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May 29, 2010

Mr. Steve Dever
Executive Director
Energy Development Task Force
Cuyahoga County Dept. of Development
112 Hamilton Ave. 4th Floor
Cleveland, Ohio 44114

SUBJECT: **Great Lakes Wind Energy Pilot Project**

Dear Steve,

We have traded e-mail regarding the Great Lakes Wind Energy Pilot Project and I sent you a letter dated March 31, 2010, based on the Final Feasibility Report issued last year. Subsequently, last week, it was announced that the Lake Erie Energy Development Corp. (LEEDCO) has signed a memorandum of understanding with GE to procure five 4MW offshore wind turbines; GE model 4.0-110. Accordingly, I am revising and re-presenting my analysis and observations as follows.

Average Annual Wind Speed at the Site(s)	7.5 m/s (per Feasibility Report & Wind Maps)
Average Annual Power Density at the Site(s)	500 W/m^2
Best Average Annual Power Density on Lake Erie	800 W/m^2 *
Wholesale Price of Electricity	$50 / MWh [$0.05 / KWh)

* Max power density in middle of lake (probably in Canada) per wind maps
* In various places in the Feasibility Report a retail price of $100 / MWh is used, but I believe $50 / MWh is closer to the average wholesale price in Ohio for 2009 & 2010, based on a quick look at information on the DOE- Energy Information Administration website.

To continue the analysis, it is necessary to have a power curve for the GE 4.0-110 wind turbines. I have been unable to find the curve in the technical data published by GE, I have inquired with GE technical support via their website, and I have asked you for this information; but so far no one has been able to provide it. It seems odd to me that we would be agreeing to spend $100 million for wind turbine power generators, yet a power curve to tell us how much electricity the turbines will generate is not immediately available. In the interest of proceeding, however, it is not very difficult for me to produce what I believe to be a very good estimate of the power curve, based on available information and basic knowledge of wind power generation. The remainder of my analysis is based in part on my assumptions regarding the power curve for the GE 4.0-110 offshore wind turbines presented in the attachments on page 5.

	Five 4.0-110 GE Turbines
Approximate Capital Investment	$100,000,000
Rotor Diameter = D	110 m
Rotor Swept Area (per GE specifications)	9567 m^2
Power Output at 7.5 m/s **(per my assumed power curve on page 5)**	< 1000 KW
Uptime (assumption based on Feasibility Report for 5MW Repower units)	7,260 hrs
Annual Energy Output per turbine	7,260,000 KWh / year (7,260 MWh / year)
Total Annual Energy Output for 5 turbines	36,300 MWh / year
Annual Revenue (at $50 / MWh)	$1,815,000 / year
Annual O&M Costs (extrapolation based on Feasibility Report)	$3,000,000 / year

As discussed in my previous letter, a simple cash flow analysis (see following pages) is bleak. Not only can the turbines not pay off the investment, they actually compound the losses over their 20 year lifespan. If one employs the more generous rate of $100 / MWh, the losses do not compound, but 64% of the investment is still left unpaid after 20 years.

Additional points to be noted are:

- My analysis does not consider the effects of ice, which will further detrimentally affect output and raise maintenance costs.
- My analysis does not account for the cost that will be incurred to maintain and operate a traditional back-up system for generating power when the wind is not blowing adequately, and for the added cost and inefficiency of cycling this back-up system on and off to balance the supply load against the variability of the wind generated power.
- The lowest wind conditions (at or under 6.0 m/s) and the lowest outputs, will occur in the summer when the electricity demand is highest. Please refer to the chart in the following pages.
- The best power density, 800 W/m^2, is out in the middle of the Lake (probably in Canada). Locating there would improve output by only a factor of 1.6, and at the same time would undoubtedly increase installation and O&M costs.
- Given the available 500 W/m^2 power density at the site, the GE turbine will generate 7,260 MWh out of a theoretically available 41,903 MWh/yr (17%). Assuming that as yet unknown and quite miraculous technology improvements implemented in the future are somehow able to triple this efficiency to 50%, without increasing investment or O&M costs; the GE turbines still do not pay off the projected investment within their 20 year lifespan. Please refer to cash flow with future improvement factor of 3 times, attached on page 8.
- It continues to be disconcerting that a large portion of the Feasibility Study and the on-going discussion is devoted to proposals to make the project appear viable with public spending and artificially inflated electricity prices. I can point to the situation currently in progress in Massachusetts, where National Grid has been induced to sign an agreement to pay 4 times the current wholesale price for electricity from the Cape Wind project. Presumably, something similar can be expected in Ohio.

The evidence continues to indicate to me that the business case for this Pilot Project is a losing proposition. Without huge public intervention in the form of subsidies, grants, incentives, and artificially inflated electricity prices, the project can not be viable. Also, the evidence still indicates to me that the long term outlook for implementation of wind power generation in Ohio and/or on Lake Erie is similarly dismal. Even with larger systems and as yet unknown vast improvements in technology, I do not see how one can realistically expect the business case to improve to the point of true viability. I believe our dollars being devoted to improving our energy strategy can be better spent in other ways.

Once again, I would like to see my concerns and observations addressed at the EDTF meetings, and would like an answer to the basic question, “Why is this wind energy project continuing?” If I have made an error in my observations or am failing to consider pertinent facts, I would appreciate further information and an open discussion.

Thank you again for your consideration.

Sincerely,

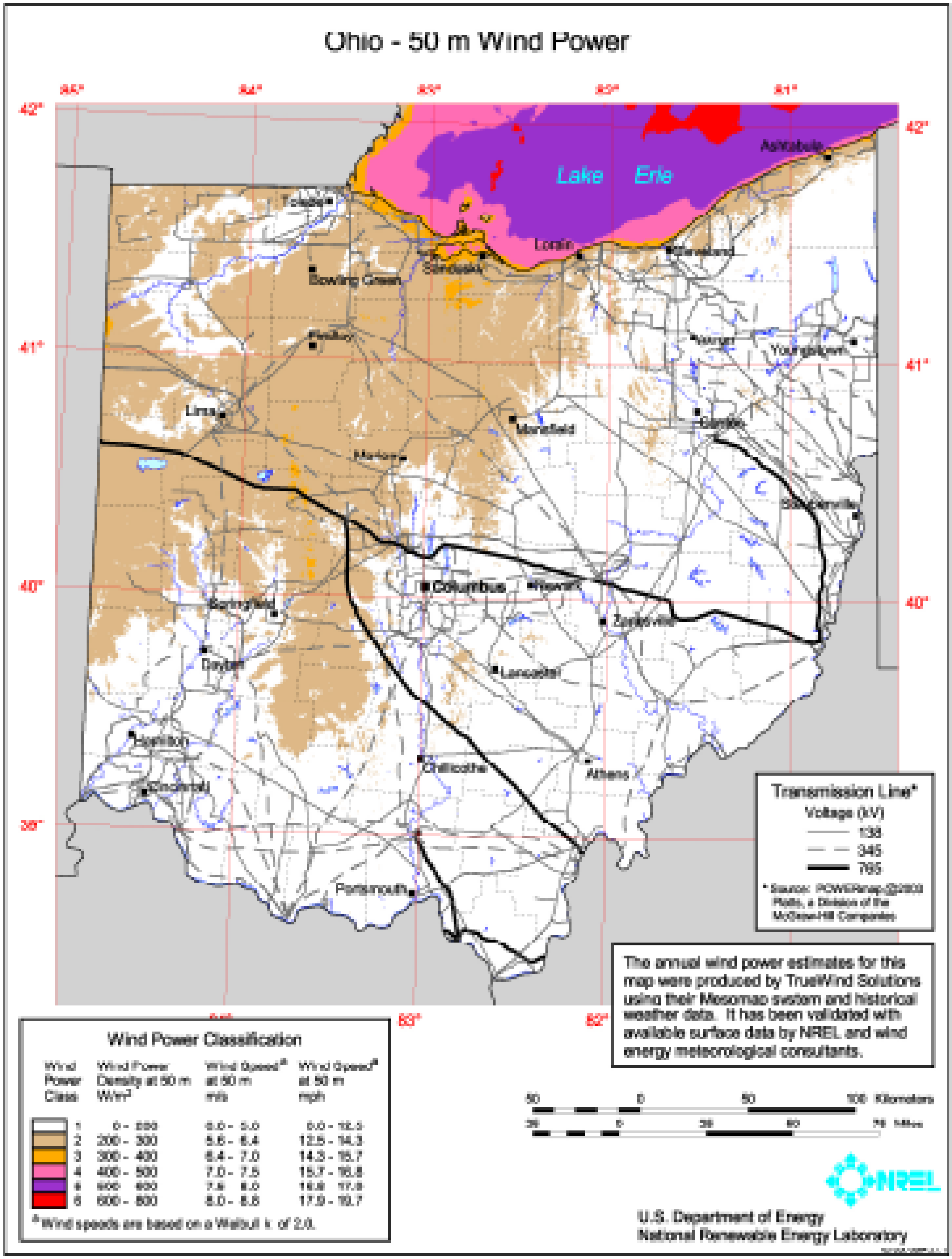
Jerry A. Graf

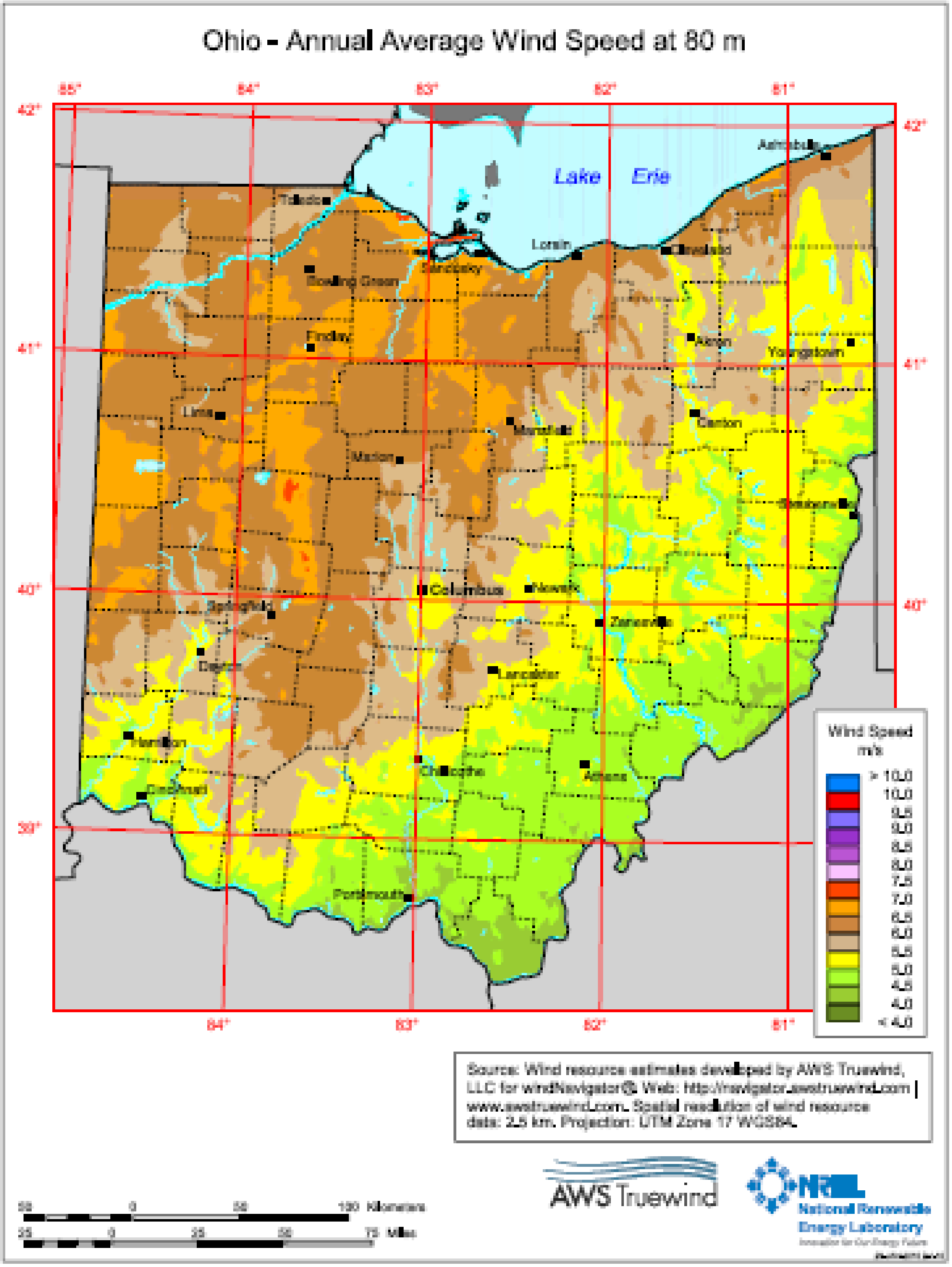
Cc:

Gregory Zucca – Strategic Prog. Officer
Paul Oyaski – Director of Dept. of Development
Ted Strickland – Governor of Ohio
Lisa Patt-McDaniel – Director of ODOD
Bill Harris – President of the Ohio Senate
Armond Budish – Speaker of the Ohio House
Betty Blair – Lorain County Commissioner
Lori Kokoski - Lorain County Commissioner
Ted Kalo - Lorain County Commissioner
Jim Dimora – Cuyahoga County Commissioner
Tim Hagan - Cuyahoga County Commissioner
Peter Lawson Jones - Cuyahoga County Commissioner

Bob Downing – Akron Beacon Journal
Susan Ketchum – Sun News
Randy Roguski – Cleveland Plain Dealer
Elizabeth Sullivan – Cleveland Plain Dealer
Todd Franko – Youngstown Vindicator
Joe Hallet – Columbus Dispatch
John Funk – Cleveland Plain Dealer
Tom Stacy – SaveWesternOhio,.org
Jim Quinn – Clear Channel Radio
Dr. Celal Batur – Univ. of Akron ME Dept.
Ellen Kolman – Star Beacon
Neil Freider – Star Beacon

Attachments:


Ohio - 50 m Wind Power
42°
41°
40°
39°
Lake Erie
Ashtabula
Toledo
Lorain
Cleveland
Sandusky
Bowling Green
Findlay
Akron
Youngstown
Lima
Mansfield
Canton
Marion
Steubenville
Columbus
Newark
Springfield
Zanesville
Dayton
Lancaster
Hamilton
Chillicothe
Athens
Cincinnati
Portsmouth
83°
82°
Transmission Line*
Voltage (kV)
138
345
765
* Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies
The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Power Classification
Wind Power Class
Wind Power Density at 50 m W/m²
Wind Speed at 50 m m/s
Wind Speed at 50 m mph
1 0 - 200 0.0 - 5.6 0.0 - 12.5
2 200 - 300 5.6 - 6.4 12.5 - 14.3
3 300 - 400 6.4 - 7.0 14.3 - 15.7
4 400 - 500 7.0 - 7.5 15.7 - 16.8
5 500 - 600 7.5 - 8.0 16.8 - 17.9
6 600 - 800 8.0 - 8.8 17.9 - 19.7
Wind speeds are based on a Weibull k of 2.0.
50 0 50 100 Kilometers
0 30 60 Miles
NREL
U.S. Department of Energy
National Renewable Energy Laboratory


Ohio - Annual Average Wind Speed at 80 m
Lake Erie
Ashtabula
Toledo
Lorain
Cleveland
Sandusky
Bowling Green
Findlay
Akron
Youngstown
Lima
Canton
Mansfield
Marion
Steubenville
Columbus
Newark
Springfield
Zanesville
Dayton
Lancaster
Hamilton
Chillicothe
Athens
Cincinnati
Portsmouth
Wind Speed m/s
> 10.0
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0
Source: Wind resource estimates developed by AWS Truewind, LLC for windNavigator®. Web: http://navigator.awstruewind.com | www.awstruewind.com. Spatial resolution of wind resource data: 2.5 km. Projection: UTM Zone 17 WGS84.
AWS Truewind
NREL
National Renewable Energy Laboratory
Kilometers
Miles

GE 4.0-110 Offshore Wind Turbine - Power Curve Assumption

Basic assumptions

Cubic curve: $P = K * V^3$

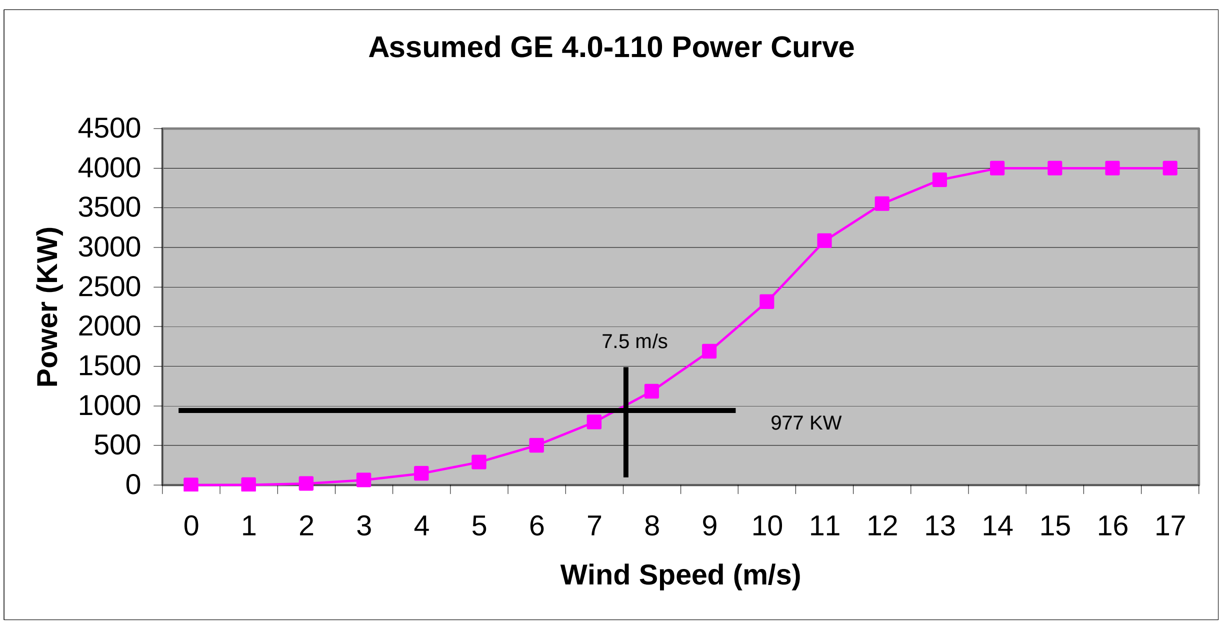
Assume K so that peak power is obtained at 12 m/s rather than 14 m/s

$$K = 4000 \text{ KW} / (12 \text{ m/s})^3 = 2.315 \text{ KW*s}^3/\text{m}^3$$

Set rated power output of 4000 KW at 14 m/s per manufacturer's specification

Extrapolate values at 12 m/s and 13 m/s to smooth the curve

V Wind Velocity (m/s)	P Power Output (KW)	K	
0	0	2.315	
1	2	2.315	
2	19	2.315	
3	63	2.315	
4	148	2.315	
5	289	2.315	Cubic Curve
6	500	2.315	$P = K * V^3$ where K=2.315
7	794	2.315	
8	1185	2.315	
9	1688	2.315	
10	2315	2.315	
11	3081	2.315	
12	3550		extrapolated value to smooth curve
13	3850		extrapolated value to smooth curve
14	4000		rated 4000 KW at 14 m/s
15	4000		
16	4000		
17	4000		



4.0-110 GE Offshore Wind Turbines (5 total turbines)
Wind speed 7.5 m/s
Power Density 500 W/m^2

Annual Energy Production	*input*	36,300	MWh
Value of Electricity	*input*	$50	per MWh
Annual Inflation Rate	*input*	2.5%	
1st Year Revenue		$1,815,000	
1st Year Maint & Oper Cost	*input*	($3,000,000)	

Year	Inflation Factor	Revenue	Maint & Ops	Cash Flow
0				($100,000,000)
1		$1,815,000	($3,000,000)	($101,185,000)
2	1.025	$1,860,375	($3,000,000)	($102,324,625)
3	1.025	$1,906,884	($3,000,000)	($103,417,741)
4	1.025	$1,954,556	($3,000,000)	($104,463,184)
5	1.025	$2,003,420	($3,000,000)	($105,459,764)
6	1.025	$2,053,506	($3,000,000)	($106,406,258)
7	1.025	$2,104,844	($3,000,000)	($107,301,414)
8	1.025	$2,157,465	($3,000,000)	($108,143,950)
9	1.025	$2,211,401	($3,000,000)	($108,932,548)
10	1.025	$2,266,686	($3,000,000)	($109,665,862)
11	1.025	$2,323,353	($3,000,000)	($110,342,509)
12	1.025	$2,381,437	($3,000,000)	($110,961,071)
13	1.025	$2,440,973	($3,000,000)	($111,520,098)
14	1.025	$2,501,998	($3,000,000)	($112,018,101)
15	1.025	$2,564,547	($3,000,000)	($112,453,553)
16	1.025	$2,628,661	($3,000,000)	($112,824,892)
17	1.025	$2,694,378	($3,000,000)	($113,130,514)
18	1.025	$2,761,737	($3,000,000)	($113,368,777)
19	1.025	$2,830,781	($3,000,000)	($113,537,997)
20	1.025	$2,901,550	($3,000,000)	($113,636,446)
21	1.025	$2,974,089	($3,000,000)	($113,662,358)

4.0-110 GE Offshore Wind Turbines (5 total turbines)
Wind speed 7.5 m/s
Power Density 500 W/m^2

Annual Energy Production	*input*	36,300	MWh
Value of Electricity	*input*	$100	per MWh
Annual Inflation Rate	*input*	2.5%	
1st Year Revenue		$3,630,000	
1st Year Maint & Oper Cost	*input*	($3,000,000)	

Year	Inflation Factor	Revenue	Maint & Ops	Cash Flow
0				($100,000,000)
1		$3,630,000	($3,000,000)	($99,370,000)
2	1.025	$3,720,750	($3,000,000)	($98,649,250)
3	1.025	$3,813,769	($3,000,000)	($97,835,481)
4	1.025	$3,909,113	($3,000,000)	($96,926,368)
5	1.025	$4,006,841	($3,000,000)	($95,919,527)
6	1.025	$4,107,012	($3,000,000)	($94,812,516)
7	1.025	$4,209,687	($3,000,000)	($93,602,829)
8	1.025	$4,314,929	($3,000,000)	($92,287,899)
9	1.025	$4,422,803	($3,000,000)	($90,865,097)
10	1.025	$4,533,373	($3,000,000)	($89,331,724)
11	1.025	$4,646,707	($3,000,000)	($87,685,017)
12	1.025	$4,762,875	($3,000,000)	($85,922,143)
13	1.025	$4,881,946	($3,000,000)	($84,040,196)
14	1.025	$5,003,995	($3,000,000)	($82,036,201)
15	1.025	$5,129,095	($3,000,000)	($79,907,106)
16	1.025	$5,257,322	($3,000,000)	($77,649,784)
17	1.025	$5,388,755	($3,000,000)	($75,261,028)
18	1.025	$5,523,474	($3,000,000)	($72,737,554)
19	1.025	$5,661,561	($3,000,000)	($70,075,993)
20	1.025	$5,803,100	($3,000,000)	($67,272,893)
21	1.025	$5,948,178	($3,000,000)	($64,324,715)

4.0-110 GE Offshore Wind Turbines (5 total turbines)
Wind speed 7.5 m/s
Power Density 500 W/m^2

Annual Energy Production	*input*	36,300	MWh
Future Improvement Factor	*input*	3	
Future Annual Energy Production		108,900	MWh
Value of Electricity	*input*	$50	per MWh
Annual Inflation Rate	*input*	2.5%	
1st Year Revenue		$5,445,000	
1st Year Maint & Oper Cost	*input*	($3,000,000)	

Year	Inflation Factor	Revenue	Maint & Ops	Cash Flow
0				($100,000,000)
1		$5,445,000	($3,000,000)	($97,555,000)
2	1.025	$5,581,125	($3,000,000)	($94,973,875)
3	1.025	$5,720,653	($3,000,000)	($92,253,222)
4	1.025	$5,863,669	($3,000,000)	($89,389,552)
5	1.025	$6,010,261	($3,000,000)	($86,379,291)
6	1.025	$6,160,518	($3,000,000)	($83,218,774)
7	1.025	$6,314,531	($3,000,000)	($79,904,243)
8	1.025	$6,472,394	($3,000,000)	($76,431,849)
9	1.025	$6,634,204	($3,000,000)	($72,797,645)
10	1.025	$6,800,059	($3,000,000)	($68,997,586)
11	1.025	$6,970,060	($3,000,000)	($65,027,526)
12	1.025	$7,144,312	($3,000,000)	($60,883,214)
13	1.025	$7,322,920	($3,000,000)	($56,560,294)
14	1.025	$7,505,993	($3,000,000)	($52,054,302)
15	1.025	$7,693,642	($3,000,000)	($47,360,659)
16	1.025	$7,885,984	($3,000,000)	($42,474,676)
17	1.025	$8,083,133	($3,000,000)	($37,391,543)
18	1.025	$8,285,211	($3,000,000)	($32,106,331)
19	1.025	$8,492,342	($3,000,000)	($26,613,990)
20	1.025	$8,704,650	($3,000,000)	($20,909,339)
21	1.025	$8,922,267	($3,000,000)	($14,987,073)

Monthly Wind Speed Chart taken from Final Feasibility Report

Figure 4-5: Monthly average wind speeds for 50 m anemometers A5 and A6*