200 kW Solar PV Third Creek Elementary School

Revenue and Incentives

	Year	1	2	3	4	5	6	7	8	9	10
Buyout Realized								$0	$0	$0	$92,255
Est. SREC Value *(for investor)*		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Est. Electricity Value *(Sell-All PPA)*		$ 22,528	$ 22,415	$ 22,303	$ 22,192	$ 22,081	$ 21,970	$ 21,860	$ 21,751	$ 21,642	$ 21,534
Assumed Value Base Capacity		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net-Meter Retail Power Offset *(post-flip)*							$ -	$ -	$ -	$ -	$ 19,796
Subtotal Revenue		$ 22,528	$ 22,415	$ 22,303	$ 22,192	$ 22,081	$ 21,970	$ 21,860	$ 21,751	$ 21,642	$ 113,789
Grant Proceeds	$ -										
Federal InvestmentTax Credit		$ 180,690									
Federal Depreciation (after tax value)	$ -	$ 35,837	$ 57,339	$ 34,403	$ 20,606	$ 20,606	$ 10,393				
State Renewable Energy Tax Credit		$ 42,161	$ 42,161	$ 42,161	$ 42,161	$ 42,161					
Subtotal Tax Benefits		$ 258,688	$ 99,500	$ 76,564	$ 62,767	$ 62,767	$ 10,393				
SubTotal -- Revenues + Tax Benefits	**$ -**	**$ 281,216**	**$ 121,915**	**$ 98,867**	**$ 84,959**	**$ 84,848**	**$ 32,363**	**$ 21,860**	**$ 21,751**	**$ 21,642**	**$ 113,789**

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
Buyout Realized	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	92,255	Buyout Realized
Est. SREC Value *(for investor)*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	Est. SREC Value *(for investor)*
Est. Electricity Value *(Sell-All PPA)*	$ 21,426	$ 21,319	$ 21,213	$ 21,107	$ 21,001	$ 18,806	$ 18,712	$ 18,619	$ 18,526	$ 18,433	$ 18,341	$ 18,249	$ 18,158	$ 18,067	$ 17,977	510,231	Est. Electricity Value *(Sell-All PPA)*
Assumed Value Base Capacity	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	Assumed Value Base Capacity
Net-Meter Retail Power Offset *(post-flip)*	$ 20,091	$ 20,391	$ 20,694	$ 21,003	$ 21,316	$ 21,633	$ 21,956	$ 22,283	$ 22,615	$ 22,952	$ 23,294	$ 23,641	$ 23,993	$ 24,351	$ 24,713	354,722	Net-Meter Retail Power Offset *(post-flip)*
Subtotal Revenue	$ 21,426	$ 21,319	$ 21,213	$ 21,107	$ 21,001	$ 21,633	$ 21,956	$ 22,283	$ 22,615	$ 22,952	$ 23,294	$ 23,641	$ 23,993	$ 24,351	$ 24,713	**650,027**	**Subtotal Revenue**
Grant Proceeds																-	Grant Proceeds
Federal InvestmentTax Credit																180,690	Federal InvestmentTax Credit
Federal Depreciation (after tax value)																179,184	Federal Depreciation (after tax value)
State Renewable Energy Tax Credit																210,805	State Renewable Energy Tax Credit
Subtotal Tax Benefits																**570,679**	**Subtotal Tax Benefits**
SubTotal -- Revenues + Tax Benefits	**$ 21,426**	**$ 21,319**	**$ 21,213**	**$ 21,107**	**$ 21,001**	**$ 21,633**	**$ 21,956**	**$ 22,283**	**$ 22,615**	**$ 22,952**	**$ 23,294**	**$ 23,641**	**$ 23,993**	**$ 24,351**	**$ 24,713**	**1,220,706**	**SubTotal -- Revenues + Tax Benefits**

General Expense and Maintenance

	Year	1	2	3	4	5	6	7	8	9	10
Buyout Purchase Price											
Lease Expense ***(Revenue to Lessor)***		$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)
Maintenance Expense (O&M)		$ (3,945)	$ (4,044)	$ (4,145)	$ (4,248)	$ (4,355)	$ (4,463)	$ (4,575)	$ (4,689)	$ (4,807)	$ (4,927)
Debt Repayments		$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)
Debt Interest Payment		$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)
Facility Charge		$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)
Property Tax		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Insurance		$ (1,184)	$ (1,213)	$ (1,243)	$ (1,275)	$ (1,306)	$ (1,339)	$ (1,372)	$ (1,407)	$ (1,442)	$ (1,478)
Asset Management Expense		$ (263)	$ (270)	$ (276)	$ (283)	$ (290)	$ (298)	$ (305)	$ (313)	$ (320)	$ (328)
Sub Total Expenses -- (Gen & Maint)		**$ (7,392)**	**$ (7,526)**	**$ (7,665)**	**$ (7,806)**	**$ (7,951)**	**$ (8,100)**	**$ (8,253)**	**$ (8,409)**	**$ (8,569)**	**$ (8,733)**

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
Buyout Purchase Price																$ -	Buyout Purchase Price
Lease Expense ***(Revenue to Lessor)***	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (10,000)	Lease Expense
Maintenance Expense (O&M)	$ (5,050)	$ (5,176)	$ (5,306)	$ (5,438)	$ (5,574)	$ (5,714)	$ (5,856)	$ (6,003)	$ (6,153)	$ (6,307)	$ (6,464)	$ (6,626)	$ (6,792)	$ (6,961)	$ (7,135)	$ (134,752)	Maintenance Expense (O&M)
Debt Repayments	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1)	Debt Repayments
Debt Interest Payment	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (1)	Debt Interest Payment
Facility Charge	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (25,000)	Facility Charge
Property Tax	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	Property Tax
Insurance	$ (1,515)	$ (1,553)	$ (1,592)	$ (1,631)	$ (1,672)	$ (1,714)	$ (1,757)	$ (1,801)	$ (1,846)	$ (1,892)	$ (1,939)	$ (1,988)	$ (2,037)	$ (2,088)	$ (2,141)	$ (40,426)	Insurance
Asset Management Expense	$ (337)	$ (345)	$ (354)	$ (363)	$ (372)	$ (381)	$ (390)	$ (400)	$ (410)	$ (420)	$ (431)	$ (442)	$ (453)	$ (464)	$ (476)	$ (8,983)	Asset Management Expense
Sub Total Expenses -- (Gen & Maint)	**$ (7,902)**	**$ (8,074)**	**$ (8,251)**	**$ (8,432)**	**$ (8,618)**	**$ (8,808)**	**$ (9,004)**	**$ (9,204)**	**$ (9,409)**	**$ (9,619)**	**$ (9,835)**	**$ (10,055)**	**$ (10,282)**	**$ (10,514)**	**$ (10,752)**	**$ (219,163)**	**Sub Total Expenses -- (Gen & Maint)**

Option to Purchase

Option to Purchase		*Buyout Valuation = NPV of EBITDA for remaining years in service*	***Year***	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*
Buyout Year	***10***		***Buyout Valuation***	$0	$0	$0	$92,255	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0 -	

Asset Performance -- *Initial Investor*

	Year	1	2	3	4	5	6	7	8	9	10
EBITDA		$ 15,136	$ 14,889	$ 14,639	$ 14,386	$ 14,129	$ 13,870	$ 13,608	$ 13,342	$ 13,073	$ 105,055
Annual Cashflow *(pre-tax)*	$ (602,300)	$ 273,824	$ 114,389	$ 91,203	$ 77,153	$ 76,896	$ 24,263	$ 13,608	$ 13,342	$ 13,073	$ 105,055
Cumulative Cashflow *(pre-tax)*	$ (602,300)	$ (328,476)	$ (214,087)	$ (122,884)	$ (45,732)	$ 31,165	$ 55,428	$ 69,035	$ 82,377	$ 95,451	$ 200,506
Internal Rate of Return *(pre-tax)*	-	-	-	-	-	**2.22%**	**3.72%**	**4.46%**	**5.11%**	**5.67%**	**8.96%**

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
EBITDA	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ 232,128*	***EBITDA***
Annual Cashflow *(pre-tax)*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ 200,506*	**Annual Cashflow** *(pre-tax)*
Cumulative Cashflow *(pre-tax)*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Internal Rate of Return *(pre-tax)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Asset Performance -- *Purchasing Entity*

	Year	1	2	3	4	5	6	7	8	9	10
EBITDA		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Cashflow *(pre-tax)*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (92,255)
Cumulative Cashflow *(pre-tax)*		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (92,255)
Internal Rate of Return *(pre-tax)*	-	-	-	-	-	-	-	-	-	-	-

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
EBITDA	$ 13,525	$ 13,245	$ 12,962	$ 12,674	$ 12,383	$ 12,825	$ 12,952	$ 13,079	$ 13,206	$ 13,333	$ 13,459	$ 13,585	$ 13,711	$ 13,837	$ 13,962	*$ 198,737*	***EBITDA***
Annual Cashflow *(pre-tax)*	$ 13,525	$ 13,245	$ 12,962	$ 12,674	$ 12,383	$ 12,825	$ 12,952	$ 13,079	$ 13,206	$ 13,333	$ 13,459	$ 13,585	$ 13,711	$ 13,837	$ 13,962	*$ 106,483*	**Annual Cashflow** *(pre-tax)*
Cumulative Cashflow *(pre-tax)*	$ (78,730)	$ (65,485)	$ (52,523)	$ (39,849)	$ (27,466)	$ (14,641)	$ (1,689)	$ 11,390	$ 24,596	$ 37,929	$ 51,388	$ 64,973	$ 78,684	$ 92,521	$ 106,483		
Internal Rate of Return *(pre-tax)*	-	-	-	-	-	-	-	**2.68%**	**5.03%**	**6.82%**	**8.20%**	**9.30%**	**10.17%**	**10.87%**	**11.45%**		

500 kW Public - Private Partnership /// 50% Grant Subsidized – Catawba Indian Nation

	Year	1	2	3	4	5	6	7	8	9	10	11	12
Revenue and Incentives													
Buyout Realized								$0	$0	$0	$0	$0	$0
Est. SREC Value *(for investor)*		-	-	-	-	-	-	-	-	-	-	-	-
Est. Electricity Value *(Sell-All PPA)*		50,920	50,665	50,412	50,160	49,909	49,659	49,411	49,164	48,918	48,674	48,430	48,188
Assumed Value Base Capacity		-	-	-	-	-	-	-	-	-	-	-	-
Est. Post-PPA Electricity Value *(post-flip)*							-	-	-	-	-	-	-
Subtotal Revenue		50,920	50,665	50,412	50,160	49,909	49,659	49,411	49,164	48,918	48,674	48,430	48,188
Federal InvestmentTax Credit		395,580											
Federal Depreciation (after tax value)	-	39,228	62,765	37,659	22,556	22,556	11,376						
State Renewable Energy Tax Credit		3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500		
Subtotal Tax Benefits		438,308	66,265	41,159	26,056	26,056	14,876	3,500	3,500	3,500	3,500		
SubTotal -- Revenues + Tax Benefits	**659,300**	**489,228**	**116,931**	**91,571**	**76,216**	**75,965**	**64,536**	**52,911**	**52,664**	**52,418**	**52,174**	**48,430**	**48,188**
General Expense and Maintenance													
Buyout Purchase Price													
Lease Expense		(1,050)	(1,050)	(1,050)	(1,050)	(1,050)	(1,155)	(1,155)	(1,155)	(1,155)	(1,155)	(1,271)	(1,271)
Maintenance Expense (O&M)		(9,660)	(9,902)	(10,149)	(10,403)	(10,663)	(10,929)	(11,203)	(11,483)	(11,770)	(12,064)	(12,366)	(12,675)
Debt Repayments		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Debt Interest Payment		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Facility Charge		(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)
Property Tax		-	-	-	-	-	-	-	-	-	-	-	-
Insurance		(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)
Asset Management Expense		(5,000)	(5,125)	(5,253)	(5,384)	(5,519)	(5,657)	(5,798)	(5,943)	(6,092)	(6,244)	(6,400)	(6,560)
Sub Total Expenses -- (Gen & Maint)		**(21,710)**	**(22,077)**	**(22,452)**	**(22,837)**	**(23,232)**	**(23,742)**	**(24,156)**	**(24,581)**	**(25,017)**	**(25,463)**	**(26,037)**	**(26,506)**
Asset Performance													
EBITDA		29,210	28,589	27,960	27,323	26,677	25,918	25,255	24,583	23,902	23,210	22,394	21,682
Annual Cashflow *(pre-tax)*	(659,300)	467,518	94,854	69,119	53,379	52,733	40,794	28,755	28,083	27,401	26,710	22,394	21,682
Cumulative Cashflow *(pre-tax)*	(659,300)	(191,782)	(96,928)	(27,809)	25,570	78,303	119,097	147,852	175,935	203,336	230,046	252,440	274,123
Internal Rate of Return *(pre-tax)*	-	-	-	-	**2.46%**	**6.55%**	**8.93%**	**10.26%**	**11.31%**	**12.14%**	**12.79%**	**13.24%**	**13.61%**

	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL
Revenue and Incentives														***TOTAL***
Buyout Realized	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-
Est. SREC Value *(for investor)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Est. Electricity Value *(Sell-All PPA)*	47,947	47,708	47,469	42,508	42,296	42,084	41,874	41,665	41,456	41,249	41,043	40,838	40,633	1,153,281
Assumed Value Base Capacity	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Est. Post-PPA Electricity Value *(post-flip)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal Revenue	47,947	47,708	47,469	42,508	42,296	42,084	41,874	41,665	41,456	41,249	41,043	40,838	40,633	**1,153,281**
Federal InvestmentTax Credit														395,580
Federal Depreciation (after tax value)														196,142
State Renewable Energy Tax Credit														35,000
Subtotal Tax Benefits														**626,722**
SubTotal -- Revenues + Tax Benefits	**47,947**	**47,708**	**47,469**	**42,508**	**42,296**	**42,084**	**41,874**	**41,665**	**41,456**	**41,249**	**41,043**	**40,838**	**40,633**	**1,780,003**
General Expense and Maintenance														***TOTAL***
Buyout Purchase Price														-
Lease Expense	(1,271)	(1,271)	(1,271)	(1,398)	(1,398)	(1,398)	(1,398)	(1,398)	(1,537)	(1,537)	(1,537)	(1,537)	(1,537)	(32,052)
Maintenance Expense (O&M)	(12,992)	(13,316)	(13,649)	(13,991)	(14,340)	(14,699)	(15,066)	(15,443)	(15,829)	(16,225)	(16,630)	(17,046)	(17,472)	(329,964)
Debt Repayments	(0)	(0)	(0)	-	-	-	-	-	-	-	-	-	-	(1)
Debt Interest Payment	(0)	(0)	(0)	-	-	-	-	-	-	-	-	-	-	(1)
Facility Charge	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(25,000)
Property Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Insurance	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(125,000)
Asset Management Expense	(6,724)	(6,893)	(7,065)	(7,241)	(7,423)	(7,608)	(7,798)	(7,993)	(8,193)	(8,398)	(8,608)	(8,823)	(9,044)	(170,789)
Sub Total Expenses -- (Gen & Maint)	**(26,987)**	**(27,480)**	**(27,985)**	**(28,630)**	**(29,160)**	**(29,704)**	**(30,262)**	**(30,834)**	**(31,559)**	**(32,160)**	**(32,776)**	**(33,406)**	**(34,053)**	**(682,806)**
Asset Performance														***TOTAL***
EBITDA	20,961	20,228	19,484	13,879	13,136	12,380	11,612	10,831	9,897	9,089	8,267	7,431	6,580	***470,477***
Annual Cashflow *(pre-tax)*	20,961	20,228	19,484	13,879	13,136	12,380	11,612	10,831	9,897	9,089	8,267	7,431	6,580	***437,897***
Cumulative Cashflow *(pre-tax)*	295,083	315,311	334,795	348,674	361,810	374,190	385,801	396,632	406,529	415,618	423,885	431,317	437,897	
Internal Rate of Return *(pre-tax)*	**13.90%**	**14.13%**	**14.32%**	**14.44%**	**14.53%**	**14.61%**	**14.67%**	**14.71%**	**14.75%**	**14.78%**	**14.81%**	**14.82%**	**14.84%**	

100 kW Net-Metered System /// 90% Grant Subsidized – Catawba Indian Nation

	Year	1	2	3	4	5	6	7	8	9	10	11	12
Revenue and Incentives													
Buyout Realized								$0	$0	$0	$0	$0	$0
Est. SREC Value *(for investor)*		-	-	-	-	-	-	-	-	-	-	-	-
Est. Electricity Value *(Sell-All PPA)*		11,730	11,905	12,082	12,262	12,445	12,630	12,818	13,009	13,203	13,400	13,599	13,802
Assumed Value Base Capacity		-	-	-	-	-	-	-	-	-	-	-	-
Est. Post-PPA Electricity Value *(post-flip)*							-	-	-	-	-	-	-
Subtotal Revenue		11,730	11,905	12,082	12,262	12,445	12,630	12,818	13,009	13,203	13,400	13,599	13,802
Federal InvestmentTax Credit		-											
Federal Depreciation (after tax value)	-	-	-	-	-	-	-						
State Renewable Energy Tax Credit		-	-	-	-	-							
Subtotal Tax Benefits		-	-	-	-	-	-						
SubTotal -- Revenues + Tax Benefits	**264,060**	**11,730**	**11,905**	**12,082**	**12,262**	**12,445**	**12,630**	**12,818**	**13,009**	**13,203**	**13,400**	**13,599**	**13,802**
General Expense and Maintenance													
Buyout Purchase Price													
Lease Expense		-	-	-	-	-	-	-	-	-	-	-	-
Maintenance Expense (O&M)		(3,225)	(3,306)	(3,388)	(3,473)	(3,560)	(3,649)	(3,740)	(3,834)	(3,929)	(4,028)	(4,128)	(4,231)
Debt Repayments		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Debt Interest Payment		(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Facility Charge		(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)
Property Tax		-	-	-	-	-	-	-	-	-	-	-	-
Insurance		(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)
Asset Management Expense		-	-	-	-	-	-	-	-	-	-	-	-
Sub Total Expenses -- (Gen & Maint)		**(5,975)**	**(6,056)**	**(6,138)**	**(6,223)**	**(6,310)**	**(6,399)**	**(6,490)**	**(6,584)**	**(6,679)**	**(6,778)**	**(6,878)**	**(6,982)**
Asset Performance													
EBITDA		5,755	5,849	5,944	6,039	6,135	6,231	6,328	6,426	6,524	6,622	6,721	6,821
Annual Cashflow *(pre-tax)*	(29,340)	5,755	5,849	5,944	6,039	6,135	6,231	6,328	6,426	6,524	6,622	6,721	6,820
Cumulative Cashflow *(pre-tax)*	(29,340)	(23,585)	(17,737)	(11,793)	(5,754)	380	6,612	12,940	19,365	25,889	32,511	39,232	46,053
Internal Rate of Return *(pre-tax)*	-	-	-	-	-	**0.43%**	**6.05%**	**9.89%**	**12.59%**	**14.55%**	**16.00%**	**17.10%**	**17.93%**

	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL
Revenue and Incentives														***TOTAL***
Buyout Realized	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-
Est. SREC Value *(for investor)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Est. Electricity Value *(Sell-All PPA)*	14,008	14,216	14,428	14,643	14,861	15,083	15,308	15,536	15,767	16,002	16,241	16,483	16,728	352,188
Assumed Value Base Capacity	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Est. Post-PPA Electricity Value *(post-flip)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal Revenue	14,008	14,216	14,428	14,643	14,861	15,083	15,308	15,536	15,767	16,002	16,241	16,483	16,728	**352,188**
Federal InvestmentTax Credit														-
Federal Depreciation (after tax value)														-
State Renewable Energy Tax Credit														-
Subtotal Tax Benefits														**-**
SubTotal -- Revenues + Tax Benefits	**14,008**	**14,216**	**14,428**	**14,643**	**14,861**	**15,083**	**15,308**	**15,536**	**15,767**	**16,002**	**16,241**	**16,483**	**16,728**	**352,188**
General Expense and Maintenance														***TOTAL***
Buyout Purchase Price														-
Lease Expense	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maintenance Expense (O&M)	(4,337)	(4,446)	(4,557)	(4,671)	(4,788)	(4,907)	(5,030)	(5,156)	(5,285)	(5,417)	(5,552)	(5,691)	(5,833)	(110,159)
Debt Repayments	(0)	(0)	(0)	-	-	-	-	-	-	-	-	-	-	(1)
Debt Interest Payment	(0)	(0)	(0)	-	-	-	-	-	-	-	-	-	-	(1)
Facility Charge	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(250)	(6,250)
Property Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Insurance	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(2,500)	(62,500)
Asset Management Expense	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub Total Expenses -- (Gen & Maint)	**(7,087)**	**(7,196)**	**(7,307)**	**(7,421)**	**(7,538)**	**(7,657)**	**(7,780)**	**(7,906)**	**(8,035)**	**(8,167)**	**(8,302)**	**(8,441)**	**(8,583)**	**(178,910)**
Asset Performance														***TOTAL***
EBITDA	6,920	7,021	7,121	7,222	7,324	7,426	7,528	7,630	7,733	7,835	7,938	8,042	8,145	***173,279***
Annual Cashflow *(pre-tax)*	6,920	7,021	7,121	7,222	7,324	7,426	7,528	7,630	7,733	7,835	7,938	8,042	8,145	***143,938***
Cumulative Cashflow *(pre-tax)*	52,973	59,993	67,115	74,337	81,661	89,087	96,614	104,245	111,977	119,813	127,751	135,793	143,938	
Internal Rate of Return *(pre-tax)*	**18.57%**	**19.08%**	**19.48%**	**19.79%**	**20.05%**	**20.25%**	**20.41%**	**20.55%**	**20.66%**	**20.75%**	**20.82%**	**20.88%**	**20.93%**	

Terms and Definitions

3rd Party Power Sales

This term refers to an entity that produces power selling it to a neighboring company, organization, or industrial plant. 3rd party power sales are only allowed in unregulated utility states. North and South Carolina are regulated markets, therefore 3rd party sales is not legal.

Avoided Cost

Avoided cost is the lowest cost to the utility to produce electricity amongst all their generating assets. Avoided cost is the rate that utilities will pay to purchase renewable electricity from private entities that produce electricity for their grid. Currently, the Duke Energy rate is 5.9 cents per kilowatt hour

Buy Back

Buy back represents the date when a government purchases the energy asset from the original owner.

Kilowatt

A kilowatt is a measure of electricity usage, and refers to 1,000 watts.

Kilowatt Hour

A kilowatt hour is the consumption of 1 kilowatt for the duration of 1 hour.

Megawatt

A megawatt is the equivalent of 1,000 kilowatts. The average household in the United States uses 1.2 megawatt hours per month.

ROI

In calculating the figure of percent that a capital expense will be paid back, the most accurate term is return on investment, or ROI.

Public/Private Partnership:

Fortunately public entities do not have tax burdens, however this means they have no way to take advantage of tax based incentives. For this reason, the most common way that solar is installed on public sites is through the use of lease and buyback structures. Under this arrangement, the tax-exempt entity leases the property to a solar developer who, along with tax-equity investors (i.e. investors with tax a liability large enough to monetize the credits), own the system. By year 7, all of the tax incentives have been utilized; the tax-exempt entity retains the option to purchase the system outright for fair market value OR to continue with the original lease payment arrangement. A further description of this mechanism is in the appropriate scenario modeling.

S-REC

An S-REC stands for Solar Renewable Energy Certificate, which has a value in states with a Renewable Portfolio Standard. North Carolina utilities must reach 12.5% renewable power by 2021, and S-RECs account for a percentage of this.

Energy Working Group

Name	Organization	Role
Lisa Lee Morgan	Calor Energy	Chair
Eldewins Haynes	City of Charlotte	Member
Mike Davis	NC Sustainable Energy Assoc.	Member
Nicole Storey	City of Charlotte	Member
Karen Nichols	Catawba Indian Nation	Member
Justin Sharp	Calor Energy	Member
Wendy Bell	Catawba COG	Member
Bob Crawford	Piedmont Natural Gas	Member
Tim Gause	Duke Energy	Member
Regina Guyer	UNC Charlotte IDEAS Center	Member
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Jason Wager	Centralina COG	Member
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Solar Photovoltaic Feasibility Study:
Third Creek Elementary

Statesville, North Carolina

North Carolina State University
Certificate in Renewable Energy Management

Leigh Bumgardner | Will Etheridge| Christian Manansala | Jesse O'Neal

26 November 2012

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Abstract
This was to determine the technical and financial feasibility of generating supplementary power using photovoltaic (PV) panels on the roof of a public school in North Carolina. Third Creek Elementary School in Statesville, North Carolina was selected using a semi-quantitative screening process. The roof of the school is suitable in terms of orientation, available space and anticipated service life. A highly efficient Monocrystalline/Polycrystalline hybrid Silicon cell, the Panasonic (Sanyo) HIT, was selected, in 225Watt panels. The financial base case assumes third-party ownership, and participation in the Duke-Progress SunSense program which guarantees $0.15 for each kWhr generated over 20 years. Given these assumptions and 25-year overall duration, the Internal Rate of Return (IRR) is 9.3%, Net Present Value (NPV) is positive at a discount rate of 9.0%, and the payback is 5 years. When SunSense is replaced with a PPA at $0.10/kWhr, the IRR falls to 5.4% and NPV is positive at 5.3%, payback increases to 6 years. For the investment returns to be positive and for payback to be accomplished, the project must have all of the following economic benefits in place: Federal ITC at 30%, State Renewable Energy ITC at 35%, Accelerated Depreciation, sale of kWhrs generated at above-market rates.

1. Introduction

The definition of sustainability is meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Meeting our energy needs, to have the ability to turn on the lights or turn on the heat, to turn on the computer to learn and communicate within a global society. This is an uncompromised luxury of a developed world. It is a luxury inherent within the youth and students of today's generation. However, what if the luxury of readily available energy was not available to everyone, or what if this energy was available only under compromising circumstances; be they political, economical, or environmentally compromising circumstances?

These questions were at the core of a feasibility study of Third Creek Elementary School conducted by Jesse O'Neal, Christian Manansala, Leigh Bumgardner, and Will Etheridge; Certificate in Renewable Energy Management (CREM) students and Team A. Could a school, a non-profit, housed in an innovatively designed building educating the future generations of tomorrow, be taken to the next level through energy efficiency and renewable energy education. Could this be accomplished structurally and financially by placement of solar photovoltaic panels on the campus, with benefits to all stakeholders involved?

The timing is never more right as the cities of Charlotte and Raleigh, North Carolina have publicly stated their goals to promote the development of an energy hub in the Carolinas. Leading energy companies have formed a foundation, E^4 Carolinas, to generously fund the effort. High schools, community colleges, and universities, have partnered with government and private investment to build sustainability labs, STEM academies, EPIC and FREEDM centers, with the intention of educating and training a new generation in energy. This is the new economic focus for the Carolinas and for those beginning their education and their career path.

In keeping, this was the focus of this study, to present the feasibility of actual implementation of solar photovoltaic energy at Third Creek Elementary School, while simultaneously educating students, bringing to life actual renewable energy and technology on the school's campus, not just through pictures or words.

2. Site Screening and Selection

CREM "Team A" began with the objective of assessing the feasibility of photovoltaic (PV) supplementary electricity at a public school in North Carolina. To this end, the team established screening criteria and set about reviewing schools in 12 counties in the central part of the state. Altogether, approximately 100 schools were screened as possible sites for a PV installation.

A set of five finalist schools were selected based on a combination of: (i) indication of interest in renewable energy (e.g., school's mission or vision statement, school's design) and (ii) apparent suitability of the school's roof for PV panel installation and/or availability of land for on-ground installation. Both screening questions could be answered quickly using the Internet. A review of the schools' websites provided their posture on renewable energy. The roof-size analysis was quickly done using aerial views and tools provided in "Google Earth." Adjoining undeveloped and un-forested land for possible ground arrays was also to be determined using this software.

The five schools selected in this way were:

School	Location	School System	Website
Riverside High	Durham	Durham Public Schools	http://riverside.dpsnc.net/
South Johnston High	Four Oaks	Johnston County Schools	http://www.southjohnstontrojans.com/
East Wake High	Wendell	Wake County Public School System	http://ewhs.wcpss.net/
Carrboro High	Carrboro	Chapel Hill-Carrboro City Schools	http://chs.chccs.k12.nc.us/
Third Creek Elementary	Statesville	Iredell-Statesville Schools	http://iss.schoolwires.com/Domain/2330

Each of five finalist schools was visited by a member of CREM Team A and the project was discussed with the school's principal or assistant principal. The purpose of these meetings was to determine the receptiveness of site leadership to the feasibility study. In all cases the site leadership was receptive to our investigation and agreed with our contention that there would be benefits from energy efficiency and educational instructional benefits from having the PV panels at the school.

Three high schools (East Wake, Riverside, and South Johnston) were eliminated from consideration because their roofs were on the order of 20 years old and there is no way to predict when a significant repair might be necessary. In addition, roof sections had been replaced over the years on an as-needed basis which results in differences in warranty terms and duration. The screening evaluation results for these three schools is provided in Appendix C. Five weighted selection criteria were established for the screening process (see table below).

Criterion	Explanation	Weight Assigned	Scoring
1) Mission	The published school mission/vision explicitly notes a commitment to renewable energy.	5	High = 5 Medium = 3 Low = 1 For each criterion, the raw score was multiplied by the weight to get a weighted score. The weighted scores were summed to give an overall score for the school.
2) Site and County Leadership Receptive	The administration (Principal) and County official see the value in the project and endorse the feasibility study.	5	
3) Energy Efficiency of the School	School was designed to be an energy efficient structure, and therefore the PV-generated power will have a material impact on consumption.	3	
4) Space Available for Installation	School has a large, flat roof with adequate sun exposure that would be suitable for PV panels. Alternatively, there is over 1 acre of adjoining undeveloped and unobstructed land by shade suitable for PV ground installation.	3	
5) Near Population Centers	School is within easy driving distance from major population centers, from which the school may draw visitors to this demo project.	2	

Both Carrboro High and Third Creek Elementary ranked high in suitability, with scores of 74 and 80, respectively. The schools have raised-seam metal roofs which makes them acceptable for PV panel installation. Both schools were designed to be energy efficient; Carrboro High is USGBC LEED® Silver certified and Third Creek Elementary is USGBC LEED® Gold certified. As the screening analysis suggests, it was the presence of already-owned, undeveloped land that prompted the selection of Third Creek Elementary over Carrboro High. However, Carrboro High remains an excellent candidate for solar PV arrays and may be approached again at a later date.

Carrboro High, Carrboro

Selection Criterion	Wt	Raw Score	Wted Score	Notes
1) Mission	5	3	15	School does not have, on the Internet, a stated mission/vision to educate students in renewable energy or engineering but is a USGBC LEED® Silver Certified building. The school began operation in August 2007.
2) Site and County Leadership Receptive	5	5	25	Team member Jesse O'Neal met with Principal LaVerne Mattocks on August 7. Ms. Mattocks is interested in the project and identified the appropriate county official for follow-through contact.
3) Energy Efficiency of the School	3	5	15	School is recently built and is the only USGBC LEED® Silver certified high school in the state. Like Third Creek Elementary, this is an energy efficient school where supplementary power would have a substantial impact on a percentage basis.
4) Space Available for Installation	3	3	9	School has a small solar thermal installation on the roof already. This suggests that the roof could readily support and accept solar PV panels. School does not have unused land on the campus that could be used for a ground array.
5) Near Population Centers	2	5	10	This school is easily accessible. It is just off Route 54, South of Carrboro.
Total Score for this site			74	

Third Creek Elementary, Statesville

Selection Criterion	Wt	Raw Score	Wted Score	Notes
1) Mission	5	3	15	The school does not have an Internet-published mission statement on renewable energy, but it is well known as the world's first USGBC LEED® Gold certified elementary school. Completed in 2002, the school has a well-established culture of energy efficiency and recycling.
2) Site and County Leadership Receptive	5	5	25	Team member Leigh Bumgardner initiated contacts with Principal Angel Oliphant, and County official, Rob Jackson. The original designers of the building, (Moseley Architects) and a local PV engineering firm were also contacted. All parties are receptive to the feasibility assessment and actively provided time and information.
3) Energy Efficiency of the School	3	5	15	Of the candidate schools, Third Creek and Carrboro High are strongest in this category. Their energy consumption per sq ft area is expected to be the lowest and the impact of PV supplementary power will be greatest on a percentage basis.
4) Space Available for Installation	3	5	15	Third Creek has the newer raised seam metal roof that lends it to PV panel attachment, with an east to west orientation (pre-designed for renewables), 36 degree slope, slant off to the side, rigid panels, and no need to put any additional framing. Third Creek currently includes over 10 acres of undeveloped land making the site equally feasible for a PV ground array.
5) Near Population Centers	2	5	10	Third Creek is convenient to the major metropolitan area of Charlotte.
Total Score for this site			80	

3. Site Description: Third Creek Elementary

Third Creek Elementary in Statesville, North Carolina was the first elementary school in the world to be certified as USGBC LEED® Gold. Designed by Moseley Architects and completed in 2002, the building was designed, according to Moseley Architects, "to provide a state-of-the art, green school experience for students, faculty, and staff while replacing the district's aging ADR and Wayside schools".

Features related to energy efficiency that contributed to Third Creek Elementary School's Leadership in Energy and Environmental Design (LEED®) Gold certification include:

- Full cutoff light fixtures to reduce light pollution on site;
- Native and drought-tolerant landscaping to eliminate the need for permanent irrigation;
- Highly-reflective roofing materials to reduce the building's cooling loads;
- High performance windows, increased insulation, occupancy sensors, and day lighting to reduce energy use by at least 25 percent;
- A permanent temperature and humidity monitoring system;
- Carbon dioxide monitors for improved indoor air quality and energy efficiency.

Information provided on the Moseley Architects web site states, “since opening in 2002, Moseley Architects has monitored how the design has affected the students and staff that use Third Creek and to track and document energy savings. The following data represents data collected through the end of the 2004-2005 school year”.

School Year	Test Scores (%)	Average Over this Period	Comments
1996 - 1997	51.0	62.4	
1997 - 1998	68.6		
1998 – 1999	64.5		
1999 – 2000	64.5		
2000 – 2001	61.5		
2001 – 2002	64.5		
2002 – 2003	79.8	80.1	First year of operation of LEED Gold Certified Third Creek Elementary School
2003 - 2004	79.7		
2004 - 2005	80.9		

http://www.moseleyarchitects.com/PDF’s/New/Third%20Creek%20Stats%20LEED%20Project%20Sheet.pdf.

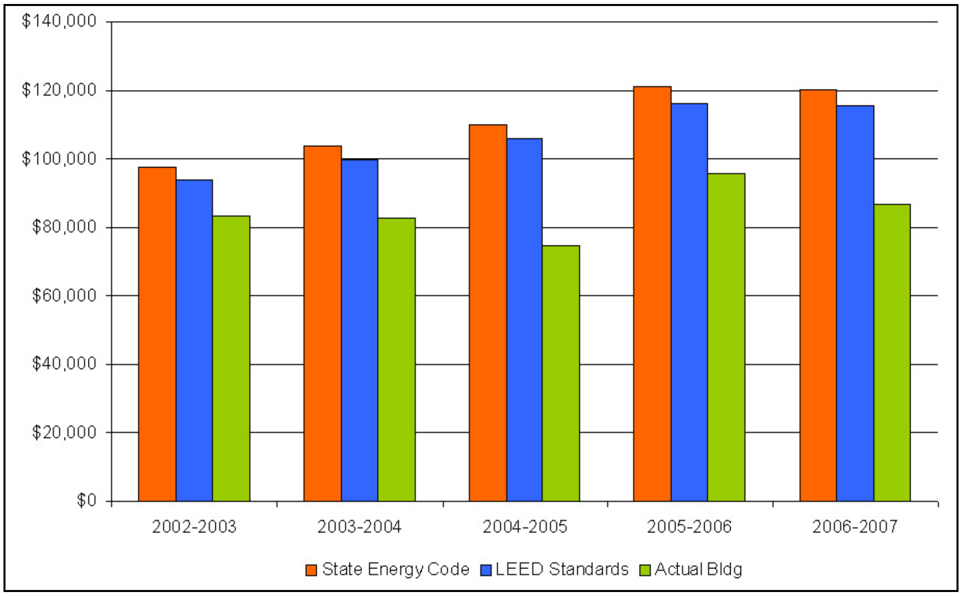
The Moseley Architects web site continues to state that, “a number of studies have repeatedly established that an influential relationship exists between a school’s physical condition and student’s performance. During the first three years of operation, students significantly improved their test scores. These figures are perhaps the most interesting and encouraging to teachers and parents. Comparing Third Creek Elementary School students’ test scores to ADR Elementary and Wayside Elementary schools reveals a significant improvement”.

“These data suggest that a distinct correlation exists between improving a student’s learning environment by incorporating sustainable elements into the design of a school and the positive effect it has on his or her performance”.

“The cost of integrating high performance design and construction elements into a project is almost always a concern to owners, both initially and once the facility has been constructed and is operating. For Third Creek Elementary School, the high performance features equated to just 1.5 percent of the total cost of construction”.

“Third Creek was designed and built to achieve between 20 and 25 percent energy savings beyond what LEED® standards set forth. Because these standards were more stringent than the state energy code in place at the time of construction, the school has saved more than what would have been produced through a conventional design process. In the first five years of operation, Third Creek saved an average of $26,028 annually on gas and electric bills. Through this energy performance and an estimated annual water savings of $2,087, the school district has been able to recoup its entire investment in high performance strategies in less than five years”.

http://www.moseleyarchitects.com/PDF’s/New/Third%20Creek%20Stats%20LEED%20Project%20Sheet.pdf. (pages 3-4)



http://www.moseleyarchitects.com/PDF's/New/Third%20Creek%20Stats%20LEED%20Project%20Sheet.pdf.

According to the US Green Building Council, (USGBC) Leadership in Energy and Environmental Design (LEED®) "provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, and operations and maintenance solutions. LEED® certification provides independent third party verification that a building, home or community was designed and built using strategies aimed at achieving high performance in key areas of human and environmental health; sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality".

Third Creek Elementary School excels in all areas of targets for a Green School through the North Carolina Green Building documentation. Noted below are the elements related to the efficient use of energy for Third Creek Elementary according to North Carolina Green Building.

	Technology	Description
1	Energy modeling software used	The architectural and mechanical design of this building, according to advanced energy modeling, was shown to reduce annual energy costs by an additional 25% over the ASHRAE guidelines.
2	Motion/heat/light sensors	All building and site lighting include multiple levels of control and all classroom lights work on occupancy sensors in order to save energy in unoccupied rooms.
3	Passive cooling strategies	All of the trees planted on the site were selected to be fast growing and drought-tolerant, and will shade at least 30% of the impervious surfaces within 5 months, which will help keep those surfaces cool during the warm summer months and thereby reduce energy demand.

4	Pre-design for future renewables	The roofs of the classroom wings were also designed and oriented such that photovoltaic material may be added in the future to further improve the energy performance and educational capabilities of this building.
5	Continuous metering	A permanent energy measurement and verification system has been installed to track long term energy performance.
6	Light shelves	All of the classroom wings are oriented to the sun and all of the windows are designed with light shelves to throw natural light deeper into the classroom spaces. Coupled with ceiling tiles that are more reflective than standard tiles, natural daylight is bounced deep into the classroom spaces.
7	Highly efficient lighting system	All building and site lighting include multiple levels of control and all classroom lights work on occupancy sensors in order to save energy in unoccupied rooms.

http://www.ncgreenbuilding.org/site/ncg/public/show_project.cfm?project_id=67

Through the above documentation and the quotes below, there is no question that Third Creek Elementary School performs as intended and is an ideal candidate school for solar photovoltaic roof and ground installation and implementation. CREM Team A will now provide for this in forthcoming customized documentation.

"On each of the things we've done in this project, we've learned things that made me ask why we don't do it on every project. Some of it is just common-sense things we ought to do on every one."

Mary Bruce McKenzie Serene
Member of the Iredell-Statesville School Board

"The teachers are just amazed. They are integrating it into the standard course of study [for] ecology issues, recycling issues, or garden issues."

Rob Jackson
Director of Facilities, Iredell-Statesville Schools

"Third Creek Elementary School replaced ADR and Wayside Elementary schools, which were two of the district's lowest performing schools in regards to test scores and teacher retention/absence. This same group of students and teachers improved from less than 60 percent of students on grade level in reading and math to 80 percent of students on grade level in reading and math since moving into the new Third Creek Elementary School. Third Creek had the most gains in academic performance of any of the 32 schools in the school system. We feel that the sustainable approach to this project has had very positive results."

Terry Holliday
Superintendent, Iredell-Statesville Schools

http://www.moseleyarchitects.com/PDF's/New?Third%20Creek%20Stats%20LEED%20Project%20Sheet.pdf

http://www.usgbc.org (page 5)

4. Site Power Consumption and Cost

Thanks to Iredell-Statesville Schools engineering officials, actual consumption and cost of electricity was obtained. The school system was able to provide month-by-month data for all utilities [kWhrs of electricity, therms of natural gas, hundred cubic feet (CCF) of water] since the school was occupied in June 2002 up through August 2012.

For the purpose of estimating future demand for power an average by month was determined using the most recent four years of data. The twelve representative (average) months were then summed to give the average annual consumption of power for the school.

Actual Electricity Used by Month by Third Creek Elementary													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
2009	79400	95000	95200	86200	92000	114400	106600	109400	88200	106600	110200	94400	1,177,600
2010	76200	89600	79800	88600	79400	79200	97400	76600	110200	94400	76200	79800	1,027,400
2011	88600	79200	97400	76600	110200	94300	99400	104600	88000	76400	75600	77200	1,067,500
2012	77200	78400	78400	68800	80200	79200	67800	79400					
divisor	4	4	4	4	4	4	4	4	3	3	3	3	
Avg	80,350	85,550	87,700	80,050	90,450	91,775	92,800	92,500	95,467	92,467	87,333	83,800	**1,060,242**
	Average annual power need, taking into consideration the Actuals for 2009, 2010, 2011 and 2012 (year-to-date), is 1,060,242 kWhrs.												

For financial modeling, the cost of electricity was estimated with the following considerations in mind. There are several familiar rates currently in use for project analyses. These include a state-wide rate of 8.43¢ documented in "North Carolina Energy Facts" by the Institute of Energy Research (IER)[1] and a 10.5¢ rate for energy cooperatives which is noted by the NC Sustainable Energy Association in their report, "Levelized Cost of Solar Photovoltaic in North Carolina."[2]

Since the team was able to obtain actual costs, these were used to develop an average rate. There is month-to-month and year-to-year variability in these rates, in both the positive and negative direction (see below). The team elected to average the rates by month for the last four years. The average rate per month was then averaged over a year and this value, $0.075 per kWhr, was used as the starting point for the 25-year duration of the project.

[1] http://www.instituteforenergyresearch.org/state-regs/pdf/North%20Carolina.pdf
[2] http://energync.org/feature/study-finds-decline-in-solar-costs

Actual Rates by Month for Power Consumed by Third Creek Elementary													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**
2009	0.082	0.079	0.082	0.082	0.078	0.077	0.079	0.075	0.079	0.076	0.070	0.073	0.078
2010	0.077	0.073	0.077	0.081	0.062	0.071	0.070	0.076	0.070	0.073	0.077	0.077	0.074
2011	0.081	0.071	0.070	0.072	0.070	0.073	0.069	0.071	0.072	0.072	0.073	0.076	0.073
2012	0.076	0.076	0.073	0.075	0.077	0.076	0.080	0.062					0.074
divisor	4	4	4	4	4	4	4	4	3	3	3	3	
Avg	0.079	0.075	0.076	0.078	0.072	0.074	0.075	0.071	0.074	0.074	0.073	0.075	**0.075**
	Average per kWhr cost for power over this period is $0.075												

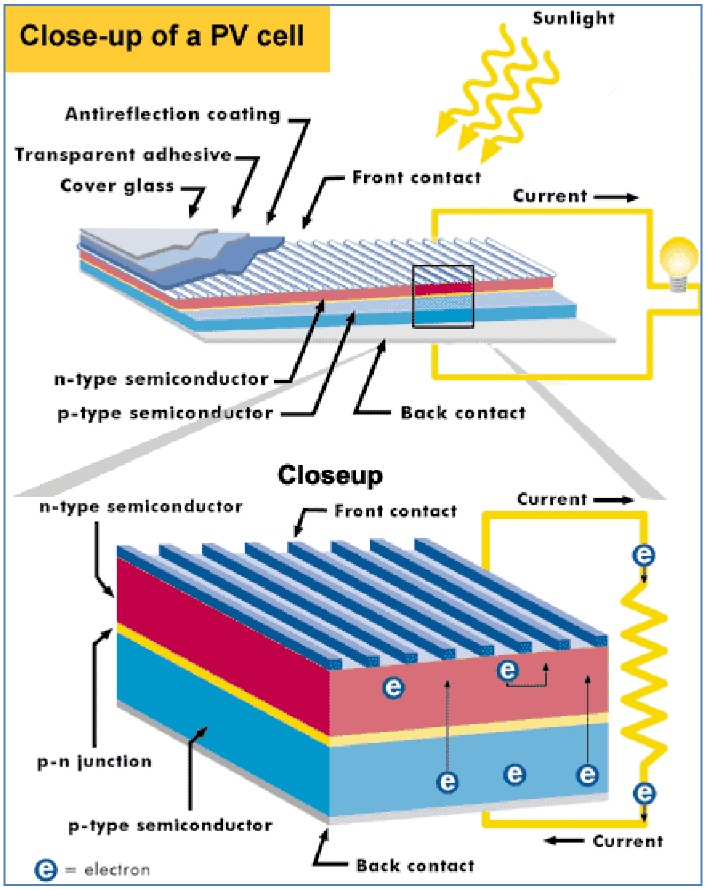
Note: Third Creek Elementary receives power from the cooperative, EnergyUnited (See Addendum C)
https://www.energyunited.com/

5. Photovoltaic (PV) Technology Review and Selection

The purpose of this section is to briefly review PV technology and make a recommendation on the type and manufacturer of PV panels to be used at the site.

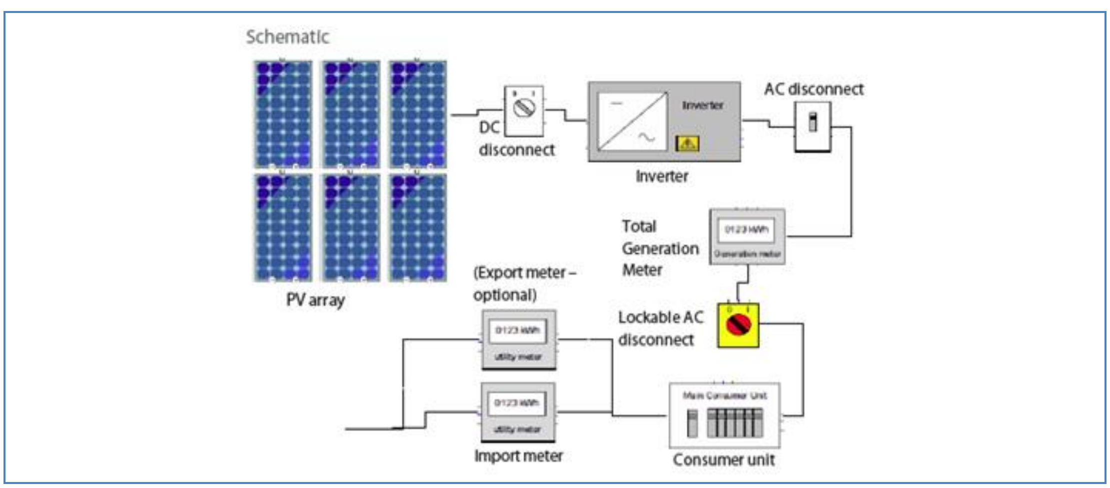
Technology Overview

The diagram below illustrates the application of the photo-electric effort to generating electricity with a PV cell. Photons move through the Silicon wafer to that portion of the substrate where Phosphorus has been applied (“doping”) to provide additional loosely-bonded valence electrons. These additional electrons create instability in the sharing of electrons throughout the p-type Silicon crystalline lattice. The energy provided by the sun’s photons causes the electrons to be released from the p-Silicon to the n-Silicon. With negatively-charged electrons continuously leaving the p-Silicon, it takes on, in aggregate, a positive charge, hence the designation “positive-Silicon” or p-Silicon. Conversely the n-Silicon is the recipient of electrons and is therefore negative in charge.



From: Alternative Power Generation
http://alternativepowergen.com/SolarTechnology.html

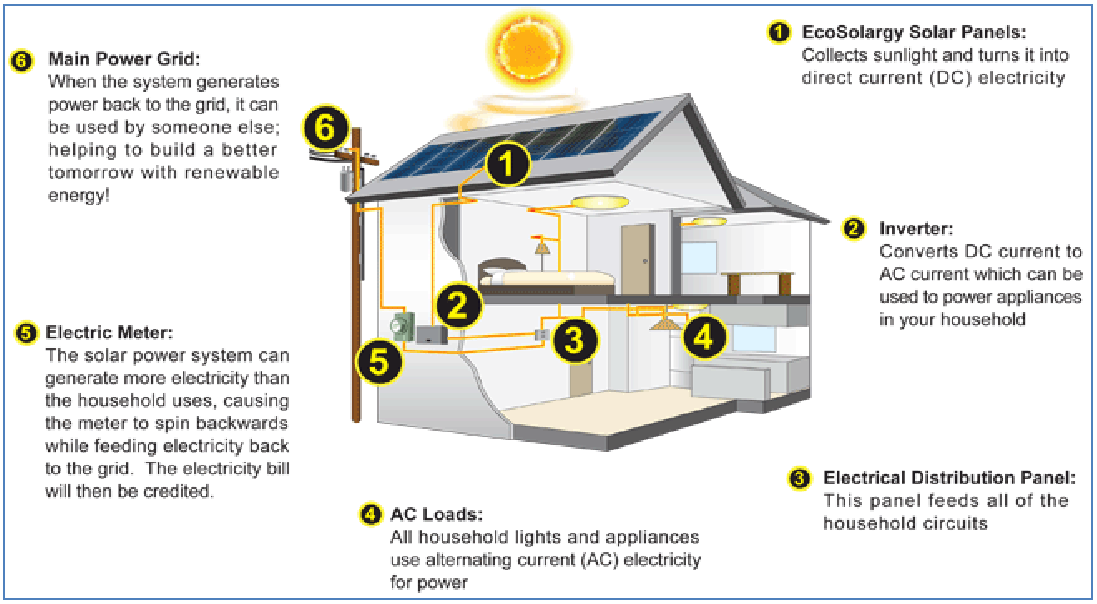
The electrons are released as direct current (DC) from the solar panels, in series, and the voltage is additive. In this way, high voltage DC is delivered to the Inverter (see diagram below).



From: Solar Panel Challenge
http://solarpanelchallenge.org/solar-inverter-schematic

The inverter transforms the DC to the alternating current (AC) to be consistent with the existing power delivery format. The AC moves through a meter ("Total Generation Meter" above) to determine the amount of power produced and is delivered to a main circuit panel (see "Consumer Unit" above). From here the current can be used to power selected AC circuits in the building and/or delivered to the grid via meter (see "Export Meter"). In many locations in the U.S. there is a single meter than runs "backwards" when unneeded locally-generated power flows to the grid.

These relationships are illustrated in the diagram below:



From: Making Solar Panels from Scratch
http://www.makingsolarpanelsfromscratch.com/solar-panels-4-home/

Photovoltaic Cells – Types

PV cells are characterized by their materials and technology into First, Second and Third Generations. The First Generation includes Monocrystalline and Polycrystalline Silicon. As the names suggest the former are sections sliced from a large single crystal of Silicon (Si) whereas the latter is comprised of multiple crystals. The Polycrystalline cells are less expensive to produce, but there is a penalty in conversion efficiency. Below is PV cell material and technology conversion documentation of various products.

Technology and Conversion Efficiency Range[3]	Conversion Efficiency - State of Technology[4]	Distinguishing Feature	General Technical Reference
First Generation: Crystalline Silicon			
Monocrystalline silicon 16-22%	22.5% Sunpower http://www.solarplaza.com/top10-monocrystalline-cell-efficiency/	Cells sliced from large single crystals of Silicon grown under controlled conditions	http://www.solar-facts-and-advice.com/solar-cells.html
Polycrystalline 14-18%	19.3% Mitsubishi http://www.mitsubishielectric.com/company/rd/research/highlight/infra/crystal.html	Wafers produced in molds from multiple Silicon crystals	http://www.solar-facts-and-advice.com/solar-cells.html
Hybrid Heterojunction with Intrinsic Thin layer (HIT) *no range provided*	21.6% Panasonic http://reseller.segen.co.uk/reseller/docs/Panasonic%20Technical%20Brochure.pdf	Mono thin crystalline Silicon wafer surrounded by ultra-thin amorphous Si layers; higher efficiency at high ambient temps	http://panasonic.net/energy/solar/
Second Generation: Thin Film			
Amorphous silicon (a-Si) 5.4-7.7%	7.7% *research grade* http://www.sciencedirect.com/science/article/pii/S0040609011020967	Silicon deposited in thin layer to flexible substrate	http://www.solar-facts-and-advice.com/solar-cells.htm
Copper-indium-gallium diselenide (CIGS aka CIS) 7.3-12.7%	15.8% Avancis http://www.avancis.de/en/cis-technology/	CIS is synonymous with CIGS Layer thickness is 1/100 of crystalline Si Constituents: Cu, In, Ga, Se	http://www.avancis.de/en/cis-technology/
Cadmium telluride (CdTe) 9-12.5%	17.3% First Solar http://www.pv-tech.org/news/nrel_confirms_new_cdte_cell_efficiency_record_from_first_solar	CdTe is the semi-conductor material	http://www.pv-tech.org/news/calyxos_cdte_technology_claims_16.2_cell_efficiency

[3] Standard Test Conditions (STC) by European Photovoltaic Industry Association (EPIA), which cites Strategic Research Agenda (2011) and Photo International (February 2011) http://www.epia.org/solar-pv/pv-technologies-cells-and-modules.html

[4] Highest reported conversion efficiency for a commercial application (i.e., not lab unless otherwise noted)

Technology and Conversion Efficiency Range[3]	Conversion Efficiency - State of Technology[4]	Distinguishing Feature	General Technical Reference
Third Generation			
Concentrated Photovoltaic (CPV) 30-38%	33.5% (module) Amonix http://www.greentechmedia.com/articles/read/Stat-of-the-Day-CPV-Solar-at-Record-33-Percent-Efficiency-in-Field/	Lenses or curved mirrors used to concentrate sunlight onto cell	http://en.wikipedia.org/wiki/Concentrated_photovoltaics
Dye-sensitized Solar Cell (DSSC) 2-4%	10.6% (lab) Yanagida, et. al. http://sciencesupply.com.au/research/sandwichcell.pdf	Semiconductor formed between photo-sensitized anode and an electrolyte	http://en.wikipedia.org/wiki/Dye-sensitized_solar_cell
Organic Photovoltaic Technology(OPV) *no range provided*	9.3% (lab) South China University of Technology http://www.businesswire.com/news/home/20120821005794/en/CORRECTING-REPLACING-Phillips-66-South-China-University	Organic polymer layer to convert light into electricity	http://www.solarmer.com/about_opv.html

Note: Conversion Efficiency = "… the percentage of the solar energy shining on a PV device that is converted into electrical energy" U.S. Dept. of Energy http://www.eere.energy.gov/basics/renewable_energy/pv_cell_conversion_efficiency.html

A range of efficiency is noted for each PV cell type. These are 2011 data, which are provided by the European Photovoltaic Association (EPIA). More recent data (see "State of Technology") illustrate how quickly this technology is moving. In most cases these data significantly exceed the EPIA range.

From a technology standpoint, the Panasonic (formerly Sanyo) "Hybrid" lies between the First and Second generation. The HIT (Heterojunction with Intrinsic Thin layer) cell uses both Monocrystalline Si and amorphous Si, which is a Thin Film technology.

The Second Generation Thin Film approaches include Amorphous Si, CIGS/CIS and CdTe. The latter two diverge from Si approaches to use different materials as the semi-conductor. PV thin film has the two advantages of (i) lower manufacturing cost and (ii) virtually unlimited flexibility in physical application. As noted in the table, they are not as efficient as the hard-wafer First Generation cells.

The Third Generation includes such novel approaches of concentrating sunlight onto each cell (CPV), creating semiconductors through printing processes (DSSC) and use of organic polymers (OPV). In addition, there are variations of the above PV approaches (e.g., very thin, flexible Polycrystalline wafers). It is an industry of rapid advances.

Photovoltaic Cells – Selection

The Panasonic (formerly Sanyo) HIT was selected as the PV cell for the baseline analysis and calculations. This cell was selected for three reasons:

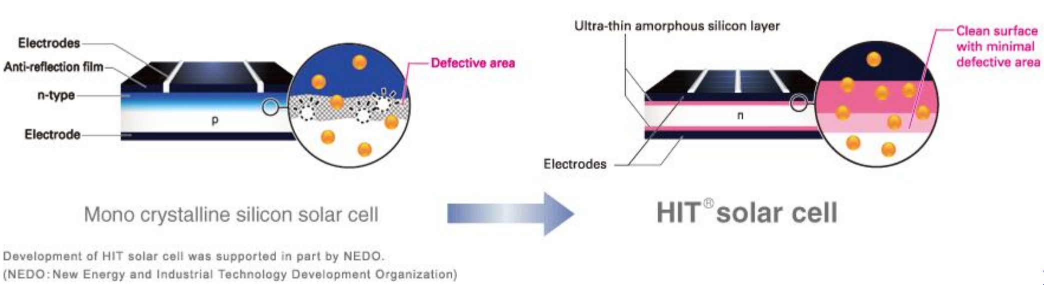
- Among commercially available Silicon-based PV cells, it has one of the highest conversion efficiencies;
- Its performance under high ambient temperature is compromised the least; and
- Panasonic guarantees the output to be at least the nameplate value in DC Watts.

As a point of reference, this chart (below) was reproduced from "Solar Plaza." On their website, they note a "top 10" ranking of Silicon cells based on the tested conversion efficiency. This review was first published in March 2012.

	Manufacturer	**Cell Efficiency**	**Cell Type**
1.	Sunpower	22.5%	Maxeon Cell Technology
2.	**Sanyo Electric**	**20.2%**	**HIT Solar Cell Structure**
3.	JA Solar	20.0%	JAC M6SL Secium
4.	Suntech	19.7%	Pluto Cell
5.	Suniva	19.4%	Artisan Select
6.	Shinsung Solar Energy	19.4%	SH-1940S3
7.	E-Ton	19.3%	Mono Cell 3BB
8.	Motech	19.2%	XS156B3-200R X-Cells
9.	Neo Solar Power	19.2%	Perfect 19
10.	Solartech Energy	19.1%	SR-156-3

From: Solar Plaza
http://www.solarplaza.com/top10-monocrystalline-cell-efficiency/

Cell conversion efficiency is only the first possible attenuation in the transformation of insolation into usable AC. When considering that roof space for the system is limited, it is important to begin with the most efficient cell that can be afforded.

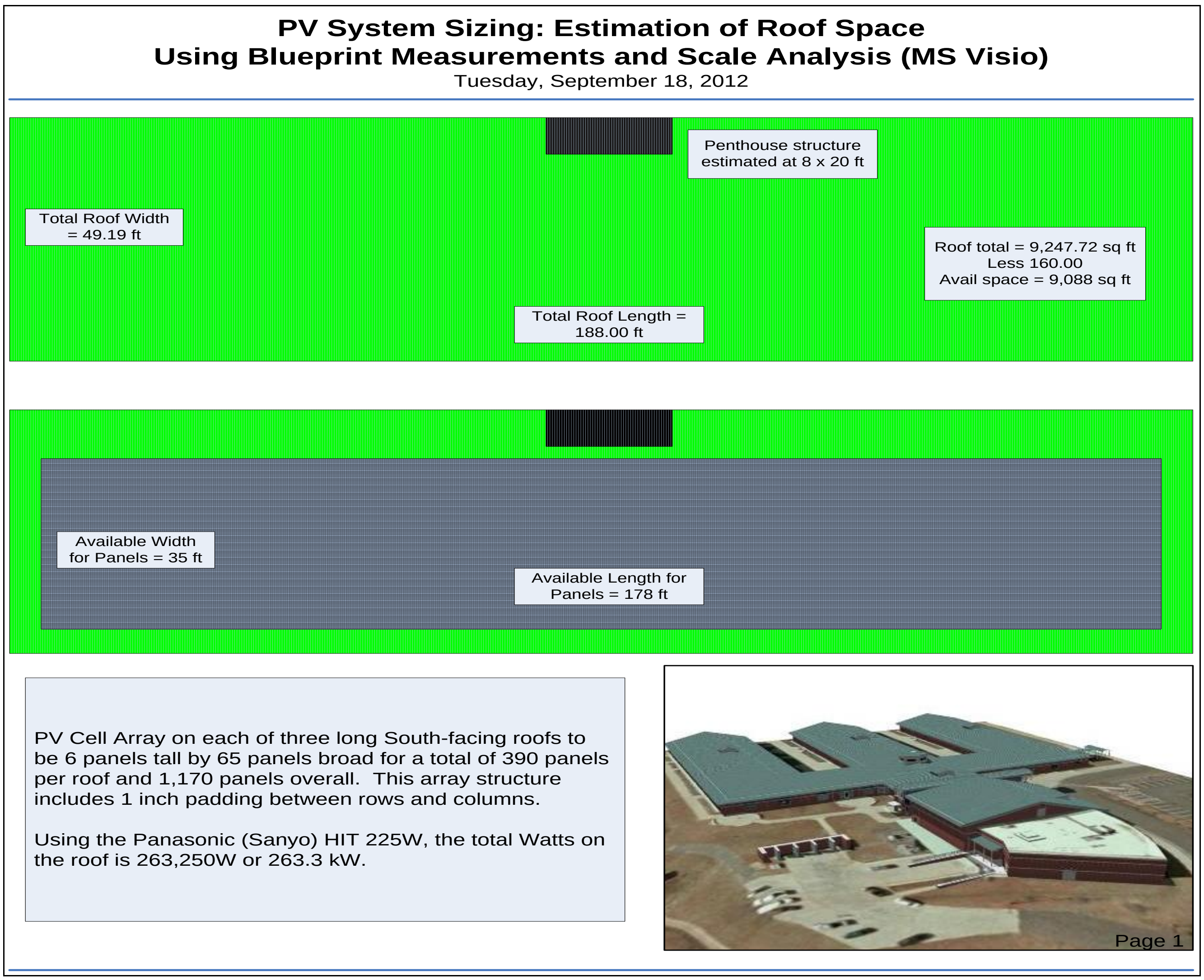


www.panasonic.net

6. Roof Space Available and System Sizing

To determine roof space available, the Team met with John Nichols, Senior Sustainability Coordinator, of Moseley Architects at the Morrisville office in August to review the original project blueprints. Using the blueprints, the design measurements of the roofs were determined. At this meeting it was agreed, that for practical and aesthetic reasons, the installation should be placed on the south-facing slope of the three long building segments (see photo below). By design, these three segments stretch East to West, providing a long expanse of roof facing almost due South.

The blueprint measurements were then used for a “scale analysis” using Microsoft® Visio®. In this analysis, the roof and build-able area were represented on scale to determine the number of panels in the array. This scale approach was consistent with installers’ rule of thumb which indicates that 70-80% of the roof can be assignable to panels for the purposes of initial system sizing. The Visio® analysis follows below.



7. Solar Resource

The insolation available at the site was determined using NREL's PVWATTS Model v.2.

Station Identification	
Cell ID:	0255384
State:	North Carolina
Latitude:	35.9 ° N
Longitude:	80.7 ° W
PV System Specifications	
DC Rating:	263.3 kW
DC to AC Derate Factor:	0.849
AC Rating:	223.5 kW
Array Type:	Fixed Tilt
Array Tilt:	35.9 °
Array Azimuth:	198.0 °
Energy Specifications	
Cost of Electricity:	7.5 ¢/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	3.74	25744	1930.80
2	4.21	25834	1937.55
3	5.32	34877	2615.78
4	5.91	36236	2717.70
5	5.65	35564	2667.30
6	5.75	33798	2534.85
7	5.53	33287	2496.53
8	5.27	31883	2391.22
9	5.38	32092	2406.90
10	5.10	32523	2439.22
11	3.86	24698	1852.35
12	3.63	24475	1835.62
Year	4.95	371012	27825.90

As the "PV System Specifications" indicate, the overall DC to AC derate factor has been boosted from the PVWatts default of 0.77 to 0.849. The rationale for this increase is noted below (see table). The Panasonic HIT PV cell was selected, among other reasons, because of the power output tolerance established by the manufacturer. Panasonic warrants the actual output to be -0%/+10% of the nameplate. That is, based on finished product testing, there is no expectation that the power output will be less than nameplate. Therefore, the de-rating category related to power tolerance should be 1.00 and not 0.950 as in the PVWatts default entry.

In addition, there is no reason to expect a 5% power decrement from "soiling" when placing the panel in service for the first time. Rather than use the default value of 5%, this has been reduced to 0.5% (see factor of 0.995, in table below) which is within the range established by NREL for the PVWatts model.

The output of the panels is expected to degrade over time and this degradation includes the impact of soiling. This has been extensively studied by NREL and the output reduction assumed is 0.71% per year for each of the 25 years in service. [5]

[5] http://www.nrel.gov/docs/fy02osti/31455.pdf, page 1

Adjustments to PVWatts Default Derate Factor for Sanyo (Panasonic) HIT Power 225W Module				
	Acceptable Range for PVWatts Model	**PVWatts Defaults**	**Revised Value**	**Comments**
Module nameplate DC rating	0.80 - 1.05	**0.950**	**1.000**	Mfg (Power) tolerance is -0%/+10%*
Inverter and Transformer	0.88 - 0.98	0.920	0.920	
Mismatch	0.97 - 0.995	0.980	0.980	
Diodes and connections	0.99 - 0.997	0.995	0.995	
DC wiring	0.97 - 0.99	0.980	0.980	
AC wiring	0.98 - 0.993	0.990	0.990	
Soiling	0.30 - 0.995	**0.950**	**0.995**	Assume no efficiency compromise from soiling when placed into service.
System availability	0.00 - 0.995	0.980	0.980	
Shading	0.00 - 1.00	1.000	1.000	
Sun-tracking	0.95 - 1.00	1.000	1.000	
Age	0.70 - 1.00	1.000	1.000	
DC to AC Derate Factor		**0.770**	**0.849**	

*http://www.solarsystemsusa.net/solar-panels/by-brand/sanyo/hit-n225a01/

Also of note related to the PV System Specifications –

<u>Array Tilt</u>: The default value in PVWatts, which is equal to the latitude for the location of interest, has been accepted for our feasibility study. Note that the Tilt matches the Latitude in the Station Identification panel above it.

<u>Azimuth (angle)</u>: The Azimuth corrects for systems that do not face "due South," meaning, precisely 180 degrees from true North. To determine this angle, the architectural plans were oriented due North and due South was identified. A perpendicular was applied to the edge of the South facing roof and the angle deflection off vertical (facing the plans) was measured. This angle was determined to be 18 degrees to the West. Thus the azimuth angle is 180 + 18 for 198 degrees.

As noted in the PVWatts Results panel (see table above), the insolation at Third Creek Elementary ranges from 3.63 to 5.91 kWhr/m^2/day. According to the model, and considering every day of the year, the average daily insolation is 4.95 kWhr/m^2/day.

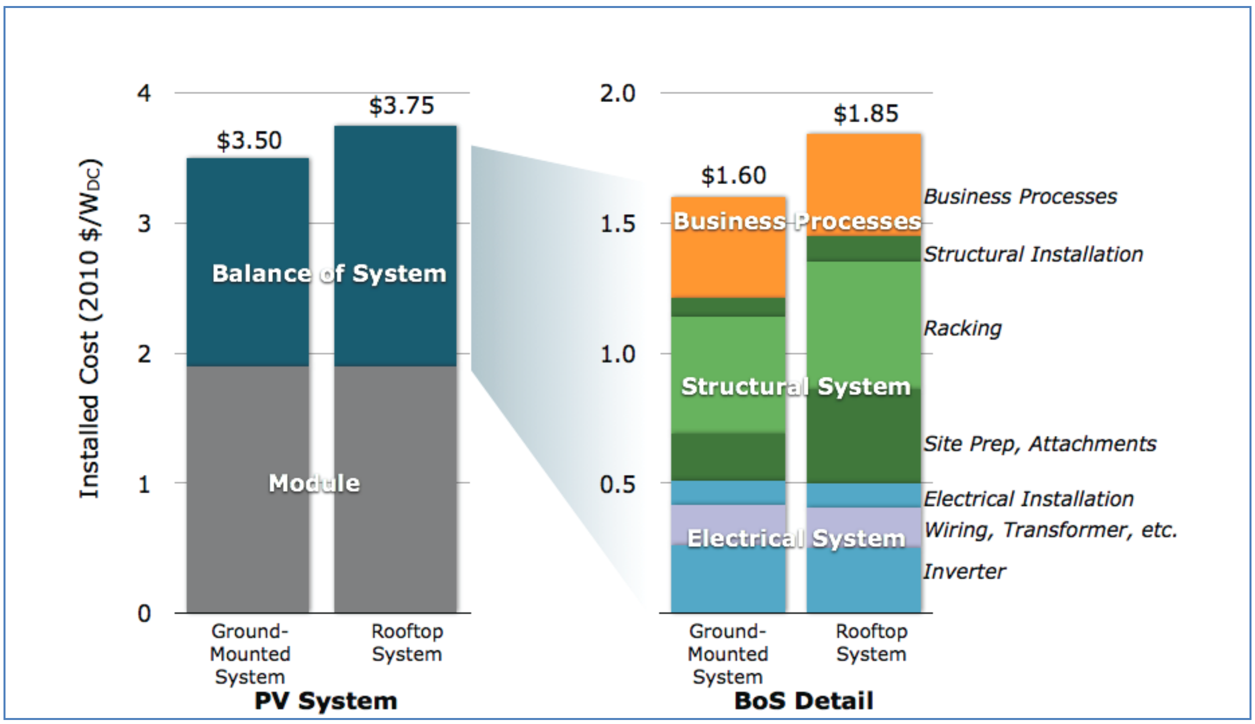
Given the insolation determined for this point of Latitude/Longitude and factoring in the azimuth angle, the angle of incidence, and the specified DC to AC aggregate derate, PVWatts has determined that the system can generate 371,012 kWh during the first year of operation.

8. Estimation of Capital Investment

For the purpose of the feasibility study, the system costs were determined in the following way. First the PV cell was selected: the Panasonic HIT 225. Once the cell was selected an Internet search was conducted to find pricing information. The company, Solar Systems USA, offers the HIT in a 225W panel for $606.38 as a single panel purchase. No doubt a significant discount could be obtained, since we would be purchasing over 1,000 panels. To be conservative in the analysis the one-panel price point of $606.38 was utilized.

All the rest of the PV system, the so-called "Balance of System" or "BoS" was estimated according to information in a Rocky Mountain Institute (RMI) report. In this report, RMI indicates that for a rooftop system the BoS is $1.85/$3.75 or 49.3% of the overall cost (see "Rooftop System" in following figure).

Since we know both our nameplate Watts (263,250) and our cost ($709,465) we can determine the Module portion of the cost on a per-Watt basis and by proportion determine the BoS. Reasoning in this way, the BoS is $690,794 and the total system is $1,400,259.



From: Rocky Mountain Institute, "Achieving Low-Cost Solar PV: Industry Workshop Recommendations for Near-Term Balance of System Cost Reductions"
http://www.rmi.org/Content/Files/BOSReport.pdf

9. Financing the System: Background on Options for K-12 Public Schools

As education budget cuts hover in both federal and state, it can be very challenging for Iredell-Statesville Schools, the supervising district of Third Creek Elementary School, to procure funding for projects and improvements, particularly for energy efficiency initiatives. In this report, we will examine the school district's financing options, as well as strategies on how to pay for a particular project, and what type of financing tools does a school district have. In addition, we will also include some case studies and a recommendation.

HOW SCHOOL DISTRICT PAYS FOR A PROJECT

DISTRICT CASH RESERVES
No Interest cost but depletes reserves
Need to evaluate opportunity for funds
ELIGIBLE GENERAL OBLIGATION FUNDS PROCEEDS
Cost of financing shifted to property tax
Energy savings recognized in general fund
TRADITIONAL EQUIPMENT LEASE FROM GENERAL OPERATING BUDGET
Similar to certificate of participation for traditional school projects
Interest cost must be programmed into budget

FINANCING TOOLS

A. **Direct Ownership**

With Direct Ownership, Third Creek pays for the system and installation with funds on hand or through a loan. The school owns the system and receives all the benefits of utility incentives and energy savings for the entire life of the system (20+ years). The solar project is procured through a design-build contract. Third Creek finances the project's purchase price with 100% debt financing which may include either traditional tax-exempt municipal bonds or taxable bonds that provide a form of federal subsidy; namely, Build America Bonds, Clean Renewable Energy Bonds, Qualified Energy Conservation Bonds, Qualified School Construction Bonds, and Qualified Zone Academy Bonds.

Build America Bonds

Build America Bonds, a program develop by the Obama administration, assists states and municipalities to pursue needed capital projects which build infrastructure. The existing tax-exempt bond market has faced significant challenges over the past two years. Build America Bonds (BABs) address this by providing state and local governments with a new, direct federal payment subsidy for a portion of their borrowing costs on taxable bonds.[6] BABs provide a deeper federal subsidy to state and local governments (equal to 35 percent of the taxable borrowing cost) than traditional tax-exempt bonds which leads to lower net borrowing costs for state and local governments.[7] This feature also makes Build America Bonds attractive to a broader group of investors who typically invest in more traditional state and local tax-exempt bonds. The capital projects these bonds fund include work on public buildings, courthouses, schools, transportation infrastructure, government hospitals, public safety facilities and equipment, water and sewer projects, environmental projects, energy projects, government housing projects and public utilities.[8]

Clean Renewable Energy Bonds

With CREBS, a type of tax credit bond, the investor receives a tax credit from the U.S. Department of the Treasury (Treasury Department) rather than an interest payment from the issuer. However as discussed below, in many cases the tax credit provided to investors has been insufficient and investors have required issuers to pay supplemental interest payments or issue their bonds at a discount. Tax credit bonds differ from traditional tax-exempt municipal bonds in several ways.[9]

- Tax-exempt municipal bonds. The issuer makes cash interest payments. The federal government exempts this interest income from federal taxes, thereby allowing an investor to offer bond rates that are lower than those for a corporate bond of similar credit rating.[10]

- Tax credit bonds. The federal government provides the investor with tax credits in lieu of interest payments from the borrower, theoretically subsidizing municipal borrowing completely.

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[6] Recovery Act, Internal Revenue Services, http://www.treasury.gov/initiatives/recovery/Pages/babs.aspx
[7] Ibid.
[8] Ibid
[9] Financing Public Sector Projects with Clean Renewable Energy Bonds, National Renewable Energy Laboratory: http://www.nrel.gov/docs/fy10osti/46605.pdf
[10] Ibid

Case Study #1: Clean Energy Revenue Bond Measure - Implemented by the State of New Mexico for K12 Public Schools and government entities[11]

Eligible Entities	K12 Public Schools/ Govt. Entities
Statute Citation	Energy Efficiency & Renewable Energy Bonding Act
Types of measures	Building efficiency and renewable energy systems
Financier	Public: New Mexico Finance Authority (NMFA); does not impact School District's bonding capacity; does not require voter approval
Maximum financing term	Flexible terms: based on equipment life
Aggregate financing available	$20 million
Project steps	1. Procure and conduct investment-grade energy audit. Obtain NMFA Board financing approval a. NMFA determines term of loan b. ECMD certifies energy savings is sufficient for debt service 2. Procure and implement building energy efficiency measures (contract cannot exceed 10 years) 3. Monitor and verify energy savings
Loan Repayment	1) PED deducts 90% of debt service from School District's funding allocation until the loan is paid in full 2) School district retains 10% for discretionary use
EMNRD responsibilities	3) Certification of energy audit reports 4) Monitoring and verification of energy savings

[11] Energy, Minerals, and Natural Resources Department (ENMRD), http://www.emnrd.state.nm.us/ecmd/CleanEnergyPerformanceFinancing/documents/CERBforSchools-Highlights.pdf

Qualified Energy Conservation Bonds[12]

The definition of qualified energy conservation projects is fairly broad and contains elements relating to energy efficiency capital expenditures in public buildings; renewable energy production; various research and development applications; mass commuting facilities that reduce energy consumption; several types of energy related demonstration projects; and public energy efficiency education campaigns. In contrast to CREBs, QECBs are not subject to a U.S. Department of Treasury application and approval process. Bond volume is instead allocated to each state based on the state's percentage of the U.S. population as of July 1, 2008. Each state is then required to allocate a portion of its allocation to "large local governments" within the state based on the local government's percentage of the state's population. Large local governments are defined as municipalities and counties with populations of 100,000 or more. Large local governments may reallocate their designated portion back to the state if they choose to do so.

Qualified School Construction Bonds

QSCB are a U.S. debt instrument created by Section 1521 of the American Recovery and Reinvestment Act of 2009. Section 54F of the Internal Revenue code covers QSCBs. QSCBs allow schools to borrow at nominal, zero percent for the rehabilitation, repair and equipping of schools. The QSCB lender receives a Federal tax credit in lieu of receiving an interest payment.[13] The annual allocation of $11,000,000,000 has been approved for 2011 and 2012 resulting in a total of $22,000,000,000 in QSCB authority. The US Treasury and the IRS allocate the authority to issue QSCBs to all fifty states and US possessions.

Case Study #2: Charlotte County Public Schools (CCPS), State of Virginia

CCPS was awarded $1.5 million in QSCB for the renovation of Randolph-Henry High School in March 2011. Renovation includes energy upgrades for the entire school, such as lighting and HVAC. Additional upgrades will focus on the auditorium which includes flooring, curtains, sound system, and stage lighting. CCPS Board of Supervisors passed the resolution last 20 September 2011 and bonds are sold 8 November 2011. Renovation will be fully completed on or before the end of 2012.

Qualified Zone Academy Bonds

QZAB program permits public schools serving large concentrations of low-income families to benefit from interest-free financing to pay for building repair, invest in equipment and technology, develop challenging curricula, and train quality teachers. The federal government provided this tool under the “Taxpayer Relief Act of 1997” to help encourage formation of partnerships between public schools and local businesses. Each State is allotted an amount of money its schools may borrow using QZABs.[14] Thus, the allocation formula is based on state percentages of the national population of individuals with incomes below the poverty line. States have the flexibility to choose their own processes to award bond authority to qualified schools. A qualified school is one

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[12] QECBs, United States Environment Protection Agency, http://www.epa.gov/chp/funding/funding/usqualifiedenergyconservationb.html
[13] Qualified School Construction Bonds, Wikipedia, http://en.wikipedia.org/wiki/Qualified_school_construction_bond
[14] QZAB, United States Department of Education, http://www2.ed.gov/programs/qualifiedzone/faq.html

that is located in an Empowerment Zone or Enterprise Community or has at least 35% of its students eligible for free or reduced price school lunch.[15] In addition, a qualified school must develop a partnership with a business and private entities must make a contribution to the school worth at least 10% of the money borrowed using the QZAB. These contributions can take many forms: cash, goods (technology or equipment), services, and field trips. The donor does not simply donate to the school. Both the academic institution and the donor become partners, creating a plan together to improve the education system.

Case Study # 3 Sidwell Friends School Bonds

Sidwell Friends School (SFS), a coeducational 15-acre elementary school in Washington DC with a population of 1,123 students, has been generating its own electricity with the recent installation of 224 solar panels. The 53-kilowatt system is a collaboration between the SFS and Common Cents Solar. SFS worked with Common Cents Solar, a local non-profit that facilitates solar projects, to launch a program of community-based "solar bonds". The bonds will be repaid over about ten years after which the SFS community members may donate the system to SFS, providing free energy for the remaining life of the system, estimated at 20 years. In 2010, the school and CCS installed a 120-panel system on the SFS Lower School gym roof using a similar financing scheme.[16]

B. **Power Purchase Agreement**

A Solar Power Purchase Agreement (SPPA) is a financial arrangement in which a third-party developer owns, operates, and maintains the photovoltaic (PV) system, and a host customer agrees to site the system on its roof or elsewhere on its property and purchases the system's electric output from the solar services provider for a predetermined period.[17] This particular financing scheme allows the school to receive non-volatile, and lower cost electricity, while the solar services provider or another party acquires financial benefits such as tax incentives and revenues acquired from the sale of electricity. The scheme allows schools to embark on a solar project while avoiding upfront costs as well as maintenance and operations responsibilities. As practiced in 45 states, solar companies finance and install the equipment while retaining ownership of the system. The school then makes monthly payments to the company based on the amount of electricity that will be generated.[18]

"PPAs have become the most common method of financing solar panels," according to lawyer Stephen O'Day, partner and head of the environmental and sustainability practices at Atlanta-based Smith, Gambrell & Russell LLP. Solar installation in schools via PPA agreement has become the most attractive scheme for schools in the US. These solar school projects have been all over the country, including South San Francisco Unified School District, San Diego Unified School District, Greenfield Union School District, San Ramon Valley Unified School District, San Dieguito Union High School District, East Side Union High School District, Lodi Unified School District, and Mountain View Los Altos High School District in California; Mercy High School in Farmington Hills, MI; George Washington Carver Elementary School in Lexington Park MD; Berkshire School in Sheffield, MA; Paradise Valley Unified School District, Copper Ridge School, and Cholla Elementary in Arizona; Irving

[15] Ibid.
[16] Sidwell Friends School, Solar Bonds, http://www.sidwell.edu/about_sfs/environmental-stewardship/solar-bonds/index.aspx
[17] Solar Power Purchase Agreements, United States Environmental Protection Agency, http://www.epa.gov/greenpower/buygp/solarpower.htm
[18] "Solar bill gets lengthy airing," *Atlanta Business Chronicle*, 23 February 2012, Sec. 4 E11

Independent School District and Paseda Independent School District in Texas; and Bnos Bais Yaakov High School in New Jersey.[19]

Case Study #4 Milpitas Unified School District (MUSD) collaborated with Chevron Energy Solutions (CES) and Bank of America via SPPA.

In 2007, MUSD engaged Chevron Energy in the development of solar power and energy efficiency for its schools. CES developed a solar power generating system and installed energy efficiency measures. CES constructed a 3.4 MW PV on parking canopies and shade structures in 13 school sites. To improve efficiency, energy management software was installed on the district's computers. CES maintains the solar equipment and measures its overall performance. As part of the educational component, the solar installations provide a living laboratory that supports curriculum aligned with California state testing and education standards. Bank of America structured and financed the project through its Bank of America Capital Corporation Environmental Services Team. The entire cost of the program was offset by $4.2 million from California Solar Initiatives.[20]

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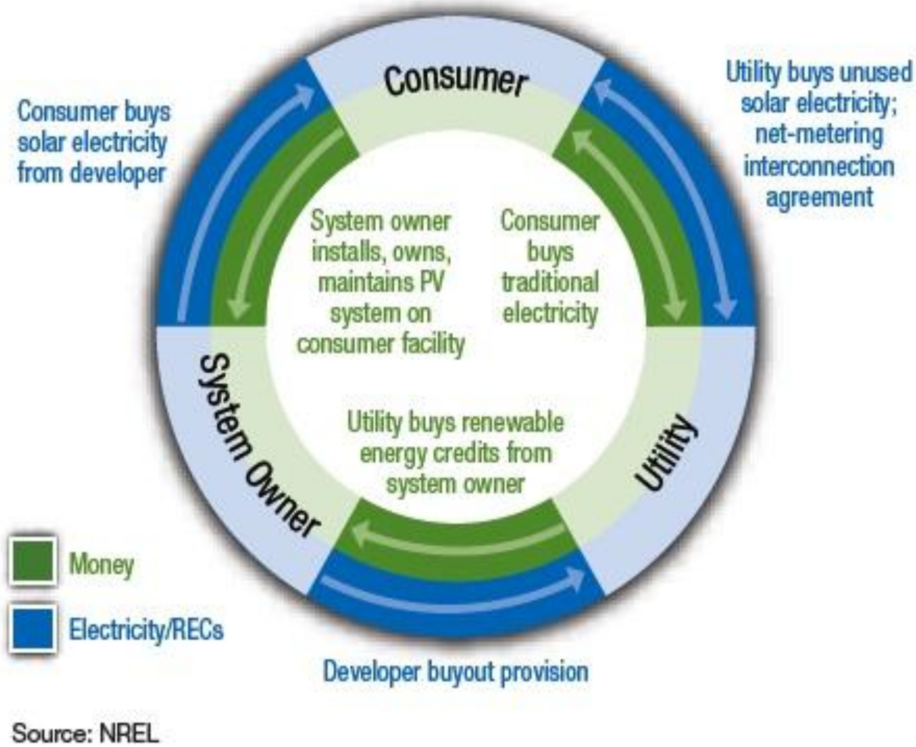
[19] How To Take Your School Solar, The Journal, 18 October 2011, http://thejournal.com/Articles/2011/10/18/How-To-Take-Your-School-Solar.aspx?Page=1

[20] Case Study: Milpitas Unified School District CA, http://www.chevronenergy.com/case_studies/musd.asp

Figure 1. Contracts and Cash Flow in Third-Party Ownership/PPA Model[21]



The system owner is often a third-party investor who provides investment capital to the project in return for tax benefits. The tax investor is usually a limited liability corporation (LLC) backed by one or more financial institutions. In addition to receiving revenues from electricity sales, they can also benefit from federal tax incentives. These tax incentives can account for approximately 50% of the project's financial return (Bollinger 2009, Rahus 2008). Without the PPA structure, the school (government agency) could not benefit from these federal incentives due to its tax-exempt status.

The developer and the system owner often are distinct and separate legal entities. In this case, the developer structures the deal and is simply paid for its services. However, the developer will make the ownership structure transparent to the government agency and will be the only contact throughout the process.[22] A recently emerging PPA structure has consumers either 1) prepay for a portion of the power to be generated by the PV system or 2) make certain investments at the site to lower the installed cost of the system. Either method can reduce the cost of electricity agreed to in the PPA itself.

This structure takes advantage of a governmental entity's ability to issue tax-exempt debt or to tap other sources of funding to buy-down the cost of the project. Prepayments can improve economics for both parties and provide greater price stability over the life of the contract. In spite of the enormous appeal of the PPA structure, four states — Georgia, Florida, North Carolina and Kentucky — "prohibit third party power purchase

[21] Solar, National Renewable Energy Laboratory, http://www.nrel.gov/solar/
[22] Ibid.

agreements," according to the United States Department of Energy.[23] With regard to North Carolina, it has not deregulated its electric utility industry based on the North Carolina General Statues (NCGS). NCGS define a public utility as:

> "Public utility" means a person, whether organized under the laws of this State or under the laws of any other state or country, now or hereafter owning or operating in this State equipment or facilities for:
>
> 1. Producing, generating, transmitting, delivering or furnishing electricity, piped gas, steam or any other like agency for the production of light, heat or power to or for the public for compensation; provided, however, that the term "public utility" shall not include persons who construct or operate an electric generating facility, the primary purpose of which facility is for such person's own use and not for the primary purpose of producing electricity, heat, or steam for sale to or for the public for compensation;..." (NCGS 62-3 (23) a)[24]

Therefore, a third party developer of a solar energy generation source would be considered a public utility if the developer attempted to enter into a third party PPA arrangement with one or more customers.

GRANTS

21st Century Learning Grants

The United States Department of Education supports the creation of community learning centers that provide academic enrichment opportunities during non-school hours for children, particularly students who attend high-poverty and low-performing schools. The program helps students meet state and local student standards in core academic subjects, such as reading and math; offers students a broad array of enrichment activities that can complement their regular academic programs; and offers literacy and other educational services to the families of participating children.[25] (See Addendum B)

Case Study #5 - Charlotte County Schools has been awarded $523,779 for 21st Century Community Learning Center Grant for the improvement and educational enhancements of Central Middle School. The first award received in 2008 was for $429,288. The school has benefited from after school remediation and recreation programming for the past three years.[26]

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[23] "Solar Bill Jolted Back to Life," http://savannahnow.com/exchange/2012-02-24/solar-bill-jolted-back-life#.UED4j44SSYc
[24] North Carolina General Statute, http://www.ncleg.net/gascripts/statutes/statutestoc.pl
[25] United States Department of Education, http://www2.ed.gov/programs/21stcclc/index.html
[26] Charlotte County Public Schools VA, http://www.ccpsk12.org/47.html

Energy Efficiency and Conservation Block Grants

The ARRA supervises grants of up to $200,000 for each selected local government entities including school systems and municipalities for energy efficiency and renewable energy technologies building enhancement. Qualifying projects include solar photovoltaic, solar thermal systems, energy efficiency lighting and HVAC upgrades. [27]

North Carolina Green Business Fund

The North Carolina Green Business Fund provides competitive grants between $30,000-$100,000 to help North Carolina small businesses develop commercial innovations and applications in the befouls industry and the green building industry, as well as attract and leverage private sector investments and entrepreneurial growth in environmentally conscious technologies and renewable energy products and businesses.[28]

North Carolina GreenPower Program

The North Carolina GreenPower program funds grid-tie electricity from solar, wind, biomass resources and micro-hydro (10 megawatts or less). The program aims to offset petroleum-based energy from utility companies with renewable energy generated from third parties (commercial, industrial, residential, nonprofit, schools, local government, and state government, agricultural and institutional).[29] To access the funding opportunity, one must submit a proposal and enter into an open-bid process.

Wal-Mart Foundation School Grants

The Wal-Mart Foundation has been funding solar initiatives of school localities in the United States by way of awarding grants to the National Energy Education Project (NEED). In 2011, NEED was awarded a $1.2 million donation to install solar panels on 20 schools in five cities across the country. The five cities taking part in the program are Chicago, Washington D.C., Los Angeles, Minneapolis and Seattle.[30]

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[27] North Carolina Grants for Energy, http://www.ehow.com/list_6539710_north-carolina-grants-green-energy.html#ixzz267CzhKBT

[28] NC Science and Technology, Department of Commerce, http://www.ncscitech.com/grant-programs/green-business-fund

[29] North Carolina Grants for Green Energy, http://www.ehow.com/list_6539710_north-carolina-grants-green-energy.html

[30] Wal-Mart Foundation, http://corporate.walmart.com/global-responsibility/environment-sustainability/energy

TWO-WAYS FOR SCHOOLS TO ACQUIRE SOLAR ENERGY

There are two basic ownership strategies in financing solar energy projects for school districts in most states:

GOVERNMENT/HOST OWNERSHIP	THIRD PARTY OWNERSHIP
Service agreement, not a financing - Power Purchase Agreement	Cash Purchase
Energy assets owned by a third party	Tax Exempt Financing Options - General Obligation Bonds - Lease Revenue Bonds/Certificate of Participation - Installment purchase agreements
Host customer purchases output at a fixed price	Tax Credit Bonds -CREBs; QECBs; QSCBs; QZABs; Build America Bonds
Cost effective solutions (?)	

NORTH CAROLINA SCENARIO

One structure that could be utilized to finance a solar array at Third Creek Elementary would be through a Third-Party Power Purchase Agreement (PPA). Under this arrangement, Third Creek Elementary would host but not own or lease the solar array. Instead, a third party (the project developer) would maintain ownership of the system and sell the electricity to the school through a contractually-binding power purchase agreement. In this way the developer, and any investing partners, would be able to take advantage of the Investment Tax Credits (ITCs) provided at Federal and State level. Meanwhile, Third Creek Elementary would be receiving electricity from a renewable energy source with a portion of its energy costs stabilized over an extended period.[31]Unfortunately, as noted above, Third Party PPA's are not now possible in North Carolina.

N.C.G.S. 62-3(23) defines a public utility as any person:

> Producing, generating, transmitting, delivering or furnishing electricity, piped gas, steam or any other like agency for the production of light, heat or power to or for the public for compensation.

As such, any person or business operating under a Third Party Solar PPA would be considered a public utility by the state and would therefore be subject to extensive regulation by the North Carolina Utilities Commission. This barrier to Third Party PPAs is reinforced by N.C.G.S. § 62-110.2 which ultimately requires that any solar developer hoping to operate under a Third Party PPA would have to receive permission from their customer's utility company to operate within their territory.[32]

31 Financing Non-Residential Photovoltaic Projects: Options and Implications, Mark Bolinger, Lawrence Berkeley National Laboratory, January 2009.

32 Barriers to Military Installations Utilizing Distributed Generation from Renewable Energy Resources Isaac Panzarella, Southeast Clean Energy Application Center, May 2011

10. Financing the Project

While a Third-Party PPA is not available at this moment in time, it appears to be one of the few ways in which Third Creek Elementary could obtain a solar PV System. Given that this approach has been successfully demonstrated outside North Carolina and given that the Investor Owned Utility (IOU) Duke Energy has experience owning and operating hosted systems, we are hopeful that such an arrangement could be accomplished in the near future.

With this in mind we developed our base case around third-party ownership and participation in the Progress Energy (now part of Duke Energy as of 2 July 2012) SunSense program.

Under this arrangement, Third Creek Elementary would host but not own or lease the solar array. Instead, a third party (the project developer) would maintain ownership of the system and sell the electricity to the school through a contractually-binding power purchase agreement. In this way the developer, and any investing partners, would be able to take advantage of the Investment Tax Credits (ITCs) provided at Federal and State level. Meanwhile, Third Creek Elementary would be receiving electricity from a renewable energy source with a portion of its energy costs stabilized over an extended period.[33]

While there are regulatory and administrative impediments to Third Party PPA financing *per se* there are analogous business arrangements, currently in operation in North Carolina, which provide the essential outcome desired; introducing solar generation via the public school system. These analogs are in the form of programs initiated by Progress Energy (SunSense) and Duke Energy (Distributed Generation).

For both programs, the IOU owns the renewable energy asset and provides some monetary compensation to the host site. In the Duke Energy program, the company pays the host annual rental fees; for Progress Energy, it is $0.15/kWhr for all power generated with the renewable energy asset.

The Duke Distributed Energy program has a number of forward-looking aspects and is consistent with the underlying impetus for this feasibility study; the introduction and understanding of PV power generation:

> Program Overview - In 2009, Duke Energy launched its solar power initiative in North Carolina. The $42 million, 10-megawatt (MW) program is now among the nation's largest distributed generation demonstrations. **With distributed generation, electricity is produced at many micro-generating sites** rather than at a large, centralized, traditional power plant. **We believe that partnering with sites in our communities helps build a broader understanding of solar energy and distributed generation**. (emphasis added)
>
> Site Selection - The solar program **comprises 25 sites in North Carolina, including homes, schools, businesses** and more. Each was selected based on the landowner's interest in solar energy, the site's proximity to the electrical grid and its solar potential. **Duke Energy owns and maintains the solar components, as well as the electricity generated.** In return, **property owners receive annual rental fees for use of their roof**s or land. (emphasis added)

33 Financing Non-Residential Photovoltaic Projects: Options and Implications, Mark Bolinger, Lawrence Berkeley National Laboratory, January 2009.

> Renewable Energy Standard - Duke Energy **developed its solar program in response to North Carolina's renewable energy standard,** which was adopted in 2007. The mandate requires utilities to meet at least 12.5 percent of its North Carolina customers' electricity needs through new renewable energy sources or energy efficiency measures by 2021.[34] (emphasis added)

Our understanding is that the Duke Energy program is "fully subscribed" at this point, meaning that they have identified all the renewable energy needed to be compliant with the NC Renewable Portfolio Standard (RPS). However, the practices described above position Duke Energy operationally to understand Third Party PPA projects and it sets a precedent that such projects are feasible.

The Progress Energy program, "SunSense" is currently fully subscribed but they will begin to take applications in December 2012 for projects that begin in 2013.[35] Again, as for the Duke Energy program, the essential things taking place in these programs:

- A for-profit entity owns the asset so that they can take advantage of the Investment Tax Credits, thereby lowering the initial capital and raising the return on investment to existing hurdle rates.
- A way is found to capture the economic value of the asset's output:
    - For Duke Energy, the value is in the power generated by the renewable resource. This power is sold at prevailing market rates.
    - In the Progress Energy program, the owner of the asset obtains $0.15 for each kWhr generated.

Financial Base Case

For the purpose of our project financial analysis, we established a "base case" which is consistent with the two principles above. Since the Duke Distributed Energy program may be closed for some time, we focused on the SunSense Program. To be sure, there are issues of third-party ownership that would need to be negotiated but the ongoing nature and vitality of this program suggests that such issues can be addressed and resolved.

The base case set-up assumptions:

- 3rd Party Ownership is feasible, and SunSense or PPA can be established
- Project has 25-year life; Investors are involved for the first 20 years
- Total panels on the roof is 1,170 in 3 sets of 390; total nameplate output is 263.3 kW
- Panel used is Panasonic (Sanyo) HIT 225W purchased at $606.38 each (Solar Systems USA)
- Total Cost is $1,400,259 with $709,465 for the panels and $690,794 for "Balance of System" (BoS)

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[34] http://www.duke-energy.com/north-carolina-business/renewable-energy/nc-solar-distributed-generation-program.asp

[35] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC65F&re=0&ee=0

- Duke Energy accepts project into SunSense Program which guarantees purchase of all PV-generated power at $0.15/kWhr for first 20 years of project
- Roof of school is leased to Investor for an amount equal to half of the SunSense revenue, which is approx $25k/year (Note: This is consistent in order of magnitude of other such commercial leases.)
- Only other recurring cost to Investor is system maintenance which is estimated to be one person-day per month at a fully-loaded pay rate of $40/hr, escalated 5% per year
- At the end of Yr 20, the Investor sells the PV system to the school system for the amount of the SunSense revenue in that year, which is $48k

The entire spreadsheet is provided as Appendix B. Because it warrants comment, the cash flow structure and first five years are provided below:

Cash Flow Analysis (Investor's Perspective)					
Cash In	Year 1	2	3	4	5
SunSense $0.15/kWhr	$55,652	$55,257	$54,864	$54,475	$54,088
Fed Govt ITC 30%	$420,078				
St of NC ITC 35%	$98,018	$98,018	$98,018	$98,018	$98,018
Depreciation Benefit	$83,315	$83,315	$83,315	$83,315	$83,315
Sell System to County					
Total for Year	$657,063	$236,590	$236,197	$235,808	$235,421
Cash Out					
Capital Investment	$1,400,259				
System Maintenance	$3,840	$4,032	$4,234	$4,445	$4,668
Lease of Roof	$27,826	$27,628	$27,432	$27,237	$27,044
Total for Year	$1,431,925	$31,660	$31,666	$31,683	$31,711
Net Cash to Investor	-$774,862	$204,929	$204,532	$204,125	$203,710
Cumulative cash	-$774,862	-$569,933	-$365,401	-$161,276	$42,433

Note that the first year includes the Federal ITC and launches the NC Renewable Energy ITC and the depreciation benefit, both of which are taken evenly over five years. This model assumes that the Investor covers maintenance costs (which are minimal) and leases the roof space from the school. The Investor sells the system to the school at the end of Year 20. It is the “Net Cash to Investor” line that is used for the Internal Rate of Return (IRR) and Net Present Value (NPV) determination. Note that “Cumulative cash” goes positive in Year 5.

Financial Results

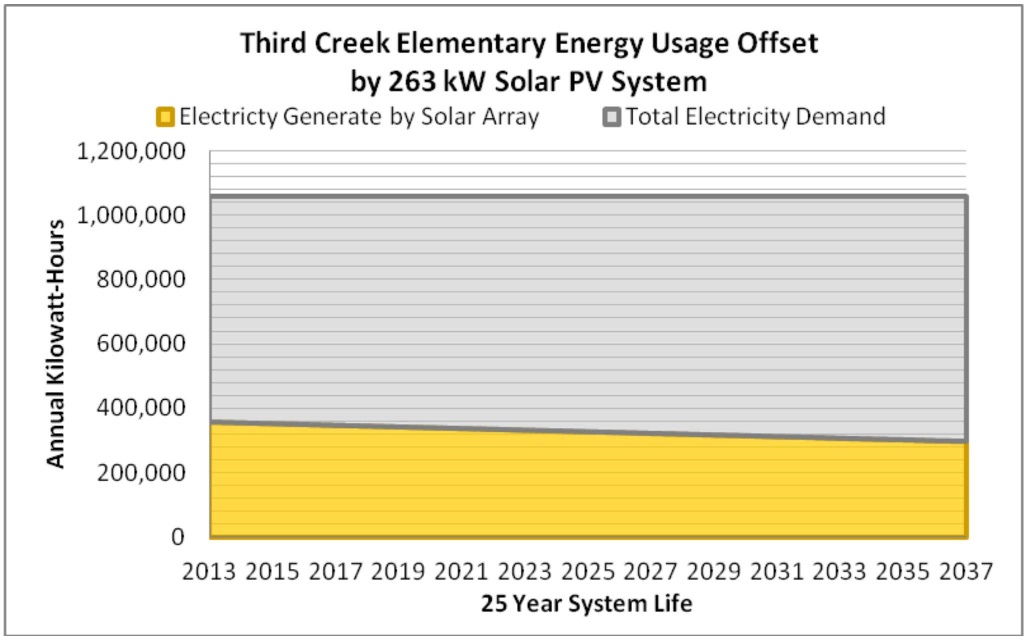
Measure of Return	**Base Case**	**Base Case without SunSense but with PPA at $0.10/kWhr**	**Base Case without Fed ITC**	**Base Case without NC RE ITC**
Payback Period	5 year	6 years	> 20 years	> 20 years
Internal Rate of Return	9.3 %	5.4 %	negative	negative
Discount Rate at which Net Present Value is positive	9.0 %	5.3 %	never positive	never positive
Cash Benefit to School over 25-yr project	$675,393	$518,084	moot	moot

These results confirm our two principles: Given the low market price for a kWhr of electricity, the initial investment must be reduced by incentives and the value of the asset's output (i.e., PV-generated power) must be monetized and captured for the benefit of the Investor.

11. Emissions Avoidance & Environmental Impact

Actual data for electricity consumed and cost have been made available by Iredell-Statesville Schools. Taking into consideration the actual data for 2009-2011 and 2012 year-to-date, Third Creek Elementary consumed, on average, 1.06 Million kilowatt-hours of electricity per year. For the purposes of this study we are assuming that the electricity generated from the solar array will displace only electricity usage and not the relatively cleaner energy resource of natural gas.

The graph below illustrates the estimated impact a 263 kilowatt (nameplate DC output) solar array would have on demand for utility generated electricity. Assuming an annual degradation of system output of 0.71%, and a 25 year system life-span, Third Creek Elementary demand for utility generated electricity would be reduced by approximately 325,300 kilowatt-hours annually and 8,130 megawatt-hours over its lifetime.



Looking past electricity demand reductions, carbon emissions reductions are a commonly used metric to measure the environmental impact and benefits of renewable energy projects. According to NC GreenPower, 1,200 kilowatt-hours of electricity generated by a renewable energy source in North Carolina offsets 2,497 pounds of carbon. Therefore, using the same system assumptions as earlier, a 263 kilowatt solar array would result in 676,000 pounds less carbon emissions annually, and 16,917,400 pounds avoided over a 25 year span.[36]

The table below provides other metrics used to characterize the environmental benefits of the project.

Third Creek Elementary 263 kW Solar PV System Environmental Impact Equivalents[37]		
Metric	**Avoided Per Year**	**Avoided Over 25 Years**
Kilowatt Hours	325,205 kWh	8,130,113 kWh
Carbon Emissions	676,696 lbs.	16,917,410 lbs.
Coal Consumption	263,416 lbs.	6,585,391 lbs.

[36] NC GreenPower "Environmental Benefit Calculator," [URL: http://www.ncgreenpower.org/signup/calculator.html] Accessed 9/16/2012.
[37] NC GreenPower "Environmental Benefit Calculator," [URL: http://www.ncgreenpower.org/signup/calculator.html] Accessed 9/16/2012.

NO_X Emissions	995 lbs.	24,865 lbs.
SO_2 Emissions	2,114 lbs.	52,846 lbs.
Cars Off the Road For One Year	137 cars	3,425 cars
Gasoline Consumption	13,128 gallons	328,198 gallons

There are a number of other positive environmental impacts that will result from Third Creek Elementary relying on solar energy for an average of 325,205 kWh of its energy needs each year that are not easily quantifiable. These benefits stem from the avoidance of activities in the supply chains of non-renewable energy sources. Third Creek Elementary use of solar energy contributes to mitigation of emissions and environmentally impacts of constructing and operating additional power plants, mining of coal, drilling for natural gas, and long-term storage of nuclear waste. While these considerations are harder to quantify, they should not be overlooked when considering the impact of a solar installation.

12. Recommendations

(1) Educate advocates and leaders to lobby for a legislative measure to allow third parties to access utility transmission and distribution facilities to power schools with reasonable guidelines and compensation.

(2) Advocate for a provision in the tax code to encourage participation of public entities to install renewable energy in their sites, instead of cash grants, production based incentives, and similar other forms.

13. Addendum A.

On October 22nd, Justin Taylor, President and Owner of Pure Power Contractors, Inc., met with team member Leigh Bumgardner at Third Creek Elementary School. The intent of this meeting was to have a professional analysis given of the building's roof and the grounds for solar photovoltaic installation and implementation after the initial completion of Team A's feasibility study on September 19th. Justin Taylor assessed the campus grounds, the school's roof, the main electrical room, and the school's interior.

It was initially determined that the campus, with its abundance of available property clear of any shading, was a prime location to host a photovoltaic installation. The roof, and its existing condition, materials, and structure were also proven to be well conducive for a photovoltaic installation. However, the various roof air vents on the three main south facing segments of the roof, as well as some minor shading from roof structures, will have to be factored into the system's design. It was further determined that the placement of the school's existing transformers, and the remaining vast open space between the wall and the transformers, will allow for future photovoltaic equipment placement within this space, an important assessment factor.

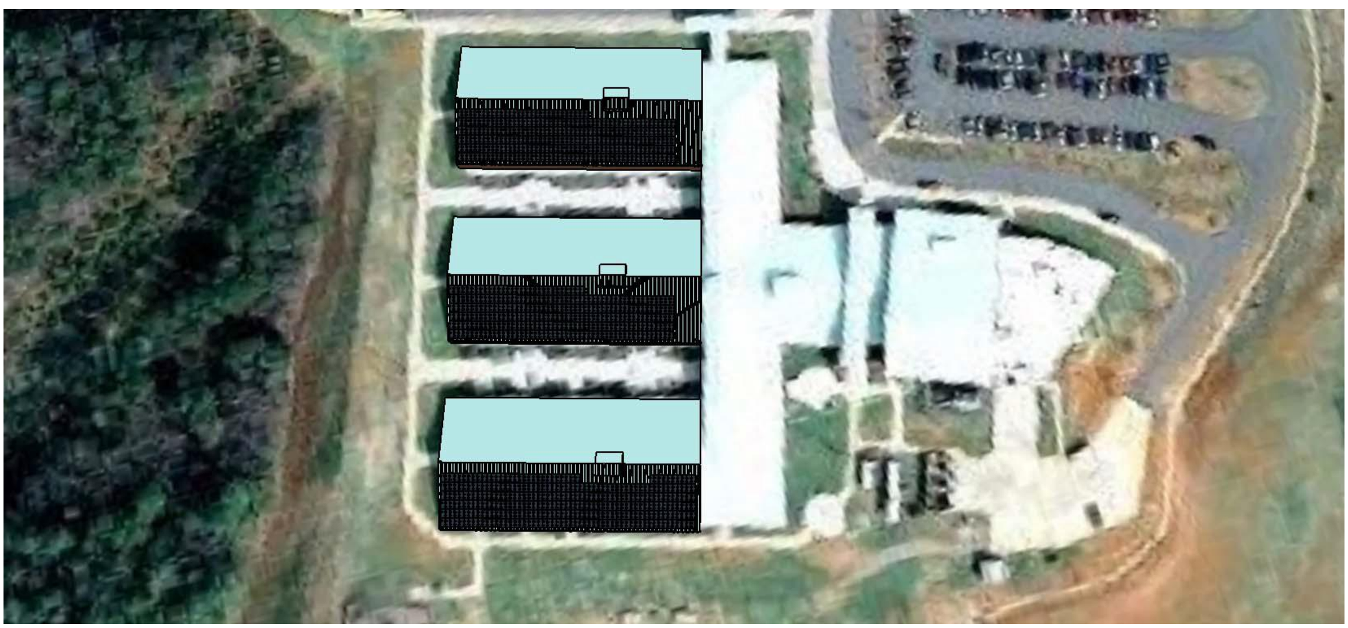
The distance between the main electrical room and the proposed system's location will require additional attention from a design perspective. Several electrical design options were discussed during the site assessment to accommodate for this vast distance.

Outlying structures such as light posts and a single large electrical tower were all taken into consideration for possible obstruction of maximum photovoltaic output due to casting of shadows. However, these structures were not initially seen to pose any significant hindrance from shadows. By all accounts, Third Creek Elementary School was professionally shown to be feasible to photovoltaic installation.

Third Creek Elementary School Statesville, North Carolina Justin Taylor, Pure Power Contractors, Inc.

http://www.purepowercontractors.com

Third Creek Elementary School   Statesville, North Carolina   Justin Taylor, Pure Power Contractors, Inc.



Third Creek Elementary School Statesville, North Carolina   Justin Taylor, Pure Power Contractors, Inc.

http://www.purepowercontractors.com

14. Addendum B.

21st Century Learning Grants

The 21st Century Learning Grants of the US Department of Education is still accepting applications for funding in terms of technology/school improvement. Thus, solar project(s) such as Third Creek Elementary School are a form of technology/school improvement. The following are the contact persons:

Donna Brown, donna.brown@dpi.nc.gov
Phone Number: 919.807.3959

Charlotte Hughes, charlotte.hughes@dpi.nc.gov
Phone Number: 919.807.3957

The US Department of Education provides that the federal government still has funding. Since the Third Creek Elementary School project is worth 1 million dollars plus, the federal government can still provide 100% funding, if not 40-50%, and perhaps Third Creek Elementary School can acquire other funding sources from other grants. Third Creek Elementary School will file the applications on their behalf.

15. Addendum C.

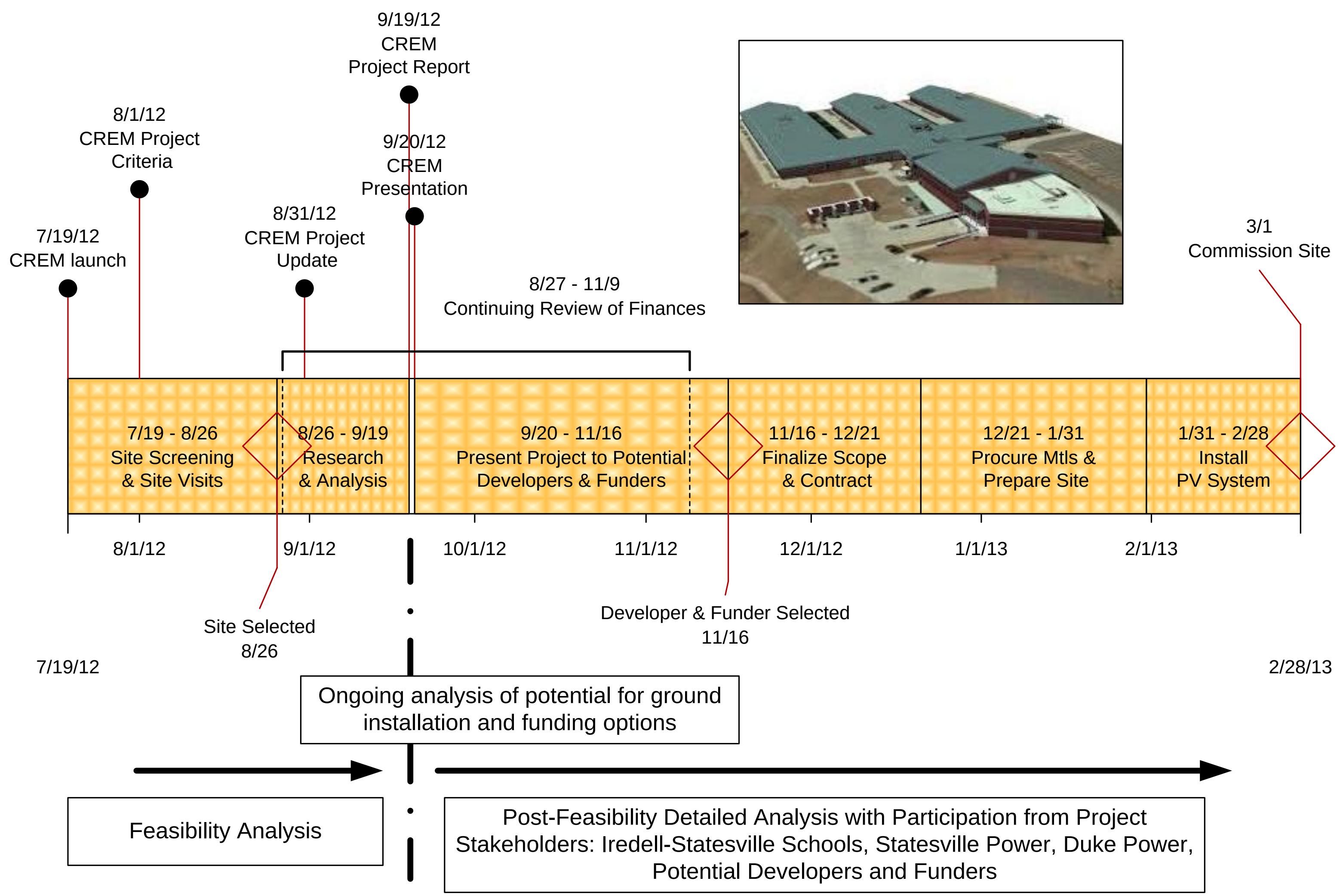
How to Capture the Output of the Panels

Since the Cooperatives like EnergyUnited of Statesville obtain their power from the producers such as Duke Energy, would it be possible for a customer (of a Cooperative) to take advantage of a renewable energy purchase agreement (like SunSense) offered by the producer?

According to Rick Feathers (North Carolina Membership Corporation), since the customer is not getting the power directly from the producer, they could not be included in such a program. For initiatives such as this, it was suggested that options be investigated through “GreenCo Solutions.” This entity was established for the Cooperatives for just this purpose. http://www.greencosolutions.net/

Photovoltaic Power for Third Creek Elementary

Sunday, September 09, 2012



Appendix B Financial Base Case

Year	1	2	3	4	5	6	7	8	9	10	11	12
Calendar	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
kWhrs PV generated	371,011	368,377	365,761	363,164	360,586	358,026	355,484	352,960	350,454	347,966	345,495	343,042
KWhrs needed	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242
Reduction	35.0%	34.7%	34.5%	34.3%	34.0%	33.8%	33.5%	33.3%	33.1%	32.8%	32.6%	32.4%
Rate per kWhr	$0.0745	$0.0764	$0.0783	$0.0802	$0.0822	$0.0843	$0.0864	$0.0886	$0.0908	$0.0930	$0.0954	$0.0978
kWhrs cost w/o PV	$78,988	$80,963	$82,987	$85,061	$87,188	$89,368	$91,602	$93,892	$96,239	$98,645	$101,111	$103,639
Cost savings w/ PV	$27,640	$28,130	$28,629	$29,136	$29,652	$30,178	$30,713	$31,257	$31,811	$32,375	$32,949	$33,533
Net Cost w/ PV	$51,348	$52,833	$54,358	$55,925	$57,536	$59,190	$60,889	$62,635	$64,428	$66,270	$68,163	$70,107
Cash In												
SunSense $0.15/kWhr	$55,652	$55,257	$54,864	$54,475	$54,088	$53,704	$53,323	$52,944	$52,568	$52,195	$51,824	$51,456
Fed Govt ITC 30%	$420,078											
St of NC $10,200	$98,018	$98,018	$98,018	$98,018	$98,018							
Deprec benefit	$83,315	$83,315	$83,315	$83,315	$83,315							
Sell System to County												
Total for year	$657,063	$236,590	$236,197	$235,808	$235,421	$53,704	$53,323	$52,944	$52,568	$52,195	$51,824	$51,456
Cash Out												
Capital Investment	$1,400,259											
System maint.	3,840	4,032	4,234	4,445	4,668	4,901	5,146	5,403	5,673	5,957	6,255	6,568
Lease of Roof (half of SunSense)	$27,826	$27,628	$27,432	$27,237	$27,044	$26,852	$26,661	$26,472	$26,284	$26,097	$25,912	$25,728
	$1,431,925	$31,660	$31,666	$31,683	$31,711	$31,753	$31,807	$31,875	$31,957	$32,055	$32,167	$32,296
Net Cash to Investor	-$774,862	$204,929	$204,532	$204,125	$203,710	$21,951	$21,515	$21,069	$20,611	$20,140	$19,657	$19,160
Cumulative	-$774,862	-$569,933	-$365,401	-$161,276	$42,433	$64,384	$85,900	$106,968	$127,579	$147,719	$167,377	$186,537

13	14	15	16	17	18	19	20	21	22	23	24	25
2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
340,606	338,188	335,787	333,403	331,036	328,685	326,352	324,035	321,734	319,450	317,182	314,930	312,694
1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242	1,060,242
32.1%	31.9%	31.7%	31.4%	31.2%	31.0%	30.8%	30.6%	30.3%	30.1%	29.9%	29.7%	29.5%
$0.1002	$0.1027	$0.1053	$0.1079	$0.1106	$0.1134	$0.1162	$0.1191	$0.1221	$0.1251	$0.1283	$0.1315	$0.1348
$106,230	$108,886	$111,608	$114,398	$117,258	$120,190	$123,194	$126,274	$129,431	$132,667	$135,983	$139,383	$142,868
$34,127	$34,732	$35,347	$35,974	$36,611	$37,260	$37,920	$38,592	$39,276	$39,972	$40,681	$41,402	$42,135
$72,103	$74,154	$76,261	$78,425	$80,647	$82,930	$85,274	$87,682	$90,155	$92,694	$95,303	$97,981	$100,732
$51,091	$50,728	$50,368	$50,010	$49,655	$49,303	$48,953	$48,605	End of Involvement for Investors				
							$48,605					
$51,091	$50,728	$50,368	$50,010	$49,655	$49,303	$48,953	$97,210					
									hrs/month	hrs/yr	loaded rate	cost
6,896	7,241	7,603	7,983	8,382	8,801	9,241	9,703		8	96	$40	$3,840
$25,545	$25,364	$25,184	$25,005	$24,828	$24,651	$24,476	$24,303					
$32,442	$32,605	$32,787	$32,988	$33,210	$33,453	$33,718	$34,006					
$18,649	$18,123	$17,581	$17,022	$16,445	$15,850	$15,235	$63,204					
$205,186	$223,310	$240,891	$257,913	$274,358	$290,208	$305,443	$368,648					

Appendix C Evaluation for Riverside High, South Johnston High, East Wake High

Riverside High, Durham

Selection Criterion	Wt	Raw Score Hi 5; Med 3; Low 1	Wted Score	Notes
1) Mission	5	5	25	Website: "Riverside is also the site of the district's Engineering Technology pathway. Students in the engineering program take courses in design, engineering principles, digital electronics, civil engineering and architecture, and aerospace engineering."
2) Site and County Leadership Receptive	5	5	25	Met with Asst Principal Paul Keene on Weds Aug 8, and exchanged emails with the Engineering teacher, Tim Velegol. They are both interested in digging deeper into the feasibility. They agree that installing a PV system has instructional value for the students.
3) Energy Efficiency of the School	3	1	3	Riverside is over 20 years old. Energy efficiency was not a primary objective when it designed and built in the 1980s.
4) Space Available for Installation	3	1	3	From the aerial view, the school appears to have a sizeable flat roof suitable for PV panels. There is not an expanse of undeveloped land adjoining the school property. At follow-up meeting learned that the roofs are on the order of 20 years old and not, therefore, good candidates for PV installation.
5) Near Population Centers	2	5	10	School is easily accessed from Rt 147 in Durham; easily reached from Durham, Raleigh, and Chapel Hill.
Total Score for this site			66	

South Johnston High, Four Oaks

Selection Criterion	Wt	Raw Score Hi 5; Med 3; Low 1	Wted Score	Notes
1) Mission	5	1	5	School does not have a mission or vision dealing with energy, energy efficiency or renewable energy.
2) Site and County Leadership Receptive	5	5	25	Met with Principal Eddie Price on Thurs Aug 9. Principal is interested from a cost-savings standpoint and referred us to the County Asst Superintendent of Facilities.
3) Energy Efficiency of the School	3	1	3	An older school built in the 1980s before there was any urgency about energy efficiency.
4) Space Available for Installation	3	5	15	School has large flat roof areas that appear more than adequate for an on-roof installation. Roof appears dark in the aerial view and it may be quite hot in the warmer months. PV might offset their cooling costs.
5) Near Population Centers	2	1	2	School is over an hour drive East of the Triangle, mostly on Interstate-40. It is not easily accessible from the population centers of Raleigh, Durham, and Chapel Hill.
Total Score for this site			50	

East Wake School of Engineering Systems, Wendell

Selection Criterion	Wt	Raw Score Hi 5; Med 3; Low 1	Wted Score	Notes
1) Mission	5	5	25	Website: "East Wake School of Engineering Systems is a member of Project Lead the Way, a non-profit organization that provides schools with technology and professional development to introduce students to engineering courses. Every student is required to complete the first two of six distinct Project Lead the Way courses: Introduction to Engineering Design and Principles of Engineering. EWSES also provides a strong Career-Technical Education base within the content areas of construction technology..."
2) Site and County Leadership Receptive	5	5	25	Met with Principal Sebastian Shipp on Thursday August 9. Mr. Shipp likes the project and sees the fit for his school. He agrees that there is educational value for students.
3) Energy Efficiency of the School	3	1	3	School appears newer than Riverside – in its design and construction, but still not of the generation of buildings explicitly designed for energy efficiency.
4) Space Available for Installation	3	1	3	Met with County officials Brian Conklin, Greg Clark, Alex Fuller, and William Hartley on August 22. Extended discussion about the roof sections of East Wake. They pointed out that the roofs are renovated on an as-needed basis and each section of roof would have a different life span and be covered (potentially) by a different warranty. There are no roof sections that are new or practically new. There is some chance that a section would need renovation within the 20-year lifespan of a PV project.
5) Near Population Centers	2	3	6	Not as central to the Triangle Area as Riverside High but still within reasonable driving distance from Raleigh, Durham, Chapel Hill.
Total Score for this site			62	

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Final Report
Catawba Indian Nation
1 Megawatt Photovoltaic Plant Feasibility Study

Prepared by Steve Meyer
CEO/Senior Consultant
Solid Tech Inc

Outline

I - What is PV
- Conditions for a solar project
- Radiance map
- System performance limitations

II - What does it take to build a PV Plant
- General Conditions
- Site Preparation checklist

III - How much solar power should be planned for?
- Project that meets consumption
  - PV Watts calculation for 580kW ground mount system
  - PV Watts calculation for 443kW tracking system
  - Financial consideration for consumption model
- Project Plan for 1mW ground mount plant
- Project Plan for 1mW with 2 axis tracking

IV - What are the major system components and how does the system go together?
- Typical System Diagram

V - How much does the PV system cost?
- A - Conditions within the PV Industry
  - Supplier business conditions
  - Warranties
- B - Project Plan for 1mW ground mount plant
  - Cost estimate and Bill of Material
  - Annual Revenue Projection
  - 30 year projection
- C - Project Plan for 1mW with 2 axis tracking
  - Site plan on topographic projection
  - Cost estimate and Bill of Material
  - Annual Revenue Projection
  - 30 year projection

VI - Who Buys the Power
- The Utility Industry Regulatory Environment
- Purchase Power Agreements
- Circumstances Specific to the CIN

VII - Project Financing
- Federal Programs
- Private financing

VIII - Study Conclusions

Appendix

1 Supplier Contact information

2 Focustar Capital Profile

3 Solar Panels
- Sun Tech
- Mage
- Suniva

4 Sedona Energy Systems Tracking technology

5 Other Incentive Programs
- Progress Energy
- Duke Energy
  - REC Guideline
  - Unsolicited Proposal Guideline
  - Draft PPA terms
- Palmetto Clean Energy - PaCe

6 Purchase Power Agreement (sample)
- Los Angeles
- Long Island
- Santee Cooper

7 Columbia Weather Systems

8 Mage Solar System Calculations

I - What is PV?

PV is short for Photo Voltaic. The photovoltaic or photoelectric effect occurs in a specific group of chemicals where electrons are liberated by light and electricity is output directly. The term “PV panel” has generally replaced the term “Solar Cell” which is also widely used since the most common application is creating electrical energy from the sun. The basic technology has been in use for many years providing high performance power sources for the space program. More recently, and of direct relevance to this feasibility study, PV has become a worldwide industry for creating electrical power instead of using coal or natural gas powered generator plants.

Photovoltaic projects seek to convert sunlight to revenue as efficiently and cost effectively as possible in order to achieve financial viability. However, the sun is only shining a certain number of hours during the day, making financial performance more challenging. Add to this the fact that the PV system is only producing peak power a few hours each day, and it quickly becomes apparent that cost effective performance is difficult to achieve. For this reason there are many programs which offer financial incentives to make PV attractive to investors and lending institutions that finance these projects.

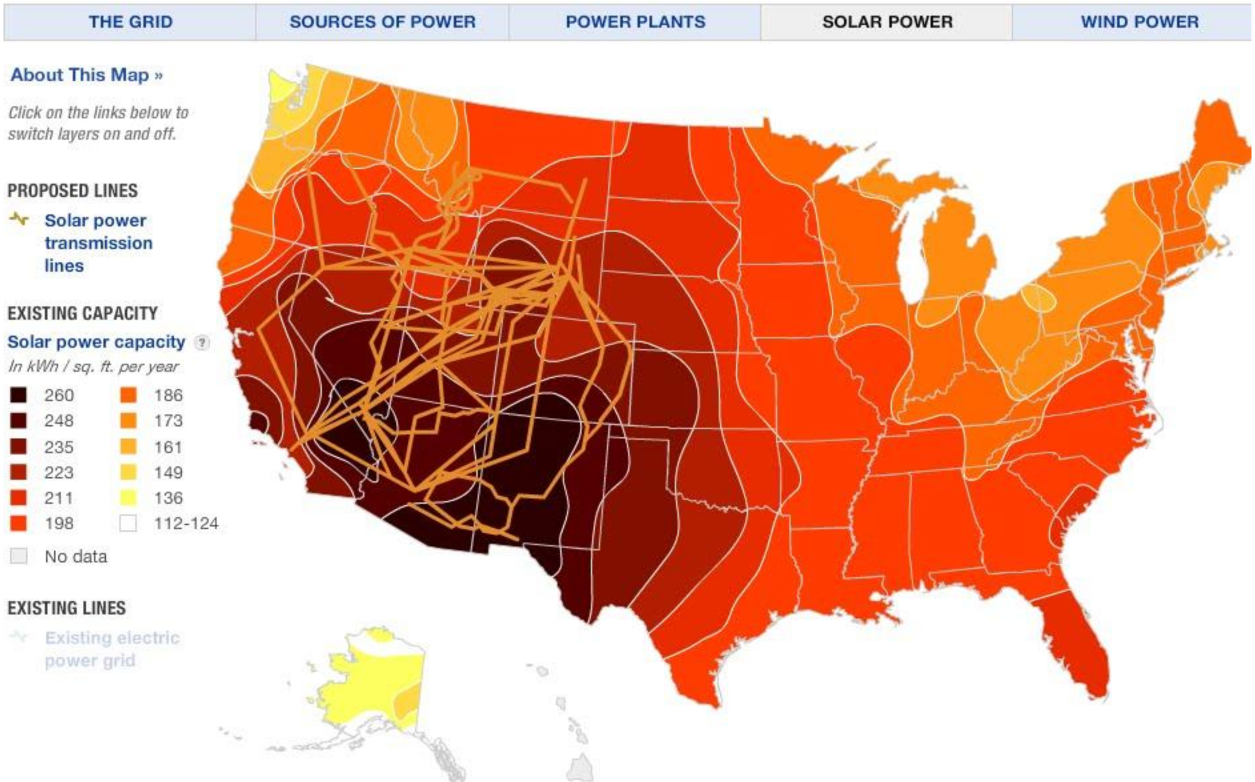
PV panels generate maximum power when they are roughly perpendicular to the sun. The most common method for placing solar panels is in fixed arrays using structural framing to hold the panels at a fixed elevation to average the best solar exposure for the location of the equipment. This is generally considered the lowest equipment cost, but peak productivity only occurs for 2 to 3 hours per day when the sun is directly overhead.

Solar tracking systems are mechanical systems that move arrays of solar panels so that they are perpendicular to the sun during the day and maximize solar power production. According to the National Renewable Energies Laboratory, tracking will increase system production by 25-36%. For this reason we have included a tracking system as one of the major options in the evaluation of this project. We were not able to get quotations for single axis tracking due to the fact that SunPower, which controls most of the commercially available technology for single axis tracking, refused to quote this project.

General Conditions for Solar project

The starting point for all PV projects is the solar radiance, or the number of watts of energy per square meter that sun produces at a location on the Earth. The following map is a plot of solar radiance across the United States and a partial image of the proposed additions to the electrical power grid to facilitate delivery of power as new solar projects are added in the west. Obviously from the data, the dark regions shown in Southern California, Nevada, Arizona and New Mexico are where solar production is likely to be the highest. Unfortunately, with the exception of Southern California, these areas are not very highly populated, so if large solar power plants were constructed in these areas, they would have to consider the cost of transmission lines to ship the power elsewhere.

Interestingly, the proposed site near Rock Hill, South Carolina is in a fairly high category of solar radiance at 211 watts per square meter, making the proposed site location favorable.



From this starting point, one can simply multiply the average energy per square meter (211 W/m2) times the number of square meters of photovoltaic panels, times the solar panel efficiency, and reach a theoretical capacity for electric power generation. But this theoretical calculation is limited by a number of practical issues such as clouds, rain, snow, dirt on the surface of the solar panel, inverter efficiency, dc wiring losses, etc. All of these variables are integrated into a simulation program called PV Watts developed and hosted by the National Renewable Energies Laboratories. In some cases vendors have used PV Watts for calculation of the projected system performance.

System Performance Limitations

In the PV watts program is a portion of the program called the "Overall Derate Factor" for a given installation. This is a collection of all the aspects of a project in which losses can occur. It is extremely important to carefully examine each parameter listed so that realistic results can be achieved in the simulation portion of the software. The default setting for the derate factor is .77 which means that for every nameplate kilowatt of power that is purchased only 77% is producing power in the simulation. This approach is probably intended to be overly conservative so that customers can be assured of minimum output for a given installation. However, in larger projects the cost variance and the amount of equipment required will vary considerably if the derate factor is not properly calculated.

The impact of the Derate Factor can be seen immediately from the first parameter, PV Panel nameplate value. Currently there are several vendors providing excess nameplate capacity at 1.05 percent. This means that the PV panel will likely put out 5% more power that it's rating. This would cause the overall derate value to go up from .77 to .82 if all other conditions are equal, resulting in 5% fewer solar panels being specified for a given power objective. So the value of the Derate Factor is significant.

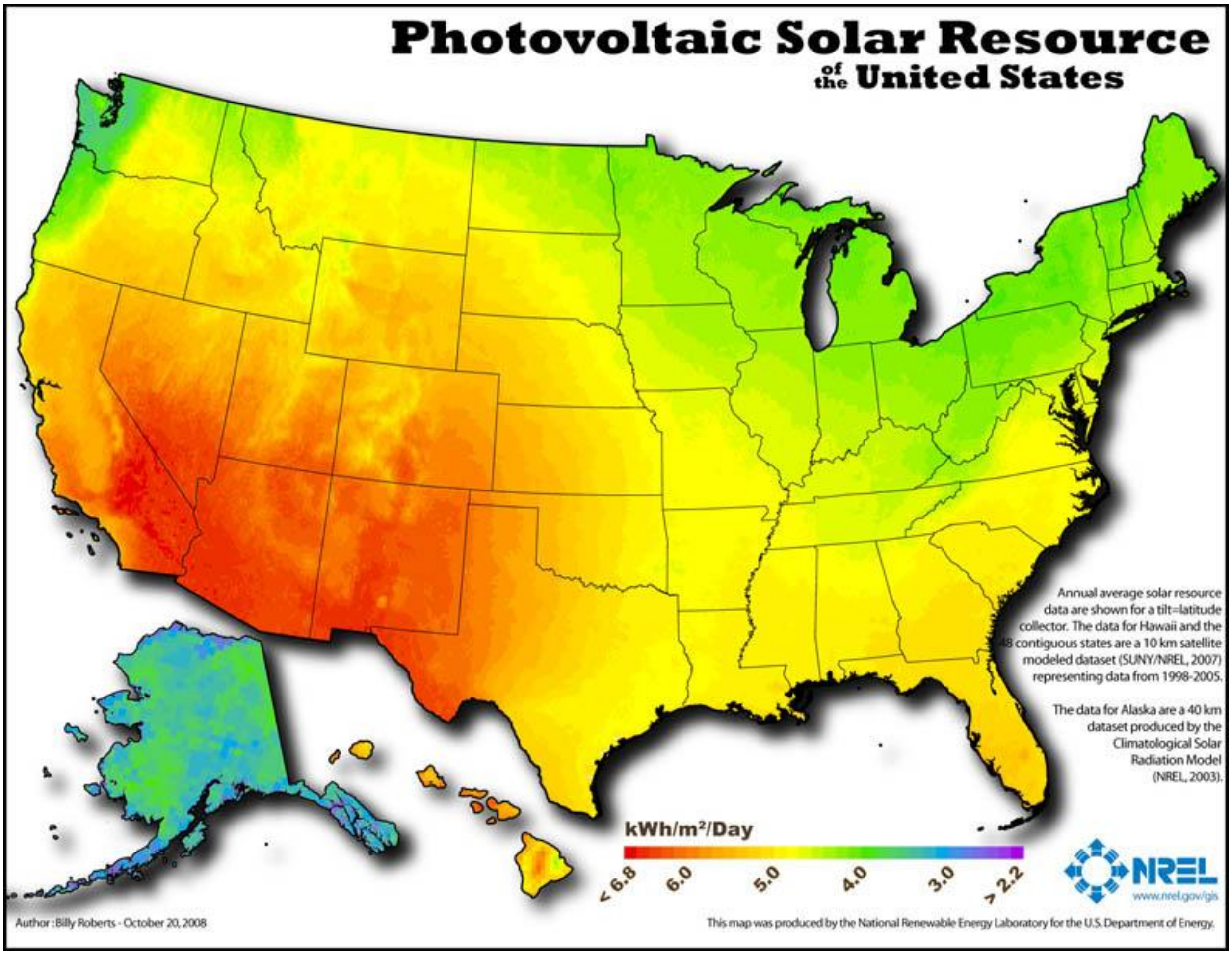
Calculator for Overall DC to AC Derate Factor

Component Derate Factors	Component Derate Values	Range of Acceptable Values
PV module nameplate DC rating	1.00	0.80 - 1.05
Inverter and Transformer	0.965	0.88 - 0.98
Mismatch	0.98	0.97 - 0.995
Diodes and connections	0.995	0.99 - 0.997
DC wiring	0.98	0.97 - 0.99
AC wiring	0.99	0.98 - 0.993
Soiling	0.99	0.30 - 0.995
System availability	0.99	0.00 - 0.995
Shading	1.00	0.00 - 1.00
Sun-tracking	1.00	0.95 - 1.00
Age	1.00	0.70 - 1.00
Overall DC to AC derate factor	**0.894**	

All the simulations run on PV Watts were done with a .894 derate factor. This was the result of taking all the vendor specifications and best case operating conditions into account. Among the assumptions is the need for a full time employee to be hired to maintain the solar farm and keep the panels clean. Providing a water line and storage area for maintenance equipment is incorporated in the site preparation schedule in order to properly support this requirement.

The disclaimer to the PV Watts software states "Compared to long-term performance over many years, the values in the table are accurate to within 10 to 12%." In the context of modern simulation software in other industries this is a relatively large error. As a result some vendors choose to run their own simulation software or they will purchase a standard software product for the purpose. This was the case with Mage Solar's data which is included in the study. This is also the reason that there is poor correlation between the 1mW fixed panel system and the 1mW system with dual axis tracking. Sedona Energy Labs used PV Watts and its own set of assumptions, Mage Solar used an in-house software product with different assumptions.

Another way to model PV performance is the use of a solar energy map that is plotted in kilowatt hours per unit of surface area per day. This is essentially pre-digested data which is simplified for the purpose of making solar project planning more straightforward, but the details of the assumptions made about local conditions cannot be examined or adjusted in any way.



What does it take to build PV project?

Large scale PV projects, such as 1 megawatt (mW) and larger require space, physical access to deliver manpower and equipment needed to do construction on the site, electrical access, and financing. A singles solar panel has a footprint of approximately 17 square feet, so a large array of 5000 solar panels will require 85,000 square feet just for the direct surface area of the panels. Since they require racking, access between the panels and sufficient separation to prevent shadowing, the actual space requirement is easily double. As we have found in the course of this investigation, 1mW will occupy approximately 5.7 Acres (detailed site plan is provided).

In terms of other site related constraints, level space with an open south exposure is required. The east and west directions of the site need to be free from obstructions that will cast shadows on the solar panels at sunrise and sunset. There should be the least possible surrounding obstructions so that there are no shadows cast on the solar panels during the day.

A new road providing access to the site having already been initiated, the necessary activities to be support a solar installation are as follows;

- Tree removal sufficient to prevent shadowing from East and West exposures
- Stump pulling
- Grading to level the surface are required
- Installation of 1400 ground pins in the case of the tracking version of the project
- 2 concrete pads for mounting the inverters
- shade structure over the inverters
- piping and cable from the inverters to the utility
- small storage shed for miscellaneous maintenance equipment
- 1" water line for grounds maintenance
- Clearing around the equipment and chain link fence to secure access to the installation

Estimate for the site preparation as prepared by DPR Associates is $160,000.

Proximity to a utility electrical site is needed in order to deliver power to the utility grid. This can take the form of an existing transformer site and depending on the amount of power to be delivered, can require substantial upgrading by the utility company in order to properly manage the load. York Electric has standard agreements for systems up to 100kW, presumably to handle residential and small commercial structures. Any power levels above 100kW have to be directly contracted with the parent utility company, which at present is Santee Cooper.

Estimate for the utility interface and necessary upgrade is $60,000.

In the case that a distributed power option is considered, the PV panels should be installed on top of or immediately adjacent to each building where they are supplying power. The existing utility wiring will need to be maintained to allow the buildings to use utility power when solar power is not available. The local utility coop, York Electric, would be required to replace existing meters with meters that can run in both directions, called net metering. This allows the use of locally generated power for the majority of building operations with the added ability to sell excess power to the utility through a lower level PPA which could probably be negotiated locally.


PROPERTY LINE
Floodplain
(shaded)
Sturgis Road
Power Connection
(+/-700 LF)
Existing
Transformer
Solar Farm
(+/-5.5 ac.)
Access Drive
(Existing)
Future
Development
PROPERTY LINE
SOLIDTECH INC
DPR
landscape architecture
planning
civil engineering
CONCEPT PLAN
CATAWBA INDIAN NATION-
SOLAR FARM PROJECT
YORK COUNTY, SOUTH CAROLINA
Scale: 1"= 200'
Date: 2-18-11
Job #: P-11016
By: CG

How much PV should be planned for?

There are two ways to approach this question. First by analyzing the existing demand for power we can establish an economic envelope for either replacing the utility demand with locally generated power, or secondly, we can establish a revenue target that offsets the cost for power that is presently being purchased.

System sizing and considerations based on Internal Demand
Directly satisfying internal demand can be considered as an option. Given the current demand of the commercial buildings on the Catawba property this option is achievable from a technical standpoint. While commercial buildings use power primarily during the day and the daily cycle of solar power generation closely follows this pattern, there is still the need to provide backup power to manage off peak loads and to support night time operation of critical systems such as heating. For this reason the best approach would be to implement a grid-tied distributed system with the solar components sized appropriately and located at each building. The primary technical consideration for this system will be the replacement of the conventional electrical meters by the utility company with net metering and signing of a low-level Purchase Power Agreement for any excess power generated.

CIN Electric Power Usage

	kWh	$	$/W
Head Start Building	99,520	$11,339.38	0.114
Senior Center	50,289	$5,137.85	0.102
Long House	276,560	$26,240.73	0.095
Cultural Center	85,846	$9,708.90	0.113
Clinic	276,560	$26,240.73	0.095
ISWA	50,289	$5,137.85	0.102
Day Care	50,289	$5,137.85	0.102
	889,354	$88,943.28	
rate increase 2012	11%	$98,727.04	

It should be noted that a rate case is currently pending in North Carolina in which Duke Energy has applied for the first rate increase in ten years. This is likely to push power cost up by the forecast level and it would be likely to go into effect sooner rather than later.

The system size needed to offset the current demand for electricity is 580 kW according to the simulation data using PV Watts as shown in the following table. The system configuration is for a fixed ground mount installation.

Station Identification	
City:	Charlotte
State:	North_Carolina
Latitude:	35.22° N
Longitude:	80.93° W
Elevation:	234 m
PV System Specifications	
DC Rating:	580.0 kW
DC to AC Derate Factor:	0.894
AC Rating:	518.5 kW
Array Type:	Fixed Tilt
Array Tilt:	35.2°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	10.0 ¢/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	4.04	64375	6437.50
2	4.46	63707	6370.70
3	5.30	81061	8106.10
4	5.89	85888	8588.80
5	5.79	84219	8421.90
6	5.77	79506	7950.60
7	5.55	78352	7835.20
8	5.59	79956	7995.60
9	5.26	73052	7305.20
10	5.23	77636	7763.60
11	4.25	63287	6328.70
12	3.74	59100	5910.00
Year	5.07	890139	89013.90

For the same system specifications, but with dual axis tracking, the system size can be reduced to 443 kW illustrating the substantial increase in efficiency that is created.

Station Identification	
City:	Charlotte
State:	North_Carolina
Latitude:	35.22° N
Longitude:	80.93° W
Elevation:	234 m
PV System Specifications	
DC Rating:	443.0 kW
DC to AC Derate Factor:	0.894
AC Rating:	396.0 kW
Array Type:	2-Axis Tracking
Array Tilt:	N/A
Array Azimuth:	N/A
Energy Specifications	
Cost of Electricity:	10.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	5.01	60712	6071.20
2	5.61	61582	6158.20
3	6.56	77039	7703.90
4	8.01	90260	9026.00
5	7.98	89738	8973.80
6	8.16	87060	8706.00
7	7.55	82487	8248.70
8	7.10	78107	7810.70
9	6.59	70425	7042.50
10	6.54	74470	7447.00
11	5.32	60478	6047.80
12	4.65	55953	5595.30
Year	6.59	888311	88831.10

Financial Considerations

At forecast costs of $3.8mil/mW a fixed array of 580 kW size is likely to cost $2.2mil. If the CIN can acquire funding for half the cost of the system, and fund the balance directly, then the avoided cost of electricity represents a roughly 9% annual rate of return on the money invested. If a conventional loan is used to finance the balance of the system cost, then the rate of return is likely to be 2-3% in which case this course of action should not be pursued. However, if a low interest loan can be acquired for 2-3%, then the return on the investment is likely to be 4-5% which is an acceptable option.

1mW Project Size

The second way to consider how large a system of photovoltaics is to look at it as a revenue opportunity. In this case, the objective is to make as much money as possible within other limitation such as the available amount of land or the availability of finances to support execution of the project.

As will be shown in subsequent data, it is difficult to be profitable with solar power without a preferential rate paid for the power that is produced. But for the purpose of assessing the feasibility of building a 1mW solar power plant, CIN has all the physical resources needed to make this project feasible.

Since there are a number of special rates for electricity available, the opportunity to create a profitable project is entirely feasible.

1mW Fixed Ground Mount

Ground mount solar is very simple to install. Framing components are modular and pre-configured to allow rapid construction. This approach is generally found to be the lowest cost and very popular as a result. A 1mW ground project will typically take 2-3 months to construct using an experienced crew.

1mW Single Axis Tracking

Single axis tracking of the sun is technically much more simple than dual axis tracking. Because of the relative mechanical simplicity and the fact that the largest increase in output comes from azimuth tracking, single axis tracking is by far the most popular type of solar tracking in the PV market.

SunPower is the primary supplier of large single axis tracking systems and sells its tracking technology exclusively with its solar cells. As the company has sold all of its US capacity for 2011 they have declined to offer pricing for this project.

The Sunpower solution is widely used in utility scale projects, as suggested in the above photo. The tracking system is based on pre-cast concrete piers, which eliminates the need for trenching and custom concrete.

1mW Dual Axis Tracking

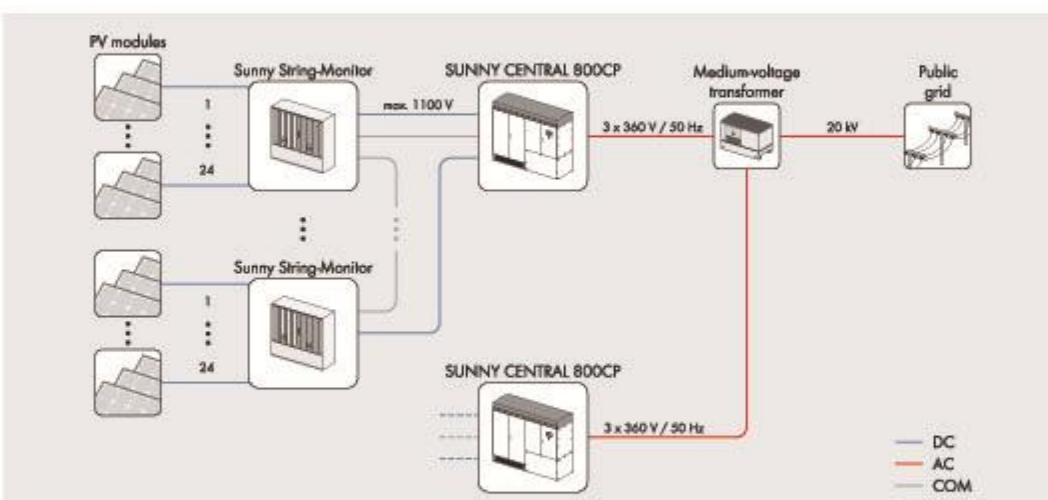
As with the smaller system size, tracking systems provide increased production by maintaining ideal orientation of the PV panel to the sun. NREL reports increased power production of 36% in dual tracking projects. However, traditional tracking technology normally requires much more complex equipment and requires significant concrete foundation work to mount the tracker on.

The concrete foundation is not merely a footing, but is the top surface of a larger mass sunk in the ground to provide counterweight for the mass of weight that is suspended and the force created by wind loads caused by the large array of solar panels. Because of the cost and complexity tracking systems are often avoided. However a new tracking system is now available from Sedona Energy Systems that does not require concrete foundations. Because of this and the relative simplicity of the solution, Sedona Energy was asked to bid to the same specification.

Recently, Sedona Energy Systems has released a dual axis tracking system that does not require concrete, but can be installed using 3" x 3" steel posts sunk directly into the earth. This approach is relatively simple and inexpensive. Details are provided in Appendix Section 4.

IV - What are the system components and how does it go together?

The major components of a photovoltaic system are the solar panels which are wired in strings to combiner boxes, and then the combiner boxes are wired to the inverters. The wiring of the PV panels is designed to increase the low voltage output of the solar panel to either 600 or 1000 volts direct current. This gives the inverter a high enough source voltage so that it can convert the source to alternating current. The following illustration is typical for any PV system.



V - How much does the System Cost?

Solar Industry Conditions
The solar industry is in very high gear in the US. In 2009 over 600 megawatts of photovoltaics were installed and the estimate for 2010 is expected to be double. Individual suppliers are having to ramp up production in order to keep up with demand. But this is not a stable condition as many foreign suppliers are attempting to enter the US market through domestic manufacturing resources. This creates a situation in which prices are continuing to fall and availability can be subject to spot shortages. In order to secure project delivery commitments most suppliers are requiring deposits.

PV systems are designed for operation of 25 to 30 years. Warranty representations by the component suppliers are extremely important for two reasons. First, because the warranty protects the owner in terms of solar panel reliability and the power production or revenue generation of a project using a given brand product. Secondly, because solar projects are financed, the lender will require the highest level of protection for the investment, and the solar panel performance warranty is a key element in securing the investment.

As a result of these conditions, Suntech, Mage and Suniva were selected as having the best performance guarantees in the market. Suntech and Mage guarantee 105% output and offer 10 year product replacement for any panels that are not performing.

For a 1mW ground mount system, the costs are estimated as follows;

	Target AC Power level				1,000,000	
	Peak DC power				1,627,733	
	Annual kilowatt hours produced				1,176,000	
	panel watts	$/W	qty	$/unit	category $	supplier
Panels	240	1.800	4900	432	2,116,800	Mage Solar
Racking	240	0.400	4900	96	470,400	Crider Americas
racking labor	240	0.150	4900	36	176,400	contractor
Inverter		0.250	2	125,504	251,008	SMA America
combiner (28 circuit)		0.100	175	588	102,900	SMA America
wire/cable		0.150	1		150,000	contractor
utility interface		0.060	1		60,000	York Electric
electrical labor	240	0.150	4900	36	176,400	contractor
site prep		0.160	1		160,000	DPR Associates
project management		0.060	1		60,000	
weather station			1		7,000	Columbia Instrument
		3.280			3,730,908	

For the 1mW ground mount system a possible financial structure could be as follows;

annual output (kWh)		1,627,733	
system cost		$3,730,908	
Other program funding	20%	-$746,182	
1603 Funds	30%	-$1,119,272	
Finance Loan Amount		$1,865,454	
Annual loan payments		$141,300	25 year @ 6%

Annual revenue projected for the 1mW ground mount project is shown using the full spread of rates that are being offered across the US.

	$/kWh	$/year	
Utility cost avoidance rate	0.069	$112,314	($28,986)
Utility rate	0.085	$138,357	($2,943)
Utility rate	0.09	$146,496	$5,196
Current Billing rate	0.11	$179,051	$37,751
Georgia Fit	0.14	$227,883	$86,583
Progress Electric	0.18	$292,992	$151,692
Massachusetts retail	0.19	$309,269	$167,969
California retail	0.23	$374,379	$233,079

30 Year Revenue Projections for 1mW ground mount are shown in the following table with all the appropriate price levels for electrical power.

	year 1-10	year 11-20	year 21-30	30 year revenue estimate
$/kWh	1.0	0.9	0.8	
0.069	$112,314	$101,082	$89,851	$3,032,467
0.085	$138,357	$124,522	$110,686	$3,735,647
0.09	$146,496	$131,846	$117,197	$3,955,391
0.11	$179,051	$161,146	$143,241	$4,834,367
0.14	$227,883	$205,094	$182,306	$6,152,831
0.18	$292,992	$263,693	$234,394	$7,910,782
0.19	$309,269	$278,342	$247,415	$8,350,270
0.23	$374,379	$336,941	$299,503	$10,108,222

For the 1 mW tracking system the estimated costs are as follows;

	target ac power				1,005,000	
	annual kilowatt hours produced				1,726,653	
	panel rated watts	$/W	qty	$/unit	category $	supplier
panels	300	1.800	3350	540	1,809,000	Suniva
tracking	300	0.400	3350	375	1,256,250	Sedona Energy
tracking labor	300	0.150	3350	45	150,750	
crating					29,480	
shipping					18,000	
inverter			2	125,504	251,008	SMA
combiner			120	588	70,350	SMA
wire/cable					150,000	
utility interface			1		60,000	
electrical labor	300	0.150	3350	45	150,750	
site prep					150,000	DPR Associates
Project mgt					60,000	
weather station			1		7,000	Columbia
		2.500			4,162,588	

The financial structure for the tracking system would be;

annual output in kWh		1,726,653	
system cost at 4.269 mil/mW		$4,162,588	
Other program funding	20%	-$832,518	
1603 Funds	30%	-$1,248,776	
Finance Loan Amount		$2,081,294	
Annual loan payments		$160,920	25 year @ 6%

The 30 year revenue performance could be

			annual revenue or loss
	$/kWh	$/year	
utility cost avoidance rate	0.069	$119,139	($41,781)
Utility rate	0.085	$146,766	($14,154)
Utility rate	0.09	$155,399	($5,521)
Current Billing rate	0.11	$189,932	$29,012
Georgia Fit	0.14	$241,731	$80,811
Progress Electric	0.17	$293,531	$132,611
Massachusetts retail	0.19	$328,064	$167,144
California retail	0.23	$397,130	$236,210

VI - Who Buys the Power?

Utility Industry Regulatory Environment

The utility industry is a government regulated industry. As a result the legislation enacted by the individual states with regard to solar power, each state has different rules for how solar power will be implemented. The State of South Carolina has no Renewable Energy Portfolio Standard so there is no major effort taking place to promote alternative energy in the state. In North Carolina some legislation has been enacted, so alternative energy is being promoted.

The following table is the price per kilowatt hour of electricity paid by different levels of the industry.

Utility internal rate	0.045
Utility cost avoidance rate	0.069
Utility rate	0.085
Utility rate	0.09
Current Billing rate	0.11
Georgia Fit	0.14
Progress Electric	0.18
Massachusetts retail	0.19
California retail	0.23
New Jersey FiT	0.30
Canada FiT	0.63

In addition there are specific conditions which must be considered for the CIN project. While the CIN is currently served by Santee Cooper, the wire infrastructure and geographical service area is actually Duke Energy. The Santee Cooper agreement is expected to expire in 2013 and will be taken over by Duke. These specific conditions make the execution of a Purchase Power Agreement slightly more complex, but nevertheless manageable.

Duke Energy representative Kathy Dunn said that they have fully subscribed their alternative energy requirements for 2012. Based on this input it is not likely that Duke will make a significant offer to purchase the power.

Purchase Power Agreements

A Purchase Power Agreement is a contract which specifies a price and duration that a utility company will pay to receive power from an independent source. The PPA is a mechanism for providing a revenue opportunity for a prospective developer of alternative energy generation. The availability of PPA is very much a function of the political environment and revenue available to pay a premium price for the power. This is illustrated in the table shown above.

In order to access the very high rates paid for power in other markets, the CIN would have to create the capability to enter into a "Wheeling" agreement. A wheeling agreement is one in which the local utility company is paid a small fee per kWh to simply make wire available for transmission of power to other locations. This requires the creation of a utility company under the jurisdiction of the CIN. There are legal expenses of $100-150K estimated to create this entity, and a third party could be contracted to work on behalf of the CIN, but this is clearly the way to access high value markets for electric power.

Sample copies of PPA's are provided on CD in the Appendix to this report.

Prospective Buyers of the power:
Santee Cooper has expressed interest in entering in to a Purchase Power Agreement with the Catawba Indian Nation to purchase the power. Steve Spivey is the contact for Santee Cooper. One complicating issue is that the agreement to deliver power to the Central Coop is scheduled to end sometime during the period 2013 to 2016. At this time power will be delivered by Duke Energy. This means that either Santee Cooper will need to engage a wheeling agreement with Duke to use its infrastructure to deliver the power, or come up with an alternative structure to the PPA at the time the delivery agreements change.

Progress Electric has recently offered programs for solar power at rates as high as 18 cents/kWh. This kind of rate structure for the PPA would be extremely profitable for the proposed project. Given the recent acquisition of Progress Electric by Duke, it is not clear if a PPA can be negotiated for the CIN project. Effort should be made to build a relationship with Progress Electric so that the CIN can understand the goals and efforts under way at Progress for the furtherance of alternative energy in the State.

Duke Energy representative Kathy Dunn is in charge of unsolicited project proposals for alternative energy projects seeking to sell power to Duke. She informed me that Duke has already met its requirement for 2012 PV power. She also said that their requirement for 2013 has not been fully met and that this project might fit into that timeline for them. Given the current time line for Duke to resume electrical power service to the CIN property, 2013 would be a good time to start a PPA if they can come up with a preferred rate that makes it worthwhile.

<u>VII – Project Financing</u>

Financing a solar power project is a little bit like buying real estate. Projects are usually a combination of debt and equity. And each project presents unique circumstances that will affect the final outcome.

There are a variety of lending institutions that are expert in financing of these assets, who are familiar with the legal environment for alternative energy projects and who are expert at finding additional resources that can be used to pay for part of the project. This role is crucial to the success of the project as nothing can happen without proper financing.

Subsidy programs are constantly being circulated for assisting in the creation of viable alternative energy projects. Several such programs have been identified in the course of this investigation. One of the most significant is the New Market Tax Credit program which is based on targeted Zip codes throughout the country and which offers 20% financing of a project as an incentive to bring conventional lending to the project. The CIN is identified as being in a target Zip code area and the funds have been distributed to various private financing companies to be made available immediately based on certain project criteria.

The Department of Energy has a Loan Programs Office which provides special loans for alternative energy projects. Presumably the DOE LPO will make special loans at low rates available, but the rules are complex and some expertise is required to determine if a project qualifies and what terms will be applied to a given proposal.

1603 Program has been extended for project applications made in 2011. This program is designed to operate like the Investment Tax Credit. 30% of the project cost can be paid for with funds offered under this program.

Other program announcements from Progress Energy, Duke Power and Palmetto Clean Energy are attached in Appendix Section 5.

Private Financing
Focustar Capital is interested and qualified to act as a financial advisor to the CIN. They have significant expertise in financing alternative energy projects. They can provide a complete financial solution by packaging the New Market Tax Credit, the 1603 funds, and the private investment funds to provide the CIN with complete financing of this project.

VIII - Conclusions

A 1 megawatt PV project on the site proposed is technically feasible. All the necessary conditions can be easily met with regard to available land for the site, suitability for the exposure, proximity to a utility connection, etc. Costs associated with site preparation are well within the range of cost-effectiveness relative to the overall project, and should be pursued.

The gating factor will be the availability of a buyer for the power at a price level that is high enough to make such an effort profitable. From the current analysis of the financing of such a project, the sale of power at any value less than 11 cents per kilowatt hour will not be sufficient to justify the project unless there is substantial further reduction in the development cost through outside funding measures.

In order to pursue the highest possible value for the power that is created the Catawba Indian Nation must consider the possibility of creating a tribal power coop or joint venture with a firm to enable sale of the power in other markets outside of the current area served by Duke and Santee Cooper. This would be greatly facilitated by hiring a consultant who is recently retired from the utility industry who can inform the tribe about other utilities that are purchasing power from alternative sources and what their current requirements are. The role fulfilled by this industry executive can also include early negotiation to secure a Purchase Power Agreement in a market that pays well for the power.

An important contribution can also be made by retaining a financial advisor in the form of a company like Focustar Capital which has the experience in energy project financing to the able to integrate all the legal and financial complexities of the final financing plan. Funding from many outside sources can be combined with conventional sources to create a unique solution for the financing of the final project and the administration of the various components can be simplified through a single point of contact. Focustar provides these capabilities as well as a client base that will allow them to source the private equity needed to successfully fun the entire project.

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Vertical Axis Wind Turbine (VAWT)

AVX-3K

*Pole not included.
Shown for illustrative purposes only.

AVIAX™

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Specification	Model : AVX-3K
Rated Power	3kW (3000W)
Rated Capacity (@Wind Speed)	3kW @26.8 mph (12 m/s)
Annual Energy Production	4,900 kWh @12 mph (5.4 m/s)
Body and Blades / Axis Material	Aluminum Alloy / Galv. Steel (SS400)
Rotor Height	13.8 ft. (4.2 m)
Rotor Diameter	13.1 ft. (4 m)
Number of Blades	7 (3 Darrieus and 4 Savonius)
Turbine Weight	1,500 lbs. (680 kg)
Rated Wind Speed	26.8 Mph (12 m/s)
Cut-in Speed (Power Generation)	≤5.6 Mph (≤2.5 m/s)
Cut-out Wind Speed	33.6 Mph (15 m/s)
Survival Wind Speed	134 Mph (60 m/s)
Application Ratio (Cp)	28%~30%
Swept Area	113 $ft.^2$ (10.5 m^2)
Noise @ 11.2 Mph (5 m/s)	≤50 db
Noise @ 22.4 Mph (10 m/s)	≤65 db
Generator	AC, 3 Phase Synchronism PMG
Generator Type	Disk, NdFeB Permanent-Magnet
Ambient Temperature Range	-13°F~140°F (-25°C~60°C)
Ambient Humidity	95% RH
Drive System	Direct Drive, No Transmission
Maximum RPM	250
Rated Output Voltage	48V DC (Stand-alone) / AC220V
Generator Efficiency	≥ 80%
Controller Output Current (Max.)	16 Amp.
Inverter Rated (AC Output Range)	211/264V, 60Hz
Peak Power	3,800W
Controller Braking System	Automatic Dump-Load and 3-Phase
	Short Circuit Braking System
Over-speed Protection	Electromagnetic Torque Control
Direction Control	Vertical Axis
Yaw Control	360°, No Yaw Required
Certification	MIRDC
Turbine Warranty	5 Year
Suggested Tower Height	13-26 ft. (4-8 m)

Built-in Intelligent Power Management with:

Power-assist Function	Over-charge/Discharge/MPPT
Control Function (Dual Mode)	Yes
Protection Circuit	Yes
Safety Control	Yes
Battery Charge Management	Yes
Data Communication	Yes
Data Logger (Connected to PC)	Yes
Maximum Efficiency (n_{max})	96.8%
User Interface	16 characters x 2 lines LCD display
Communication (Signal Output)	RS485 (GPRS / GSM)
Ambient Temperature Range	-13°F~140°F (-25°C~60°C)
Certification	UL 1741, CSA - C22.2 N. 107.1-01
Grid Standard	IEEE 1547
Environmental Protection Rating	NEMA 4X

AVX-3K Power Output and Annual Energy Table

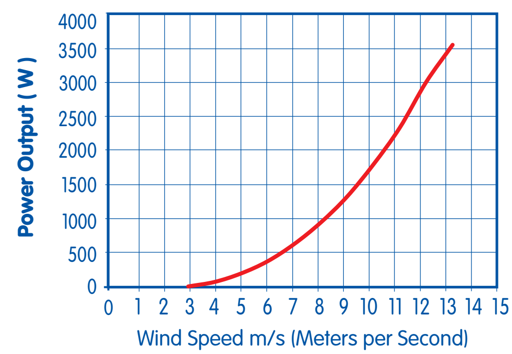
Wind Speed (m/s)	Wind Speed (mph)	Power (W)	Annual (kWh)
3	6.7	2.1	-
4	8.9	68	1,370
5	11.2	193	2,958
6	13.4	371	5,067
7	15.7	622	7,158
8	17.9	936	8,654
9	20.1	1,317	9,373
10	22.4	1,791	9,448
11	24.6	2,332	9,009
12	26.8	3,003	-
13	29.1	3,550	-

Offset Greenhouse Gas Emissions*

AVX-3K offsets an average of 11,520 lbs. (5,230 kg.) of greenhouse gases annually or equivalent to 288,000 auto-miles (460,800 km) over its lifespan. That is equivalent to saving 785 trees.

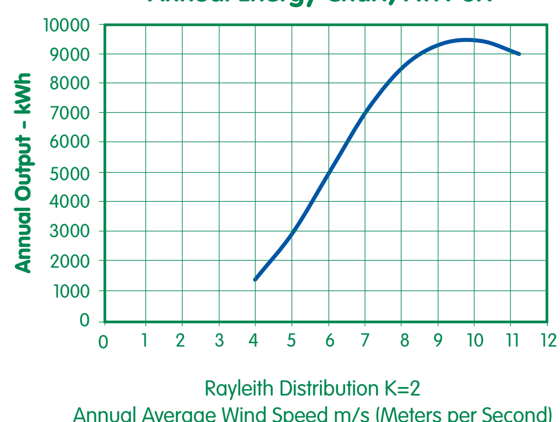
* Based on current global emissions of average utility fossil fuels mix

Power Output Chart, AVX-3K



Weibull Shape Parameter=2

Annual Energy Chart, AVX-3K



Rayleith Distribution K=2
Annual Average Wind Speed m/s (Meters per Second)

Important Disclaimer: Actual power resources and selected site conditions will highly affect energy production, which will vary with the surrounding environment. Therefore, ARVA, LLC. makes no definitive representation, guarantees, or warranties regarding accurate or actual energy production. The user of this information and product assumes full responsibility and risk.

Figures and comments provided by ARVA are believed to be reliable. However, the information provided must only be used as general information. Even though obtained from sources deemed reliable, no warranty or representation, express or implied, is made as to the accuracy of the information herein, and it is subject to errors and omissions. ARVA, LLC. assumes no responsibility for inaccuracies or omissions and expressly disclaims liability for any opinion expressed.

AVX-3K Ground Installation

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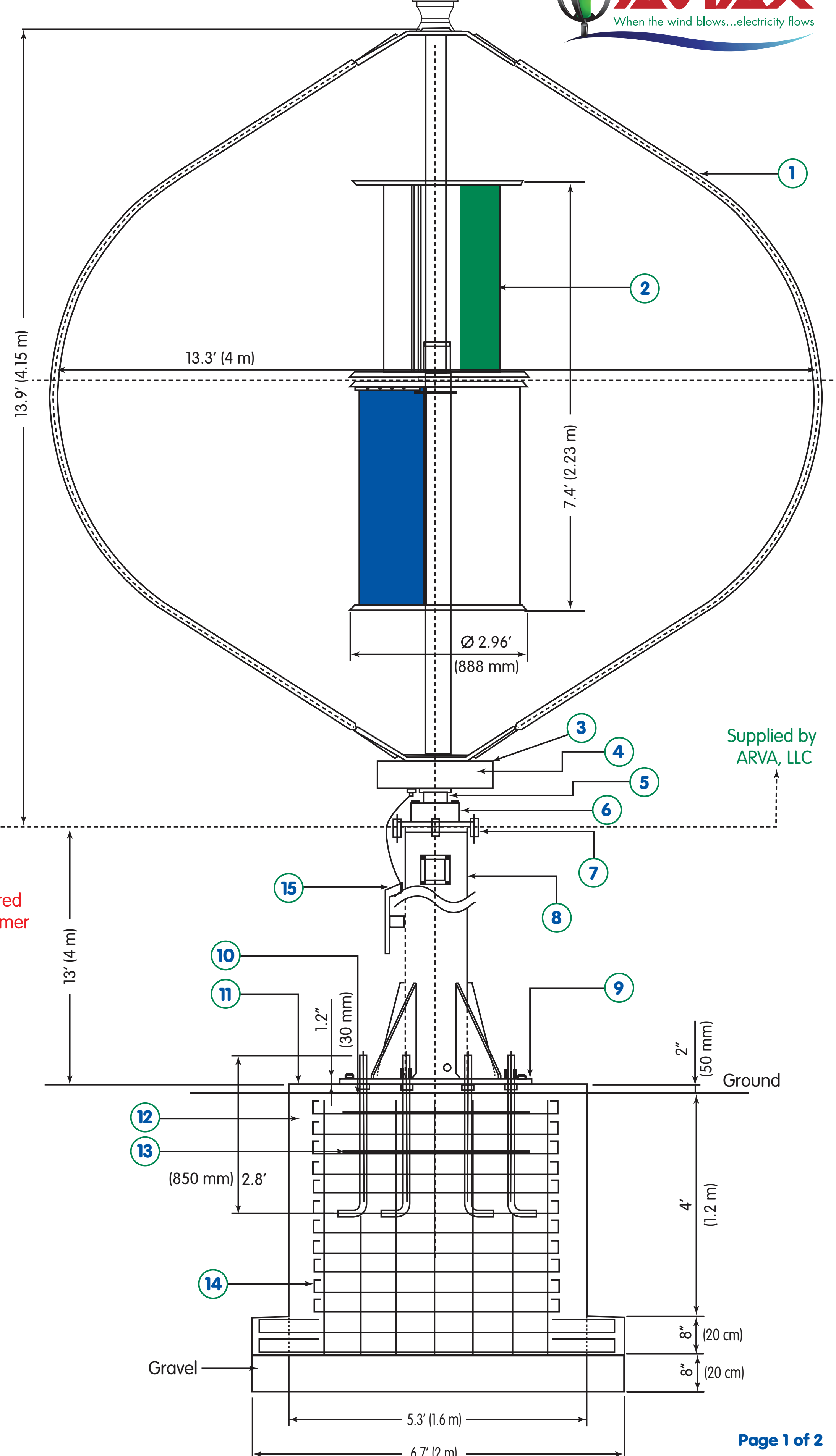
Legend :

No.	Description (Material)	Qty.
1	Darrieus Blade (A6063/T3)	3
2	Savonius Blade (A6061P)	4
3	Generator	1
4	Brake	1
5	Turbine Axis (SS400)	1
6	Base Axis Flange (SS400)	1
7	Mounting Flange (SS400) = Ø445 Thickness = 26 mm	1
	Securing Bolts @PCD (Pitch Circle Diameter) = Ø400	
	Hexagon Securing Bolts (SUS304)	
	M22 x 80 mm x 2.5	8
	Securing Nuts : M22	8
	Spring Washers : M22	8
8	Galvanized Steel Pole (SS400) : OD Ø318.5, ID Ø304.7, L=4m	1
9	Base Plate (SS400) : 1 m x 1 m x 30 mm Thick	1
10	Foundation Anchor "J" Bolts (SS400) :	
	M30 x 850 mm	8
	Anchor Nuts : M30	24
11	Firm Concrete Foundation Top : 1.6m x 1.6m x 50 mm²	1
12	Concrete Foundation Base : Min. Strength = 3000 psi	1
13	Reinforcing Steel Plate for Foundation : 1m x 1m x 5mm Thick	2
14	Grid for Reinforcing Foundation (in compliance per local laws)	
15	Mechanical Manual Brake	1



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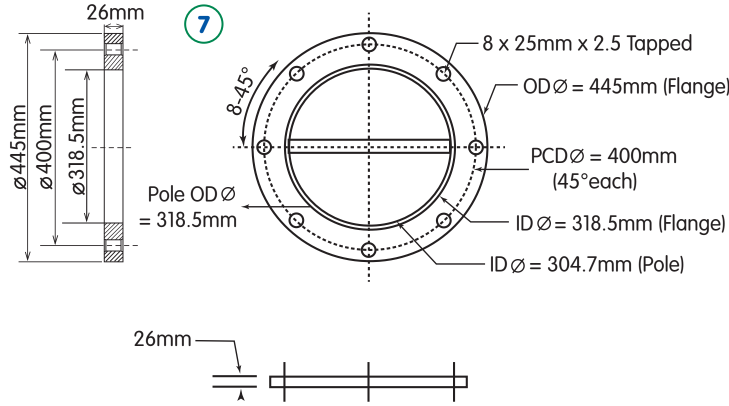
AVX-3K Ground Installation

Private, Confidential & Privileged

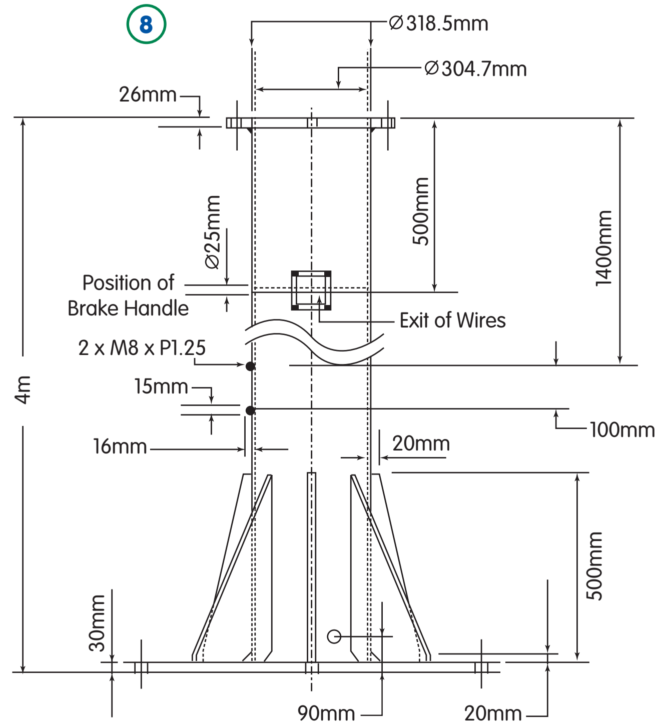
7



Legend :

No.	Description (Material)
7	Mounting Flange (SS400) = Ø445 Thickness = 26 mm Securing Bolts @PCD (Pitch Circle Diameter) = Ø400
8	Galvanized Steel Pole (SS400) : OD Ø318.5, ID Ø304.7, L=4m
9	Base Plate (SS400) : 1 m x 1 m x 30 mm Thick
13	Reinforcing Steel Plate for the Foundation : 1m x 1m x 5mm Thick 2 pcs.

8



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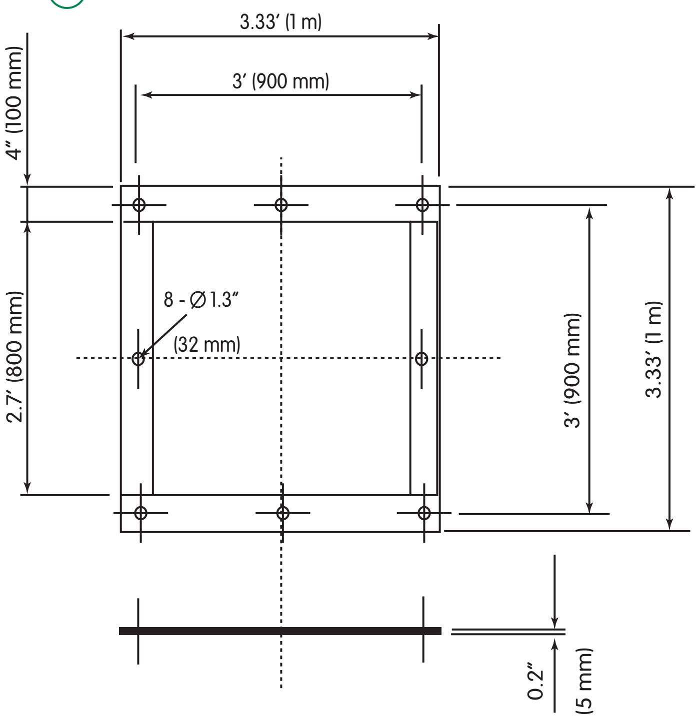

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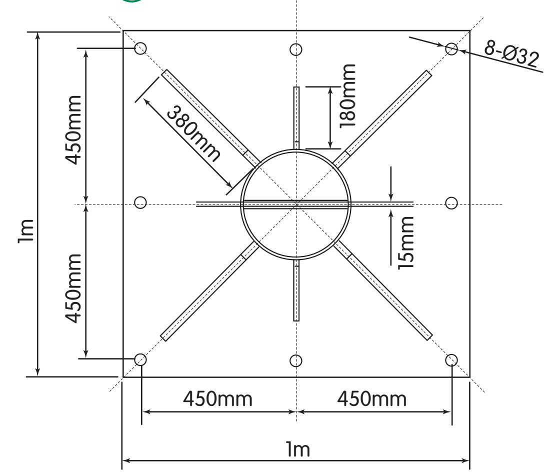
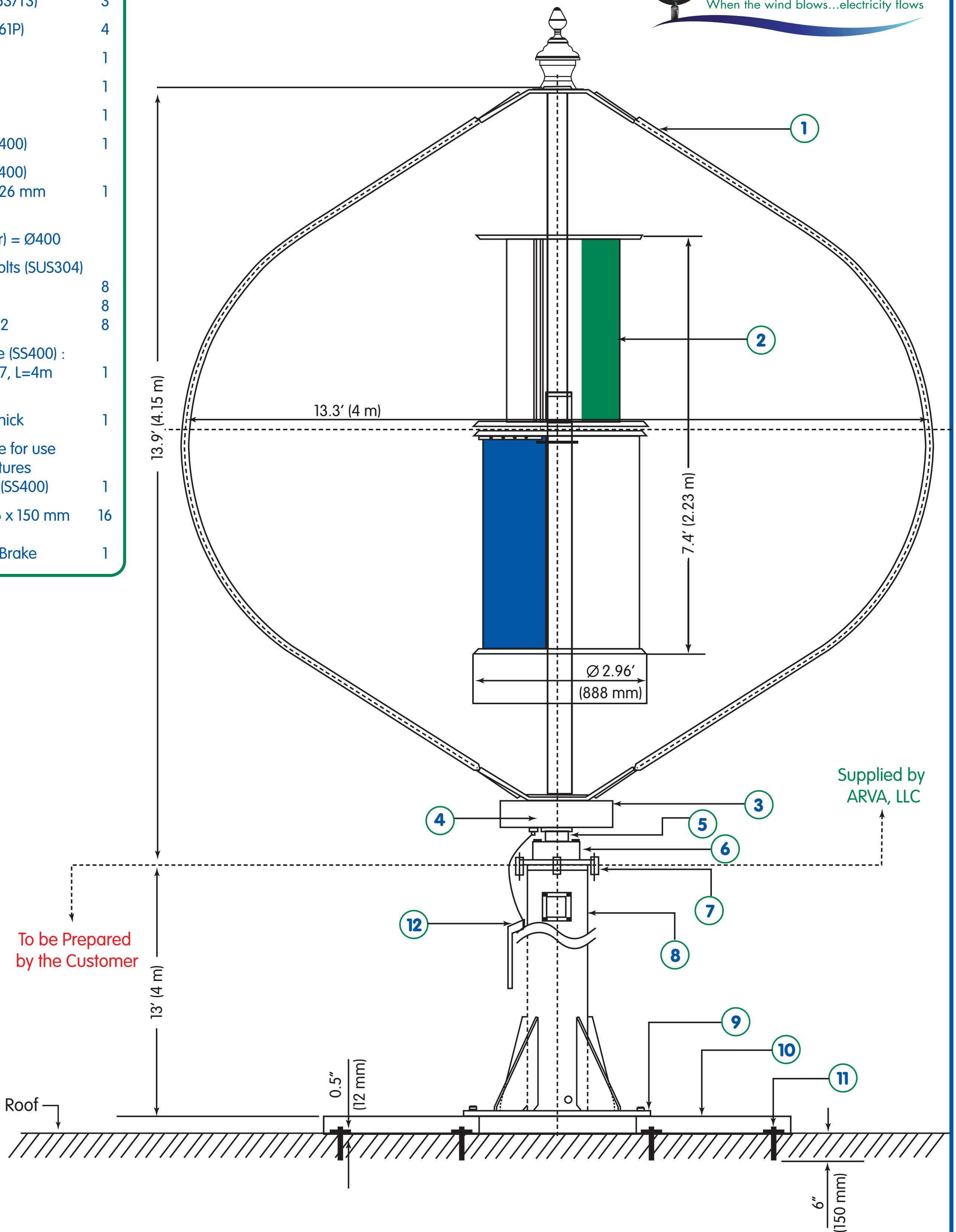


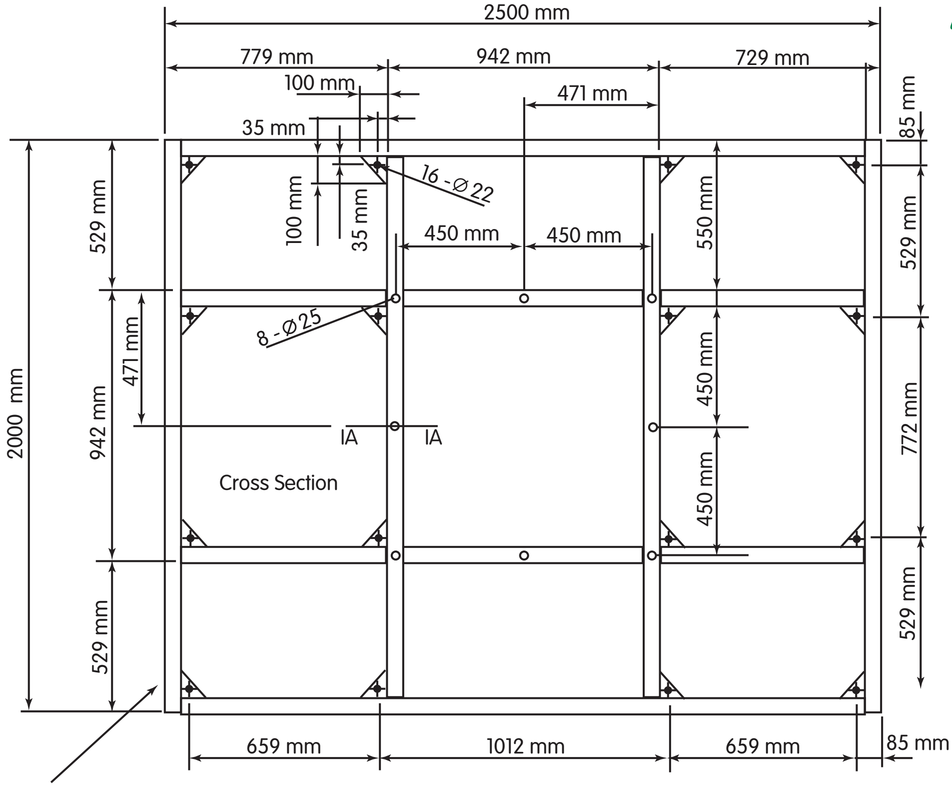
Legend :

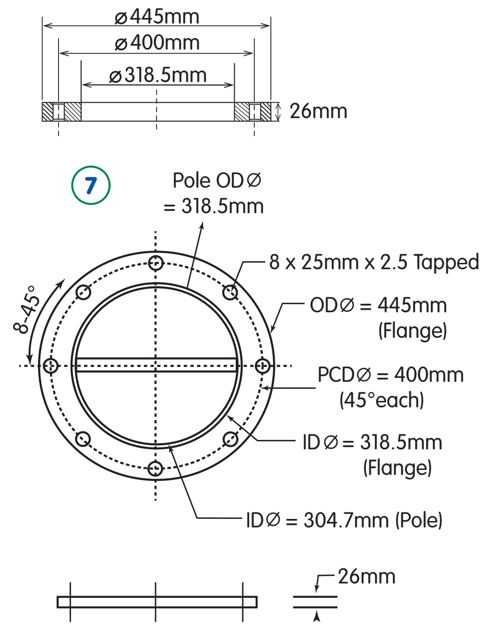
No.	Description (Material)	Qty.
1	Darrieus Blade (A6063/T3)	3
2	Savonius Blade (A6061P)	4
3	Generator	1
4	Brake	1
5	Turbine Axis (SS400)	1
6	Base Axis Flange (SS400)	1
7	Mounting Flange (SS400) = Ø445 Thickness = 26 mm	1
	Securing Bolts @PCD (Pitch Circle Diameter) = Ø400	
	Hexagon Securing Bolts (SUS304) M22 x 80 mm x 2.5	8
	Securing Nuts : M22	8
	Spring Washers : M22	8
8	Galvanized Steel Pole (SS400) : OD Ø318.5, ID Ø304.7, L=4m	1
9	Base Plate (SS400) : 1 m x 1 m x 30 mm Thick	1
10	Structural Steel Frame for use on Old Rooftop Structures 2m x 2.5m x 37 mm (SS400)	1
11	Expansion Bolts: M16 x 150 mm	16
12	Mechanical Manual Brake	1

AVX-3K Rooftop Installation

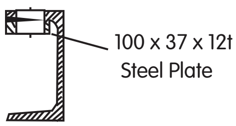


AVX-3K Rooftop Installation





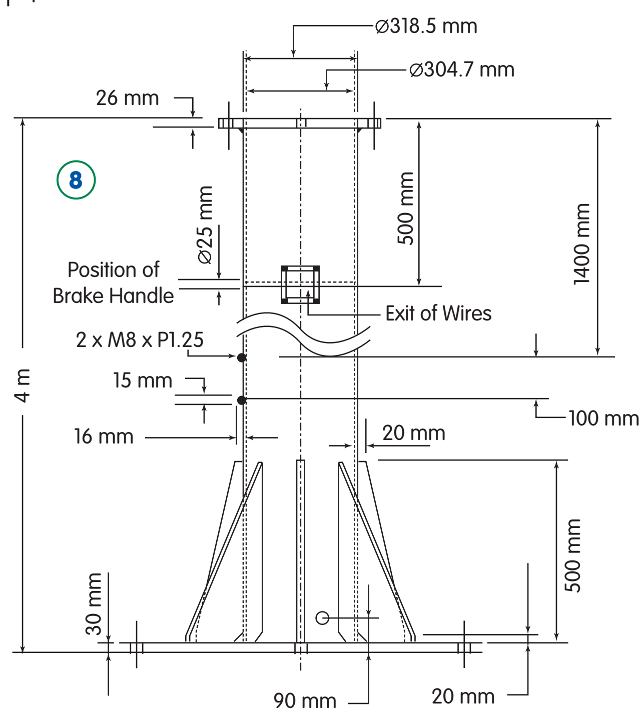
4" x 2" C Channel
Structural Steel

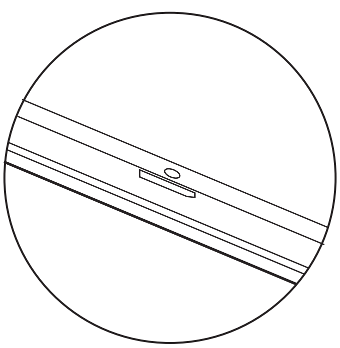


Steel Structural Frame for use on Old Rooftop Structures

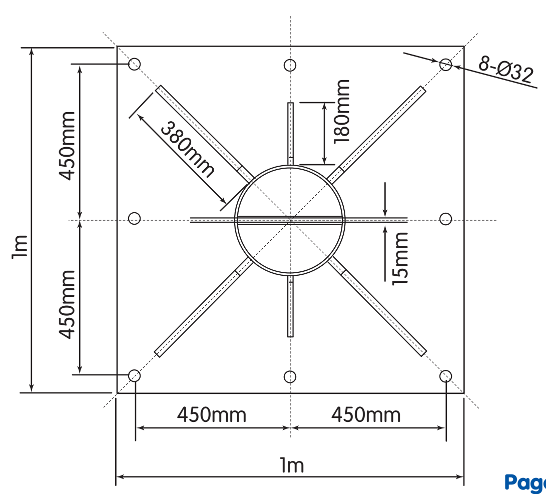
Structural Steel Frame to be filled and covered by Concrete to avoid water seepage.

N.B : Structural Steel Frame is not necessary for new Rooftops.





Exploded View of Welding for the Steel Structural Frame



Legend :

No.	Description (Material)
7	Mounting Flange (SS400) = Ø445 Thickness = 26 mm Securing Bolts @PCD (Pitch Circle Diameter) = Ø400
8	Galvanized Steel Pole (SS400) : OD Ø318.5, ID Ø304.7, L=4m
9	Base Plate (SS400) : 1 m x 1 m x 30 mm Thick

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PVI-3.0-OUTD-US-W
PVI-3.6-OUTD-US-W
PVI-4.2-OUTD-US-W

Grid-Tie Wind Inverters

Aurora grid-tie transformerless wind inverters offer a unique combination of high efficiencies, installer-friendly designs and long service life. A major selling point of the Aurora Wind inverter is its very wide input voltage range ensuring power is continuously harvested from the lightest breeze to the strongest wind.

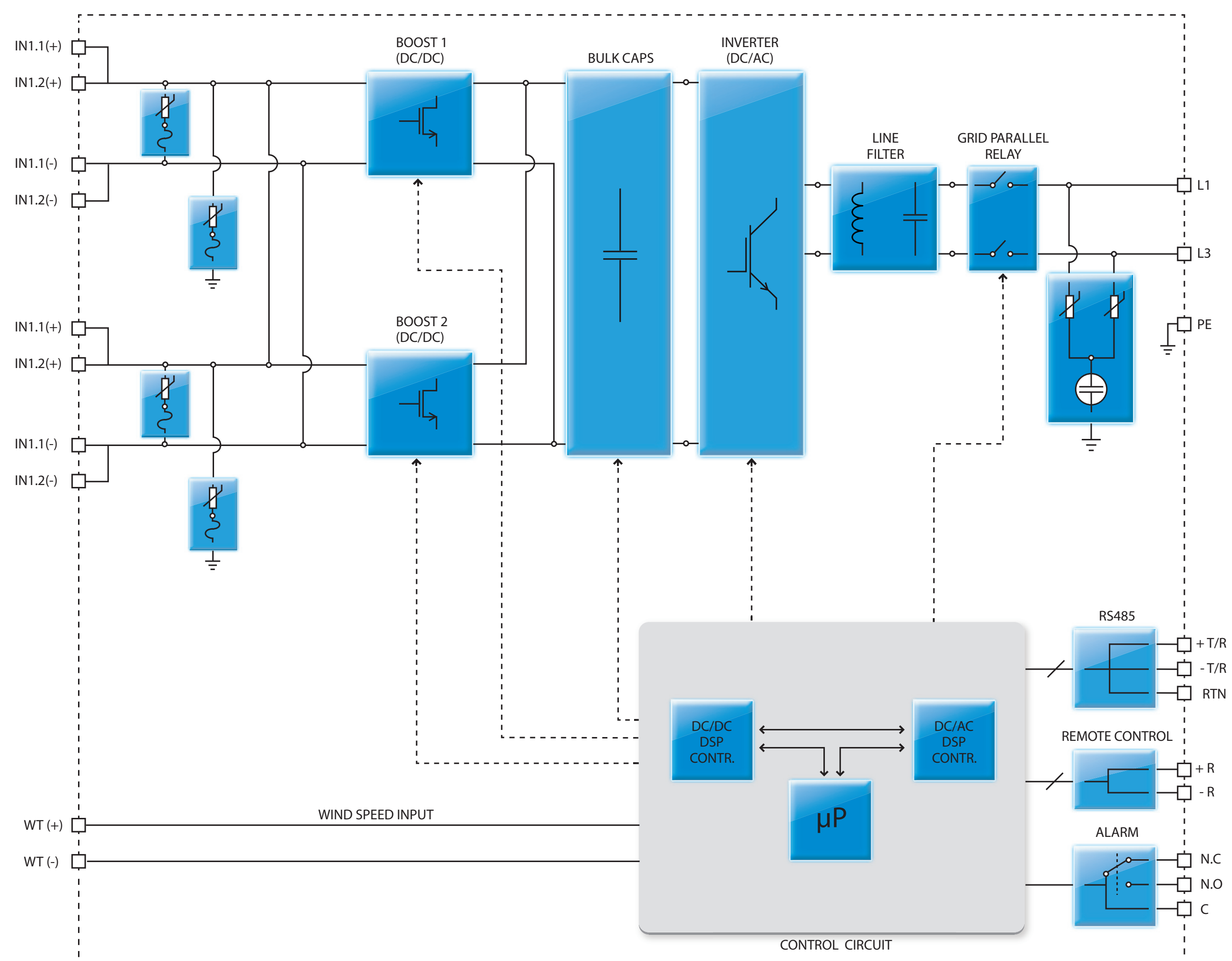
The competitive initial acquisition costs matched with the high efficiencies of up to 96.9% significantly increase return on investment on wind-power installations.

This compact, weather-sealed inverter has a programmable 16-point profile which allows a tight match for any compatible permanent magnet turbine.

Features

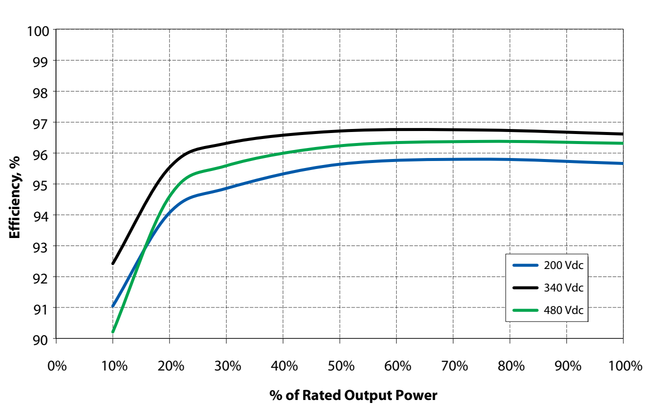
- Single Phase Output
- Transformerless operation for highest efficiency
- Power curve customization with high granularity to reach high level of power production yield
- Outdoor enclosure for unrestricted use under any environmental conditions
- Compact size and high power density
- Optimized real time power curve tracking algorithm and improved energy harvesting
- High overload capability: works up the power max limits under most ambient conditions
- Compatible with 25kW Wind Interface
- Compatible with 7200 Wind Interface
- Compatible with 4000 Wind Interface

BLOCK DIAGRAM OF PVI-3.0-OUTD-W, PVI-3.6-OUTD-W AND PVI-4.2-OUTD-W FOR NORTH AMERICA

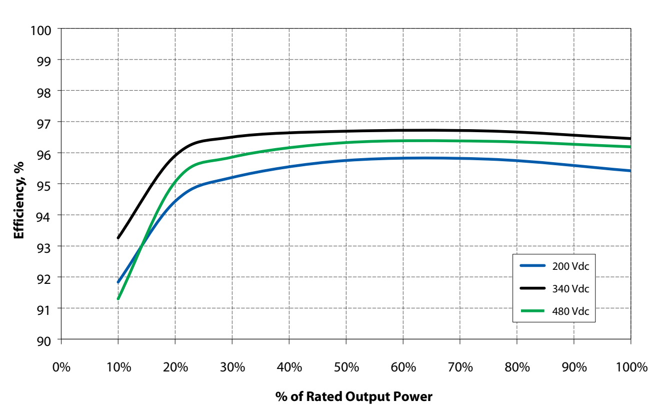


Block Diagram and Efficiency Curves

PVI-3.6-OUTD-US-W



PVI-4.2-OUTD-US-W



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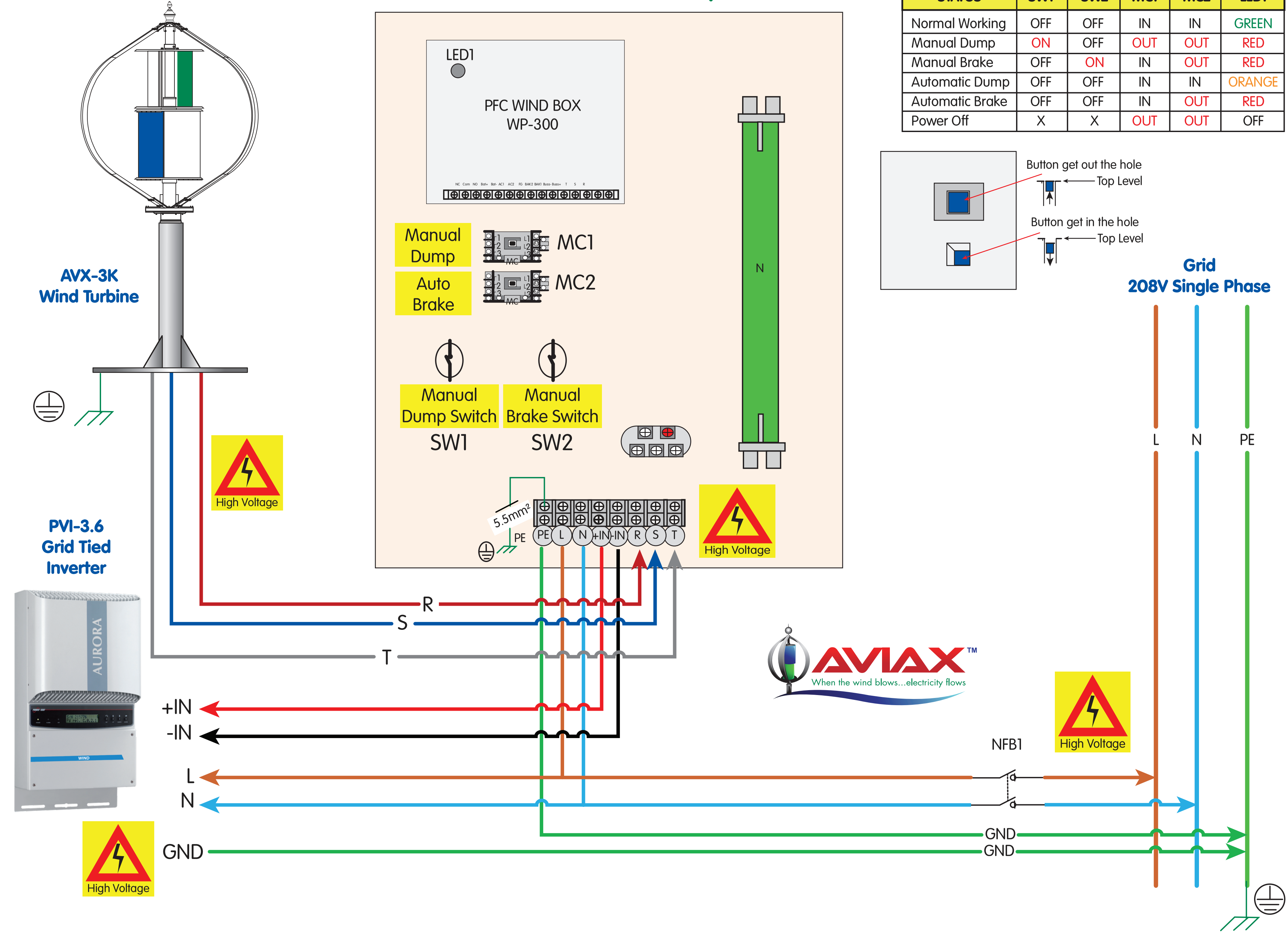
Grid-Tie Wind Inverters

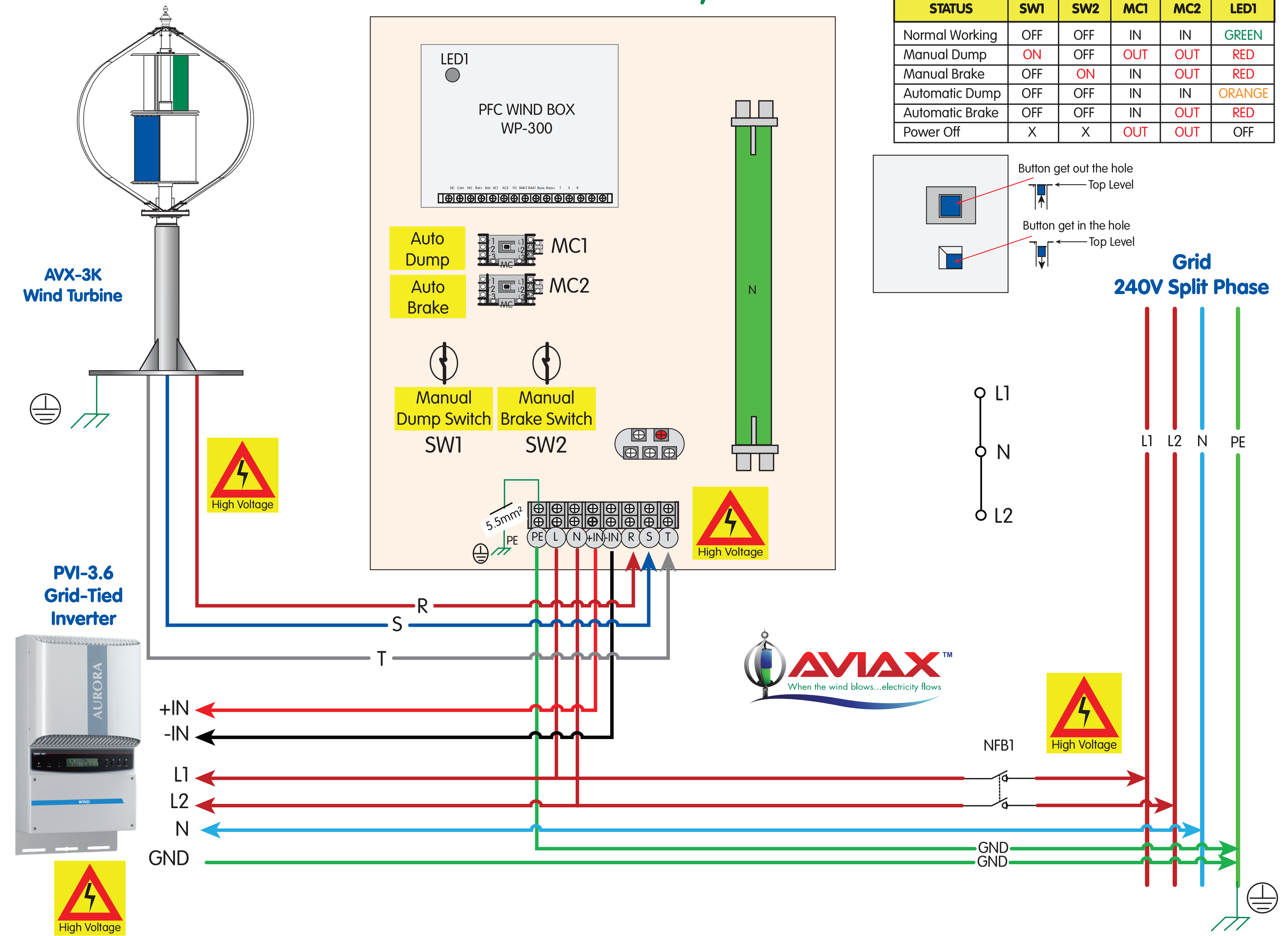
PARAMETER	PVI-3.0-OUTD-US-W			PVI-3.6-OUTD-US-W			PVI-4.2-OUTD-US-W		
Input Side									
Maximum Absolute DC Input Voltage $V_{(dc,abs)}$	600 V								
Operating DC Input Range (V_{dcmin}...V_{dcmax})	50...580 V								
DC Input range at full power ($V_{fp,min}$...$V_{fp,max}$)	200...530 V			220...530 V			200...530 V		
Dc Power Limitation	Linear Derating From MAX to Null [530V≤Vdc≤580V]								
Maximum DC Input Current (I_{dcmax})	20 A			32 A			32 A		
Maximum Input Short Circuit Current	25 A			40 A			40 A		
DC Connection Type	Screw Terminal Block 3 Knock-Outs: 1 ½" or 1" (w/ Ring Red.)								
Input Protection									
Reverse Polarity Protection	No								
Input Over Voltage Protection - Varistor	4								
Generator Isolation Control	Yes								
Output Side	208	240	277	208	240	277	208	240	277
AC Grid Connection	Single Phase / Split Phase								
Rated AC Power (P_{acr})	3000 W			3600 W			4200 W		
Maximum AC Output Power (P_{acmax})	3000 W	3300 W	3300 W	3600 W	4000 W	4000 W	4200 W	4600 W	4600 W
Rated Grid AC Voltage ($V_{ac,r}$)	208 V	240 V	277 V	208 V	240 V	277 V	208 V	240 V	277 V
AC Voltage Range	183...228 V	211...264 V	244...304 V	183...228 V	211...264 V	244...304 V	183-228 V	211-264 V	244-304 V
Maximum Output AC Current ($I_{ac,max}$)	14.5 A	14.5 A	12.0 A	17.2 A	16 A	16 A	20 A	20 A	20 A
Rated Frequency (f_r)	60 Hz								
Frequency Range (f_{min}...f_{max})	59.3...60.5 Hz								
Nominal Power Factor ($Cosphi_{ac,r}$)	> 0.995								
Total Harmonic Distortion	< 2%								
AC Connection Type	Screw Terminal Block 3 Knock-Outs: 1 ½" or 1" (w/ring reducer)								
Output Protection	208	240	277	208	240	277	208	240	277
Anti-islanding protection	According to UL 1741/IEE1547								
Maximum AC Overcurrent Protection	20 A	20 A	15 A	25 A	20 A	20 A	25 A	25 A	25 A
Output Over Voltage Protection - Varistor	2 (L-N/L-PE)								
Operating Performance									
Maximum Efficiency (η_{max})	96.8%								
Stand-by Consumption	< 8W								
Communication									
Wired Local Monitoring	PVI-USB-RS485_223 (opt.), PVI-DESKTOP (opt.)								
Remote Monitoring	PVI-AEC-EVO (opt.), AURORA-UNIVERSAL (opt.)								
Wireless Local Monitoring	PVI-DESKTOP (opt.) with PVI-RADIOMODULE (opt.)								
User Interface	16 characters x 2 lines LCD display								
Environmental									
Ambient Temperature Range	-25...+ 60°C/-13...140°F with derating above 55°C/131°F								
Noise Emission	< 50 dB(A)								
Maximum Operating Altitude with Derating	2000 m / 6560 ft								
Physical									
Environmental Protection Rating	NEMA 4X								
Cooling	Natural								
Dimension (H x W x D)	618mm x 325mm x 222mm / 24.3" x 12.8" x 8.7"								
Weight	18 kg / 39.6 lb								
Safety									
Isolation Level	Transformerless								
Marking	cCSAus								
Safety and EMC standard	UL 1741, CSA - C22.2 N. 107.1-01								
Grid Standard	IEEE 1547								
Available Products Variants									
Standard	PVI-3.0-OUTD-US-W			PVI-3.6-OUTD-US-W			PVI-4.2-OUTD-US-W		

General Overview of Aviax Grid-Tie Power System - 208V

STATUS	SW1	SW2	MC1	MC2	LED1
Normal Working	OFF	OFF	IN	IN	GREEN
Manual Dump	ON	OFF	OUT	OUT	RED
Manual Brake	OFF	ON	IN	OUT	RED
Automatic Dump	OFF	OFF	IN	IN	ORANGE
Automatic Brake	OFF	OFF	IN	OUT	RED
Power Off	X	X	OUT	OUT	OFF



General Overview of Aviax Grid-Tie Power System - 240V



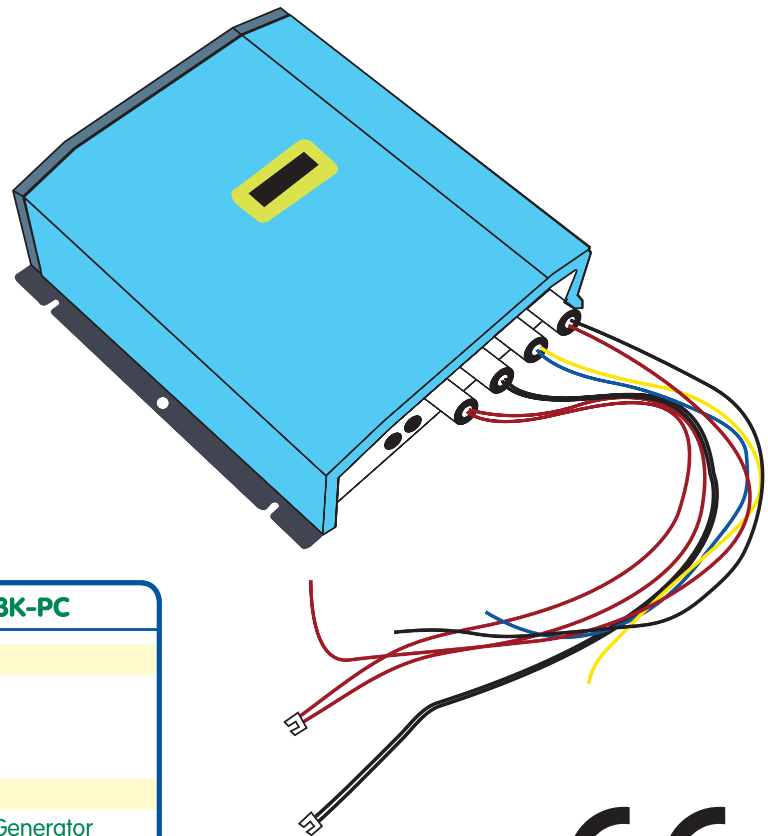
STATUS	SW1	SW2	MC1	MC2	LED1
Normal Working	OFF	OFF	IN	IN	GREEN
Manual Dump	ON	OFF	OUT	OUT	RED
Manual Brake	OFF	ON	IN	OUT	RED
Automatic Dump	OFF	OFF	IN	IN	ORANGE
Automatic Brake	OFF	OFF	IN	OUT	RED
Power Off	X	X	OUT	OUT	OFF

Aviax Off-Grid Power Controller

AVX-OG-3K-PC

Standard Features

- Designed specifically for AVX-3K Vertical Axis Wind Turbine (VAWT)
- Built-in Maximum Power Point Tracking (MPPT) technology to transfer the maximum amount of energy from the wind turbine generator
- Designed for high efficiency transfer rate above 85% including rectifier
- Built in LCD Display for status monitoring
- Automatic Power Dump and Brake Control Function
- Battery Charging Management System
- Built-in Heat Sink for Cooler Running
- For 48V Deep Cycle Batteries

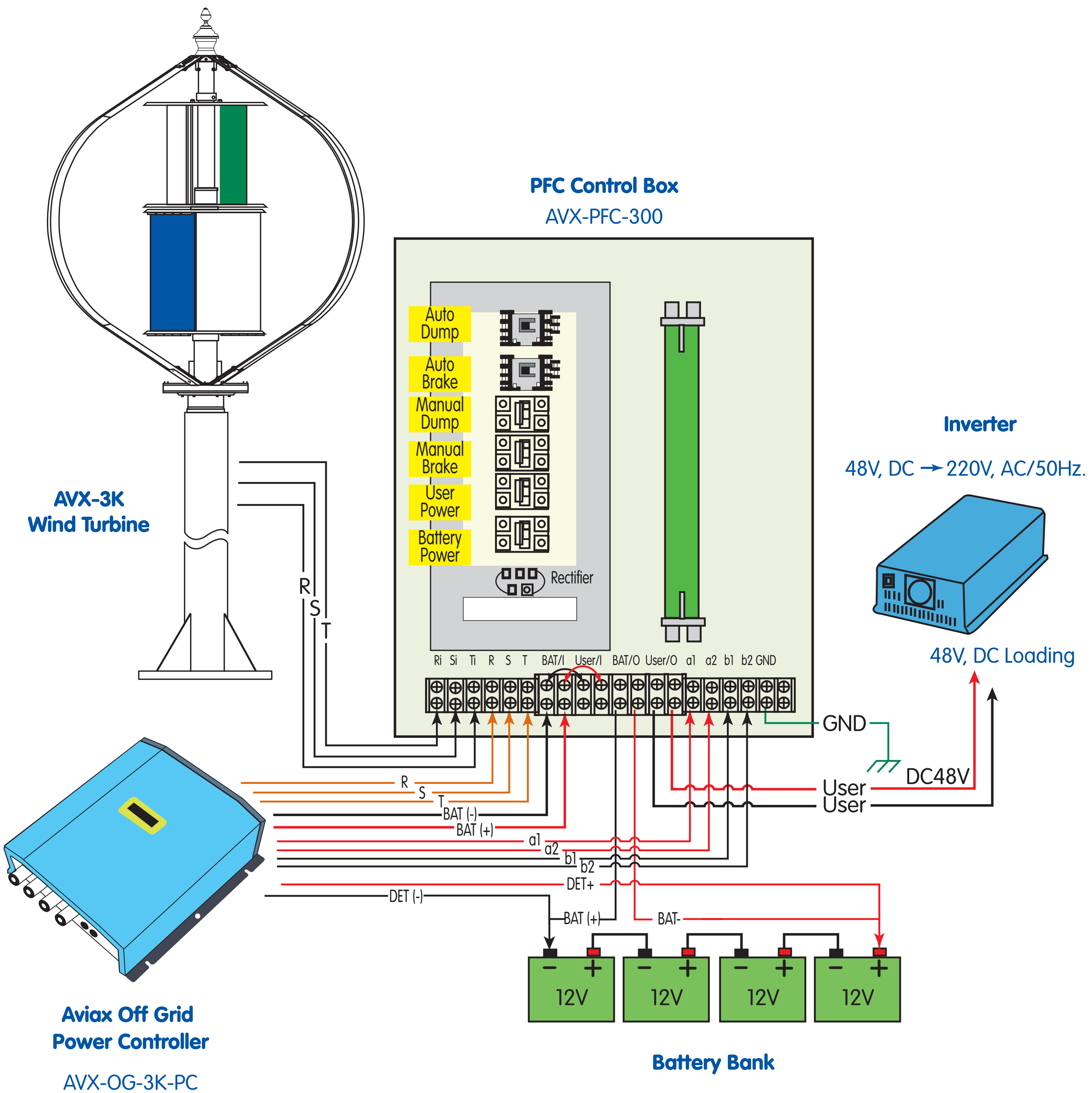


Specifications	AVX-OG-3K-PC
MPPT Off-Grid Wind Power Controller	
Output Power	0~3000W
Maximum Power	3000W
Input	
Generator Required	3-phase, AC PM Generator
Working Range	0~ 150V, AC ±5%
MPPT Range	65 to 150 V, AC
Maximum Input Current	15 A
System Cut-out Voltage	150V
Output	
Charging Voltage	48V, DC
Maximum Output Current	60A
Stand-by Power Consumption	<5W
Lowest Voltage Limitation	40V, DC ±0.5V
Maximum Charging Voltage	57.6V, DC ±0.5V
MPPT Efficiency	>90%
Environment	
Protection	IP43
Operation Temperature	-40°F ~ 104°F (-40°C ~ 40°C)
Humidity	0 to 95%, Non-condensing
Heat Dissipation	Conventional Heat Sink
Acoustic Noise Level	<40dB, A-weighted
Mechanical	
Width × Depth × Height	16” x 13” x 5.2” (400mm x 325mm x 130mm)
Weight	33 lbs. (15kg.)

AVIAX™
When the wind blows...electricity flows

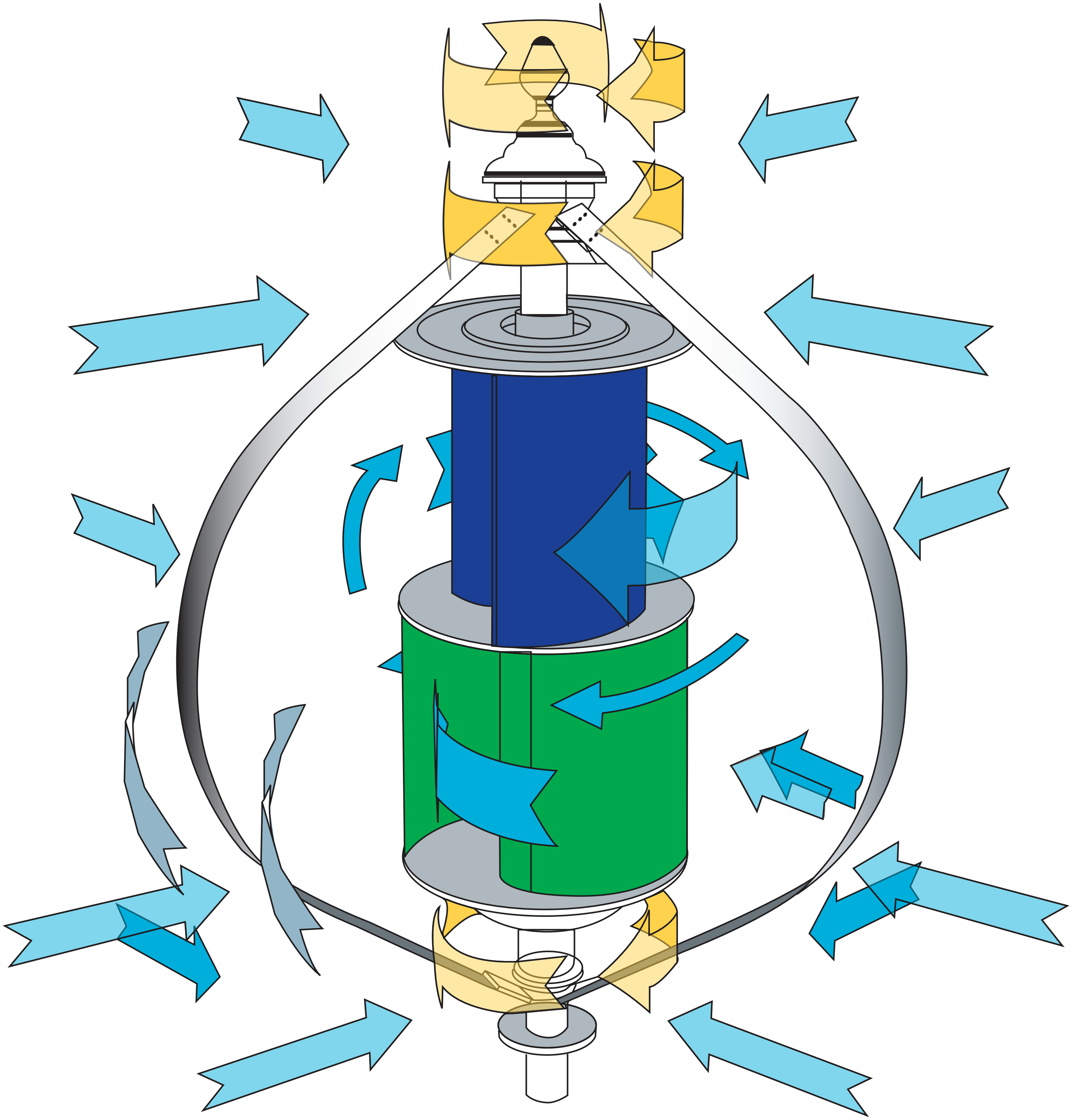
ARVA™
An Eco-Friendly Company

General Overview of Aviax Off-Grid Power System



Aerodynamic Technology

Omni-Directional : Generates Power with wind from any direction at wind velocity of less than 5.6 Mph (≤2.5 m/s).



Omni-directional Blades: The airfoil rotor blades of the Aviax turbine reduce wind direction limitations as they collect wind power on a 360° basis. This pioneering technology eliminates the need for a yaw to re-orient the wind turbine to face the wind direction. This also maximizes energy production by increasing wind velocity and pressure, while eliminating back pressure, allowing the turbine to operate with low wind speeds.

ECONOMIC PARAMETERS

By WATERFURNACE INTERNATIONAL

Project Name: Catawba Senior Housing
Location: Charlotte, NC
Building Owner: The Housing Partnership
Program User: Mike Lemmon
Company: WaterFurance International
Comments:

Study Life:	20 Yrs
Mortgage Life:	30 Yrs
Depreciation Life:	20 Yrs
Mortgage Interest Rate:	6.000 %
Percent Financed:	65.0 %
Depreciation Method:	None
Declining Balance Taxes:	150.0 %

Income Tax Rate:	0.000 %
Cost of Capital:	8.000 %
Property tax rate:	3.000 %
Insurance Expense rate:	0.000 %

<u>Annual Inflation Rate Of</u>

Maintenance Expense	3.000 %
Replacement Expense	2.000 %
Property Taxes	2.000 %
Insurance Expense	1.000 %

Alt #	First Cost ($/ton)	First Cost ($/ft²)	Additional First Cost	Total First Cost	Maintenance Cost ($/ton)	Maintenance Cost ($/ft²)	Total Maint. Cost	Total Alt. Cost
2	3,179.24	7.40	584,800.00	1,192,160.88	15.70	0.04	3,000.00	1,195,160.88
1	2,742.74	6.38	0.00	523,971.88	26.17	0.06	5,000.00	528,971.88

Economic Summary

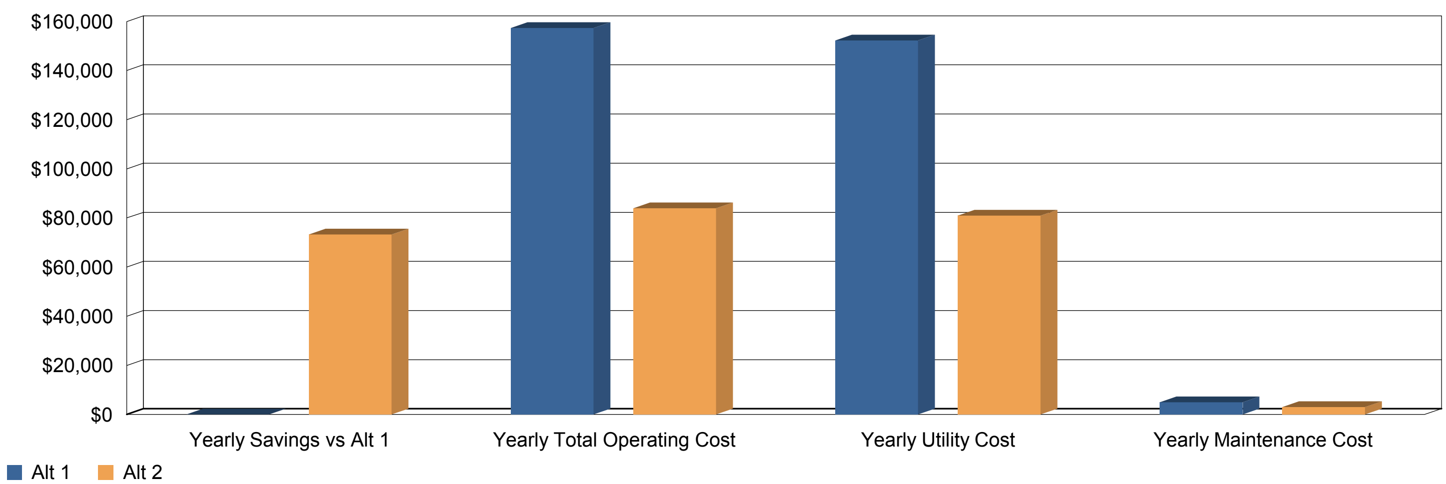
Project Information

Location	Charlotte, NC	Study Life:	20 years
Project Name	Catawba Senior Housing	Cost of Capital:	8 %
User	Mike Lemmon	Alternative 1:	Catawba Split System w Elect DWH
Company	WaterFurance International	Alternative 2:	Catawba Ground Source CLG - HTG- DHW
Comments			

Economic Comparison of Alternatives

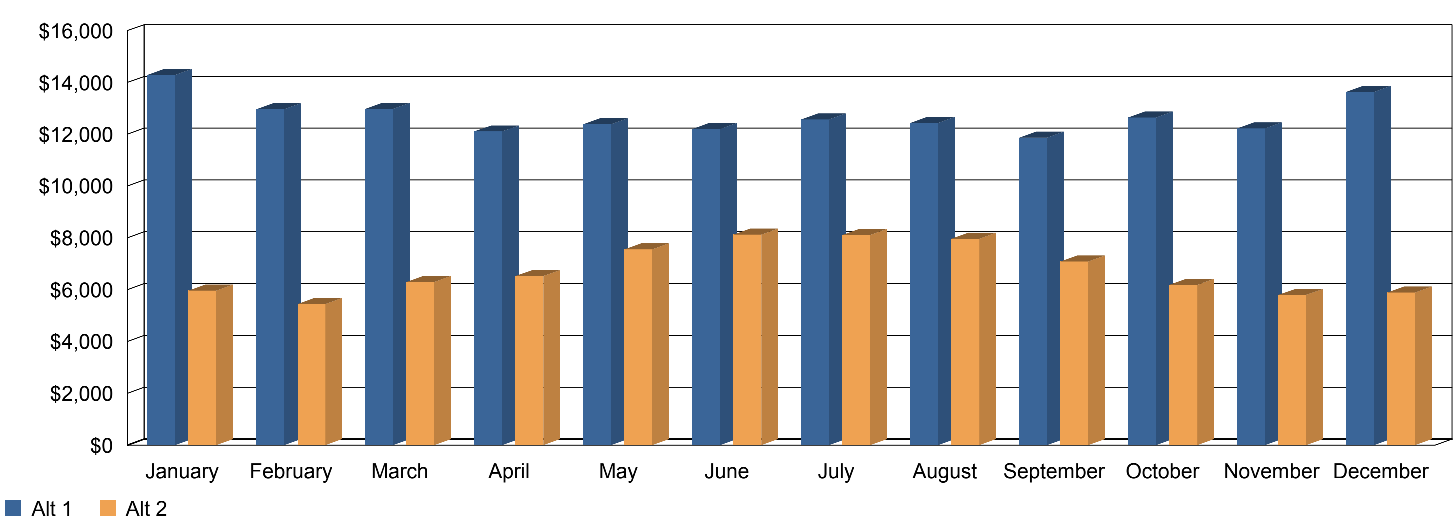
	Yearly Savings ($)	First Cost Difference ($)	Cumulative Cash Flow Difference ($)	Simple Payback (yrs.)	Net Present Value ($)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost
Alt 2 vs Alt 1	73,354	668,189	869,581	9.1	187,335	14.3	14.0	187,334.70

Annual Operating Costs



	Yearly Savings vs Alt 1	Yearly Total Operating Cost ($)	Yearly Utility Cost ($)	Yearly Maintenance Cost ($)	Plant kWh/ton-hr
Alt 1	0	157,326	152,326	5,000	0.473
Alt 2	73,354	83,973	80,973	3,000	0.617

Monthly Utility Costs



System Checksums

By WATERFURNACE INTERNATIONAL

System - 001 **Packaged Terminal Air Conditioner**

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 6 / 14; Outside Air: OADB/WB/HR: 96 / 73 / 88

Clg Space Peak — Mo/Hr: Sum of; OADB: Peaks

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	855,520	0	855,520	37	857,012	42
Skylite Cond	0	63,059	63,059	3	0	0
Roof Cond	0	40,577	40,577	2	0	0
Glass Solar	725,303	0	725,303	32	732,190	36
Glass/Door Cond	50,044	0	50,044	2	45,516	2
Wall Cond	125,171	49,240	174,411	8	124,232	6
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	0		0	0	0	0
Sub Total ==>	1,756,039	152,876	1,908,915	83	1,758,950	86
Internal Loads						
Lights	164,445	41,111	205,556	9	164,037	8
People	54,323	0	54,323	2	37,996	2
Misc	67,243	0	67,243	3	66,021	3
Sub Total ==>	286,011	41,111	327,123	14	268,054	13
Ceiling Load	27,605	-27,605	0	0	27,138	1
Ventilation Load	0	0	27,667	1	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	0		0	0	0	0
Exhaust Heat		-775	-775	0		
Sup. Fan Heat			29,546	1		
Ret. Fan Heat		1	1	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	2,069,656	165,608	2,292,476	100.00	2,054,142	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 22

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	-175,165	29.34
Roof Cond	0	-44,955	7.53
Glass Solar	0	0	0.00
Glass/Door Cond	-176,835	-176,835	29.62
Wall Cond	-115,426	-159,700	26.75
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	0	0	0.00
Sub Total ==>	-292,261	-556,655	93.23
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	-51,274	0	0.00
Ventilation Load	0	-42,148	7.06
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		1,731	-0.29
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-343,535	-597,071	100.00

TEMPERATURES

	Cooling	Heating
SADB	56.0	73.2
Ra Plenum	76.1	68.0
Return	75.9	68.0
Ret/OA	76.0	67.7
Fn MtrTD	0.0	0.0
Fn BldTD	0.1	0.0
Fn Frict	0.2	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	99,714	99,714
Terminal	99,714	99,714
Main Fan	99,714	99,714
Sec Fan	0	0
Nom Vent	810	810
AHU Vent	810	810
Infil	0	0
MinStop/Rh	0	0
Return	99,714	99,714
Exhaust	810	810
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	0.8	0.8
cfm/ft²	1.21	1.21
cfm/ton	521.96	
ft²/ton	429.63	
Btu/hr·ft²	27.93	-7.27
No. People	217	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	191.0	2,292.5	2,260.0	99,714	76.1	59.4	51.1	55.8	51.0	49.4
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	191.0	2,292.5								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	82,076		
Part	0		
Int Door	0		
ExFlr	0		
Roof	27,359	3,776	14
Wall	17,972	5,392	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-597.1	99,714	67.7	73.2
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-597.1			

System Checksums

By WATERFURNACE INTERNATIONAL

System - 001 — **Water Source Heat Pump**

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 6 / 14; Outside Air: OADB/WB/HR: 96 / 73 / 88

Clg Space Peak — Mo/Hr: Sum of; OADB: Peaks

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	855,520	0	855,520	37	857,012	42
Skylite Cond	0	63,059	63,059	3	0	0
Roof Cond	0	40,577	40,577	2	0	0
Glass Solar	725,303	0	725,303	32	732,190	36
Glass/Door Cond	50,044	0	50,044	2	45,516	2
Wall Cond	125,171	49,240	174,411	8	124,232	6
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	0		0	0	0	0
Sub Total ==>	1,756,039	152,876	1,908,915	83	1,758,950	86
Internal Loads						
Lights	164,445	41,111	205,556	9	164,037	8
People	54,323	0	54,323	2	37,996	2
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Sub Total ==>	286,011	41,111	327,123	14	268,054	13
Ceiling Load	27,605	-27,605	0	0	27,138	1
Ventilation Load	0	0	27,667	1	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	0		0	0	0	0
Exhaust Heat		-775	-775	0		
Sup. Fan Heat			29,546	1		
Ret. Fan Heat		1	1	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	2,069,656	165,608	2,292,476	100.00	2,054,142	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 22

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
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Misc	0	0	0.00
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Ventilation Load	0	-42,148	7.06
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Ov/Undr Sizing	0	0	0.00
Exhaust Heat		1,731	-0.29
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
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Grand Total ==>	-343,535	-597,071	100.00

TEMPERATURES

	Cooling	Heating
SADB	56.0	73.2
Ra Plenum	76.1	68.0
Return	75.9	68.0
Ret/OA	76.0	67.7
Fn MtrTD	0.0	0.0
Fn BldTD	0.1	0.0
Fn Frict	0.2	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	99,714	99,714
Terminal	99,714	99,714
Main Fan	99,714	99,714
Sec Fan	0	0
Nom Vent	810	810
AHU Vent	810	810
Infil	0	0
MinStop/Rh	0	0
Return	99,714	99,714
Exhaust	810	810
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

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	Cooling	Heating
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cfm/ton	521.96	
ft²/ton	429.63	
Btu/hr·ft²	27.93	-7.27
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Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	191.0	2,292.5								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	82,076		
Part	0		
Int Door	0		
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Main Htg	-597.1	99,714	67.7	73.2
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-597.1			