PV Solar System Installation

Introduction

- Hello, I'm Dave Twellman
- My background is in Chemical Engineering with several years' "experience" as we say.
- I am a Johnson's Controls Inc. employee with the good fortune to be working with one of our Environmentally Concerned RTP companies.
- In the Fall of 2007 I was asked to get started on the Engineering Design of a replacement roof for one of their Bldgs. And it was suggested that I look into PV Solar Production Opportunities.

Early Efforts



Building Roof (before)



Design Criteria

- Consult with RTP Architectural Committee
- Area Sizing requirements ~ 1 ft²± is needed for every 7 Watts
- System installed cost ~ \$7.00± per Watt
- Plan for Combiner Box(es), Disconnect Switches, Inverter(s) <u>and Meters/Monitors</u>.
- Make sure everything is UL approved for SOLAR
- Will System be fixed, one axis, or two axis?



Collector Orientation

Flat-plate collector facing south at fixed tilt equal to the latitude of the site: Capturing the maximum amount of solar radiation throughout the year can be achieved using a tilt angle approximately equal to the site's latitude.



Proposed PV System Performance Calculations

	82,280 DC Watts max									
→	75,000 AC Watts inverter max									
-	4.4 nominal hours/day									
	330,000.00 nominal Wh/day									
_	0.96 inverter efficiency									
	316,800.00 nominal Wh/day									
_	÷1,000 Watts/kilowatt									
	316.8 nominal kWh/day									
_	365 days/year									
→	115,632.00 nominal kWh/year									
-	0.05 nominal \$/kWh cost									
→	\$5,781.60 nominal cost avoidance/year									

Building with PV Cells (after)



Combiner Boxes and Disconnects



Design Criteria Cont.

- Don't forget Maintenance
- Inverter Sizing come in 30 kW, 75 kW, 100 kW, 200 kW, 500 kW, etc.
- Know your voltage & phase of grid intersect
- Roof Loading <u>don't forget "lifting load"</u>
- Decide if you are going Off Grid or On Grid
- Is this an Energy Saving, Business Project, or ...?
- What is your goal, save money, make money, public relations, community good will, training, etc.

Proposed PV System Installation Cash Flow Calculations

Buildings' Proposed Photo Voltaic System

Cash Flow Summary

Total System Production Capacity		82,680 Wa	itts (p	ower)							
Nominal Annual System Production Capacity		122,000 kW	/h/yr (w	vork)							
Proposed Installation Cost of 82,680 Watt PV System		\$850,000									
Transfer Cost of HQ Roofing Project		\$223,000									
plus mgmt, & contingency		\$120,000									
Total installed costs		\$1,193,000									
Federal Income Tax Credit		\$357,900 = 3	0% x \$1,113,000								
NC State Income Tax Credit		\$417,550 = 3	5% x \$1,113,000								
Total Tax Credit Available for Program		\$775,450									
Depreciable Basis	\$1,014,050 = \$	1,113,000 - (\$333,900/	2)								
Corporate Federal Income Tax Rate =	37.63%										
Corporate NC State Income Tax Rate =	6.90%										
5 year accumulated depreciation schedule		yr l	yr2	ут3	yr4	yr5	угб	yr7	yr8	yr9	yr10
half year convention Depreciation		20% \$202,810	32% \$324,496	19.20% \$194,698	11.52% \$116,819	11.52% \$116,819	5.76% \$58,409				
Energy Savings/ Purchase Avoidance (kWh) cost of energy @ 0.5 + (0.03% annual inflation)		122,000 \$0.0500	122,000 \$0.0515	122,000 \$0.0530	122,000 \$0.0546	122,000 \$0.0563	122,000 \$0.0580	122,000 \$0.0597	122,000 \$0.0615	122,000 \$0.0633	122,000 \$0.0652
Estimated Energy Savings per year (before taxes)		\$6,100	\$6,283	\$6,471	\$6,666	\$6,866	\$7,072	\$7,284	\$7,502	\$7,727	\$7,959
Estimated Energy Savings per year (after taxes)		\$6,077	\$6,259	\$6,447	\$6,641	\$6,840	\$7,045	\$7,256	\$7,474	\$7,698	\$7,929
Renewable Energy Credits (REC's)		122 (RI	EC)/yr								
Estimated Value of REC's (per year) @ \$40/REC			r								
Tax Savings are based on receipt of depreciation funds that otherw	ise would have been taxed as income.										
Cost of money =	8.00%										

Cost of Money is the interest costs for the future TAX Saving monies that has to be invested in year 1 but for which the return isn't repaid until subsequent years

compounded.

Proposed PV System Installation Cash Flow Calculations cont.

Cash Flow and Rate of Return:

	Energy Savings St	ale of REC's loss. In	vereased Value North Carolina Tay	Federal Tax Incentive		FEDERAL Tay	NC STATE Tax		Cost of Money (@	Net Depreciation	Total net Depreciation		Cumulative Cash
	less tax effect	tax effect	of Building incentive (35%)	(30%)	Depreciation	Savings (@37.63%)	Savings (@ 6.9%)	Tax Savings Totals	%)	Savings	Savings	Net Cash Flow	Flow
year	(\$)	(\$)	(\$) (\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)
0												(\$890,000)	(\$890,000)
1	\$6,077	\$3,044	\$83,510	\$357,900	\$202,810	\$76,317	\$13,994	\$90,311	\$42,463	\$47,848	\$47,848	\$498,379	(\$391,621)
2	\$6,259	\$3,044	\$83,510		\$324,496	\$122,108	\$22,390	\$144,498	\$25,478	\$119,020	\$119,020	\$211,833	(\$179,788)
3	\$6,447	\$3,044	\$83,510		\$194,698	\$73,265	\$13,434	\$86,699	\$15,287	\$71,412	\$71,412	\$164,413	(\$15,375)
4	\$6,641	\$3,044	\$83,510		\$116,819	\$43,959	\$8,060	\$52,019	\$9,172	\$42,847	\$42,847	\$136,042	\$120,667
5	\$6,840	\$3,044	\$83,510		\$116,819	\$43,959	\$8,060	\$52,019	\$3,057	\$48,962	\$48,962	\$142,355	\$263,022
6	\$7,045	\$3,044			\$58,409	\$21,979	\$4,030	\$26,010	\$0	\$26,010	\$26,010	\$36,098	\$299,120
7	\$7,256	\$3,044										\$10,300	\$309,420
8	\$7,474	\$3,044										\$10,518	\$319,938
9	\$7,698	\$3,044										\$10,742	\$330,680
10	\$7,929	\$3,044										\$10,973	\$341,653
11	\$8,167	\$3,044										\$11,211	\$352,863
12	\$8,412	\$3,044										\$11,456	\$364,319
13	\$8,664	\$3,044										\$11,708	\$376,027
14	\$8,924	\$3,044										\$11,968	\$387,995
15	\$9,192	\$3,044										\$12,236	\$400,231
16	\$9,468	\$3,044										\$12,511	\$412,742
17	\$9,752	\$3,044										\$12,796	\$425,538
18	\$10,044	\$3,044										\$13,088	\$438,626
19	\$10,346	\$3,044										\$13,389	\$452,015
20	\$10,656	\$3,044										\$13,700	\$465,715
totals	\$163,292	\$60,873	\$417,550		\$1,014,050	\$381,587	\$69,969	\$451,556					
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Funding cont.



Reasons for Selection

- Some of my reasons:
- Best Overall Proposal
- Ease of Installation
- Architecturally <u>CLEAN</u>
- Installation by Roofers
- Past Experiences with Installer a roofing company

PERMITTING

- Who is your current electrical provider:
- What is your provider's criteria?
- What will your provider bring to the table?
- File for FERC
- File for NCUC
- Apply to Utility Provider

FERC

- FERC Form No. 556
- 18 C.F.R. § 131.80

- CERTIFICATION OF QUALIFYING FACILITY STATUS FOR AN EXISTING OR A PROPOSED SMALL POWER PRODUCTION OR COGENERATION FACILITY
- ETC.

NCUC Filing

- Reports of Construction
- Full Name, Business Address, and Business Telephone Number of Applicant
- COMPANY NAME
- ADDRESS 1
- ADDRESS 2
- Contact Operator's Name
- (919) phone #
- Commercial Account
- •
- Individual
- •
- (Business)
- Nature of generating facility including the type and source of its power or fuel
- The generating facility consists of a 75 kilowatt photovoltaic array.

Interconnection Request

- NORTH CAROLINA
- INTERCONNECTION REQUEST
- Utility: Duk
- Designated Contact Person:
- Address:

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- Duke Energy Carolinas
- Steve Smith
- 4412 Hillsboro Rd., Durham, NC 27705 919 687 3030

- Telephone Number:
 - Fax: E-Mail Address: swsmith@dukeenergy.com
- An Interconnection Request is considered complete when it provides all applicable and correct information required below.
- Preamble and Instructions
- An Interconnection Customer who requests a North Carolina Utilities Commission jurisdictional interconnection must submit this Interconnection Request by hand delivery, mail, e-mail, or fax to the Utility.

Purchase

- Solicit for proposals
- Obtain funding (see next slide)
- Select Installer/System
- Get Permits and proceed

75kW Inverter



Installation and Commissioning

- Obtain local Building Electrical Permits
- Proceed with installing panels
- Schedule Electrical shutdown for Disconnect Installation
- Install Inverter and Disconnects
- Label, Label, Label, etc.
- Get CofO
- Commission System and ENJOY Clean, Green, Energy

PV System Production

14 September 2010



Electricity Purchased from Utility

14 September 2010



Buildings' Utility Energy Usage on a Cloudy Day



date/time

Buildings' Utility Energy Usage on a Sunny Day



date/time

Buildings' 2009 PV Solar Production



Buildings' 2009 Utility Energy Consumption



www.gsksolar.com



Future Plans

- Several mega-Watts of opportunity have been identified.
- Currently in Process of installing 240 DC-kW roof top System.
- Currently Progress Energy and DUKE Energy are limiting their involvement
- We have some work to do