Solar Power for Home...

...and making sure it does not interfere with ham radio hobby.

XARC meeting September 8, 2016 Steve Verzulli KA1CNF

Topics covered

- Types of Panels
- Is it practical for our area
- How to choose a vendor
- Considerations
- Solar one year later quick analysis

Some interesting Facts

- Largest solar power plant in the world is in the Gujarat Solar Park in India, 605 MW, 4,900 acres. Mojave desert in California, 1000 acres largest in US
- In one hour the sun provides more energy to the earth than the whole world uses in one year, 1,366 watts/square meter
- 10,000 square miles in the southwestern US would generate enough energy to meet the needs of the entire country
- Earth gets 174 petawatts of incoming solar radiation at any given moment
- Germany is the world's top solar panel installer but gets as much sunshine as Alaska producing 31% of world's renewable energy
- Per Kevin Williams, Rochester gets more sunshine than Miami does during the summer due to the "reverse lake effect".

Experimental Solar Setup



WARNING ELECTRICAL HAZARD						
AT PANEL TE SHOCK AND	ERMINALS BY POTENTIAL) SPARKS.					
太陽電池モジュール (PHOTOVOLTAIC MODULE)						
種類 (TYPE)	多結晶 (MULT /STAL)					
型 式 (MODEL)	LA361G51S					
最大出力 (MAXIMUM POWER) 51., 0 W						
最大出力動作電圧 (MAXIMUM POWER VOLTAGE)	16. 9 V					
最大出力動作電流 (MAXIMUM POWER CURRENT)	最大出力動作電流 (MAXIMUM POWER CURRENT) 3.02 A					
外形寸法 (DIMENSION) 988X448X52mm						
製造番号 (SER No.) 95505087						
製造年月 (DATE) 1995. 5						
KYOCERA CORPORATION MADE IN JAPAN						

- 51 W Panel. Cost: \$225
- Voltage: 16.9 volts
- Current: 3.02 amps
- Cost/Watt: \$4.41
- Manufactured at energy loss
- Installed July 2014

What is inside the Blue box?



- Started with (1) 12V, 7 AH battery added a second
- (2) Arduino unos
- (1) Raspberry Pi Zero with internet connectivity
- APRS Baofeng (subsequently uninstalled)
- Current draw approx. 350 ma.

Lots of data (csv) from "blue box"

- Voltage
- Current
- Calculated watt hours
- Light hours
- Temperature
- First Charge controller defective after 3 months
- Ran 24/7 except for 2 weeks in December 2014
- Bottom line solar is practical for Rochester!



Solar (photovoltaic, PV) Panels

- Crystalline
 - More expensive
 - More efficient (12-20%)
 - Recommended for home
 - Best of power vs space
 - Rigid, flat mount construction
 - Mature technology

- <u>Thin Film</u>
 - Less expensive
 - Less efficient (6-10%)
 - Requires more area for equivalent power generated
 - Deformable/Flexible

Types of Crystalline Panels

- Polycrystalline
 - Less expensive (\$300)
 - Less efficient
 - Performance varies between manufacturer and models



- <u>Monocrystalline</u>
 - More expensive (\$800)
 - More efficient
 - Performance varies between manufacturer and models



Solar Insolation for Rochester

(data from http://rredc.nrel.gov/solar/old_data/nsrdb/1961-1990/redbook/atlas/)

TMY3 Data:

This data provides hourly temperature and Solar Insolation Readings for Rochester NY taken at the Airport. This data represents the typical meteorological year for Rochester, NY. Below are the Daily values for average temperature and the total solar insolation for each day of the year calculated from this data set. A smooth sinusoidal fit was also calculated for these two graphs and used in the sensitivity analysis which is discussed later.









Solar for the home

- Net Metering
- Solar feeds grid when more power generated than used
- Dual reading meter
- Incentives (\$0.70/watt)
- Tax credits (30% Fed, \$5K state)



How much Solar?

	History	
Date	Read by	kW used
07/21/15	RGE	1735
06/18/15	EST	2214
05/20/15	RGE	258
04/20/15	EST	2443
03/19/15	RGE	831
02/18/15	EST	1704
01/20/15	RGE	1364
12/18/14	EST	1159
11/18/14	RGE	1246
10/20/14	EST	1166
09/18/14	RGE	2332
08/19/14	EST	1724
07/21/14	RGE	5337
06/18/14	EST	2170
05/19/15	RGE	1028
04/17/15	EST	932
03/19/14	RGE	2426
02/19/14	EST	981
01/20/14	RGE	1259
12/19/13	EST	1137
11/19/13	RGE	1158
10/18/13	EST	1064
09/19/13	RGE	1826

- You can install anything up to 120%
- Consider payback time
- How long will you stay in present house
- Site survey
- Roof or ground
- Shading

Vendor & Size Comparison

Vendor SED 70%. System Cost \$43,607 System Size in kW 11.44 NYSERDA Incentive @ \$0.70 per watt \$8,008 Cost after Incentive \$35,599 Federal Tax Credit (25%) (after incentive) \$10,680 NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details 44 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) \$MA \$85000TL Ground Mounting tonRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$381 Levelized cost of energy \$0.072 Onling Monitoring System \$300.00 webconnect vs webb \$300.00 Webconnect vs webb \$300.00 Webconnect vs webb \$32,999.00 Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warantie					Vendo	or and Payback Analysis	Grid-Tied PV Syste	em with State Solar Incenti	ives and Feder	al Incentive			
Vendor SED 70% System Cost \$43,607 System Size in kW 11.44 NYSERDA Incentive @ \$0.70 per watt \$8,008 Cost after Incentive \$35,599 Federal Tax Credit (25%) (after incentive) \$10,680 NYS Tax Credit (25%) - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$10 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) \$MA \$B5000TL Ground Mounting ItonRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per kWh \$3,235 Price per ach (approx.) \$300.00 webconnect vs webb \$300.00 Webconnect vs webb \$32,999.00 Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25					Domorio % Et						Donnio		
Ventor Sector System Cost \$43,607 System Size in kW 11.44 MYSERDA incentive @ \$0.70 per watt \$8,008 Cost after Incentive \$35,599 Federal Tax Credit (30%) (after incentive) \$10,680 MYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$10,000 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) \$MA \$B5000TL Ground Mounting ItonRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Opling Monitoring System \$300.00 webconnect vs webo \$300.00 System Efficiency 10 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.05 Inverter Load Ratio 1.14	SE	ED 70%	SED 90%	SED 00%	Owik Solar	owikSolar Alt Dapols	OwikSolar alt Kw	Penewable Pochester		ACES	Solar& MindEx	OwikSolar	Renewable Pochester
System Cost \$43,607 System Size in KW 11.44 NYSERDA Incentive @ \$0.70 per watt \$8,008 Cost after Incentive \$35,599 Federal Tax Credit (30%) (after incentive) \$10,680 NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$10,800 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting IrooRidge Price per kWh \$3,235 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 Webconnect vs webdo \$2,999.00 Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 20	<u>244</u>	-0.1070	<u>9229 0070</u>	<u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>	XIIINOOIU	Concolar ne. r ancio	Xuinoola al. INI	<u>Henewable Hoenester</u>		NOLD	Solard Mildl &	XIIIIOO	<u>Renewable Roenester</u>
System Size in kW 11.44 NYSERDA Incentive @ \$0.70 per watt \$8,008 Cost atter Incentive \$35,599 Federal Tax Credit (30%) (after incentive) \$10,680 NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$10,680 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) \$MA SB5000TL Ground Mounting InorRidge First Year Production in kWh \$3,235 Price per kWh \$3,235 Price per watt \$3,80.00 System Efficiency \$300.00 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25 Inverters 25		\$43.607	\$50,299	\$57.955	\$48,564	\$39.687	\$41.093	\$50,400		\$41.050	\$40.255	\$36,846	\$39.50
NYSERDA Incentive @ \$0.70 per watt \$8,008 Cost after Incentive \$35,599 Federal Tax Credit (30%) (after Incentive) \$10,680 NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$10,680 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) \$MA SB5000TL Ground Mounting InoRRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$38.81 Levelized cost of energy \$0.072 System Efficiency 10 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$20,990.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25 Inverters 25		11.44	13.52	15.6	13.52	11.7	11.44	10.46		10.26	12.48	10.4	9.8
Cost after Incentive \$35,599 Federal Tax Credit (30%) (after incentive) \$10,680 NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$19,919 Details \$200 Solar Panel Kyocera KD200-604 Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting InoRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Onling Monitoring System \$300.00 System Efficiency 10 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.05 Inverter Load Ratio 1.14 Warranties (in years) \$25 Inverters 25	\$0.70 per watt	\$8,008	\$9,464	\$10.920	\$9,464	\$8,190	\$8,008	\$7.322		\$7.182	\$8,736	\$7.280	\$6.86
Pederal Tax Credit (30%) (after incentive) \$10,680 NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$10,680 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) \$MA SB5000TL Ground Mounting InorRidge Frist Year Production in kWh \$3,235 Price per watt \$3,830 Levelized cost of energy \$0,072 Online Monitoring System \$300.00 System Efficiency 10 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Waranties (in years) 25 Inverters 25 Inverters 25		\$35,599	\$40,835	\$47.035	\$39,100	\$31,497	\$33,085	\$43.078		\$33,868	\$31,519	\$29,566	\$32,640
NYS Tax Credit (25% - \$5k max) \$5,000 Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details \$19,919 Details 44 Panel Number of Panels 44 Panel Watts 260 Inverters (2) \$MA SB5000TL Ground Mounting InorRidge First Year Production in kWh \$3,235 Price per kWh \$3,235 Price per watt \$300.00 Webconnect vs webb \$300.00 System Efficiency 10 Danel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Waranties (in years) 25 Inverters 25 Inverters 25	6) (after incentive)	\$10,680	\$12,251	\$14.111	\$11,730	\$9,449	\$9,926	\$12,923		\$10,160	\$9,456	\$8,870	\$9,79
Bridge Loan amount yes low interest Cost after Incentive/Tax Credits \$19,919 Details Solar Panel Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting InorRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Opling Monitoring System \$300.00 webconnect vs webo System Efficiency Total Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.05 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25 Inverters 25	\$5k max)	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000		\$5,000	\$5,000	\$5,000	\$5,000
Droge Coart amount yes fow interest Cost after Incentive/Tax Credits \$19,919 Details \$19,919 Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting IronRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 webconnect vs webconn	VA	e low interest						Low or no cost tax amt					
Details Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting IrooRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 webconnect vs webcon	ax Credits	\$19,919	\$23,585	\$27,925	\$22,370	\$17,048	\$18,160	\$25,155		\$18,708	\$17,063	\$15,696	\$17,848
Solar Panel Kyocera KD200-60F Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting IronRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 System Efficiency 10 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25													
State State Number of Panels 44 Panel Watts 260 Inverters (2) SMA SB5000TL Ground Mounting ItonRidge First Year Production in kWh 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Onling Monitoring System \$300.00 System Efficiency 10 Danel Cost each (approx.) \$300.00 Inverter Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25	Kv	ocera KD200-60E	Kvocera KD260	Kvocera KD260	Kvocera A-KD 260	ReneSolar	Kyocera KD 260	SunPower SPR-327		SolarWorld 285	Suniva 260	Kyocera KD-260	Sunnower SPR-327
Name 260 Inverters 20 Ground Mounting IronRidge First Year Production in kWh 13.479 Price per kWh \$3.235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitring System \$300.00 Webconnect vs webc \$200.00 System Efficiency \$200.00 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Waranties (in years) 25 Inverters 20	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	44	52	60	52	52	44	32		36	48	40	30
Inverters (2) SMA SB5000TL Ground Mounting IronRidge First Year Production in kWh 13.479 Price per kWh \$3.235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 System Efficiency \$300.00 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter Load Ratio 1.14 Waranties (in years) 25 Inverters 25		260	260	260	260	225	260	327		285	260	260	327
Arrowski statistic Arrowski statistic First Year Production in kWh 13.479 First Year Production in kWh 13.479 Price per kWh \$3.235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 webconnect vs webo \$20.000 System Efficiency 10 Danel Cost each (approx.) \$300.00 Inverter Load Ratio 1.14 Waranties (in years) 25 Inverters 25	(2)	SMA SB5000TI	(2) SMA SB5000T	(2) SMA SB5000T	Fronius	Fronius	Fronius	(2) SMA 5000TL-12-240		Emphase M250 micro	DwrOne 6kw	Fronius Drimo 8.2	(1) SMA 6000TL-22-240
Journal Maining Journal Journal 13.479 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 webconnect vs webo \$200.00 System Efficiency 10 Danel Cost each (approx.) \$2099.00 Inverter Load Ratio 1.14 Waranties (in years) 25 Inverters 25	(2)	nRidge	(2) 500 50500011	(2) 500 30300011	Schletter	Schletter	Schletter	DPW mulitoole		IronRidge	Zilla	Schletter	Lini-Rac (2 poles)
Price per kWh 13.3/9 Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Quine Monitoring System \$300.00 webconnect vs webo System Efficiency 10 Panel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$300.00 Inverter Load Ratio 11.14 Warranties (in years) Panels 25 Inverters 20		12 470	15.020	10.270	14 072	12.07	12 407	12.452		ITOIRTidge	15 200	11 44	11 67/
Price per kWh \$3,235 Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 System Efficiency \$2000 Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$300.00 Inverter Load Ratio 11.14 Warranties (in years) Panels 25 Inverters 20	I KVVII	13.479	15.929	10.370	14.072	12.07	12.407	12.432			13.200	11.44	11.0/4
Price per watt \$3.81 Levelized cost of energy \$0.072 Online Monitoring System \$300.00 Webconnect vs webo \$300.00 System Efficiency 10 Panel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 20		\$3,235	\$3,158	\$3,153	\$3,265	\$3,084	\$3,291	\$4,048		#DIV/0	\$2,633	\$3,221	\$3,384
Levelized cost of energy \$0.072 Online Monitoring System \$300.00 System Efficiency webconnect vs webo Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) Panels Panels 25 Inverters 20		\$3.81	\$3.72	\$3.72	\$3.59	\$3.39	\$3.59	\$4.82		\$4.00	\$3.23	\$3.54	\$4.03
Opline Monitoring System \$300.00 System Efficiency webconnect vs webo Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25	rgy	\$0.072	\$0.072	\$0.074				\$0.074			\$0.046		
System Efficiency webconnect webconnect Total Inverter AC (kW) 10 Panel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 25	om	\$300.00			2	2	2	Ves Suppower		\$550.00	included	2	2
System Efficiency December 10 (Mediater 10) (M	we	phonnect vs webr	v2					res, componed		\$000.00	mondaed		
Optimization Control Panel Cost each (approx.) \$300.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) 25 Inverters 20			(<u>)</u>										
Nata Inforto Froe (approx.) \$300.00 Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) Panels Panels 25 Inverters 20		10	12	15				10			6	2	F
Inverter cost each (approx.) \$2,999.00 Inverter Load Ratio 1.14 Warranties (in years) P Panetes 25 Inverters 25) (YC	\$300.00	included	included				\$833.00					\$833.00
Inverter Load Ratio 1.14 Warranties (in years) Panels 25 Inverters 25	irox.)	\$2,999.00	lineidada	inolada				\$2,999.00		\$300.00	\$3,390.00	\$2,834.00	\$2,999.00
Warranties (in years) Panels 25 Inverters 20		1.14	1.13	1.04	#DIV/0!	#DIV/0!	! #DIV/0!	1.05	****	# #DIV/0	.08	1.27	1.63
Panels 25 Inverters 20													
Inverters 20		25	25	25	25	25	25	25		25	25	25	25
		20	20	20	10	10) 10	10		10	25	10	10
Mounting System 20		20	20	20	10	10) 10	10		10) 10	20	10
Labor 5		5	5	5	5	10	10	?		5	5	20	5
Payback Time (years)								12					
Notes:													
1.0 QwikSolar note on Dennis quote mentions installation will inc	Dennis quote mentions	installation will ind	clude a PVC Pipe sl	eeve for the first 18	" of embedment of	the solar posts							

Grid-Tied PV System Types



PV Array: Each module wired to its individual microinverter; paralleled AC output

Our system

- Goal was to cover 90% of electric usage for year 15.6 kW
- Installer selected SED, Sustainable Energy Developments, Ontario, NY
- 60 Kyocera 260 watt panels -25 year warranty
- One SMA 7,000 watt string inverter & One SMA 6,000 watt string inverter. Best reliability, web interface, display, longest warranty, RFI tested. 3000 watts available if grid goes down (secure power supply). Premium cost compared to other vendors -20 yr. warranty
- Iron Ridge Support system, concrete sono tubes vs pound-in brackets. Fixed 30 degrees -25 yr. warranty
- South facing, 180 degrees, no shade, 30 degree fixed tilt angle, Ideal conditions.
- No microinverters or optimizers!

15.6 kW Solar Array



	JOCEI	Ra PHOT			
MODEL	KD260GX	-LER2	OTOLIA	IC MODULE	
SERIAL NO.	152AKT4	10013605			
IRRADIANCE AND CELL TEMPERATURE	1000Wm -2 AM 1.5 25° C	800Wm -2 AM 1.5	VOLTAGE	600 V	
Pmax	260 W	187 W	SERIES EU	20.0 Kg	
Vpmax	31.0 V	27.9 V	FIRE DAT	INC CLASS 0	
Ipmax	8.39 A	6.71 A		ING CLASS C	
Voc	38.3 V	-	STRANDED	GOPPER ONLY	
Isc	9.09 A	-	10~14AWG	500 00°0	
WARNING	AVERTISS	SEMENT	THOULATED	FOR SU'C MIN.	
E)Do not touch terminals when exposed to light. F)Ne past oucher les connecteurs forsque le module est exposé à la lumière E)When connected or disconnacted to the output cable, upper surface should be shaded from light. F)Lonque vous connectez ou déconnectez les câbles de actie veillez à ce que la face supérieure avec les cables de actie veillez à ce que la face supérieure avec les cables de actie E)Must comply with local safety standards prior to installation. F)Dot être contrame aux normes de sécurité locales avant Installation.					
с С.	US BD 9P82 C MODULE				
MADE IN MEXICO (FWT2910)					
	Heater	e Type Design	ation		

- 260 W Panels \$300 ea.
- Approx. 1107 sq. footage
- 85 feet long
- Kyocera brand*
- Voltage: 31 volts
- Current: 8.39 amps
- Cost/Watt: \$1.15
- In 6 months produced the energy used to manufacture panels.
- *Fine print-data sheet: 1000W/sq.m, 25 degrees C, AM 1.5 spectrum

String Inverters

- SMA 7000 Watt
 - Channel A, 11 modules in series
 - Channel B, 11 modules in series then in parallel with 11 modules

- SMA 6000 Watt
 - Channel A, 9 modules in series
 - Channel B, 9 modules in series then in parallel with 9 modules





NYSERTA Incentives

Upstate Residential Block Structure

BLOCK	MEGAWATTS	INCENTIVE/WATT
1	40	\$1.00
2	15	\$0.90
3	19	\$0.80
4	22	\$0.70
5	24	\$0.60
6	35*	\$0.50
7	70	\$0.40
8	75	\$0.30
9	148	\$0.20

*Revised 12/30/2015



Submitted 🗌 Available

System Selected but will it generate RFI?

- Google search
- Talked to vendors
- Decided to do my own testing
- SED arranged for a visit to existing solar installation with 5K SMA string inverters

- Spectrum Analyzer up to 1 Ghz
- AM shortwave radio
- Various handheld Dual band radios

Spectrum Plots at test home with 5kW and 3kW inverters









Estimated and Actual Production

(data from http://pvwatts.nrel.gov/pvwatts.php)

		_
пго		
		•
NLJ	ULI	
		-

Print Results

19,023 kWh per Year * System output may range from 18,458 to 19,624kWh per year near this location. Click HERE for more information.

Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Energy Value (\$)
January	2.19	945	123
February	3.29	1,279	166
March	4.02	1,674	218
April	5.00	1,911	248
Мау	5.51	2,102	273
June	6.13	2,194	285
July	5.92	2,180	283
August	5.47	2,014	262
September	4.89	1,791	233
October	3.37	1,324	172
November	2.12	851	111
December	1.78	759	99
Annual	4.14	19,024	\$ 2,473

- 1 year savings: \$2,713
- 9.3 yr payback

Month	Year	kWh Produced
Aug	2015	2231.822
Sep	2015	2025.014
Oct	2015	1533.527
Nov	2015	1127.134
Dec	2015	584.702
Jan	2016	617.978
Feb	2016	927.999
Mar	2016	1587.775
Apr	2016	2000.88
Мау	2016	2415.521
Jun	2016	2560.888
Jul	2016	2482.101
	First Year Total	20095.341

Lessons Learned and Take-aways

- Project will take twice as long as estimated
- Plan for future expansion
- System can be size for shorter payback times
- Allow for system inefficiencies 15.6 kW 13.6 kW actual
- Technology is always improving, ie. cheaper, more efficient, more reliable
- Batteries might be viable in the future but not yet for us
- For lowest possible RFI, EMI, use string inverters, metal conduit, ground points
- Snow cover will severely limit your output!
- Allow for ground clearance with snow!
- True up time is very important!
- · You might loose your negotiating position with your electric supplier
- RGE will not credit you on electric production until their inspection
- Inspect your bills. Do not trust utility with readings or calculations
- Increase home resale value? Check back in 25 years...
- What if we had invested the \$ in the stock market for 25 years...

Ah Winter...

Up to 3 inches will
 melt off



 But plan to remove snow if more than 3 inches and you want output



Perfect Solar Days!





Seasonal Generation Average - Pasta Power 15.600kW Northern Hemisphere: Rolling Year



PVOutput

You are logged in as stevev4220

Add Output | Your Outputs | Latest Outputs | PV Ladder | PV Donut | Daily Outputs | Live Outputs | Teams | Favourites | Settings | About | Logout



Links

- http://www.nrel.gov/gis/solar.html
- http://pvwatts.nrel.gov/
- http://pvoutput.org/
- https://www.nyserda.ny.gov/All-Programs/Programs /NY-Sun/Project-Developers/Residential-Small-Com mercial-MW-Block
- http://www.homepower.com/
- http://kuzyatech.com/solar-a-year-later
- https://www.eevblog.com/2015/03/16/eevblog-724home-solar-power-system-analysis-update/

Going Green *following Environmental summary provided by SED

Based on the annual production of your new solar energy system you will be providing the following environmental benefits:

Emissions Reductions: 132 pounds of sulfer dioxide emissions 43 pounds of nitrous oxide emisions 30,765 pounds of carbon dioxide emissions, every year.

To put these numbers in perspective, this reduction in annual carbon dioxide emissions is equivalent to: Driving 18,378 fewer miles each year or Planting 368 trees.

> Over the expected 25 year lifetime of your Solar Energy System: Driving 459,450 fewer miles or Planting 9,189 trees.

Questions?