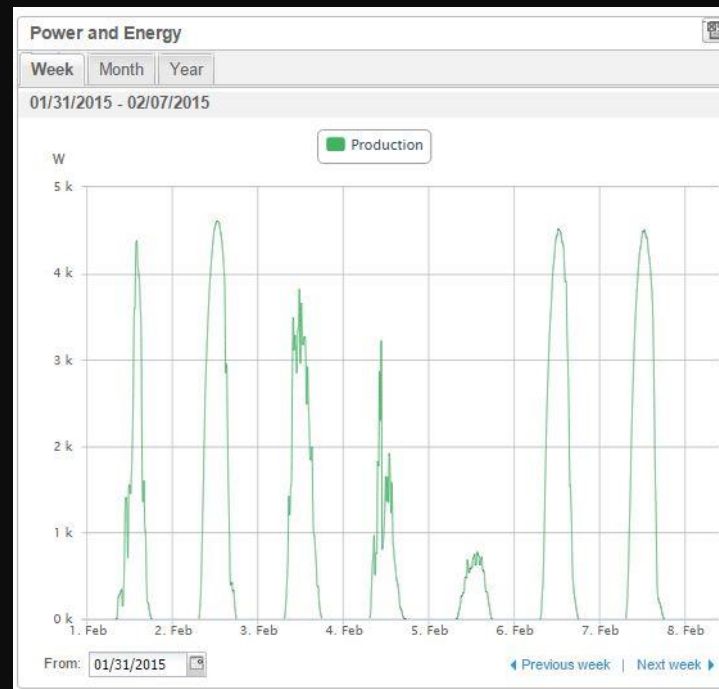
Solar Energy Generation

SOLAR DESIGN

Energy Generation

Case Study: 5.4 kW DC PV System 5.3 MWh (5,300 kWh) in 8 months

- Average of 663 kWh/month
- Approximate savings of \$80/month at 2015 rates



SOLAR DESIGN

Energy Generation

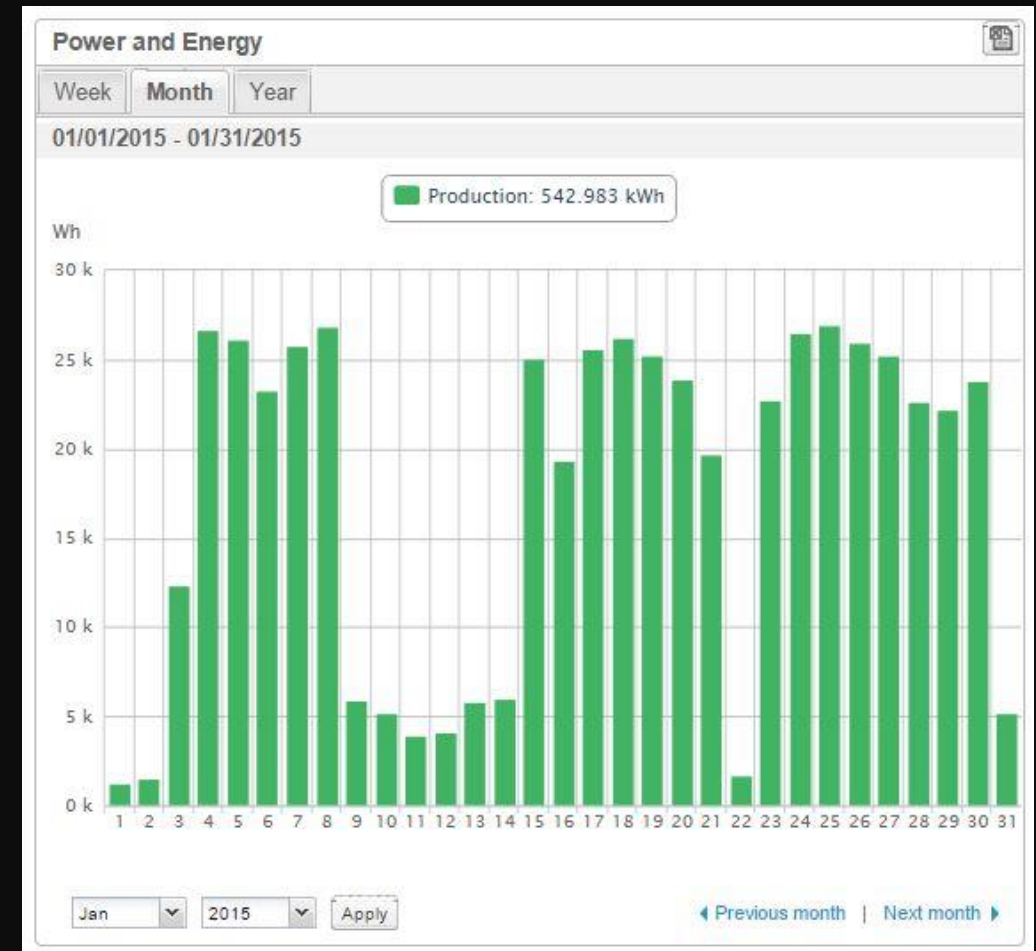
Solar Energy Generation

Rules of Thumb

1 kW DC = 125 kWh AC / Monthly Average

5 kW DC = 625 kWh AC / Monthly Average

10 kW DC = 1250 kWh AC / Monthly Average





Solar Energy Investment & Savings

DESIGN & BUDGETING

Roof Mounted Solar

- Budget Cost
 - Average - \$3,440 per kWdc
 - Min/Max - \$2,720 to \$4,800
- Estimated Production
 - 1,450 kWhac / kWdc
- Pitch
 - Parallel with the roof
- Power Density
 - 13 - 14 Watt / sq.ft. of roof space
- Deadload
 - 3 - 4 psf





SOLAR CASHFLOW

System Price Details	
System Size (kW DC)	5.4
System Sell Price	\$ 20,682.00
Incentives received by Contractor	
Estimated 2015 Oncor PV Incentive	\$ 5,131.00
Incentives received by Customer	
Est. 30% Federal Investment Tax Credit	\$ 4,665.30
Customer Investment	
TOTAL System Investment: (After estimated ITC and Utility Rebate)	\$ 10,885.70
Total Due Axium Solar	\$ 15,551.00

System Sell Price = \$3.83 per DC Watt

Utility Incentive = \$0.95 per DC Watt

Est. 30% Federal Tax Credit = \$4,665.30

NET System Investment = \$10,885.70

Estimated System Energy Production & Savings*		
	AC Energy (kWh)	Energy Savings (\$)
Average Annual kWh Production	7,950	\$954.00
Average Monthly Production	663	\$79.50

Projected Savings First Year = \$954

PV System Payback Analysis†	
System Life	25 Years
Utility Savings Over 25 Years	\$32,523.27
Levelized Cost of Energy	\$ 0.064 per kWh

Projected Savings Over 25 Years = \$32,523

Environmental Conservation Savings	
Pounds (lbs) of CO2 avoided annually	12267 lbs
Annual avoided need for additional acreage of trees to capture CO2	1.67 acres



SOLAR CASHFLOW

TOTAL INVESTMENT = \$10,885.70

**Current Effective Utility Rate = \$0.12/kWh
Assumed Rate of Escalation = 3% Annually**

PV System ROI = 11 Years

**Minimum System Life = 25 Years
Projected Savings Over 25 Years = \$32,523.27**

System Variables									
System kW	\$/kW	System Cost	Utility Rebate	Income Tax on Utility Rebate	30% Federal Investment Tax Credit	MACRS Tax Benefit Total	Total Customer Investment Before MACRS	Total Customer Investment	
5.40	\$ 3,830.00	\$ 20,682.00	\$ 5,131.00	-	\$ 4,665.30	-	-	\$10,885.70	
KWH Cost	Average Yearly Escalation	Discount Rate							
\$0.1200	3.00%	0%							

Estimated Cashflow Analysis									
Year #	Year	Grid kWh Rate with Escalation	Annual KWH Produced	Annual Energy Savings	MACRS Schedule	Cumulative Savings	Investment vs. Savings	NPV	
1	2014	\$ 0.120	7,950.00	\$ 954.00	-	\$ 954.00	(\$9,931.70)	(\$9,931.70)	
2	2015	\$ 0.124	7,910.25	\$ 977.71	-	\$ 1,931.71	(\$8,953.99)	(\$8,953.99)	
3	2016	\$ 0.127	7,870.70	\$ 1,002.00	-	\$ 2,933.71	(\$7,951.99)	(\$7,951.99)	
4	2017	\$ 0.131	7,831.35	\$ 1,026.90	-	\$ 3,960.61	(\$6,925.09)	(\$6,925.09)	
5	2018	\$ 0.135	7,792.19	\$ 1,052.42	-	\$ 5,013.03	(\$5,872.67)	(\$5,872.67)	
6	2019	\$ 0.139	7,753.23	\$ 1,078.57	-	\$ 6,091.61	(\$4,794.09)	(\$4,794.09)	
7	2020	\$ 0.143	7,714.46	\$ 1,105.38	-	\$ 7,196.98	(\$3,688.72)	(\$3,688.72)	
8	2021	\$ 0.148	7,675.89	\$ 1,132.85	-	\$ 8,329.83	(\$2,555.87)	(\$2,555.87)	
9	2022	\$ 0.152	7,637.51	\$ 1,161.00	-	\$ 9,490.83	(\$1,394.87)	(\$1,394.87)	
10	2023	\$ 0.157	7,599.32	\$ 1,189.85	-	\$ 10,680.67	(\$205.03)	(\$205.03)	
11	2024	\$ 0.161	7,561.33	\$ 1,219.41	-	\$ 11,900.09	\$ 1,014.39	\$ 1,014.39	
12	2025	\$ 0.166	7,523.52	\$ 1,249.72	-	\$ 13,149.80	\$ 2,264.10	\$ 2,264.10	
13	2026	\$ 0.171	7,485.90	\$ 1,280.77	-	\$ 14,430.58	\$ 3,544.88	\$ 3,544.88	
14	2027	\$ 0.176	7,448.47	\$ 1,312.60	-	\$ 15,743.18	\$ 4,857.48	\$ 4,857.48	
15	2028	\$ 0.182	7,411.23	\$ 1,345.22	-	\$ 17,088.39	\$ 6,202.69	\$ 6,202.69	
16	2029	\$ 0.187	7,374.17	\$ 1,378.65	-	\$ 18,467.04	\$ 7,581.34	\$ 7,581.34	
17	2030	\$ 0.193	7,337.30	\$ 1,412.81	-	\$ 19,879.95	\$ 8,994.25	\$ 8,994.25	
18	2031	\$ 0.198	7,300.62	\$ 1,448.02	-	\$ 21,327.96	\$ 10,442.26	\$ 10,442.26	
19	2032	\$ 0.204	7,264.11	\$ 1,484.00	-	\$ 22,811.96	\$ 11,926.26	\$ 11,926.26	
20	2033	\$ 0.210	7,227.79	\$ 1,520.88	-	\$ 24,332.84	\$ 13,447.14	\$ 13,447.14	
21	2034	\$ 0.217	7,191.65	\$ 1,558.67	-	\$ 25,891.51	\$ 15,005.81	\$ 15,005.81	
22	2035	\$ 0.223	7,155.70	\$ 1,597.40	-	\$ 27,488.92	\$ 16,603.22	\$ 16,603.22	
23	2036	\$ 0.230	7,119.92	\$ 1,637.10	-	\$ 29,126.02	\$ 18,240.32	\$ 18,240.32	
24	2037	\$ 0.237	7,084.32	\$ 1,677.78	-	\$ 30,803.80	\$ 19,918.10	\$ 19,918.10	
25	2038	\$ 0.244	7,048.90	\$ 1,719.47	-	\$ 32,523.27	\$ 21,637.57	\$ 21,637.57	

IRR - Investment Life	9.62%
IRR - 7 years	-9.20%
Cost of Energy	\$ 0.064 Average cost per kWh over 25 years
NPV	\$21,637.57

Assumptions / Clarifications

1. A electric utility rebate of (per DC kW)	\$ 5,131.00
2. Assumes a marginal tax rate of	30%
3. Assumes a blended utility rate of	\$ 0.120
4. Assumes a nominal discount rate of	0%
5. Assumes a nominal utility cost escalation rate of	3.0%
6. Estimated annual kWh production	7,950
7. Pricing is based on the following system type	Roof Mount

SOLAR CASHFLOW

Cost of Ownership & Maintenance



**Inverter should be serviced at or around Year 15
Estimated cost \$500 - \$1000**



Solar Panels are kept clean by regular precipitation

Cleaning with water (no cleaning agents should be used) is recommended during prolonged periods with no rainfall

Utility Incentives (Avg ~\$1.00/Wdc)

- IOUs: Oncor & AEP
 - Oncor ~\$1.00/kWdc
- Municipal: CPS Energy, Austin Energy, El Paso Electric, Denton Municipal
- Cooperatives: Coserv, TVEC, GVEC, Perdernales

Federal Investment Tax Credit

- 30% Federal Tax Credit expires 12/31/2016



THANK YOU