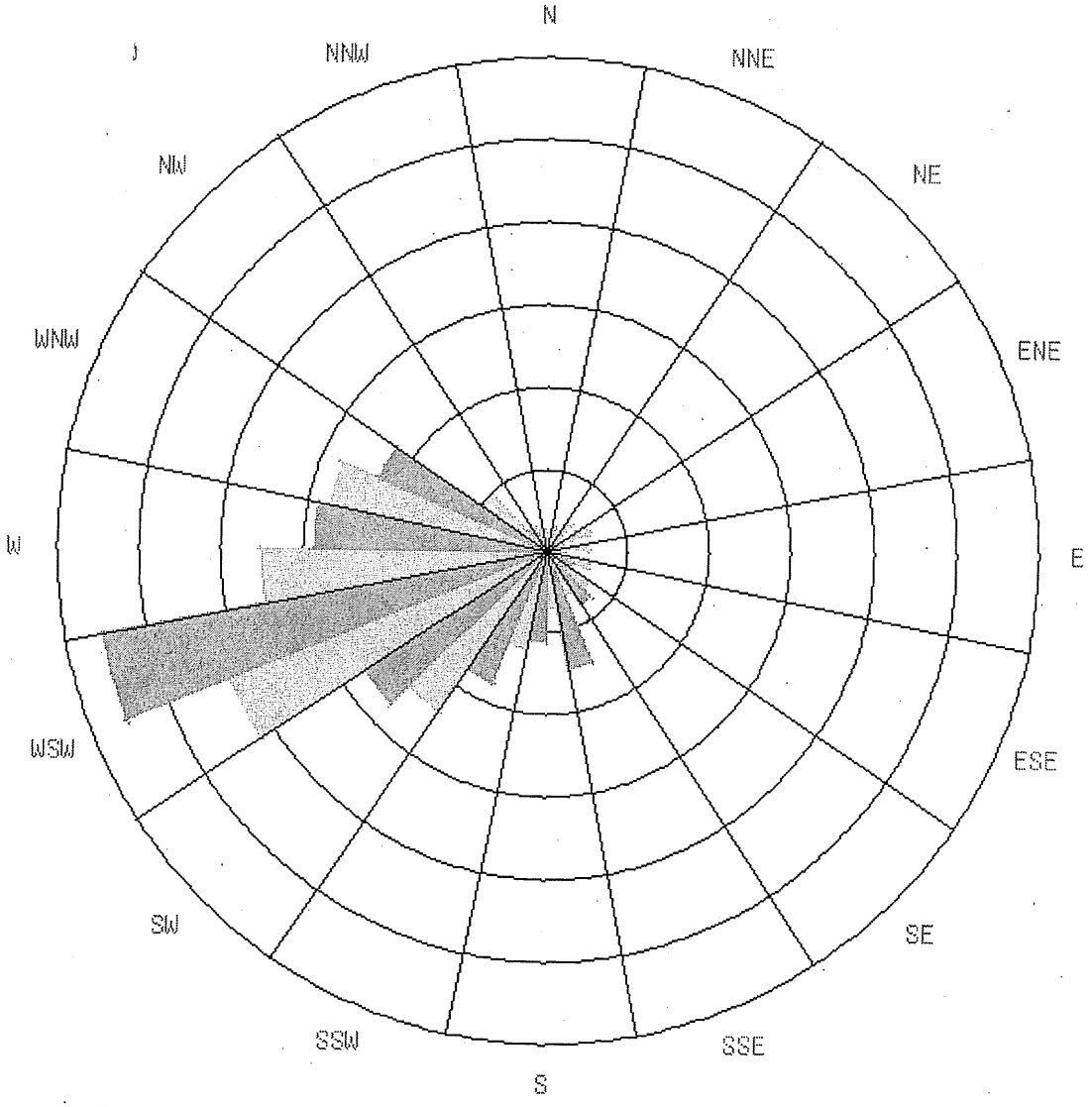
Wind Rose Graph



Percent of Total Wind Energy (Wh/m2)

Percent of Total Time

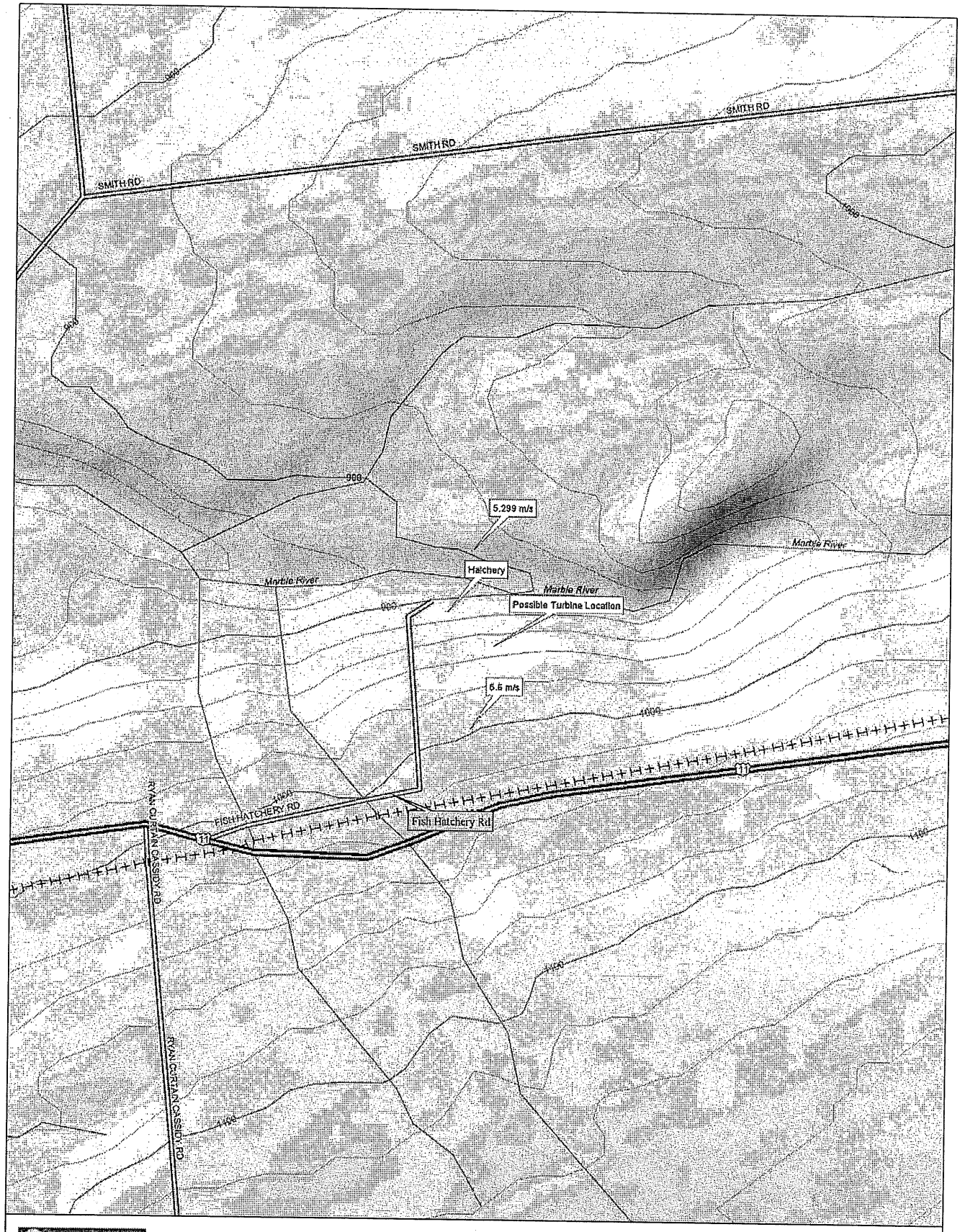
Center Point = 0%

Each Outer Circle = +5%

TrueWind Solutions

255 Fuller Road
Suite 274
Albany, NY 12203-3556

www.truewind.com
Tel: 518-437-8661
Fax: 518-437-8659



DeLORME

Zoom Level: 14-0 Datum: WGS84

Scale 1 : 12,800

1" = 1,066.69 ft

0 600 1200 1800 2400 3000 ft

0 180 360 540 720 900 m

TN

MN

15.1°W

WindCad Turbine Performance Model

BWC EXCEL-S, Grid - Intertie

Prepared For: **Chateaguay Hatchery**
Site Location: **Chateaguay, NY**
Data Source: **TrueWind NY wind map**
Date: **3/17/2016**

10 kW

Inputs:

Ave. Wind (m/s) =	5.6
Weibull K =	1.927
Site Altitude (m) =	295
Wind Shear Exp. =	0.180
Anem. Height (m) =	30
Tower Height (m) =	20
Turbulence Factor =	20.0%

Results:

Hub Average Wind Speed (m/s) =	5.21
Air Density Factor =	-3%
Average Output Power (kW) =	1.29
Daily Energy Output (kWh) =	30.9
Annual Energy Output (kWh) =	**11,278**
Monthly Energy Output =	940
Percent Operating Time =	69.0%

0.392
wind speed less 7%
5.208

Weibull Performance Calculations

Wind Speed Bin (m/s)	Power (kW)	Wind Probability (f)	Net kW @ V
1	0.00	6.20%	0.000
2	0.00	10.74%	0.000
3	0.00	13.46%	0.000
4	0.19	14.32%	0.028
5	0.62	13.60%	0.085
6	1.28	11.80%	0.152
7	1.98	9.47%	0.188
8	2.84	7.08%	0.201
9	3.77	4.95%	0.187
10	4.79	3.26%	0.156
11	5.84	2.02%	0.118
12	7.01	1.18%	0.083
13	7.39	0.65%	0.048
14	7.78	0.34%	0.027
15	6.23	0.17%	0.011
16	4.67	0.08%	0.004
17	2.10	0.04%	0.001
18	2.34	0.02%	0.000
19	2.34	0.01%	0.000
20	2.34	0.00%	0.000
1997, Bergey Windpower	Totals:	99.38%	1.287

Weibull Calculations:
Wind speed probability is calculated as a Weibull curve defined by the average wind speed and a shape factor, K. To facilitate piece-wise integration, the wind speed range is broken down into "bins" of 1 m/s in width (Column 1). For each wind speed bin, instantaneous wind turbine power (W, Column 2)) is multiplied by the Weibull wind speed probability (f, Column 3). This cross product (Net W, Column 4) is the contribution to average turbine power output contributed by wind speeds in that bin. The sum of these contributions is the average power output of the turbine on a continuous, 24 hour, basis. Best results are achieved using annual or monthly average wind speeds. Use of daily or hourly average speeds is not

Instructions:

Inputs: Use annual or monthly **Average Wind** speeds. If **Weibull K** is not known, use K = 2 for inland sites, use 3 for coastal sites, and use 4 for island sites and trade wind regimes. **Site Altitude** is meters above sea level. **Wind Shear Exponent** is best assumed as "1/7" or 0.143. For rough terrain or high turbulence use 0.18. For very smooth terrain or open water use 0.110. **Anemometer Height** is for the data used for the **Average Wind** speed. If unknown, use 10 meters. **Tower Height** is the nominal height, eg.: 24 meters. **Turbulence Factor** is a derating for turbulence, product variability, and other performance influencing factors. Use 0.1 (10%) - 0.15 (15%) is most cases. Setting this factor to 0% will over-predict performance for most situations.

Results: **Hub Average Wind Speed** is corrected for wind shear and used to calculate the Weibull wind speed probability. **Air Density Factor** is the reduction from sea level performance. **Average Power Output** is the average continuous equivalent output of the turbine. **Daily Energy Output** is the average energy produced per day. **Annual** and **Monthly Energy Outputs** are calculated using the Daily value. **Percent Operating Time** is the time the turbine should be producing some power.

Limitations: This model uses a mathmatical idealization of the wind speed probability. The validity of this assumption is reduced as the time period under consideration (ie, the wind speed averaging period) is reduced. This model is best used with annual or monthly average wind speeds. Use of this model with daily or hourly average wind speed data is not recommended because the wind will not follow a Weibull distribution over short periods. Consult Bergey Windpower Co. for special needs. ***Your performance may vary.***

Typical Cost Estimate for 10kW Bergey on a 100' Guyed Lattice Tower, Itemized System Costs			
	Cost		
10kW turbine w/ UL listed Gridtek 10 inverter (model BWC Excel-S/60)	24,750.00		
100 ft Guyed Lattice Tower (model XLG37)	9,200.00		
Wiring kit for tower (model XTWK37)	1,000.00		
Bergey Purchase Subtotal	**34,950.00**		
Foundation materials, equipment & labor	4,000.00		
Wire/conduit/electrical supplies	1,750.00		
Trenching equipment & labor for wire run	1,950.00		
Crane	2,000.00		
Permitting, Applications, Installation, 5 yr. Warranty	5,000.00		
Freight	1,780.00		
Total Installed Cost	**51,430.00**		
NYSERDA Buy Down Rate	50%		
Total after NYSERDA buy down	**$ 25,715**		

BWC 10 kW GridTek System Cash Flow

Prepared for: **Chateaguay Hatchery**
Date: **3/17/2016**

Assumptions (Inputs)

Total Installed Cost ($):	$51,430
Allocation to Business (%):	0
Annual Energy Output (kWh):	11,200
Electricity Cost ($/kWh):	$0.1120
Electricity Inflation Rate (%):	5
Down Payment (%):	100
Down Payment ($):	$25,715
Amount of Loan ($):	$0
Interest Rate (%):	2
Loan Term (Years):	10
Month Installed:	0
Net Federal Tax Rate (%):	25
Net State Tax Rate (%):	8
O & M Cost ($/kWh):	$0.017
O & M Inflation Rate (%):	3
State Rebate (%):	50
State Tax Credit (%):	0
Federal Tax Credit (%):	0

Results

Loan Payments

Monthly Payment ($):	$0
Value of Interest Deduction ($):	$0
Net Monthly Payment ($):	$0

Ave. Monthly Savings on Bill

Year 1 ($):	$105
Year 10 ($):	$170
Year 20 ($):	$277
Year 30 ($):	$452

Internal Rate of Retrurn

Years 1 - 30:	6.5%

Annual Cash Flow Model

Year	Net Energy	O&M Costs	Net Deprec.	Net Loan Payments	Annual Cash Flow	Total Cash Flow
0					($25,715)	($25,715)
1	$1,254	$0	$0	$0	$1,254	($24,461)
2	$1,317	($196)	$0	$0	$1,121	($23,340)
3	$1,383	($202)	$0	$0	$1,181	($22,159)
4	$1,452	($208)	$0	$0	$1,244	($20,915)
5	$1,525	($214)	$0	$0	$1,310	($19,604)
6	$1,601	($221)	$0	$0	$1,380	($18,224)
7	$1,681	($227)	$0	$0	$1,454	($16,770)
8	$1,765	($234)	$0	$0	$1,531	($15,239)
9	$1,853	($241)	$0	$0	$1,612	($13,627)
10	$1,946	($248)	$0	$0	$1,698	($11,930)
11	$2,043	($256)	$0	$0	$1,787	($10,142)
12	$2,145	($264)	$0	$0	$1,882	($8,260)
13	$2,253	($271)	$0	$0	$1,981	($6,279)
14	$2,365	($280)	$0	$0	$2,086	($4,193)
15	$2,484	($288)	$0	$0	$2,196	($1,998)
16	$2,608	($297)	$0	$0	$2,311	$313
17	$2,738	($306)	$0	$0	$2,433	$2,746
18	$2,875	($315)	$0	$0	$2,560	$5,307
19	$3,019	($324)	$0	$0	$2,695	$8,001
20	$3,170	($334)	$0	$0	$2,836	$10,837
21	$3,328	($344)	$0	$0	$2,984	$13,822
22	$3,495	($354)	$0	$0	$3,141	$16,962
23	$3,669	($365)	$0	$0	$3,305	$20,267
24	$3,853	($376)	$0	$0	$3,477	$23,744
25	$4,046	($387)	$0	$0	$3,659	$27,402
26	$4,248	($399)	$0	$0	$3,849	$31,252
27	$4,460	($411)	$0	$0	$4,050	$35,301
28	$4,683	($423)	$0	$0	$4,260	$39,562
29	$4,917	($436)	$0	$0	$4,482	$44,043
30	$5,163	($449)	$0	$0	$4,715	$48,758

Conservative assumption of no scrap value after 30 years.

WindCad Turbine Performance Model

BWC EXCEL-S, Grid - Intertie

Prepared For: **Chateaguay Hatchery**
Site Location: **Chateaguay, NY**
Data Source: **TrueWind NY wind map**
Date: **3/17/2016**

10 kW

Inputs:	
Ave. Wind (m/s) =	5.6
Weibull K =	1.927
Site Altitude (m) =	295
Wind Shear Exp. =	0.180
Anem. Height (m) =	30
Tower Height (m) =	27
Turbulence Factor =	20.0%

Results:	
Hub Average Wind Speed (m/s) =	5.49
Air Density Factor =	-3%
Average Output Power (kW) =	1.46
Daily Energy Output (kWh) =	35.2
Annual Energy Output (kWh) =	**12,831**
Monthly Energy Output =	1,069
Percent Operating Time =	71.6%

0.392
wind speed less 7%
5.208

Weibull Performance Calculations

Wind Speed Bin (m/s)	Power (kW)	Wind Probability (f)	Net kW @ V
1	0.00	5.60%	0.000
2	0.00	9.80%	0.000
3	0.00	12.46%	0.000
4	0.19	13.53%	0.026
5	0.62	13.19%	0.082
6	1.28	11.80%	0.152
7	1.98	9.81%	0.195
8	2.84	7.64%	0.217
9	3.77	5.60%	0.211
10	4.79	3.88%	0.186
11	5.84	2.54%	0.148
12	7.01	1.58%	0.111
13	7.39	0.93%	0.069
14	7.78	0.53%	0.041
15	6.23	0.28%	0.018
16	4.67	0.14%	0.007
17	2.10	0.07%	0.001
18	2.34	0.03%	0.001
19	2.34	0.01%	0.000
20	2.34	0.01%	0.000
1997, Bergey Windpower	Totals:	99.44%	1.465

Weibull Calculations:
Wind speed probability is calculated as a Weibull curve defined by the average wind speed and a shape factor, K. To facilitate piece-wise integration, the wind speed range is broken down into "bins" of 1 m/s in width (Column 1). For each wind speed bin, instantaneous wind turbine power (W, Column 2)) is multiplied by the Weibull wind speed probability (f, Column 3). This cross product (Net W, Column 4) is the contribution to average turbine power output contributed by wind speeds in that bin. The sum of these contributions is the average power output of the turbine on a continuous, 24 hour, basis. Best results are achieved using annual or monthly average wind speeds. Use of daily or hourly average speeds is not

Instructions:

Inputs: Use annual or monthly **Average Wind** speeds. If **Weibull K** is not known, use K = 2 for inland sites, use 3 for coastal sites, and use 4 for island sites and trade wind regimes. **Site Altitude** is meters above sea level. **Wind Shear Exponent** is best assumed as "1/7" or 0.143. For rough terrain or high turbulence use 0.18. For very smooth terrain or open water use 0.110. **Anemometer Height** is for the data used for the **Average Wind** speed. If unknown, use 10 meters. **Tower Height** is the nominal height, eg.: 24 meters. **Turbulence Factor** is a derating for turbulence, product variability, and other performance influencing factors. Use 0.1 (10%) - 0.15 (15%) is most cases. Setting this factor to 0% will over-predict performance for most situations.

Results: **Hub Average Wind Speed** is corrected for wind shear and used to calculate the Weibull wind speed probability. **Air Density Factor** is the reduction from sea level performance. **Average Power Output** is the average continuous equivalent output of the turbine. **Daily Energy Output** is the average energy produced per day. **Annual** and **Monthly Energy Outputs** are calculated using the Daily value. **Percent Operating Time** is the time the turbine should be producing some power.

Limitations: This model uses a mathmatical idealization of the wind speed probability. The validity of this assumption is reduced as the time period under consideration (ie, the wind speed averaging period) is reduced. This model is best used with annual or monthly average wind speeds. Use of this model with daily or hourly average wind speed data is not recommended because the wind will not follow a Weibull distribution over short periods. Consult Bergey Windpower Co. for special needs. ***Your performance may vary.***

Typcial Cost Estimate for 10kW Bergey on a 120' Guyed Lattice Tower, Itemized System Costs			
	Cost		
10kW turbine w/ UL listed Gridtek 10 inverter (model BWC Excel-S/60)	24,750.00		
120 ft Guyed Lattice Tower (model XLG37)	10,850.00		
Wiring kit for tower (model XTWK37)	1,070.00		
Bergey Purchase Subtotal	**36,670.00**		
Foundation materials, equipment & labor	4,000.00		
Wire/conduit/electrical supplies	1,750.00		
Trenching equipment & labor for wire run	1,950.00		
Crane	2,000.00		
Permitting, Applications, Installation, 5 yr. Warranty	5,000.00		
Freight	1,780.00		
Total Installed Cost	**53,150.00**		
NYSERDA Buy Down Rate	50%		
Total after NYSERDA buy down	**$ 26,575**		

BWC 10 kW GridTek System Cash Flow

Prepared for: **Chateaguay Hatchery**
Date: **3/17/2016**

Assumptions (Inputs)

Total Installed Cost ($):	$53,150
Allocation to Business (%):	0
Annual Energy Output (kWh):	12,800
Electricity Cost ($/kWh):	$0.1120
Electricity Inflation Rate (%):	5
Down Payment (%):	100
Down Payment ($):	$26,575
Amount of Loan ($):	$0
Interest Rate (%):	2
Loan Term (Years):	10
Month Installed:	0
Net Federal Tax Rate (%):	25
Net State Tax Rate (%):	8
O & M Cost ($/kWh):	$0.015
O & M Inflation Rate (%):	3
State Rebate (%):	50
State Tax Credit (%):	0
Federal Tax Credit (%):	0

Results

Loan Payments

Monthly Payment ($):	$0
Value of Interest Deduction ($):	$0
Net Monthly Payment ($):	$0

Ave. Monthly Savings on Bill

Year 1 ($):	$119
Year 10 ($):	$195
Year 20 ($):	$317
Year 30 ($):	$516

Internal Rate of Retrurn

Years 1 - 30:	7.4%

Annual Cash Flow Model

Year	Net Energy	O&M Costs	Net Deprec.	Net Loan Payments	Annual Cash Flow	Total Cash Flow
0					($26,575)	($26,575)
1	$1,434	$0	$0	$0	$1,434	($25,141)
2	$1,505	($198)	$0	$0	$1,308	($23,834)
3	$1,581	($204)	$0	$0	$1,377	($22,457)
4	$1,660	($210)	$0	$0	$1,450	($21,007)
5	$1,743	($216)	$0	$0	$1,526	($19,481)
6	$1,830	($223)	$0	$0	$1,607	($17,874)
7	$1,921	($229)	$0	$0	$1,692	($16,182)
8	$2,017	($236)	$0	$0	$1,781	($14,401)
9	$2,118	($243)	$0	$0	$1,875	($12,526)
10	$2,224	($251)	$0	$0	$1,973	($10,552)
11	$2,335	($258)	$0	$0	$2,077	($8,475)
12	$2,452	($266)	$0	$0	$2,186	($6,289)
13	$2,575	($274)	$0	$0	$2,301	($3,988)
14	$2,703	($282)	$0	$0	$2,421	($1,567)
15	$2,838	($290)	$0	$0	$2,548	$981
16	$2,980	($299)	$0	$0	$2,681	$3,662
17	$3,129	($308)	$0	$0	$2,821	$6,484
18	$3,286	($317)	$0	$0	$2,968	$9,452
19	$3,450	($327)	$0	$0	$3,123	$12,575
20	$3,623	($337)	$0	$0	$3,286	$15,861
21	$3,804	($347)	$0	$0	$3,457	$19,318
22	$3,994	($357)	$0	$0	$3,637	$22,955
23	$4,194	($368)	$0	$0	$3,826	$26,781
24	$4,403	($379)	$0	$0	$4,024	$30,805
25	$4,624	($390)	$0	$0	$4,233	$35,038
26	$4,855	($402)	$0	$0	$4,453	$39,491
27	$5,097	($414)	$0	$0	$4,683	$44,174
28	$5,352	($426)	$0	$0	$4,926	$49,100
29	$5,620	($439)	$0	$0	$5,181	$54,281
30	$5,901	($452)	$0	$0	$5,448	$59,729

Conservative assumption of no scrap value after 30 years.