ESTIMATED ENERGY PRODUCTION AND ECONOMICS FOR A LARGE WIND TURBINE GENERATOR INSTALLED AT THE IPSWICH MUNICIPAL LIGHT DEPARTMENT SITE IN IPSWICH, MASSACHUSETTS

Prepared For: **Meridian Associates, Inc.**
152 Conant Road
Beverly, MA 01915
and

Ipswich Municipal Light Department
Ipswich, MA
and

Ipswich School Department
Ipswich, MA

Prepared By: **William A. Vachon**
W. A. Vachon & Associates, Inc.
Manchester, MA 01944
Tel: (978) 526-4315
Fax: (978) 526-8180
wavachon@aol.com

March 2008

NOTICE

Working on a subcontract basis to Meridian Associates, Inc., this report was prepared by W. A. Vachon & Associates, Inc. for use by Meridian Associates, Inc. (MAI) and the Town of Ipswich, Massachusetts. The report summarizes our findings from our evaluation of the wind resource, energy production potential, revenue generation, and economics for a large wind turbine generator (WTG) that could potentially be installed on a plot of land at the end of Town Farm Road in Ipswich, Massachusetts. The land is owned by the Town of Ipswich. The power generated from the WTG will be shared between the Ipswich Municipal Light Department (the provider of electricity to the town), the Ipswich Middle/High School, and other Town of Ipswich buildings.

Even though wind energy technology has been under development for more than a decade, and thousands of wind turbines have operated for several years, there is still a great deal that is unknown about evaluating wind resources, wind turbines, the loads induced on wind turbines by the dynamics in winds, how to control loads, long-term wear factors, and operation and maintenance costs.

The work presented in this report represents our best efforts and judgments based on the best information available at the time that we prepared this report. Any use which is made of this report by third parties is solely their responsibility for damages that may be sustained by such third parties as a consequence of their reliance on the information and opinions that we have provided herein.

ESTIMATED ENERGY PRODUCTION AND ECONOMICS FOR A WIND TURBINE GENERATOR INSTALLED AT THE IPSWICH MUNICIPAL LIGHT DEPARTMENT SITE IN IPSWICH, MASSACHUSETTS

TABLE OF CONTENTS

Section	Description	Page
1.	EXECUTIVE SUMMARY	1
2.	INTRODUCTION	4
2.1.	Background	4
2.2.	Focus of This Report	5
3.	SITE WIND RESOURCE ANALYSIS	5
3.1.	Site Location	5
3.2.	Historical, Measured Wind Data	6
3.2.1.	Mean Annual Average Wind Speeds at WTG Hub Height	6
3.2.2.	Wind Directional Distribution	11
3.2.3.	Turbulence and Peak Wind Speed	13
3.3.	Obstructions and Wakes	12
4.	DESCRIPTION OF CANDIDATE WIND TURBINE GENERATOR (WTG)	13
4.1.	Introduction	13
4.2.	Candidate Wind Turbine	13
4.2.1.	WTG Selection.	13
4.2.2.	WTG Description	14
5.	WTG ENERGY PRODUCTION	16
5.1.	General Description of WTG Energy Capture	16
5.2.	Total Net Annual Energy Production	20
5.3.	WTG Hourly Average Output	20
6.	ECONMOMIC ANALYSIS	22
6.1.	Value of WTG Power to IMLD and the Ipswich School District (ISD)	22
6.2.	Annual Income from WTG Production (50^{th} Percentile Projection)	24
6.3.	WTG Long-Term Operation and Maintenance (O&M) Costs	25
7.	SUMMARY OF ECONOMIC PROJECTIONS	34
8.	CONCLUSIONS	34
9.	RECOMMENDATIONS	37

Appendices

Appendix	Description	Page
A .	Summary of Wind Data Measured at Ipswich Site by UMass......	A-1 thru A-8
B.	Logan Airport Wind Speed Measurements (for correlation and scaling to a long-term average).....................	B-1
C.	IMLD On-Peak and Off-Peak Monthly Schedule......................................	B-1

LIST OF FIGURES

Figure	Contents	Page
3-1.	Map of Northern Portion of Ipswich and Proposed Wind Project Site...	5
3-2.	Wind Speed Frequency Distributions for Ipswich Site on Town Farm Road, Alpha = 0.23...	9
3-3.	Calculated Monthly Average Wind Speeds at Ipswich, Town Farm Road Site, 60 and 80-m Heights..	10
5-1.	Output Power Curve of GE Model 1.5sle WTG (kW at Sea Level Air Density)..	17
6-1.	Historical Retail Electricity Costs for Ipswich Middle-High School, $/MWh..	23

LIST OF TABLES

Table	Contents	Page
1-1.	Summary of Wind Speeds and Energy Production from 1.5-MW, 77-m diameter, GE WTG at Town Farm Road Site............	2
1-2.	Estimated Net Year-1 Income from Wind Power for Each Entity......	2
1-3.	Summary of Net Revenue Projections for Each Entity for Nominal Ownership Cases Studied...	2
3-1.	Wind Speed Frequency Distribution for Alpha =0.23............................	9
3-2.	Mean Hourly Wind Speeds, 60-m Hub Height......................................	11
3-3.	Mean Hourly Wind Speeds, 80-m Hub Height......................................	12
5.2.	Output of GE Wind Model 1.5sle, 1.5-MW WTG, 60-m Hub Height....	18
5-3.	Output of GE Wind Model 1.5sle, 1.5-MW WTG, 80-m Hub Height....	19
5-4.	Estimated Hourly WTG Output, 60-m Hub Height................................	21
5-5.	Estimated Hourly WTG Output, 80-m Hub Height................................	21
6-1.	Estimated Costs for IMLD Purchased Power Based on MMWEC Projections Thru June 2009..	22

LIST OF TABLES (Continued)

Table	Contents	Page
6-2.	IMLD Projected Average Monthly Costs for Purchased Power in 2010, $/MWh	23
6-3.	Ipswich Municipal Light Department Time-of-Use Periods	23
6-4.	ISD Electrical Consumption, Average Costs and Premium Paid Vs. IMLD Costs in 2007	24
6-5.	Estimated Avg. Monthly ISD Electricity Rates in Year 2010, $/MWh	24
6-6.	Projected Average Cost of Power for IMLD Based on On-Peak and Off-Peak Schedule and Costs	26
6-7.	Projected Average Cost of Power for ISD Based on IMLD Rate + Premium	27
6-8.	Total Value of Wind-Generated Power to IMLD By Monthly Time Block for Typical Day (60-m Hub Height), $	28
6-9.	Total Value of Wind-Generated Power to ISD By Monthly Time Block for Typical Day (60-m Hub Height), $	29
6-10.	Total Value of Wind-Generated Power to IMLD By Monthly Time Block for Typical Day (80-m Hub Height), $	30
6-11.	Total Value of Wind-Generated Power to ISD By Monthly Time Block for Typical Day (80-m Hub Height), $	31
6-12.	Summary of Annual Gross Revenue Projections for Range of Expected WTG Ownership by IMLD and ISD	32
6-13.	O&M Cost Projections by Year for Single GE Model 1.5sle, 60-m Hub Height WTG (with 5-year warranty)	33
6-14.	O&M Cost Projections by Year for Single GE Model 1.5sle, 80-m Hub Height WTG (with 5-year warranty)	34
7-1.	Summary of 20-Year Cash Flows for Joint IMLD-ISD Wind Power Project on Town Farm Road (60-m Hub Height)	35
7-2.	Summary of 20-Year Cash Flows for Joint IMLD-ISD Wind Power Project on Town Farm Road (80-m Hub Height)	36

ESTIMATED ENERGY PRODUCTION AND ECONOMICS FOR A WIND TURBINE GENERATOR INSTALLED AT THE IPSWICH MUNICIPAL LIGHT DEPARTMENT SITE IN IPSWICH, MASSACHUSETTS

Prepared By: William A. Vachon
W. A. Vachon & Associates, Inc.
Manchester, MA 01944
(978) 526-4315
wavachon@aol.com

March 2008

1. EXECUTIVE SUMMARY

Introduction. This report is a follow-up to a study originally conducted in year 2005 in which we analyzed of the economics of the Ipswich Municipal Light Department (IMLD) purchasing a single large, electricity-producing wind turbine generator (WTG) and locating at the end of Town Farm Road in Ipswich. All of the power derived from the WTG was assumed to offset the wholesale purchase of electricity by IMLD at rates valued in accordance with the time-of-use costs billed to IMLD.

Goal of This Study. This study focuses a new, joint wind project involving IMLD and the Ipswich School District (ISD) in which a single MW-scale WTG would be installed at the site at the end of Town Farm Road. The output of the WTG would be shared in proportion to the funds provided by each party, and the value of the power delivered to each party would be reflective of the projected time-of-use costs for each party, starting in July 2010. The goal of this report is to project the economics of such a joint project IMLD and ISD.

WTG Studied. In this study, we have evaluated a General Electric Model 1.5sle, 1.5-MW, 77-m diameter WTG for the site because it appears that IMLD may be able to purchase such a WTG with the assistance of the Massachusetts Municipal Wholesale Electric Co-operative (MMWEC), to which they are a member utility. We have examined the use of such WTGs at a hub height of either 60 m (197 feet) or 80 m (262 feet).

Wind Resource and Energy Production Projections. Based on the one year of wind data recorded by the Renewable Energy Research Laboratory at the University of Massachusetts in Amherst, MA (UMass), we have projected the long-term average wind resource for the site (at various heights above ground), and the net energy production and revenue generation for a GE WTG with either hub height. We have included the details of our analyses of the measured winds in Appendix A. In Table 1-1, we have summarized the wind data and annual production for each WTG height analyzed.

Table 1-1. Summary of Wind Speeds and Energy Production from 1.5-MW, 77-m dia. GE WTG at Town Farm Road, Ipswich, MA

Parameter	Hub Height, feet (m)	
	197 ft (60 m)	262 ft (80 m)
Annual Average Wind Speed, mph (m/s)	12.74 (5.70)	13.64 (6.10)
Annual Average WTG Energy production, kWh	2,580,000	3,019,000
Annual Average WTG Capacity Factor, %	19.6%	23.0%

Economic Projections. Table 1-2 provides our estimated net income (prior to debt service) for IMLD and ISD as a function of project ownership. These estimates reflect a levelized annual O&M cost of $43k and $45k per year for a WTG with a 60-m or 80-m hub height, respectively. Based on an estimated project cost of approximately $3.24M for a 60-m hub-height WTG, we estimate IMLD and ISD would own roughly 51 and 49 percent of the project, respectively. Similarly, an 80-m hub height WTG would cost $3.4M to install and IMLD and ISD would own roughly 53 and 47 percent of the project, respectively.

Table 1-2. Estimated Net Year-1 Income from Wind Power for Each Entity

Percentage Ownership	Net Value at 60-m Hub Ht		Net Value at 80-m Hub Ht	
	Owner		Owner	
	IMLD	ISD	IMLD	ISD
0%	$ -	$ -	$ -	$ -
10%	$ 25,386	$ 35,380	$ 30,332	$ 42,074
20%	$ 50,773	$ 70,759	$ 60,665	$ 84,148
30%	$ 76,159	$ 106,139	$ 90,997	$ 126,222
40%	$ 101,546	$ 141,518	$ 121,329	$ 168,296
50%	$ 126,932	$ 176,898	$ 151,662	$ 210,370
60%	$ 152,318	$ 212,278	$ 181,994	$ 252,443
70%	$ 177,705	$ 247,657	$ 212,326	$ 294,517
80%	$ 203,091	$ 283,037	$ 242,658	$ 336,591
90%	$ 228,478	$ 318,416	$ 272,991	$ 378,665
100%	$ 253,864	$ 353,796	$ 303,323	$ 420,739

Note: Includes costs for O&M, that reflect a 20-year levelized estimate; no debt service costs.

After taking into account bond interest and principal payments by each project entity, we arrived at the annual net cash flow projections that we summarize in Table 1-3.

Table 1-3. Summary of Net Revenue Projections for Each Entity For Nominal Ownership Cases Studied

		Fiscal Year									
	Entity	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
60-m Hub Height	ISD	-80,000	101,595	106,135	110,788	115,558	120,447	120,774	125,338	129,342	132,264
	IMLD	-$164,000	-$21,649	-$14,092	-$6,450	$1,282	$9,104	$12,217	$19,641	$26,457	$32,130
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	ISD	135,333	138,962	143,004	147,548	150,869	154,981	161,239	166,728	171,932	177,751
	IMLD	$37,916	$44,241	$50,952	$58,138	$64,032	$70,698	$79,520	$87,513	$95,170	$103,413
Net Present Value	ISD	$1,299,609									
	IMLD	$140,501									
80-m Hub Height		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	ISD	-80,000	126,348	131,506	136,794	142,214	147,769	149,000	154,291	159,072	162,846
	IMLD	-$180,000	-$5,007	$3,755	$12,624	$21,602	$30,692	$34,875	$43,584	$51,676	$58,589
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	ISD	166,785	171,282	176,200	181,622	185,906	190,973	198,112	204,549	210,744	217,555
	IMLD	$65,642	$73,277	$81,337	$89,915	$97,161	$105,237	$115,591	$125,100	$134,281	$144,099
Net Present Value	ISD	$1,618,567									
	IMLD	$397,441									

Conclusions. We conclude the following:

1. Project Output and Value. The projected WTG energy levels and capacity factors for each hub height studied are low due to relatively low wind-speeds at the site. This leads to modest energy production from the WTG. However, the high value for the power leads to appealing cash flows for both IMLD and ISD.

2. Wind Turbine Generator.. The GE Model 1.5sle WTG is appropriate for the site (i.e., a large rotor diameter compared to its rated power and a good power curve). The annual capacity factors and revenue projections are greater than for several other candidate WTGs. If a WTG with an 80-m hub was installed it would produce approximately 439 MWh more energy per year than a WTG with a 60-m hub height. For the nominal cases of 51 to 53-percent ownership by IMLD, on average the taller tower produces enough additional energy to result in roughly a three-year simple payback for the added cost of the taller tower and additional foundation strength. However, the taller tower may lead to increased permitting problems.

3. Long-Term Operation and Maintenance (O&M) Issues. We estimate that the WTGs that we evaluated can be maintained for an annual, levelized cost of approximately $43k to $46k ($16.67/MWh to $15.24/MWh) for the 60 and 80-m hub height WTGs, respectively. These estimates include the benefit of a 5-year warranty.

Recommendations. We recommend the following:

1. WTG Acquisition. Very soon, IMLD and ISD should initiate contact with MMWEC to secure access to a GE Model 1.5sle WTG on good terms. In parallel, the Town must consider its procurement requirements with the desire to work with MMWEC.

2. Alternative Bids. Due to the constrained market for WTGs, WTG prices are high and availability is limited. IMLD should consider the potential of a bid from Vestas (the supplier of WTGs at Hull, MA) or Gamesa (from Spain) and Siemens (formerly Bonus, from Denmark). All three manufacturers supply WTGs in the size range discussed above. If Vestas is pursued, we recommend that the town focus on a Vestas Model V82, 1.65-MW WTG - reliable WTG that is also well suited to the Ipswich wind regime.

3. Warranty. The Town should seek a minimum three-year warranty on the WTG, tower and transformer, with five years the most desirable. IMLD should seek bids with an option to allow IMLD, at the end of the warranty period, to have the supplier train at least three personnel to be capable of carrying out all routine (scheduled) O&M activities on the WTG. This may save IMLD substantial funds, provide important knowledge and experience, and establish a basis for future expansion of its wind program (if desired).

2. INTRODUCTION

2.1. Background

In mid-2005, we provided a report to Meridian Associates that contained the results of an analysis of the economic potential of the Ipswich Municipal Light Department (IMLD) purchasing a single large, electricity-producing wind turbine generator (WTG) and locating at the end of Town Farm Road in Ipswich. The power from the WTG would be used to offset the wholesale purchase of electricity by IMLD. Our report was incorporated into an overall project feasibility study produced by Meridian Associates, Inc.

Since 2005, several factors have changed:

1) IMLD sought and was turned down for U. S. Government support from a fund that administers Clean Renewable Energy Bonds (CREBs),

2) Independently we also conducted a study for the Ipswich Middle-High School (IM-HS) in which we evaluated the merits of a single WTG located at the IM-HS,

3) The IM-HS applied and was successful in receiving bond interest support under the CREBs program,

4) IMLD and the IM-HS, in conjunction with the full Ipswich School District (ISD), have developed a plan by which they hope to combine efforts and place one large WTG at the IMLD site at the end of Town Farm Road and share the power output of the WTG in proportion to their investment in the wind project, and

5) Due to market conditions, there has become an extreme shortage of large WTGs, but IMLD believes that it may be able to work cooperatively with the Massachusetts Municipal Wholesale Electric Co-operative (MMWEC) to acquire a single General Electric (GE) large WTG with a rated power of 1.5 MW.

Under the plan described in (4) (above), each party would value the power derived at the rates that would be paid if they had to purchase the power from their normal source(s). That is, IMLD would value the power at the wholesale rate and ISD would value the power at the retail rate that would normally be charged by IMLD. It has also been agreed that should the portion of the power being allocated to the ISD exceed the load of the IM-HS, the excess power would be allocated to another school at the same value normally charged to the IM-HS. Thus, all WTG-generated power that is allocable to the schools is valued at the same retail rates and none is projected to be sold by ISD to IMLD at IMLD’s wholesale rate.

2.2. Focus of This Report

This report summarizes our estimates of the WTG annual electricity contribution from a 1.5-MW GE WTG to both IMLD and the ISD and the economic merits of the project to each party. Our analysis takes into account the value of the CREBs support to the ISD as well as the daily and monthly variations in the cost of power purchased by IMLD and the monthly power-cost variations for ISD. Bond payments are projected to start in FY2009 (July 1, 2009 through June 30, 2010). However, the WTG is projected to come on line in FY2010.

3. SITE WIND RESOURCE ANALYSIS

3.1. Site Location

The proposed project site is an isolated, town-owned, drumlin hill near Ipswich Bay that is adjacent to a former landfill at the end of Town Farm Road located approximately three miles north of Ipswich Center. Figure 3-1 is a map of the area – indicating the general location of the wind site and the relevant land features in the vicinity.

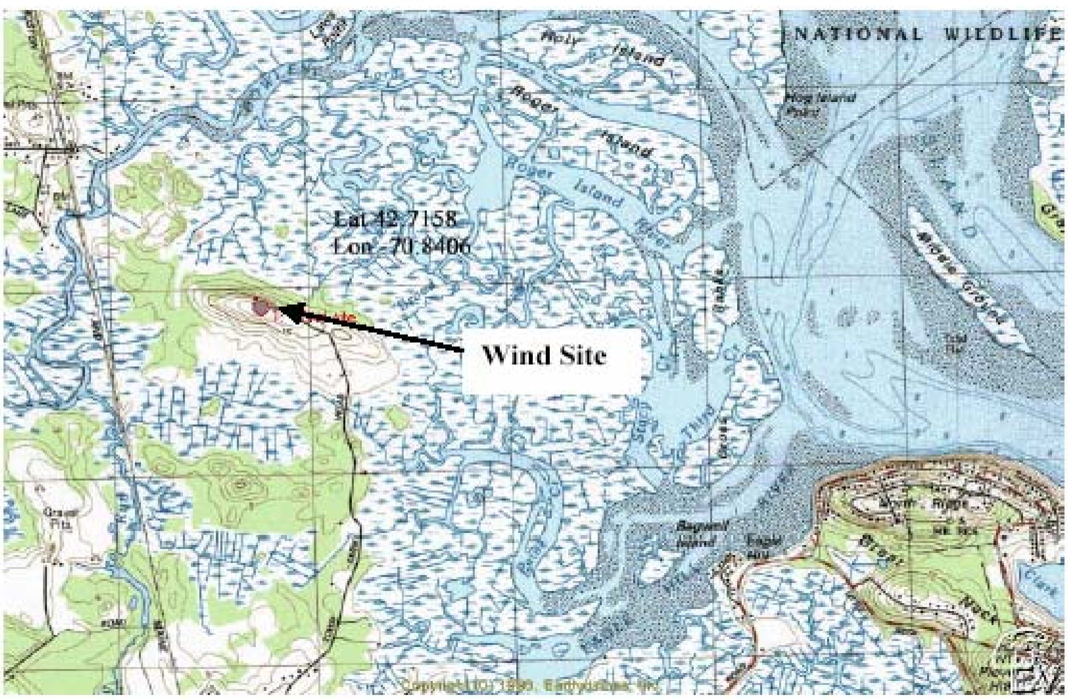


Figure 3-1. Map of Northern Portion of Ipswich and Proposed Wind Project Site

3.2. Historical, Measured Wind Data

The Renewable Energy Research Laboratory of the University of Massachusetts (UMass) in Amherst, MA measured one year of wind data at the Ipswich site. The data were measured from June 1, 2003 through May 31, 2004. The data set consists of redundant wind speed measurements (i.e., two sensors) at heights of 10, 30 and 39 m above ground level (agl), wind direction data at all three heights as well and the measured standard deviations of each sensor output. The calibration factors for each sensor are included in the data sets. The data sets include approximately 98 percent of the possible data measured during the period of record. This is a relatively high percent of acquisition of reliable wind data.

In Appendix A, Tables A-1 through A-7 we have included summaries of the wind speed and direction data measured at the three heights at the Ipswich site at the end of Town Farm Road. Our analyses allowed us to convert the measured data shown in Appendix A so that it can be used to estimate the following factors:

(a) The long-term average at the hub heights of the WTGs based on only one year of data from the site (where the one year of data may not be representative of a long-term average year).
(b) The average wind speed at a WTG hub height (of either 60 or 80 m) even though the wind data were acquired at a maximum height of 39 m.

3.2.1. Mean Annual Average Wind Speeds at WTG Hub Height

<u>Long-Term Average Wind Speed at 39-m Height</u>. We estimated the long-term, average wind resource for the site by acquiring the wind records from a reference site for a period that is longer than the Ipswich data set, but a portion of the data is coincident with the period of record for the Ipswich site. We acquired data from Boston's Logan Airport as the reference site. The data cover a period from year 2000 through June 2005 (see summary in Table B-1 of Appendix B). Logan Airport has a long-term period of wind records and provides a good long-term database by which to establish which years had good, bad or average winds. We compared the coincident wind speeds between Logan and the site for the purpose of evaluating two main factors:

1) The correlation of the site winds to those measured at Logan Airport, and
2) The amount by which the site winds, recorded during the coincident measurement period (i.e., June 1, 2003 and May 31, 2004), differed by what is estimated to be the long-term average for the site.

We did not use the detailed, hourly wind speeds from Logan Airport because it is expensive to obtain the data from the National Climatic Data Center and was not budgeted. Additionally, the hourly data might not correlate well between the two sites. However, the daily average wind speeds were available via the National Weather Service (NWS) Web Site for Boston. We obtained these data and calculated the daily average wind speeds for the 39-meter level of the meteorological (met) tower. These were then imported to an Excel Worksheet and the Regression Data Analysis tool was used to determine the correlation coefficient. The results of our analysis yielded an R-Value (correlation factor) of 0.91 and an R-Squared value of 0.832, indicating a very good relationship between these two sites.

The annual average wind speed for Logan based on these data is 11.23 mph. The annual average wind speed at Logan Airport for the 12-month measurement period from June 2003 to May 2004 is 11.09 mph. Using a simple ratio approach, we find that the annual average wind speed for the 12-month study period is 1.2 percent lower than what we consider to be the normal or long-term average. We used this adjustment (i.e., +1.2 percent) to create the long-term average wind speed for the IMLD site.

Based on the correction factor of 1.012 to estimate the long-term average, we estimated that the long-term annual average site wind speed, at a 39-m height, is 5.17 m/s (11.53 mph).

Wind Speed Variation with Height – Wind Shear. The variation of the horizontal component of wind speed with height above the ground is defined as vertical wind shear or wind shear. Wind shear is described by the following equation:

$$V_2/V_1 = (H_2/H_1)^{alpha} \qquad (1)$$

Where:

- V_2 and V_1 are the wind speeds at reference heights 2 and 1.
- H_2 and H_1 are the reference heights 2 and 1 in consistent units (i.e. meters or feet).
- Alpha is the power-law wind shear coefficient.

Wind shear is a function of the frictional effects of the ground surface cover. The wind power law attempts to emulate this change in wind speed with height through use of the power law exponent, or alpha value. One of the major sources of error in wind turbine project theoretical energy estimates is the extrapolation of wind speeds from the measurement level to the wind turbine hub height.

The power law exponent (alpha) can range in value from slightly negative (decreasing wind speeds with increasing height, found at some places in California) to values as high as 0.45 in forecast areas. The speedup of the wind as it passes over topographic obstacles such as hills and ridges will also greatly affect the expected change in wind speeds with height above ground level (agl).

The typical alpha value that most engineers are familiar with is the 1/7th power law (alpha = 0.14) which was derived over short grass-covered surfaces in the Midwest. Typical alpha values are 0.05 - 0.10 over open hills and ridges; 0.08 - 0.12 over water surfaces; 0.14 - 0.20 over flat terrain with grasses and small bushes; 0.18 - 0.25 over flat or gently rolling terrain with brush and small trees; and 0.25 to 0.45 over heavily wooded area with tall trees. In addition, the wind shear, power-law exponent is not a constant value with height agl. The shear value and resulting power law exponent may be very large in the lowest 10's of meters above ground level (agl), decreasing for higher heights.

<u>Ipswich Site Wind Shear</u>. We used the UMass data to examine the relationship in wind speeds between the 10-meter level and the 39-meter level as well as the 30-meter and 39-meter levels. To determine the change in wind speed between the lower level (either 10-meters or 30-meters) and the higher level (39-meters), we only considered those hour pairs when the wind speed at the lower level was 4.5 m/s (10 mph) or greater. We analyzed the data this way because WTGs generally do not produce useful energy unless the wind speeds are greater than 4.5 m/s. This approach removes any bias due to calm wind conditions.

The site exhibits very high wind shear with a 47 percent increase between 10-m and 39-m and an 8 percent increase between 30-m and 39-m. This increase is equivalent to a power law (shear) exponent (alpha) value of 0.28. On a sector basis, the wind shear is greatest when the wind is blowing from the Northwest and less when the wind is blowing from other compass directions.

We reviewed the wind shear coefficient at a similar type of site, for similar height ranges, at Halibut Point in Rockport, MA and find the value to be approximately the same. We also reviewed wind measurement data from a U. S. D. O. E. historical, wind measurement tower located on Nantucket Island, where, late in the 1970s, winds were measured at heights of 9.1 m (30 feet), 30 m (98 feet) and 45.7 m (150 feet) agl. The data base indicates that the measured wind shear coefficient (alpha) was approximately 0.24 between lower levels and the 45.7-m height. We do not know what type of terrain exists near the Nantucket tower, but by knowing where the tower was located (SE portion of island), we estimate that it may be much like that in and around the IMLD site.

In our current analysis, to project wind speeds to 60 and 80-m hub heights agl, ***we have assumed a wind shear power-law coefficient of 0.23*** – a value that is slightly less than that which we calculated from the UMass data (i.e., 0.28). In year 2005 we conducted a similar analysis and issued a report on our projections of site WTG power production. At that time, we had been asked to be conservative in our estimates of power production and had used a wind shear power-law coefficient of 0.18. In this analysis, we are being slightly more aggressive in our assumptions because we have seen indications from other measurements along the coast of Massachusetts that indicate the winds may be slightly better than our prior assumptions. However, we are not using the calculated value of 0.28 for wind shear because, based on experience, we estimate that the shear coefficient (alpha) decreases with height and a value of 0.28 might lead to an unrealistically high value of wind speed at the hub heights of the candidate WTGs.

<u>Projected Hub-Height Wind Speeds</u>. Based on the above approach, we developed wind speed frequency distributions for a 60-m and 80-m hub height WTG. We have listed them in Table 3-1 for both a 60-m and 80-m hub height. We have also plotted the distributions in Figure 3-2. We have computed a annual average wind speeds of 5.70 and 6.10 m/s for 60 and 80-m hub heights, respectively.

The distributions shown in Figure 3-2 indicate the typical bell-shaped Weibull distribution. Note that as the annual average wind speed at a site increases, the wind speed probability distribution shifts to the right. This results in more hours with wind speeds at higher WTG output levels and ultimately higher annual wind energy production levels.

Figure 3-2. Wind Speed Frequency Distributions for Candidate Site

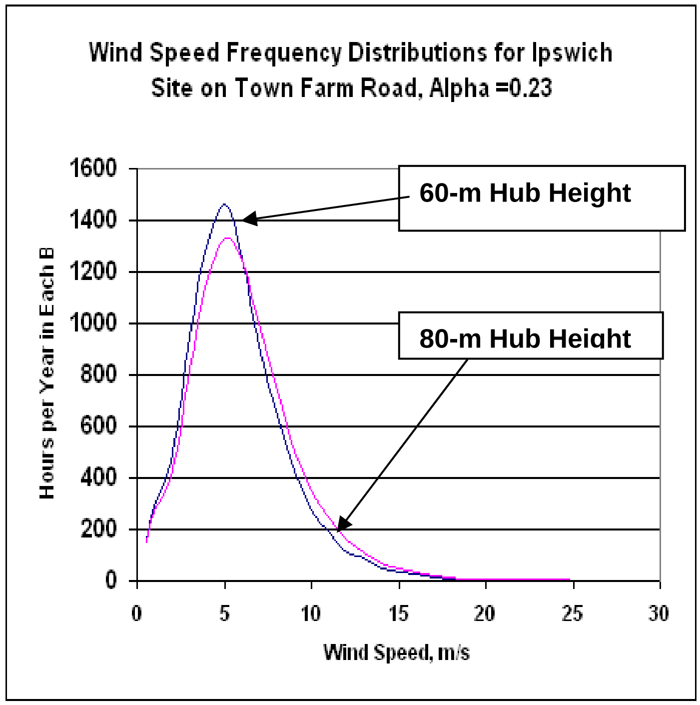


Table 3-1. Wind Speed Frequency Distributions for Alpha =0.23 - Annual Long-Term Estimates (Town Farm Road Site, Ipswich)

	Hub Height, m	
Center of Wind Speed Range (m/s)	60 Hours/ Year	80 Hours/ Year
0.5	158.7	149.3
1	286.7	269.6
2	498.0	427.3
3	954.1	821.4
4	1,300.0	1,157.3
5	1,462.2	1,330.4
6	1,257.9	1,247.8
7	910.1	999.6
8	665.4	758.3
9	430.3	500.1
10	279.1	354.0
11	194.7	249.3
12	113.3	156.6
13	90.5	110.6
14	45.5	69.1
15	33.9	47.4
16	26.8	33.4
17	11.7	21.2
18	8.6	14.2
19	6.1	10.0
20	6.1	4.8
21	7.7	5.4
22	4.6	6.4
23	5.5	6.2
24	3.0	6.0
25	-	2.5
26	-	3.0
27	-	-
Avg., m/s:	**5.70**	**6.10**

In Figure 3-3, we have plotted the monthly average wind speeds for a WTG at either a 60-m or 80-m hub height.

Two factors are clear from the data in Figure 3-3:

- There is a significant increase in average monthly wind speeds for an 80-m height compared to a 60-m height.

- The winds during the months of June through September are approximately the same and are the lowest wind speeds of the year. It will be seen in our later analyses and in the tables in Appendix B, that the wind power delivered during these months is significantly lower than during the other months.

Average Daily Wind Profiles. In Tables 3-2 and 3-3 we have listed the hourly average wind speeds for an average day in each month of the year for 60 and 80-m heights (respectively). We will use these projections of typical hourly average wind speeds to drive the analytical model that projects the average hourly, monthly and annual income from the sale of wind-generated power that offsets power purchases by each entity.

Figure 3-3. Calculated Monthly Average Wind Speeds at Ipswich, Town Farm Road Site, 60 and 80-m Heights (wind shear coefficient, alpha, = 0.23)

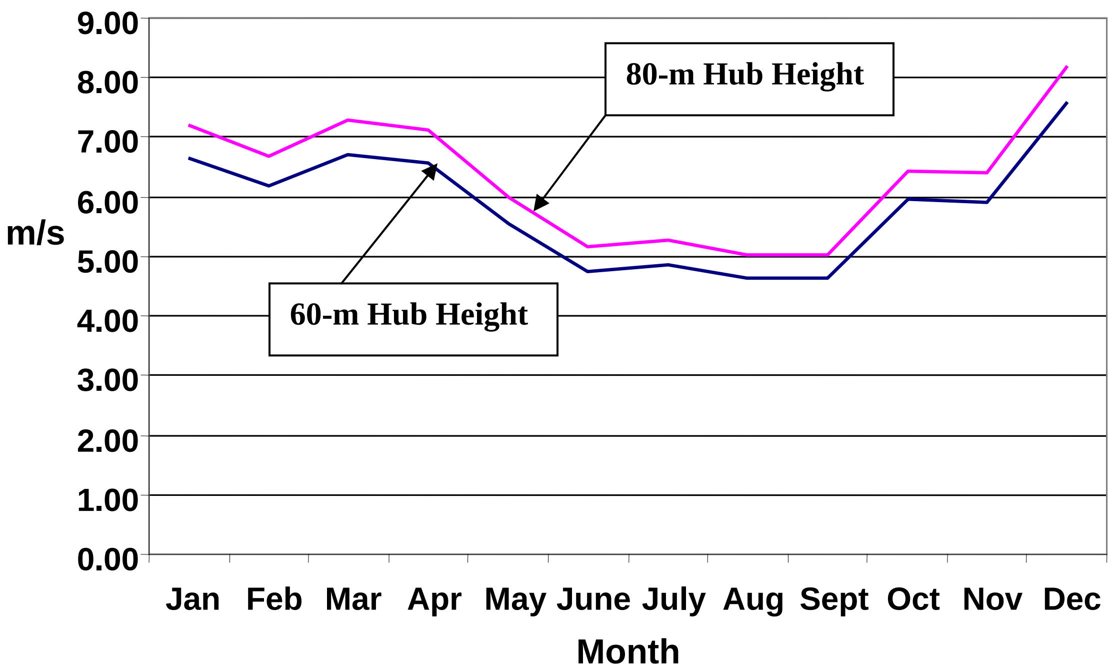


Table 3-2: Mean Hourly Wind Speeds (in m/s)
for 60-m Hub Height
Ipswich, Masschusetts (End of Town Farm Road)
60-m Wind Speed Estimates (mph) Shear Alpha = 0.23

Normalized to Long-Term from data measured during June 1, 2003 through May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1	6.8	5.8	6.2	5.8	4.7	4.3	4.2	4.2	3.9	5.7	5.7	7.6	**5.41**
2	6.9	5.6	6.0	6.3	4.8	4.5	4.0	3.9	4.3	5.5	5.8	7.0	**5.38**
3	6.6	6.0	6.1	6.5	4.6	4.5	4.1	4.0	4.3	5.7	5.4	7.1	**5.41**
4	6.2	5.9	5.9	6.3	5.3	4.0	4.0	4.2	4.6	6.0	5.5	7.5	**5.45**
5	5.9	5.7	6.0	6.5	5.3	4.1	3.9	4.3	4.8	5.9	5.7	7.8	**5.49**
6	5.7	5.6	6.0	6.4	4.9	4.1	3.8	3.9	4.7	6.2	5.6	7.7	**5.38**
7	5.7	5.2	5.9	6.3	5.0	4.3	3.8	4.1	4.3	5.8	5.8	7.2	**5.28**
8	5.8	5.5	6.2	6.5	5.5	4.6	4.0	4.4	4.9	5.2	5.7	6.3	**5.38**
9	6.3	5.5	6.3	6.5	6.0	4.9	4.3	4.6	5.0	5.4	5.6	6.4	**5.57**
10	6.6	5.5	6.5	6.9	6.0	5.0	4.5	4.8	5.1	5.6	5.9	7.1	**5.79**
11	6.9	5.7	7.2	6.8	6.4	5.5	4.9	4.9	4.9	6.1	6.1	7.1	**6.04**
12	7.1	6.3	7.5	7.1	6.8	5.6	5.3	5.2	5.2	6.3	6.0	7.7	**6.34**
13	6.7	6.9	7.5	7.2	6.6	5.4	5.9	5.5	5.2	6.7	6.1	7.3	**6.42**
14	6.9	6.7	7.9	7.5	6.3	5.4	6.4	5.6	5.1	6.5	6.3	7.7	**6.53**
15	6.8	6.9	7.5	7.0	6.4	4.9	6.4	5.5	5.2	6.4	6.2	7.6	**6.40**
16	6.4	6.9	7.3	6.8	6.0	4.7	6.1	4.9	4.8	6.3	5.4	7.5	**6.09**
17	6.1	6.0	6.8	6.4	5.9	4.4	5.6	4.1	4.2	5.5	5.8	7.4	**5.68**
18	6.3	6.2	6.8	6.0	5.5	3.9	5.0	4.3	4.0	5.5	5.7	7.6	**5.57**
19	5.9	5.8	6.5	5.9	4.9	4.1	4.9	4.5	4.0	5.4	5.7	7.5	**5.43**
20	6.4	6.4	6.4	5.8	4.7	4.5	4.6	4.6	4.0	5.3	5.6	7.8	**5.51**
21	6.7	6.4	6.0	5.8	4.5	4.7	4.6	4.4	4.0	5.5	5.5	7.8	**5.49**
22	6.8	6.2	6.4	5.4	4.4	4.8	4.5	4.2	4.0	5.5	5.6	7.6	**5.45**
23	6.9	6.1	6.2	5.8	4.6	4.5	4.6	4.2	4.0	5.6	5.6	7.8	**5.49**
24	7.1	5.6	5.9	6.0	4.5	4.5	4.3	4.2	4.0	5.6	5.8	7.5	**5.42**
Mean	6.48	6.02	6.54	6.40	5.40	4.63	4.74	4.52	4.52	5.80	5.75	7.40	**5.68**

3.2.2. Wind Directional Distribution

The percent of time that different wind speeds occur from different directions is portrayed as a plot called a wind rose. This chart displays both the fraction of the total annual wind energy that occurs in winds from the specific direction as well as the faction of time each year when the wind blows from that sector. In Figure A-1 (of Appendix A) we have plotted the wind direction data in the form of a wind rose (i.e., a polar plot of the wind directional data) for a 39-m height agl. The wind rose indicates that the primary direction for the strong winds, that can produce useable power, come from the west and northwest directions, with some reasonable winds from the southwest direction.

3.2.3. Turbulence and Peak Wind Speed

Turbulence. We used the UMass wind measurements to compute the wind turbulence intensity (TI) values (standard deviation divided by the mean). We found TI to be modest and within the envelope defined for a Class 2 wind site. For the candidate WTG for the site, a GE Model 1.5sle, 1.5-MW (77-m diameter) unit (discussed later), the site TI is significantly less than the design TI.

Table 3-3: Mean Hourly Wind Speeds (in m/s)
for 80-m Hub Height
Ipswich, Masschusetts (End of Town Farm Road)
80-m Wind Speed Estimates (mph) Shear Alpha = 0.23

Normalized to Long-Term from data measured during June 1, 2003 through May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1	7.3	6.2	6.6	6.2	5.0	4.6	4.5	4.5	4.2	6.1	6.1	8.1	**5.78**
2	7.4	6.0	6.5	6.7	5.2	4.8	4.3	4.2	4.6	5.9	6.2	7.5	**5.78**
3	7.1	6.5	6.5	7.0	5.0	4.9	4.4	4.3	4.6	6.1	5.8	7.6	**5.82**
4	6.7	6.3	6.3	6.8	5.7	4.3	4.3	4.5	4.9	6.4	5.9	8.0	**5.84**
5	6.4	6.1	6.4	7.0	5.7	4.4	4.2	4.6	5.1	6.3	6.1	8.3	**5.88**
6	6.1	6.0	6.4	6.9	5.2	4.4	4.1	4.2	5.1	6.6	6.0	8.3	**5.78**
7	6.1	5.6	6.4	6.8	5.3	4.6	4.1	4.4	4.6	6.2	6.2	7.7	**5.67**
8	6.2	5.9	6.6	6.9	5.9	5.0	4.3	4.8	5.2	5.6	6.1	6.7	**5.77**
9	6.8	5.9	6.8	7.0	6.5	5.3	4.6	4.9	5.4	5.8	6.0	6.9	**5.99**
10	7.1	5.9	7.0	7.4	6.5	5.3	4.8	5.1	5.4	6.0	6.4	7.6	**6.21**
11	7.4	6.1	7.7	7.3	6.9	5.9	5.3	5.3	5.3	6.5	6.5	7.6	**6.48**
12	7.6	6.8	8.1	7.6	7.3	6.0	5.7	5.6	5.6	6.8	6.5	8.2	**6.82**
13	7.2	7.4	8.1	7.7	7.1	5.8	6.3	5.9	5.6	7.2	6.5	7.8	**6.88**
14	7.4	7.2	8.4	8.0	6.7	5.8	6.8	6.0	5.4	7.0	6.8	8.3	**6.98**
15	7.3	7.4	8.1	7.5	6.9	5.3	6.8	5.9	5.6	6.9	6.6	8.2	**6.88**
16	6.9	7.4	7.8	7.3	6.5	5.1	6.6	5.3	5.1	6.8	5.8	8.0	**6.55**
17	6.5	6.5	7.3	6.8	6.4	4.7	6.0	4.4	4.5	5.9	6.2	8.0	**6.10**
18	6.7	6.7	7.3	6.4	5.9	4.2	5.3	4.6	4.3	5.9	6.1	8.2	**5.97**
19	6.3	6.2	7.0	6.4	5.2	4.4	5.3	4.9	4.3	5.8	6.1	8.0	**5.83**
20	6.9	6.9	6.8	6.2	5.1	4.8	5.0	4.9	4.3	5.7	6.0	8.3	**5.91**
21	7.2	6.9	6.5	6.2	4.8	5.1	5.0	4.7	4.3	5.9	5.9	8.3	**5.90**
22	7.3	6.6	6.9	5.8	4.7	5.1	4.8	4.5	4.3	5.9	6.0	8.1	**5.83**
23	7.4	6.6	6.6	6.2	4.9	4.9	5.0	4.5	4.3	6.0	6.0	8.3	**5.89**
24	7.6	6.0	6.3	6.5	4.9	4.9	4.6	4.5	4.3	6.0	6.2	8.0	**5.82**
Mean	**6.95**	**6.46**	**7.02**	**6.86**	**5.80**	**4.98**	**5.09**	**4.85**	**4.85**	**6.22**	**6.17**	**7.92**	**6.10**

Peak Winds. We did not have access to sufficient measured, site wind data to compute the peak, once in 50-year, 5-second gust used by WTG designers to qualify a site for a WTG. However, by examining wind records from the region, we find that the occurrence of peak winds in excess of 100 mph is very rare – occurring only during very infrequent hurricanes or very severe winter storms. Based on the wind speeds, turbulence intensity and projected peak winds, we estimate that the IMLD site is low-end IEC Class 2 wind site.

The design capability of a WTG such as the GE Model 1.5sle is appropriate for a Class-2 site. The WTG has a survival peak, 5-second wind-speed gust of approximately 132 mph. Therefore, we believe that the site is appropriate for a GE Model 1.5sle and all Class 2 WTGs in all respects. WTG suppliers will typically confirm these factors prior to bidding and installing a WTG at a site.

3.3. Obstructions and Wakes

Trees. There are trees located roughly north of the planned WTG location at the end of Town Farm Road. Their height appears to be approximately 50 to 70 feet (maximum) above ground. The trees are not a concern for the following reasons:

(1) There are generally few productive winds from the north.
(2) The elevation of the ground on which they are growing is approximately 20 to 30 feet below the proposed, elevated WTG location.
(3) The anticipated hub heights of the candidate WTGs are 60 m (197 feet) and 80 m (262 feet). Therefore, the lowest height for the blade passage for a 60-m high hub on a 77-m diameter GE Model 1.5sle WTG, when the blades are at the 6:00 o'clock position (i.e., straight down), is 21.5 m (70.5 feet) above ground level (agl).

Wakes. In addition, only one WTG will be installed at the site. Therefore, there should be no wind-flow affects from upwind WTGs. Based on these estimates for the heights of the trees and the hill on which the WTG would we installed, the WTG dimensions, and the use of a single WTG at the site, we conclude that there should be zero or negligible wake impacts on the WTG.

4. DESCRIPTION OF CANDIDATE WIND TURBINE GENERATOR (WTG)

4.1. Introduction

There are several new types of WTGs on the market that, on paper, may appear to hold promise for application at the IMLD site. However, the main driven in our recommendations is to aim for the WTG which Ipswich may have a chance of purchasing. There is currently a major shortage of WTGs because the demand for clean wind energy is growing at a very fast pace in the U. S.

4.2. Candidate Wind Turbine

4.2.1. WTG Selection.

The GE Model 1.5sle, 1.5-MW, 77-m diameter WTG appears to be the best WTG on which to focus for the project. We recommend this WTG at this time because of the following factors:

1) Due to an overheated wind power market, there is an extreme shortage of MW-scaled WTGs at this time. As a result, the major manufacturers are paying attention to orders that include at least 40 to 50 MW of WTGs. Therefore, by itself Ipswich may not be able to acquire a large WTG for years under these circumstances.

2) The GE Model 1.5sle WTG is a mature product that has been available for several years. Through CY2007, approximately 7,000 to 8,000 such units have been manufactured and installed worldwide.

3) The Ipswich School District (ISD) has an approval for CREBs bond-interest support from the Internal Revenue Service (IRS) up to a bonding level of $1.6

million dollars, but must start the project by December 31, 2008 to fully qualify for the support.

4) IMLD, as project partner with the ISD, is a member of the Massachusetts Municipal Wholesale Electric Cooperative (MMWEC). We understand that MMWEC is purchasing the yet-to-be-built Berkshire wind project in Western Massachusetts that will include on the order of ten (10) General Electric (GE) Model 1.5sle WTGs. We believe that it is possible that IMLD may be able to become part of a MMWEC WTG purchase by adding one unit at a reasonable price. This approach may allow Ipswich to acquire a MW-scale WTG, and it may be possible to do so in a substantially shorter time frame than otherwise.

4.2.2. WTG Description

The GE Model 1.5sle has the following features:

(1) A 77-m (253-foot) diameter rotor;
(2) Three full-span, pitchable, fiberglass blades;
(3) A three-stage gearbox that speeds up the rotational shaft speed from the rotor speed of approximately 15 rpm to a generator speed of approximately 1200 rpm;
(4) A gearbox that is a combination of a dual-stage planetary section with a single high-speed helical-gear stage;
(5) A nacelle (equipment enclosure at top of tower) that sits atop an enclosed, tubular tower that can range in height from approximately 60 m (197 feet) to greater than an 80 m (262 feet);
(6) A rotor that is upwind of the tower (i.e., an “upwind WTG”);
(7) It operates in a variable-speed manner such that the speed of the rotor can vary from the average speed by approximately plus or minus 25 percent;
(8) It meet the latest Federal Energy Regulatory Commission (FERC) requirements for (a) power factor control, (b) SCADA system accessibility for transmission-system-operator control, and (c) Voltage Ride-Through (VRT) standards recently required by FERC;
(9) The WTG has been certified by a recognized European certifying organization, such as Germanischer-Lloyd or Det Norske Veritas, indicating that it been thoroughly analyzed and tested and meet a minimum 20-year design life (on paper) for major components and can survive the required peak wind speeds for their wind-class rating without damage;
(10) Manufacturing quality control has been certified to international standards and the manufacturers keep their certifications current.

The GE Model 1.5sle is a fully variable-speed WTG that is designed for Class-2 (medium-speed) wind sites. The variable-speed feature on the GE WTG allows approximately plus or minus 25 percent rotor speed variation in response to wind gusts and varying wind speeds. This approach relieves mechanical loads and increases the efficiency of energy capture. As a result, the GE Model 1.5sle has a very beneficial power curve because it produces more power at each wind speed that a constant-speed WTG of the same size.

GE has several different versions of the 1.5-MW WTG, some with 70.5-m diameter rotors and others with different types of blades. We believe that GE has negotiated with major suppliers and established production runs to mass produce the WTG components and assemble the Model 1.5sle WTGs at the best price and with the most reliability.

WTG Background. For nearly ten years generic versions of the Model 1.5 WTG have been built by GE and prior owners of the rights to the WTG design. The first versions of the machine were developed by Tacke – a German company that built 600-kW units and larger. In the process, Tacke established a solid technology base in Germany. In parallel, Zond Energy Systems in California designed several variable-speed WTGs and, in 1998, was acquired by Enron. Tacke became insolvent shortly after that and Enron acquired Tacke and blended the Zond and Tacke designs – leading eventually to a 1.5-MW, variable-speed architecture with a 70.5-m diameter rotor – designed for Class 1 (i.e., high-speed, vigorous) wind sites. The same architecture and design features are resident in the GE Model 1.5sle, but the Model 1.5sle has a larger rotor (to capture more energy in light winds) and is rated for Class 2 (more benign) wind sites. We also believe that GE has introduced a similar WTG with a rotor diameter of approximately 82 m (269 feet) that is tailored for very low wind speed sites such as Ipswich. We are not recommending this larger unit for Ipswich at this time because of the lack of experience with the machine.

In year 2001 or 2002, Enron went into bankruptcy and had to liquidate assets. Through the courts, GE acquired the rights to the Enron 1.5-MW WTG. GE expanded the envelope of available WTGs rated at 1.5 MW and also made the 77-m diameter, Class 2 WTG available. The generic WTG has been the beneficiary of significant GE product improvement work over the past five years. The Model 1.5sle has experienced perhaps the greatest increase in market growth of all WTGs sold today. In the past we have met with GE engineering personnel on several occasions to discus various operational experiences and design aspects of the GE Model 1.5sle. We believe that, at the right price, the GE Model 1.5sle would be a good WTG for IMLD.

WTG Hub Height. We recommend that, based on supplier costs, Ipswich should seek cost data on the use of a WTG with either a 60-m or 80-m hub height. There is an economic trade-off with respect to hub height. The higher hub heights produce more annual energy due to the stronger winds found at higher heights (especially if the wind shear is great), but the WTG tower, foundation and installation costs are greater and the average annual maintenance costs are slightly greater (see O&M cost projections).

During the past several years, WTGs have seen rapid price increases attributable to (a) steep rises in steel prices, (b) an over-heated wind power market on a worldwide basis (especially the US), and (c) the strong Danish and Euro currencies relative to the dollar. The steel component of the cost will place more emphasis on using a shorter tower, especially in light of the fact that the winds at the IMLD site are relatively low and less economic gain is achieved by the taller tower than at more windy sites. We also believe that the 60-m hub height may encounter fewer problems during the permitting phase of the project.

We expect that the WTG price increases may stabilize in the next two to three years. This could result from (a) the continued strong entry of several more WTG suppliers in the US market and (b) the lack of an extension to the Federal Production Tax Credit (PTC) in the US (after December 31, 2008) – that has been a major driver for the very active wind market in the U. S. Because Ipswich is not bound by the schedules and associated with tax-credit pressures that a private developer experiences, it may make sense for Ipswich to seek to phase the installation at a low-pressure period for suppliers if the PTC is not extended beyond CY2008.

5. WTG ENERGY PRODUCTION

5.1. General Description of WTG Energy Capture

A WTG captures energy from the wind over a range of wind speeds. The wind machine's electricity production at any time is a function of the wind speed at that time. A WTG power curve characterizes its electricity production in kilowatts as a function of the wind speed at the hub height.

WTG Power Curve. Figure 5-1 is a plot of the power curve for the GE Model 1.5sle at an average annual air density of Ipswich. It should be noted that the WTG does not begin producing electricity until the wind speed reaches its cut-in wind velocity of approximately 4 m/s (9 mph). The output increases to 1500 kW at a wind speed of approximately 14 m/s after which it holds constant at that value until a wind speed of 25 m/s (55 mph) – the WTG cutout wind speed. It is then set to zero for higher wind speeds in order to protect the WTG from damage caused by high winds. To reduce output power to zero at the high wind speeds, the WTG controller causes the blades to "feather" into the wind such that they produce zero torque to the rotor. Because the WTG is designed for Class 2 winds, it is capable of surviving peak, 5-second gusts of 59 m/s (132 mph) with the blades feathered.

Gross Annual Energy Production. To estimate the annual energy production for a WTG through the use of wind data described in Section 3, we use the distribution of wind speeds between the cut-in and cut-out velocities – as shown in Table 3-1 and Figure 3-2. The wind data are provided as the number of hours per year, or percent of time the winds equal a specific wind speed at a given height agl. The number of hours per year in each wind speed range are multiplied by the WTG power output at that wind speed (see Figure 5-1) to produce an estimate of the energy production for each wind speed range. These energy estimates are summed for all wind-speed ranges to arrive at the annual total gross energy production estimates.

Net Annual Energy Production. To estimate the net annual energy production, we reduce the gross annual energy production estimate due to various inefficiencies and loss factors such as availability, electric line losses, blade soiling, etc. We base our estimates on the past performance of a great number of projects and basic research which we have conducted or reviewed. In the case of the IMLD site, we estimate a net efficiency factor of approximately 89 percent (i.e., a loss of 11 percent from gross to net energy). The efficiency factor is multiplied by the *gross* energy to result in the prediction for the average *net* energy production per year for a WTG.

Variations in Output. The actual output of the WTG may vary due to (a) errors (inaccuracies) in our projections for the average year and (b) intra-annual variations in the actual winds due to seasonal weather patterns and climatic swings. Below we discuss these variations with the goal that the estimates that we provide should be considered to be the extremes of the 95-percent confidence interval (i.e., there is a 95 percent probability that the actual production will be within the intervals listed).

Uncertainties: Based on (a) the period of data record, (b) our projections of the adjustment of site data to a long-term, annual-average mean wind speed value, (c) the accuracy of the calibrations of the wind sensors, and (d) the uncertainty in our knowledge of the actual wind shear from a height of 39 m to 60 and 80 m agl, we estimated the error bands for our projections to be approximately -20 to +25 percent.

`

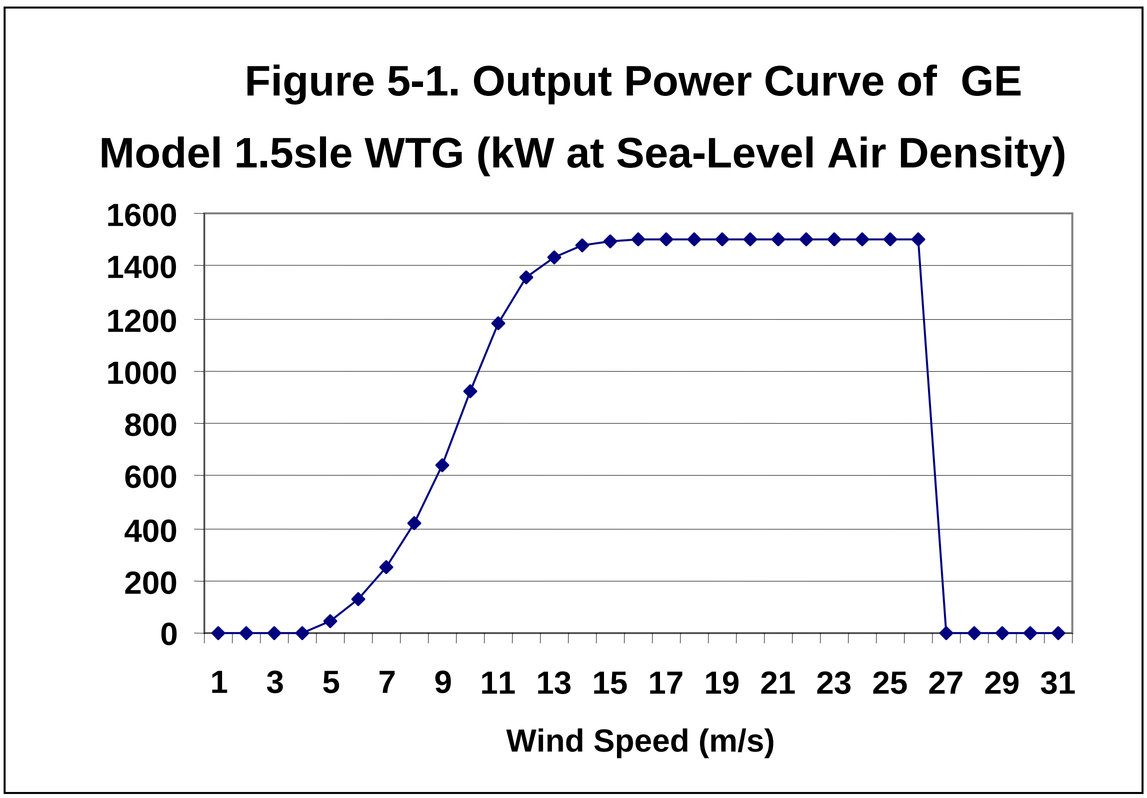


Table 5-2. Output of GE Wind, Model 1.5sle, 1.5-MW WTG, 60-m hub ht

Assume: Ipswich Annual Air Density = 1.225

MAJOR ASSUMPTIONS

Wind Turbine

(1) Turbine: GE 1.5S, 77 m
(2) Rating, kW: 1,500
(3) Baseline Air Dens: kg/m^3 1.225
(4) Actual Site Air Density, kg/m^ 1.225
(5) Rotor Diameter, m: 77
(6) Rotor Swept Area, m2: 4,656.6
(7) 1.5sle Hub Height, m: 60.0

Shear Alpha = 0.28

Wind Speed, m/s	Proba-bility	Hrs/ Year (Avg. Year)	Sea Level Power Output, kW	Site Power Output, kW	Gross Energy Prod'n, kWh
0	Not Applic.	158.7	0	0.0	-
1	Not Applic.	286.7	0	0.0	-
2	Not Applic.	498.0	0	0.0	-
3	Not Applic.	954.1	0	0.0	-
4	Not Applic.	1,300.0	43.0	43.0	55,898
5	Not Applic.	1,462.2	131.0	131.0	191,548
6	Not Applic.	1,257.9	250.0	250.0	314,475
7	Not Applic.	910.1	416.0	416.0	378,581
8	Not Applic.	665.4	640.0	640.0	425,824
9	Not Applic.	430.3	924.0	924.0	397,551
10	Not Applic.	279.1	1181.0	1181.0	329,617
11	Not Applic.	194.7	1359.0	1359.0	264,529
12	Not Applic.	113.3	1436.0	1470.0	166,478
13	Not Applic.	90.5	1481.0	1498.0	135,569
14	Not Applic.	45.5	1494.0	1494.0	67,977
15	Not Applic.	33.9	1500.0	1500.0	50,775
16	Not Applic.	26.8	1500.0	1500.0	40,200
17	Not Applic.	11.7	1500.0	1500.0	17,475
18	Not Applic.	8.6	1500.0	1500.0	12,825
19	Not Applic.	6.1	1500.0	1500.0	9,075
20	Not Applic.	6.1	1500.0	1500.0	9,150
21	Not Applic.	7.7	1500.0	1500.0	11,475
22	Not Applic.	4.6	1500.0	1500.0	6,900
23	Not Applic.	5.5	1500.0	1500.0	8,250
24	Not Applic.	3.0	1500.0	1500.0	4,500
25	Not Applic.	-	1500.0	1500.0	-
26	Not Applic.	-	0	0.0	-
27	Not Applic.	-	0	0.0	-
28	Not Applic.	-	0	0.0	-
29	Not Applic.	-	0	0.0	-
30	Not Applic.	-	0	0.0	-
Totals or Avg.:	0.0000	8759.9		Gross MW/Yr:	2,899
Site Efficiency Factors:				Availability:	0.97
				Wakes:	1.00
				Line Losses::	0.975
				Icing & Controls	0.98
				Turbulence:	0.98
				Blade Contamination:	0.98
				Micrositing:	1.00
Net Efficiency Factor:					**0.890**
				Net MWh/Yr:	**2,580**
Net Annual Capacity Factor:					**0.196**

Table 5-3. Output of GE Wind, Model 1.5 sle, 1.5-MW WTGs, 80-m hub ht
Assume: Ipswich Annual Air Density = 1.225
MAJOR ASSUMPTIONS
Wind Turbine
(1) Turbine: GE 1.5S, 77 m
(2) Rating, kW: 1,500
(3) Baseline Air Dens: kg/m^3 1.225
(4) Actual Site Air Density, kg/m^: 1.225
(5) Rotor Diameter, m: 77
(6) Rotor Swept Area, m2: 4,656.6
(7) 1.5 sle Hub Height, m: 80.0 **Shear Alpha = 0.23**

Wind Speed, m/s	Proba-bility	Hrs/ Year (Avg. Year)	Sea Level Power Output, kW	Site Power Output, kW	Gross Energy Prod'n, kWh
0	Not Applic.	149.3	0	0.0	-
1	Not Applic.	269.6	0	0.0	-
2	Not Applic.	427.3	0	0.0	-
3	Not Applic.	821.4	0	0.0	-
4	Not Applic.	1,157.3	43.0	43.0	49,764
5	Not Applic.	1,330.4	131.0	131.0	174,282
6	Not Applic.	1,247.8	250.0	250.0	311,950
7	Not Applic.	999.6	416.0	416.0	415,834
8	Not Applic.	758.3	640.0	640.0	485,312
9	Not Applic.	500.1	924.0	924.0	462,092
10	Not Applic.	354.0	1181.0	1181.0	418,074
11	Not Applic.	249.3	1359.0	1359.0	338,799
12	Not Applic.	156.6	1436.0	1470.0	230,202
13	Not Applic.	110.6	1481.0	1498.0	165,679
14	Not Applic.	69.1	1494.0	1494.0	103,235
15	Not Applic.	47.4	1500.0	1500.0	71,100
16	Not Applic.	33.4	1500.0	1500.0	50,100
17	Not Applic.	21.2	1500.0	1500.0	31,800
18	Not Applic.	14.2	1500.0	1500.0	21,300
19	Not Applic.	10.0	1500.0	1500.0	15,000
20	Not Applic.	4.8	1500.0	1500.0	7,200
21	Not Applic.	5.4	1500.0	1500.0	8,100
22	Not Applic.	6.4	1500.0	1500.0	9,600
23	Not Applic.	6.2	1500.0	1500.0	9,300
24	Not Applic.	6.0	1500.0	1500.0	9,000
25	Not Applic.	2.5	1500.0	1500.0	3,750
26	Not Applic.	6.1	0	0.0	-
Totals or Avg.:	0.0000	8764.3		**Gross MW/Yr:**	**3,391**
Site Efficiency Factors:				Availability:	0.97
				Wakes:	1.00
				Line Losses::	0.975
				Icing & Controls:	0.98
				Turbulence:	0.98
			Blade Contamination:		0.98
				Micrositing:	1.00
Net Efficiency Factor:					**0.890**
			Net MWh/Yr:		**3,019**
Net Annual Capacity Factor:					**0.230**

Intra-Annual Variations: Based on the long-term wind speed records from Logan Airport, we estimate that the intra-annual variations in the site output, based strictly on wind speed variations will be plus or minus 8 to 12 percent of the estimates that we have provided herein.

5.2. Total Net Annual Energy Production

To project annual net energy production from a WTG at the site, we have employed the WTG manufacturer's power curve and the average wind speed distributions for both 60-m and 80-m hub heights (shown in Table 3-1). We have presented the projections in Tables 5-2 and 5-3 for 60-m and 80-m hub heights, respectively. The results indicate that the GE Model 1.5sle will produce a net annual energy of 2,580 MWh if a hub height of 60 m is installed and a net annual energy of 3,019 MWh if a WTG with an 80-m hub height is installed. The average estimates can be considered to be the annual energy productions for a zero inaccuracy in our projections (i.e., 50th percentile in error band) in the case of a wind year equal to the long-term average.

5.3. WTG Hourly Average Output

In order to estimate the economic value derived by ISD and IMLD from the WTG output, it is necessary to model the WTG hourly electricity output in relation to the IMLD and ISD electricity costs. I preparation for that, in Tables 5-4 and 5-5 we have listed the hourly average WTG energy production for each hour of the average day in each month for a WTG with either a 60-m or 80-m hub height, respectively.

Potential Simulation Inaccuracies. For most feasibility analyses, the most cost-effective approach in using wind data to estimate WTG output is to use hourly average wind speeds representing an average hour for the average day in each month. As we did in this analysis and as shown in Tables 5-4 and 5-5, these data are typically developed from the wind records from a site. Due to "averaging errors" in this simulation process, we had to adjust the model to assure that the average annual capacity factors shown in Tables 5-4 and 5-5 agree with the annual average capacity factors listed in Tables 5-2 and 5-3.

Due to our use of a linear averaging process applied to what is inherently a non-linear process (i.e., the WTG power curve does not vary linearly with the wind speed), our analysis may miss some of the transient-wind periods when the WTG production is at high or low levels for periods that are shorter than one hour. Therefore, it should be recognized that during periods that are shorter than one hour, transient wind events may cause the WTG power output to greatly exceed or fall far below the averages listed in Tables 5-4 and 5-5. This should not be a concern in this analysis because there is no break point in the analysis where short-term, high WTG output may exceed the load of either IMLD or the ISD, causing the excess power to be improperly valued.

Table 5-4. Estimated Hourly WTG Output (kWh) **Hub Height, m: 60**
Wind Turbine Generator (WTG): GE Model 1.5sle, 77-m diameter
Rated Power of WTG, kW 1500

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1	482.3	285.0	356.8	285.0	131.8	87.4	76.4	76.4	0.0	270.0	270.0	693.5	251.2
2	503.2	255.0	315.0	377.7	142.9	109.6	54.2	0.0	87.4	240.0	285.0	524.2	241.2
3	440.5	315.0	335.9	419.6	120.7	109.6	65.3	54.2	87.4	270.0	225.0	552.4	249.6
4	356.8	300.0	300.0	377.7	210.0	54.2	54.2	76.4	120.7	315.0	240.0	665.3	255.9
5	300.0	270.0	315.0	419.6	210.0	65.3	0.0	87.4	142.9	300.0	270.0	750.0	260.9
6	270.0	255.0	315.0	398.7	154.0	65.3	0.0	0.0	131.8	356.8	255.0	721.7	243.6
7	270.0	195.0	300.0	377.7	165.1	87.4	0.0	65.3	87.4	285.0	285.0	580.6	224.9
8	285.0	240.0	356.8	419.6	240.0	120.7	54.2	98.5	154.0	195.0	270.0	377.7	234.3
9	377.7	240.0	377.7	419.6	315.0	154.0	87.4	120.7	165.1	225.0	255.0	398.7	261.3
10	440.5	240.0	419.6	503.2	315.0	165.1	109.6	142.9	180.1	255.0	300.0	552.4	301.9
11	503.2	270.0	580.6	482.3	398.7	240.0	154.0	154.0	154.0	335.9	335.9	552.4	346.8
12	552.4	377.7	665.3	552.4	482.3	255.0	210.0	195.0	195.0	377.7	315.0	721.7	408.3
13	461.4	503.2	665.3	580.6	440.5	225.0	300.0	240.0	195.0	461.4	335.9	608.8	418.1
14	503.2	461.4	778.2	665.3	377.7	225.0	398.7	255.0	180.1	419.6	377.7	721.7	447.0
15	482.3	503.2	665.3	524.2	398.7	154.0	398.7	240.0	195.0	398.7	356.8	693.5	417.5
16	398.7	503.2	608.8	482.3	315.0	131.8	335.9	154.0	142.9	377.7	225.0	665.3	361.7
17	335.9	315.0	482.3	398.7	300.0	98.5	255.0	65.3	76.4	240.0	285.0	637.1	290.8
18	377.7	356.8	482.3	315.0	240.0	0.0	165.1	87.4	54.2	240.0	270.0	693.5	273.5
19	300.0	285.0	419.6	300.0	154.0	65.3	154.0	109.6	54.2	225.0	270.0	665.3	250.2
20	398.7	398.7	398.7	285.0	131.8	109.6	120.7	120.7	54.2	210.0	255.0	750.0	269.4
21	461.4	398.7	315.0	285.0	109.6	131.8	120.7	98.5	54.2	240.0	240.0	750.0	267.1
22	482.3	356.8	398.7	225.0	98.5	142.9	109.6	76.4	54.2	240.0	255.0	693.5	261.1
23	503.2	335.9	356.8	285.0	120.7	109.6	120.7	76.4	54.2	255.0	255.0	750.0	268.5
24	552.4	255.0	300.0	315.0	109.6	109.6	87.4	76.4	54.2	255.0	285.0	665.3	255.4
Mean	**418.3**	**329.8**	**437.9**	**403.9**	**236.7**	**125.7**	**143.0**	**111.3**	**111.4**	**291.2**	**279.9**	**641.0**	**294.2**
								Estimated Capacity Factor:					**0.196**

Table 5-5. Estimated Hourly WTG Output (kWh) **Hub Height, m:** 80
Wind Turbine Generator (WTG): GE Model 1.5sle, 77-m diameter
Rated Power of WTG, kW 1500

Hour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1	560.5	328.5	405.5	328.5	152.0	111.1	100.9	100.9	70.3	309.3	309.3	775.3	296.0
2	586.5	290.0	386.3	424.8	179.6	131.5	80.5	70.3	111.1	276.2	328.5	612.5	289.8
3	508.5	386.3	386.3	482.6	152.0	141.8	90.7	80.5	111.1	309.3	262.4	638.5	295.8
4	424.8	347.8	347.8	444.0	248.6	80.5	80.5	100.9	141.8	367.0	276.2	742.4	300.2
5	367.0	309.3	367.0	482.6	248.6	90.7	70.3	111.1	165.8	347.8	309.3	841.2	309.2
6	309.3	290.0	367.0	463.3	179.6	90.7	60.1	70.3	165.8	405.5	290.0	841.2	294.4
7	309.3	234.8	367.0	444.0	193.4	111.1	60.1	90.7	111.1	328.5	328.5	664.4	270.3
8	328.5	276.2	405.5	463.3	276.2	152.0	80.5	131.5	179.6	234.8	309.3	424.8	271.8
9	444.0	276.2	444.0	482.6	386.3	193.4	111.1	141.8	207.2	262.4	290.0	463.3	308.5
10	508.5	276.2	482.6	586.5	386.3	193.4	131.5	165.8	207.2	290.0	367.0	638.5	352.8
11	586.5	309.3	664.4	560.5	463.3	276.2	193.4	193.4	193.4	386.3	386.3	638.5	404.3
12	638.5	444.0	775.3	638.5	560.5	290.0	248.6	234.8	234.8	444.0	386.3	808.3	475.3
13	534.5	586.5	775.3	664.4	508.5	262.4	347.8	276.2	234.8	534.5	386.3	690.4	483.5
14	586.5	534.5	874.2	742.4	424.8	262.4	444.0	290.0	207.2	482.6	444.0	841.2	511.2
15	560.5	586.5	775.3	612.5	463.3	193.4	444.0	276.2	234.8	463.3	405.5	808.3	485.3
16	463.3	586.5	690.4	560.5	386.3	165.8	405.5	193.4	165.8	444.0	262.4	742.4	422.2
17	386.3	386.3	560.5	444.0	367.0	121.3	290.0	90.7	100.9	276.2	328.5	742.4	341.2
18	424.8	424.8	560.5	367.0	276.2	70.3	193.4	111.1	80.5	276.2	309.3	808.3	325.2
19	347.8	328.5	482.6	367.0	179.6	90.7	193.4	141.8	80.5	262.4	309.3	742.4	293.8
20	463.3	463.3	444.0	328.5	165.8	131.5	152.0	141.8	80.5	248.6	290.0	841.2	312.5
21	534.5	463.3	386.3	328.5	131.5	165.8	152.0	121.3	80.5	276.2	276.2	841.2	313.1
22	560.5	405.5	463.3	262.4	121.3	165.8	131.5	100.9	80.5	276.2	290.0	775.3	302.8
23	586.5	405.5	405.5	328.5	141.8	141.8	152.0	100.9	80.5	290.0	290.0	841.2	313.7
24	638.5	290.0	347.8	386.3	141.8	141.8	111.1	100.9	80.5	290.0	328.5	742.4	300.0
Mean	**485.8**	**384.6**	**506.9**	**466.4**	**280.6**	**157.3**	**180.2**	**143.2**	**141.9**	**336.7**	**323.5**	**729.4**	**344.7**
								Estimated Capacity Factor:					**0.230**

6. ECONMOMIC ANALYSIS

6.1. Value of WTG Power to IMLD and the Ipswich School District (ISD)

IMLD Power Costs. In Table 6-1, we have listed MMWEC projections of IMLD's average electricity costs through June 2009. We have used the average rate of IMLD costs increases from January through June 2009 to develop projections for IMLD's costs through the end of 2009 (see bottom of 3rd column in Table 6-1).

Table 6-1. Estimated Costs for IMLD Purchased Power Based on MMWEC Projections thru June 2009.

Assume Post-2009 Electricty Cost Increase/Yr, %: 2.5

Month	IMLD-MMWEC Projections Provided by IMLD, Year 2008	IMLD-MMWEC Projections Provided by IMLD, Year 2009	Percent Increase 2008 to 2009	WAVA Projections Year 2010
Jan	101.1	109.7	8.5%	112.4
Feb	101.4	113.3	11.7%	116.1
Mar	80.0	92.2	15.3%	94.5
Apr	84.4	88.2	4.5%	90.4
May	80.6	96.5	19.7%	98.9
June	91.8	100.6	9.6%	103.1
July	97.5	108.8		111.5
Aug	98.2	109.5		112.3
Sept	99.7	111.2		114.0
Oct	96.9	108.1		110.8
Nov	98.5	109.9		112.6
Dec	103.7	115.7		118.6

* Note: Use projections for year 2010 in analyses.

Estimates for July thru Dec. '09 based on average increase for Jan. thru June '09

For our analyses, we assume that if a WTG project proceeded in Ipswich it would come on line at the beginning of fiscal year 2010 (i.e., July 2010). However, based on convention, we have analyzed the project economics on a calendar-year basis. We believe that any inaccuracies due to differences between calendar and fiscal years are not material in terms of the economic projections. Therefore, in the right-hand column of Table 6-1, we have developed projections for the monthly average IMLD costs in CY2010 based on an assumption of a 2.5-percent annual cost increase over those costs projected for year 2009. In Table 6-2, we have listed our assumptions for the monthly average on-peak, off-peak and average IMLD electricity costs in year 2010. In Table 6-3, we have summarized the IMLD on-peak and off-peak schedule and the months with high and low electric loads. In our economic simulations (discussed below) we use the power costs and time-of-use schedule to estimate the value of the WTG electricity to IMLD.

Table 6-2. IMLD Projected Average Monthly Costs for Purchased Power in 2010, $/MWh

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
All-Hrs Costs	112.4	116.1	94.5	90.4	98.9	103.1	111.5	112.3	114.0	110.8	112.6	118.6
On-peak Costs	130.4	134.7	109.6	104.9	114.7	119.6	129.3	130.2	132.2	128.5	130.6	137.5
Off-peak Costs	95.6	98.7	80.3	76.8	84.1	87.6	94.8	95.4	96.9	94.2	95.7	100.8

Table 6-3. Ipswich Municipal Light Department Time-of-Use Periods

Key>>>: High Season: Low Season:

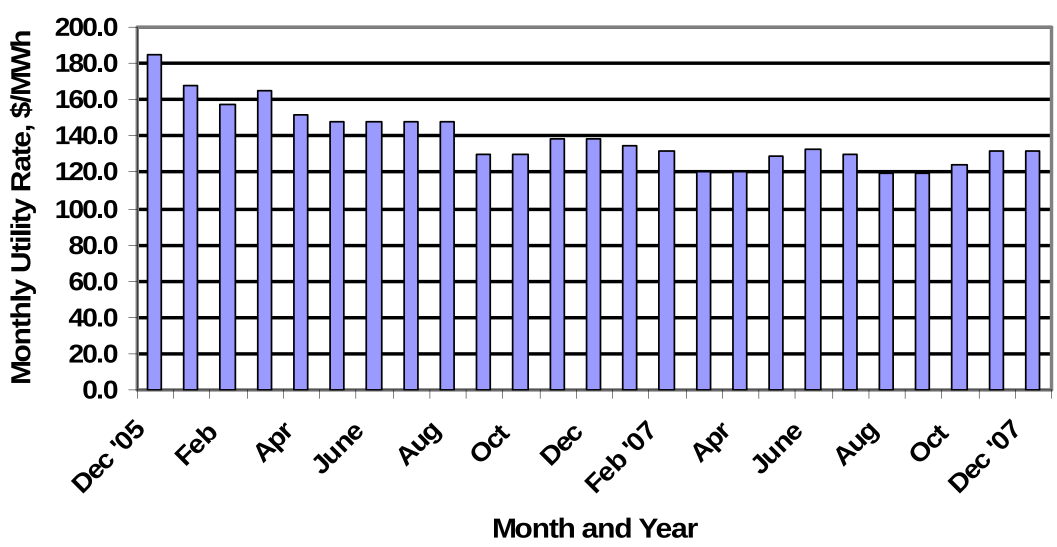
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

On-Peak Hours (all year): 7:00 am until 10:00 pm

Off-Peak Hours (all year): 10:00 pm until 7:00 am.

ISD Electricity Costs. To estimate ISD's future electricity costs, we rely on IMLD costs and the historic relationship between IMLD and ISD costs. In Figure 6-1, we have plotted the historic average monthly electric utility rates for the Ipswich School District (ISD, applicable to the Middle-High School) for calendar years 2006 and 2007. It is clear that the rates have decreased markedly during the period and appear to have nearly leveled out at costs in the range of $120 to $130 per MWh (i.e., 12 to 13 cents per kWh).

Figure 6-1. Historical Retail Electricity Costs for Ipswich Middle-High School, $/MWh



In Table 6-4, we have summarized the monthly usage and average costs for ISD and costs applicable to IMLD for year 2007. In the right-hand column of Table 6-4, we have computed the average monthly cost premium per MWh (over and above IMLD's costs) for electricity charged to ISD by IMLD during calendar year 2007. Based on these results, for our analyses we have assumed that the future ISD electricity costs are at a fixed premium of 43 percent greater than IMLD's costs – as shown in the bottom, right corner of Table 6-4.

Because IMLD does not apply time-of-use metering and billing to its customers, we have, therefore, assumed monthly average costs for power consumed by ISD, irrespective of the time of use. In Table 6-5, we have summarized our estimated average monthly electricity costs for ISD for the year 2010. Note such rates are estimated to be 43 percent greater than the IMLD rates for year 2010. After year 2010, for our 20-year cash flow analysis, we escalated monthly average rates at 2.5 percent per year for 20 years.

Table 6-4. ISD Electricity Consumption, Average Costs and Premium Paid/MWh Vs. IMLD Costs in 2007

Ipswich School District (ISD Electricity Costs					Electricity Costs	ISD Cost
Year	Month	Usage kWh	Billed Amount, $	ISD ($/MWh)	IMLD ($/MWh)	Premium Vs IMLD
2007	Jan '07	169,600	$22,858	134.8	87.0	55%
	Feb '07	147,600	$19,454	131.8	81.0	63%
	Mar	156,640	$18,921	120.8	74.0	63%
	Apr	149,440	$18,053	120.8	101.0	20%
	May	138,320	$17,887	129.3	93.0	39%
	June	134,960	$17,926	132.8	91.0	46%
	July	138,640	$17,998	129.8	88.0	48%
	Aug	146,400	$17,539	119.8	93.0	29%
	Sept	150,640	$18,047	119.8	82.0	46%
	Oct	165,360	$20,469	123.8	89.0	39%
	Nov	149,680	$19,728	131.8	88.0	50%
	Dec '07	156,480	$20,622	131.8	112.0	18%
Annual Tot or Avg:		**1,803,760**	**$229,502**	**127.3**	**89.9**	**43%**

Table 6-5. Estimated Avg. Monthly ISD Electricity Rates in Year 2010, $/MWh

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
All-Hrs Costs	160.8	166.1	135.1	129.3	141.4	147.5	159.4	160.6	163.0	158.4	161.1	169.6	**154.4**

In Tables 6-6 and 6-7, we have incorporated the variable electricity costs (in $/kWh) for IMLD and ISD, respectively, to produce an annual summary of the hourly average costs for each month of the year.

6.2. Annual Income from WTG Production (50th Percentile Projection)

We employed the WTG output on an hourly basis, averaged for each month (see Tables 5-4 and 5-5), and the value of the production for ISD and IMLD (Tables 6-6 and 6-7, respectively), to compute the gross revenue from WTG production for the average hour of each month for the average year.

<u>60-m Hub-Height Case</u>. In Tables 6-8 and 6-9, we have summarized the monthly and annual gross income projections for the case of a WTG with a 60-m hub height. In the case shown, we have allocated 51 percent of the gross revenue flow to IMLD and 49 percent to ISD – assuming that such percentages represent the portion of the total project funding derived from each entity (discussed in Section 7).

<u>80-m Hub-Height Case</u>. In Tables 6-10 and 6-11, we have summarized the gross revenue analysis for a GE Model 1.5sle with an 80-m hub height for the nominal ownership percentages based on the Meridian installed-cost estimate of $3.4 million. Due to the projection that ISD will contribute $1.6 million dollars (i.e., the bonding that is to be covered by CREBs) irrespective of WTG hub height, the ownership percentage for ISD is estimated to be 47 percent for the 80-m hub height WTG, where for the 60-m hub-height case applicable to Tables 6-8 and 6-9, the ISD ownership is projected to be 49 percent.

<u>Gross Revenue Variation by Ownership Percentage</u>. In Table 6-12, we have listed the gross revenues for each entity that are applicable for various percentages of ownership from 40 to 60 percent by each entity. In the footnotes to Table 6-12, we have provided simple equations by which the gross revenue for each entity can be obtained for any percentage of ownership for each hub height.

<u>Variations Due to Errors and Other Sources</u>. The estimates for each case that we have summarized in Table 6-12 are roughly the 50-th percentile of a distribution of possible inaccuracies and errors in the wind measurements combined with variations in such factors as WTG power curve, WTG availability, gross-to-net energy efficiencies, line losses, etc. The extreme limits (95-percent confidence interval) for such projections are approximately plus or minus 20 to 25 percent within a normal (bell-shaped) distribution. In addition to these possible variations, there will be inter-annual, year-to-year variations on the wind regime due to weather and climate phenomena. These factors also have roughly a normal distribution and will result in variations of on the order of plus or minus eight (8) to ten (10) percent variation about the means of the projected numbers listed above in Table 6-12.

6.3. WTG Long-Term Operation and Maintenance (O&M) Costs

To estimate the WTG long-term O&M costs, we applied our detailed, proprietary O&M model that is based on projected operations and scheduled maintenance costs. In addition, the cost model for unscheduled maintenance costs is driven by the mean time between failure (MTBF) of key components and the associated repair costs (including crane costs). Our failure-rate projections and repair costs are derived from our proprietary data base for this information that is based on work related to numerous wind farms in California, Texas and Minnesota . The model estimates WTG component failure rates using Weibull statistical methods and, thus, O&M costs increase in a non-linear manner in the latter years of a project (see "***Long-Term O&M Costs Based on Failure Rates and Repair Costs***", by W. A. Vachon, Windpower 2002, American Wind Energy Assoc. Conf., Portland, OR, June 2002).

Table 6-6. Projected Average of Cost of Power for IMLD Based on On-Peak and Off-Peak Schedule and Costs

Power costs are for year 2010 and have been developed from 2008 and 2009 estimates and 2.5% inflation factor.

Hour	Hourly Value of Wind-Generated Power for Each Hourly Time Block, Each Month, $/kWh												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
High Season>>	na	na	na	na	na	na	na	na	na	na	na	na	Avg.
1	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
2	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
3	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
4	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
5	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
6	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
7	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
8 (on peak)	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
9	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
10	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
11	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
12	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
13	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
14	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
15	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
16	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
17	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
18	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
19	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
20	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
21	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
22	0.1304	0.1347	0.1096	0.1049	0.1147	0.1196	0.1293	0.1302	0.1322	0.1285	0.1306	0.1375	**0.1252**
23 (off peak)	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
24	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	0.0956	**0.0956**
Average	**0.1173**	**0.1200**	**0.1043**	**0.1014**	**0.1075**	**0.1106**	**0.1166**	**0.1172**	**0.1185**	**0.1161**	**0.1175**	**0.1218**	**0.1141**

Table 6-7. Projected Average of Cost of Power for the ISD Based on IMLD Rate + Premium

Cost premium over and above IMLD costs of: **43%** Year 2010

Hourly Value of Power Purchased from IMLD for Each Hourly Time Block, Each Month, $/kWh

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
2	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
3	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
4	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
5	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
6	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
7	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
8	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
9	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
10	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
11	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
12	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
13	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
14	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
15	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
16	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
17	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
18	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
19	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
20	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
21	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
22	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
23	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
24	0.161	0.166	0.135	0.129	0.141	0.147	0.159	0.161	0.163	0.158	0.161	0.170	**0.154**
Average	**0.161**	**0.166**	**0.135**	**0.129**	**0.141**	**0.147**	**0.159**	**0.161**	**0.163**	**0.158**	**0.161**	**0.170**	**0.154**

Table 6-8. Total Value of Wind-Generated Power to IMLD By Monthly Time Block for Typical Day, $

GE Model 1.5sle, 1.5-MW WTG, 60-m (197-foot) hub height — Nominal Ownership Case

Estimated Installed Cost, K$: 3,266 — Portion of Gross Revenue Allocated to IMLD: 51%

Hourly Value of Power Sold to IMLD for Each Hourly Time Block, Each Month, $

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total $ Per Time Block
High Season>>	na	na	na	na	na	na	na	na	na	na	na	na	
1	23.50	13.89	17.39	13.89	6.42	4.26	3.72	3.72	-	13.16	13.16	33.80	**147**
2	24.52	12.43	15.35	18.41	6.96	5.34	2.64	-	4.26	11.70	13.89	25.54	**141**
3	21.47	15.35	16.37	20.45	5.88	5.34	3.18	2.64	4.26	13.16	10.97	26.92	**146**
4	17.39	14.62	14.62	18.41	10.24	2.64	2.64	3.72	5.88	15.35	11.70	32.42	**150**
5	14.62	13.16	15.35	20.45	10.24	3.18	-	4.26	6.96	14.62	13.16	36.55	**153**
6	13.16	12.43	15.35	19.43	7.50	3.18	-	-	6.42	17.39	12.43	35.17	**142**
7	13.16	9.50	14.62	18.41	8.04	4.26	-	3.18	4.26	13.89	13.89	28.29	**132**
8 (on peak)	18.95	16.49	19.95	22.45	14.04	7.36	3.57	6.54	10.38	12.78	17.98	26.49	**177**
9	25.12	16.49	21.11	22.45	18.43	9.39	5.77	8.02	11.13	14.75	16.99	27.96	**198**
10	29.29	16.49	23.45	26.92	18.43	10.07	7.23	9.49	12.14	16.71	19.98	38.74	**229**
11	33.47	18.55	32.45	25.80	23.32	14.64	10.15	10.22	10.38	22.01	22.37	38.74	**262**
12	36.74	25.95	37.19	29.55	28.21	15.56	13.85	12.95	13.15	24.76	20.98	50.61	**309**
13	30.69	34.57	37.19	31.06	25.77	13.73	19.78	15.94	13.15	30.24	22.37	42.69	**317**
14	33.47	31.70	43.50	35.59	22.10	13.73	26.29	16.93	12.14	27.50	25.16	50.61	**339**
15	32.08	34.57	37.19	28.04	23.32	9.39	26.29	15.94	13.15	26.13	23.77	48.63	**318**
16	26.51	34.57	34.03	25.80	18.43	8.04	22.15	10.22	9.63	24.76	14.99	46.65	**276**
17	22.34	21.64	26.96	21.33	17.55	6.01	16.82	4.33	5.15	15.73	18.98	44.67	**222**
18	25.12	24.51	26.96	16.85	14.04	-	10.88	5.81	3.65	15.73	17.98	48.63	**210**
19	19.95	19.58	23.45	16.05	9.01	3.98	10.15	7.28	3.65	14.75	17.98	46.65	**192**
20	26.51	27.39	22.28	15.25	7.71	6.69	7.96	8.02	3.65	13.77	16.99	52.59	**209**
21	30.69	27.39	17.61	15.25	6.41	8.04	7.96	6.54	3.65	15.73	15.99	52.59	**208**
22 ▼	32.08	24.51	22.28	12.04	5.76	8.72	7.23	5.07	3.65	15.73	16.99	48.63	**203**
23 (off peak)	24.52	16.37	17.39	13.89	5.88	5.34	5.88	3.72	2.64	12.43	12.43	36.55	**157**
24	26.92	12.43	14.62	15.35	5.34	5.34	4.26	3.72	2.64	12.43	13.89	32.42	**149**
Total $/Day	**602**	**495**	**567**	**503**	**319**	**174**	**218**	**168**	**166**	**415**	**405**	**953**	**4,985**
Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Total $/Month	**$ 18,670**	**$ 13,848**	**$ 17,566**	**$ 15,093**	**$ 9,890**	**$ 5,227**	**$ 6,771**	**$ 5,216**	**$ 4,980**	**$ 12,871**	**$ 12,150**	**$ 29,529**	**$ 151,812**

Table 6-9. Total Value of Wind-Generated Power to ISD By Monthly Time Block for Typical Day, $

GE Model 1.5sle, 1.5-MW WTG, 60-m (197-foot) hub height

Nominal Ownership Case

- Portion of Gross Revenue Allocated to ISD: 49%

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total $ Per Time Block
	Hourly Value for Power Used on Site or Sold for Each Hourly Time Block, Each Month, $												
1	38.05	23.18	23.60	18.02	9.11	6.30	5.95	6.02	0.00	20.90	21.30	57.77	230
2	39.70	20.74	20.84	23.88	9.87	7.90	4.22	0.00	6.98	18.58	22.48	43.66	219
3	34.75	25.62	22.22	26.52	8.34	7.90	5.09	4.27	6.98	20.90	17.75	46.01	226
4	28.15	24.40	19.85	23.88	14.51	3.90	4.22	6.02	9.64	24.39	18.94	55.42	233
5	23.67	21.96	20.84	26.52	14.51	4.70	0.00	6.90	11.41	23.23	21.30	62.47	238
6	21.30	20.74	20.84	25.20	10.64	4.70	0.00	0.00	10.53	27.63	20.12	60.12	222
7	21.30	15.87	19.85	23.88	11.40	6.30	0.00	5.15	6.98	22.07	22.48	48.36	204
8	22.48	19.52	23.60	26.52	16.58	8.69	4.22	7.77	12.30	15.10	21.30	31.47	210
9	29.80	19.52	24.99	26.52	21.76	11.09	6.81	9.52	13.18	17.42	20.12	33.21	234
10	34.75	19.52	27.76	31.81	21.76	11.89	8.54	11.27	14.38	19.74	23.67	46.01	271
11	39.70	21.96	38.41	30.49	27.54	17.29	12.00	12.15	12.30	26.01	26.50	46.01	310
12	43.58	30.73	44.01	34.92	33.32	18.37	16.36	15.39	15.58	29.25	24.85	60.12	366
13	36.40	40.93	44.01	36.70	30.43	16.21	23.37	18.94	15.58	35.72	26.50	50.72	376
14	39.70	37.53	51.48	42.05	26.10	16.21	31.06	20.12	14.38	32.48	29.80	60.12	401
15	38.05	40.93	44.01	33.13	27.54	11.09	31.06	18.94	15.58	30.86	28.15	57.77	377
16	31.45	40.93	40.27	30.49	21.76	9.49	26.17	12.15	11.41	29.25	17.75	55.42	327
17	26.50	25.62	31.91	25.20	20.73	7.10	19.87	5.15	6.10	18.58	22.48	53.07	262
18	29.80	29.02	31.91	19.91	16.58	0.00	12.86	6.90	4.33	18.58	21.30	57.77	249
19	23.67	23.18	27.76	18.96	10.64	4.70	12.00	8.65	4.33	17.42	21.30	55.42	228
20	31.45	32.43	26.37	18.02	9.11	7.90	9.40	9.52	4.33	16.26	20.12	62.47	247
21	36.40	32.43	20.84	18.02	7.57	9.49	9.40	7.77	4.33	18.58	18.94	62.47	246
22	38.05	29.02	26.37	14.22	6.81	10.29	8.54	6.02	4.33	18.58	20.12	57.77	240
23	39.70	27.32	23.60	18.02	8.34	7.90	9.40	6.02	4.33	19.74	20.12	62.47	247
24	43.58	20.74	19.85	19.91	7.57	7.90	6.81	6.02	4.33	19.74	22.48	55.42	234
Total Revenue, $	792	644	695	613	393	217	267	211	214	541	530	1,282	6,398
Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	365
Total $/Month	$ 24,552	$ 18,029	$ 21,550	$ 18,383	$ 12,169	$ 6,519	$ 8,288	$ 6,531	$ 6,408	$ 16,772	$ 15,897	$ 39,727	$ 194,825

Table 6-10. Total Value of Wind-Generated Power to IMLD By Monthly Time Block for Typical Day, $

GE Model 1.5sle, 1.5-MW WTG, 80-m hub height

Nominal Ownership Case

	Estimated Installed Cost, K$		3,400		- Portion of Gross Revenue Allocated to IMLD:								53%
	Hourly Value of Power Sold to IMLD for Each Hourly Time Block, Each Month, $												Total $ Per Time Block
Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
High Season>>	na	na	na	na	na	na	na	na	na	na	na	na	
1	28.39	16.64	20.54	16.64	7.70	5.63	5.11	5.11	3.56	15.66	15.66	39.27	180
2	29.70	14.69	19.56	21.51	9.09	6.66	4.08	3.56	5.63	13.99	16.64	31.02	176
3	25.75	19.56	19.56	24.44	7.70	7.18	4.59	4.08	5.63	15.66	13.29	32.33	180
4	21.51	17.61	17.61	22.49	12.59	4.08	4.08	5.11	7.18	18.59	13.99	37.60	182
5	18.59	15.66	18.59	24.44	12.59	4.59	3.56	5.63	8.39	17.61	15.66	42.60	188
6	15.66	14.69	18.59	23.46	9.09	4.59	3.04	3.56	8.39	20.54	14.69	42.60	179
7	15.66	11.89	18.59	22.49	9.79	5.63	3.04	4.59	5.63	16.64	16.64	33.65	164
8 (on peak)	22.70	19.72	23.56	25.76	16.79	9.63	5.52	9.08	12.58	15.99	21.41	30.96	214
9	30.69	19.72	25.79	26.83	23.48	12.26	7.62	9.78	14.52	17.87	20.07	33.76	242
10	35.15	19.72	28.03	32.61	23.48	12.26	9.01	11.44	14.52	19.75	25.40	46.53	278
11	40.53	22.08	38.60	31.16	28.16	17.51	13.25	13.34	13.55	26.31	26.74	46.53	318
12	44.13	31.70	45.04	35.50	34.07	18.38	17.04	16.20	16.45	30.24	26.74	58.90	374
13	36.94	41.87	45.04	36.94	30.91	16.63	23.83	19.06	16.45	36.40	26.74	50.32	381
14	40.53	38.16	50.78	41.28	25.82	16.63	30.43	20.01	14.52	32.86	30.74	61.30	403
15	38.74	41.87	45.04	34.05	28.16	12.26	30.43	19.06	16.45	31.55	28.07	58.90	385
16	32.02	41.87	40.11	31.16	23.48	10.51	27.79	13.34	11.61	30.24	18.16	54.10	334
17	26.70	27.58	32.56	24.69	22.31	7.69	19.87	6.26	7.07	18.81	22.74	54.10	270
18	29.36	30.33	32.56	20.41	16.79	4.46	13.25	7.67	5.64	18.81	21.41	58.90	260
19	24.03	23.45	28.03	20.41	10.92	5.75	13.25	9.78	5.64	17.87	21.41	54.10	235
20	32.02	33.08	25.79	18.26	10.08	8.34	10.41	9.78	5.64	16.93	20.07	61.30	252
21	36.94	33.08	22.44	18.26	8.00	10.51	10.41	8.37	5.64	18.81	19.12	61.30	253
22 ▼	38.74	28.95	26.91	14.59	7.38	10.51	9.01	6.96	5.64	18.81	20.07	56.50	244
23 (off peak)	29.70	20.54	20.54	16.64	7.18	7.18	7.70	5.11	4.08	14.69	14.69	42.60	191
24	32.33	14.69	17.61	19.56	7.18	7.18	5.63	5.11	4.08	14.69	16.64	37.60	182
Total $/Day	727	599	681	604	393	226	282	222	218	499	487	1,127	6,065
Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	365
Total $/Month	$ 22,522	$ 16,775	$ 21,125	$ 18,107	$ 12,175	$ 6,781	$ 8,741	$ 6,882	$ 6,554	$ 15,479	$ 14,603	$ 34,931	$ 184,676

Table 6-11. Total Value of Wind-Generated Power to ISD By Monthly Time Block for Typical Day, $
GE Model 1.5sle, 1.5-MW WTG, 80-m hub height

Nominal Ownership Case

- Portion of Gross Revenue Allocated to ISD: 47%

	Hourly Value for Power Used on Site or Sold for Each Hourly Time Block, Each Month, $												Total $ Per Time Block
Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
High Season>>	na	na	na	na	na	na	na	na	na	na	na	na	
1	42.41	25.63	25.73	19.92	10.07	7.68	7.54	7.64	5.39	22.97	23.40	61.95	260
2	44.38	22.63	24.51	25.76	11.90	9.09	6.02	5.32	8.51	20.51	24.86	48.94	252
3	38.48	30.14	24.51	29.26	10.07	9.79	6.78	6.09	8.51	22.97	19.86	51.01	257
4	32.14	27.13	22.07	26.92	16.47	5.56	6.02	7.64	10.86	27.26	20.90	59.32	262
5	27.77	24.13	23.29	29.26	16.47	6.27	5.25	8.41	12.70	25.83	23.40	67.21	270
6	23.40	22.63	23.29	28.09	11.90	6.27	4.49	5.32	12.70	30.12	21.94	67.21	257
7	23.40	18.32	23.29	26.92	12.81	7.68	4.49	6.86	8.51	24.40	24.86	53.09	235
8	24.86	21.55	25.73	28.09	18.30	10.50	6.02	9.95	13.76	17.44	23.40	33.94	234
9	33.60	21.55	28.17	29.26	25.60	13.36	8.30	10.73	15.87	19.49	21.94	37.02	265
10	38.48	21.55	30.62	35.56	25.60	13.36	9.83	12.54	15.87	21.54	27.77	51.01	304
11	44.38	24.13	42.16	33.98	30.70	19.08	14.45	14.63	14.81	28.69	29.23	51.01	347
12	48.31	34.64	49.20	38.71	37.15	20.04	18.58	17.77	17.99	32.98	29.23	64.58	409
13	40.45	45.76	49.20	40.29	33.70	18.13	25.99	20.90	17.99	39.69	29.23	55.17	416
14	44.38	41.70	55.47	45.01	28.15	18.13	33.18	21.94	15.87	35.83	33.60	67.21	440
15	42.41	45.76	49.20	37.13	30.70	13.36	33.18	20.90	17.99	34.40	30.69	64.58	420
16	35.06	45.76	43.81	33.98	25.60	11.45	30.31	14.63	12.70	32.98	19.86	59.32	365
17	29.23	30.14	35.56	26.92	24.32	8.38	21.67	6.86	7.73	20.51	24.86	59.32	296
18	32.14	33.14	35.56	22.25	18.30	4.86	14.45	8.41	6.17	20.51	23.40	64.58	284
19	26.32	25.63	30.62	22.25	11.90	6.27	14.45	10.73	6.17	19.49	23.40	59.32	257
20	35.06	36.15	28.17	19.92	10.99	9.09	11.36	10.73	6.17	18.46	21.94	67.21	275
21	40.45	36.15	24.51	19.92	8.72	11.45	11.36	9.18	6.17	20.51	20.90	67.21	277
22	42.41	31.64	29.40	15.91	8.04	11.45	9.83	7.64	6.17	20.51	21.94	61.95	267
23	44.38	31.64	25.73	19.92	9.39	9.79	11.36	7.64	6.17	21.54	21.94	67.21	277
24	48.31	22.63	22.07	23.42	9.39	9.79	8.30	7.64	6.17	21.54	24.86	59.32	263
Total Revenue,	**882**	**720**	**772**	**679**	**446**	**261**	**323**	**260**	**261**	**600**	**587**	**1,399**	**7,190**
Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Total $/Month	**$ 27,349**	**$ 20,163**	**$ 23,927**	**$ 20,360**	**$ 13,834**	**$ 7,825**	**$ 10,019**	**$ 8,063**	**$ 7,828**	**$ 18,604**	**$ 17,623**	**$ 43,360**	**$ 218,955**

Table 6-12. Summary of Annual Gross Revenue Projections for Range of Expected WTG Ownership By IMLD and ISD
(GE Model 1.5sle, 1.5-MW WTG)

	Year:	2010
	Hub Height, m	
	60	80
Gross Production/Yr (MWh)>>:	2,580	3,019
Ownership Percentage, IMLD	Gross Revenue/Yr, $	
IMLD 40.0%	119,068	139,378
45.0%	133,952	156,800
50.0%	148,835	174,223
Nominal Case Ownership:	(51 %) 151,812	(53%) 184,676
55.0%	163,719	191,645
60.0%	178,603	209,067
Ownership Percentage, ISD	Gross Revenue/Yr, $	
40.0%	159,041	186,344
45.0%	178,921	209,637
Nominal Case Ownership:	(49%) 194,825	(47 %) 218,955
ISD 50.0%	198,801	232,930
55.0%	218,681	256,223
60.0%	238,562	279,516

Notes: For other ownership percentages for 2 hub heights
(1) IMLD Gross revenue @ 60m = $297,671 x fractional ownership
(2) IMLD Gross revenue @ 80m = $348,445 x fractional ownership
(3) ISD Gross revenue @ 60m = $397,603 x fractional ownership
(4) ISD Gross revenue @ 80m = $465,861 x fractional ownership

In Tables 6-13 and 6-14, we have included the projected 20-year O&M costs, derived from the model and applied to the GE Model 1.5sle with a 60-m or 80-m hub height, respectively. We estimate that the annual O&M costs for a WTG with an 80-m hub height would be 3 percent greater per year (vs. a WTG with a 60-m hub height), but the output per year would be 17 percent greater (i.e., 3,019 MWh/year vs. 2,580 MWh/year). Thus, the net effect of using a WTG with an 80-m hub height is that the annual O&M costs per MWh would be approximately 89 percent of those for a WTG with a 60-m hub height.

The O&M cost projections shown assume a five-year warranty period, 2.5-percent inflationary cost increases in labor and parts each year, and nominal costs for site management and data reporting. The tables indicate the operations and scheduled maintenance costs as the first line and the unscheduled costs as the second line. The third line is the total of the operations, scheduled and unscheduled costs. The fourth line is the annual O&M cost divided by the nominal, projected net annual energy production for the Ipswich site. We have listed the levelized annual O&M costs for each case at the bottom of the table.

Two factors should be noted in Tables 6-13 and 6-14:

1) There are no unscheduled O&M costs in the first five years due to the assumed five-year warranty on the full installation (including balance of plant), the cost for which are assumed to be included in the purchase price of the WTG.

2) The unscheduled O&M costs begin in year six and become greater than the scheduled costs after year ten, when large, costly items such as the generator or gearbox need repairs or replacement.

Table 6-13. O&M Cost Projections by Year, single GE Model 1.5 sle, 60-m hub height (5-year warranty)

YEAR>>>>>>>>>>>>>>>>>>>>>>>>>>>>	1	2	3	4	5	6	7	8	9	10
Total Scheduled Maint. Cost/Yr, $	26,010	26,660	27,327	28,010	28,710	29,428	30,164	30,918	31,691	32,483
Total Unscheduled Maint. Cost/Yr, $	-	-	-	-	-	9,209	10,334	12,813	17,678	22,520
Total Maintenance Cost/Yr, k$	26,010	26,660	27,327	28,010	28,710	38,637	40,498	43,731	49,368	55,003
Tot. Annual Cost, $/MWh	10.08	10.33	10.59	10.86	11.13	14.98	15.70	16.95	19.14	21.32

YEAR>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	11	12	13	14	15	16	17	18	19	20
Total Scheduled Maint. Cost/Yr, $	33,295	34,127	34,981	35,855	36,751	37,670	38,612	39,577	40,567	41,581
Total Unscheduled Maint. Cost/Yr, $	26,533	30,010	32,789	38,264	42,482	42,791	44,926	47,944	50,086	51,821
Total Maintenance Cost/Yr, $	59,828	64,137	67,769	74,119	79,233	80,461	83,538	87,521	90,652	93,402
Tot. Annual Cost, $/MWh	23.19	24.86	26.27	28.73	30.71	31.19	32.38	33.92	35.14	36.20

Net Present Value of O&M Costs, $:	$569,844	Discount Rate:	6.00%
		Interest Rate:	4.50%
Levelized O&M Cost at 60-m, $/MWh	$43,807		

Cost Premium for 80-m vs 60 m hub height:	3.0%

Table 6-14. O&M Cost Projections by Year, single GE Model 1.5 sle, 80-m hub height (5-year warranty)

YEAR>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	1	2	3	4	5	6	7	8	9	10
Total Scheduled Maint. Cost/Yr, $	26,790	27,460	28,147	28,850	29,571	30,311	31,069	31,845	32,641	33,457
Total Unscheduled Maint. Cost/Yr, $	-	-	-	-	-	9,486	10,644	13,197	18,208	23,196
Total Maintenance Cost/Yr, k$	26,790	27,460	28,147	28,850	29,571	39,797	41,713	45,043	50,850	56,653
Tot. Annual Cost, $/MWh	8.87	9.10	9.32	9.56	9.80	13.18	13.82	14.92	16.84	18.77

YEAR>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	11	12	13	14	15	16	17	18	19	20
Total Scheduled Maint. Cost/Yr, $	34,294	35,151	36,030	36,931	37,854	38,800	39,770	40,765	41,784	42,828
Total Unscheduled Maint. Cost/Yr, $	27,329	30,910	33,772	39,412	43,756	44,075	46,274	49,382	51,588	53,376
Total Maintenance Cost/Yr, $	61,622	66,061	69,802	76,342	81,610	82,875	86,044	90,147	93,372	96,204
Tot. Annual Cost, $/MWh	20.41	21.88	23.12	25.29	27.03	27.45	28.50	29.86	30.93	31.87

Net Present Value of O&M Costs, $:	$586,939	Discount Rate:	6.00%
		Interest Rate:	4.50%
Levelized O&M Cost at 80-m, $/MWh	$45,122		

There may be some minimal IMLD costs for managing the site and the O&M provider's activities. Based on the projections indicated in the tables, and the economic assumptions listed, the levelized, annual O&M costs are $43,807 per year and $45,122 per year for the 60-m and 80-m hub-height WTGs, respectively. The projections that we have developed are estimates and will vary with several factors, the most important of which are the warranty costs and the contracted costs and provisions related to the O&M provider. Based on the current market conditions for WTGs, we estimate that annual O&M costs could vary by -10/+25% in the first eight to ten years of project life, but may vary by -20/+35% in the later years due to (a) the need for a large crane for major overhauls and (2) the potential that the O&M provider may have to travel a great distance to carry out major repair work.

7. SUMMARY OF ECONOMIC PROJECTIONS

In Tables 7-1 and 7-2, we have assembled the key 20-year cash flow projections for either a 60-m or 80-m hub-height WTG, respectively. The results are for the nominal ownership percentages applicable to IMLD and ISD that are listed in Tables 6-8 through 6-11. The right-hand column in each table summarizes the net cash flow after paying constant annual principal payments on the bonds for both entities and the interest on the bonds in the case of IMLD. There is a zero bond interest payment on the ISD bonds because the interest will be covered by the Clean Renewable Energy Bonds (CREBs) for which the ISD was approved – up to a bonding limit of $1.6M. The results that we show in Tables 7-1 and 7-2 assume that ISD funds the project at its bonding limit in each case.

The installed project costs were estimated at 3.4M$ by Meridian for a WTG with an 80-m hub height. We estimated that the installed cost of a WTG with a 60-m hub height would be approximately $3.24 million. This reduction is reflective of a less costly foundation, tower and installation crane. The percentage of the project that is allocated to ISD and IMLD varies with project cost, because we have assumed that ISD will pay $1.6-million of the project cost - irrespective of the total project cost.

The notes at the bottom-left portion of each table explain that the actual gross value of the wind-generated power to each entity is determined by the simulation that takes into account the hourly and monthly availability of the wind power and the applicable electricity cost structure for each entity.

Below each table (on the right) we have also computed the Net Present Value (NPV) of the project to each entity after taking account of O&M costs, interest on bonds (IMLD only), and principal payments on the bonds. Note the significantly higher value to the ISD portion of the project. This is due to two important factors that govern the economics for ISD:

1) The 43-percent (average) higher value of the power to ISD compared to IMLD, and

2) The inclusion of CREBs bond interest coverage by ISD.

8. CONCLUSIONS

We have reached the following conclusions:

Project Output and Value. The projected WTG energy levels and capacity factors for each hub height studied are reflective of a low wind-speed site. The data indicate that the site will produce modest amounts of energy. However, due to the fact that the energy offsets the retail purchase of power by the ISD, and the IMLD rates are relatively high and projected to go higher each year, the project could produce a high economic value.

Table 7-1. Summary of 20-Year Cash Flows for Joint IMLD-ISD Wind Power Project on Town Farm Road

Key Assumptions

WTG Production, MWh/Year		2,580	
Capital Costs:	ISD Share	$1,600,000	49%
	IMLD Share	$1,640,000	51%
	Total Cost, $	$3,240,000	
ISD Gross WTG Revenue/Year		$ 194,825	
IMLD Gross WTG Revenue/Year		$ 151,812	

60-meter (197-foot) hub height

WTG Type: General Electric (GE) Model 1.5sle, 1.5-MW unit with 77-m diameter.

WTG Hub Height:	60 meters
Value of Renewable Energy Certificates, $/kWh:	0.02
Net Present Value Based on Discount Rate of:	6.00%
Annual Inflation on Utility Rates:	2.50%
Interest Rate on 20-yr IMLD Bond:	5.0%

		Avg. Rates ($/kWh), Average Value of Wind Power to Each Entity (all-hours, rates) (1)		Annual Energy Production (kWh)			ISD Share of Energy Production Credited to		Annual Gross Economic Value of Wind Power			O&M Costs			ISD Payments on Bonds	IMLD Payments Bonds		Net Value to ISD (Cash Flow)	Net Value to IMLD (cash flow)
Project Year	Fiscal Year (2)	ISD	IMLD	Total	ISD Share (kWh)	IMLD Share (kWh)	Avoided Purchase (kWh)	Sales to IMLD	To ISD	To IMLD	Total Value to Town	Total Cost Per Year	ISD Share	IMLD Share	Principal (CREBs to cover interest)	Interest	Principal	Include CREBs, No RECs	No CREBs, No RECs
1	2009	Not Applicable		$0	$0	$0	$0	$0	$0	$0	$0	0	0	0	$80,000	$82,000	$82,000	-80,000	-$164,000
2	2010	$0.1544	$0.1141	2,580,000	1,274,074	1,305,926	1,274,074	0	$194,825	$151,812	$346,637	26,790	$ 13,230	$13,561	$80,000	77,900	$82,000	101,595	-$21,649
3	2011	$0.1583	$0.1170	2,580,000	1,274,074	1,305,926	1,274,074	0	$199,696	$155,607	$355,303	27,460	$ 13,561	$13,900	$80,000	73,800	$82,000	106,135	-$14,092
4	2012	$0.1622	$0.1199	2,580,000	1,274,074	1,305,926	1,274,074	0	$204,688	$159,497	$364,185	28,147	$ 13,900	$14,247	$80,000	69,700	$82,000	110,788	-$6,450
5	2013	$0.1663	$0.1229	2,580,000	1,274,074	1,305,926	1,274,074	0	$209,805	$163,485	$373,290	28,850	$ 14,247	$14,603	$80,000	65,600	$82,000	115,558	$1,282
6	2014	$0.1704	$0.1259	2,580,000	1,274,074	1,305,926	1,274,074	0	$215,050	$167,572	$382,622	29,571	$ 14,603	$14,968	$80,000	61,500	$82,000	120,447	$9,104
7	2015	$0.1747	$0.1291	2,580,000	1,274,074	1,305,926	1,274,074	0	$220,427	$171,761	$392,188	39,797	$ 19,653	$20,144	$80,000	57,400	$82,000	120,774	$12,217
8	2016	$0.1791	$0.1323	2,580,000	1,274,074	1,305,926	1,274,074	0	$225,937	$176,055	$401,993	41,713	$ 20,599	$21,114	$80,000	53,300	$82,000	125,338	$19,641
9	2017	$0.1835	$0.1356	2,580,000	1,274,074	1,305,926	1,274,074	0	$231,586	$180,457	$412,042	45,043	$ 22,243	$22,799	$80,000	49,200	$82,000	129,342	$26,457
10	2018	$0.1881	$0.1390	2,580,000	1,274,074	1,305,926	1,274,074	0	$237,375	$184,968	$422,344	50,850	$ 25,111	$25,739	$80,000	45,100	$82,000	132,264	$32,130
11	2019	$0.1928	$0.1425	2,580,000	1,274,074	1,305,926	1,274,074	0	$243,310	$189,592	$432,902	56,653	$ 27,977	$28,676	$80,000	41,000	$82,000	135,333	$37,916
12	2020	$0.1976	$0.1461	2,580,000	1,274,074	1,305,926	1,274,074	0	$249,392	$194,332	$443,725	61,622	$ 30,431	$31,192	$80,000	36,900	$82,000	138,962	$44,241
13	2021	$0.2026	$0.1497	2,580,000	1,274,074	1,305,926	1,274,074	0	$255,627	$199,190	$454,818	66,061	$ 32,623	$33,438	$80,000	32,800	$82,000	143,004	$50,952
14	2022	$0.2077	$0.1535	2,580,000	1,274,074	1,305,926	1,274,074	0	$262,018	$204,170	$466,188	69,802	$ 34,470	$35,332	$80,000	28,700	$82,000	147,548	$58,138
15	2023	$0.2128	$0.1573	2,580,000	1,274,074	1,305,926	1,274,074	0	$268,568	$209,275	$477,843	76,342	$ 37,700	$38,642	$80,000	24,600	$82,000	150,869	$64,032
16	2024	$0.2182	$0.1612	2,580,000	1,274,074	1,305,926	1,274,074	0	$275,283	$214,506	$489,789	81,610	$ 40,301	$41,309	$80,000	20,500	$82,000	154,981	$70,698
17	2025	$0.2236	$0.1653	2,580,000	1,274,074	1,305,926	1,274,074	0	$282,165	$219,869	$502,034	82,875	$ 40,926	$41,949	$80,000	16,400	$82,000	161,239	$79,520
18	2026	$0.2292	$0.1694	2,580,000	1,274,074	1,305,926	1,274,074	0	$289,219	$225,366	$514,585	86,044	$ 42,491	$43,553	$80,000	12,300	$82,000	166,728	$87,513
19	2027	$0.2349	$0.1736	2,580,000	1,274,074	1,305,926	1,274,074	0	$296,449	$231,000	$527,449	90,147	$ 44,517	$45,630	$80,000	8,200	$82,000	171,932	$95,170
20	2028	$0.2408	$0.1780	2,580,000	1,274,074	1,305,926	1,274,074	0	$303,861	$236,775	$540,635	93,372	$ 46,110	$47,262	$80,000	4,100	$82,000	177,751	$103,413

Net Present Value to ISD:	$1,299,609
Net Present Value to IMLD:	$140,501

Notes: (1) Computed value of wind power to each entity is related to when wind power is available and coincident, historic electric rates that vary each month (for ISD) and by time of use (monthly and daily) for IMLD. Thus, the avg. value of WTG power will not equal average rates listed in columns 3 and 4.

(2) Fiscal-year 2009 is from July 1, 2009 through June 30, 2010.

Table 7-2. Summary of 20-Year Cash Flows for Joint IMLD-ISD Wind Power Project on Town Farm Road

Key Assumptions

WTG Production, MWh/Year		3,019	
Capital Costs:	ISD Share	$1,600,000	47%
	IMLD Share	$1,800,000	53%
	Total Cost, $	$3,400,000	
ISD Gross WTG Revenue/Year		$ 218,955	
IMLD Gross WTG Revenue/Year		$ 184,676	

80-meter (262-foot) hub height

WTG Type: General Electric (GE) Model 1.5sle, 1.5-MW unit with 77-m diameter.	
WTG Hub Height:	80 meters
Value of Renewable Energy Certificates, $/kWh:	0.02
Net Present Value Based on Discount Rate of:	6.00%
Annual Inflation on Utility Rates:	2.50%
Interest Rate on 20-yr IMLD Bond:	5.0%

		Avg. Rates ($/kWh), Average Value of Wind Power to Each Entity (all-hours, rates) (1)		Annual Energy Production (kWh)			ISD Share of Energy Production Credited to		Annual Gross Economic Value of Wind Power			O&M Costs			ISD Payments on Bonds	IMLD Payments Bonds		Net Value to ISD (Cash Flow)	Net Value to IMLD (cash flow)
Project Year	Fiscal Year (2)	ISD	IMLD	Total	ISD Share (kWh)	IMLD Share (kWh)	Avoided Purchase (kWh)	Sales to IMLD	To ISD	To IMLD	Total Value to Town	Total Cost Per Year	ISD Share	IMLD Share	Principal (CREBs to cover interest)	Interest	Principal	Include CREBs, No RECs	No CREBs, No RECs
1	2009	Not Applicable		$0	$0	$0	$0	$0	$0	$0	$0	0	0	0	$80,000	$90,000	$90,000	-80,000	-$180,000
2	2010	$0.1544	$0.107	3,019,000	1,420,706	1,598,294	1,420,706	0	$218,955	$184,676	$403,631	26,790	$ 12,607	$ 14,183	$80,000	85,500	$90,000	126,348	-$5,007
3	2011	$0.1583	$0.1097	3,019,000	1,420,706	1,598,294	1,420,706	0	$224,429	$189,293	$413,722	27,460	$ 12,922	$ 14,538	$80,000	81,000	$90,000	131,506	$3,755
4	2012	$0.1622	$0.1124	3,019,000	1,420,706	1,598,294	1,420,706	0	$230,040	$194,025	$424,065	28,147	$ 13,245	$ 14,901	$80,000	76,500	$90,000	136,794	$12,624
5	2013	$0.1663	$0.1152	3,019,000	1,420,706	1,598,294	1,420,706	0	$235,791	$198,876	$434,666	28,850	$ 13,577	$ 15,274	$80,000	72,000	$90,000	142,214	$21,602
6	2014	$0.1704	$0.1181	3,019,000	1,420,706	1,598,294	1,420,706	0	$241,685	$203,848	$445,533	29,571	$ 13,916	$ 15,655	$80,000	67,500	$90,000	147,769	$30,692
7	2015	$0.1747	$0.1211	3,019,000	1,420,706	1,598,294	1,420,706	0	$247,727	$208,944	$456,671	39,797	$ 18,728	$ 21,069	$80,000	63,000	$90,000	149,000	$34,875
8	2016	$0.1791	$0.1241	3,019,000	1,420,706	1,598,294	1,420,706	0	$253,921	$214,168	$468,088	41,713	$ 19,630	$ 22,083	$80,000	58,500	$90,000	154,291	$43,584
9	2017	$0.1835	$0.1272	3,019,000	1,420,706	1,598,294	1,420,706	0	$260,269	$219,522	$479,790	45,043	$ 21,197	$ 23,846	$80,000	54,000	$90,000	159,072	$51,676
10	2018	$0.1881	$0.1304	3,019,000	1,420,706	1,598,294	1,420,706	0	$266,775	$225,010	$491,785	50,850	$ 23,929	$ 26,920	$80,000	49,500	$90,000	162,846	$58,589
11	2019	$0.1928	$0.1336	3,019,000	1,420,706	1,598,294	1,420,706	0	$273,445	$230,635	$504,080	56,653	$ 26,660	$ 29,993	$80,000	45,000	$90,000	166,785	$65,642
12	2020	$0.1976	$0.1370	3,019,000	1,420,706	1,598,294	1,420,706	0	$280,281	$236,401	$516,682	61,622	$ 28,999	$ 32,624	$80,000	40,500	$90,000	171,282	$73,277
13	2021	$0.2026	$0.1404	3,019,000	1,420,706	1,598,294	1,420,706	0	$287,288	$242,311	$529,599	66,061	$ 31,088	$ 34,974	$80,000	36,000	$90,000	176,200	$81,337
14	2022	$0.2077	$0.1439	3,019,000	1,420,706	1,598,294	1,420,706	0	$294,470	$248,369	$542,839	69,802	$ 32,848	$ 36,954	$80,000	31,500	$90,000	181,622	$89,915
15	2023	$0.2128	$0.1475	3,019,000	1,420,706	1,598,294	1,420,706	0	$301,832	$254,578	$556,410	76,342	$ 35,926	$ 40,416	$80,000	27,000	$90,000	185,906	$97,161
16	2024	$0.2182	$0.1512	3,019,000	1,420,706	1,598,294	1,420,706	0	$309,378	$260,942	$570,320	81,610	$ 38,405	$ 43,205	$80,000	22,500	$90,000	190,973	$105,237
17	2025	$0.2236	$0.1550	3,019,000	1,420,706	1,598,294	1,420,706	0	$317,112	$267,466	$584,578	82,875	$ 39,000	$ 43,875	$80,000	18,000	$90,000	198,112	$115,591
18	2026	$0.2292	$0.1588	3,019,000	1,420,706	1,598,294	1,420,706	0	$325,040	$274,153	$599,192	86,044	$ 40,491	$ 45,553	$80,000	13,500	$90,000	204,549	$125,100
19	2027	$0.2349	$0.1628	3,019,000	1,420,706	1,598,294	1,420,706	0	$333,166	$281,006	$614,172	90,147	$ 42,422	$ 47,725	$80,000	9,000	$90,000	210,744	$134,281
20	2028	$0.2408	$0.1669	3,019,000	1,420,706	1,598,294	1,420,706	0	$341,495	$288,032	$629,527	93,372	$ 43,940	$ 49,432	$80,000	4,500	$90,000	217,555	$144,099

Net Present Value to ISD:	$1,618,567
Net Present Value to IMLD:	$397,441

Notes: (1) Computed value of wind power to each entity is related to when wind power is available and coincident, historic electric rates that vary each month (for ISD) and by time of use (monthly and daily) for IMLD. Thus, the avg. value of WTG power will not equal average rates listed in columns 3 and 4.

(2) Fiscal-year 2009 is from July 1, 2009 through June 30, 2010.

The WTG. Because the GE Model 1.5sle WTG is appropriate for low wind speed sites (i.e., a large rotor diameter compared to its rated power and a good power curve), the annual capacity factors and revenue projections are greater than for several other candidate WTGs. A WTG with the 80-m hub height produces approximately 439 MWh more energy per year than a WTG with a 60-m hub height. For the nominal ownership case summarized in Table 6-12, on average the taller tower produces the estimated total annual revenue increase of $56,994, where $32,864 of the revenue increase can be allocated to IMLD and $24,130 of the increase to ISD. *Based on these estimates, the added tower height appears to have roughly a three-year simple payback.* Therefore, it will be necessary to examine carefully the WTG installed costs and other issues associated with the taller WTG - to assess whether the added revenue derived from the taller WTGs (and potentially greater permitting obstacles), justifies the added cost.

Long-Term Operation and Maintenance (O&M) Issues. We estimate that the WTGs considered can be maintained for an annual, levelized cost of approximately $43k to $46k ($16.67/MWh to $15.24/MWh) for the 60 and 80-m hub height WTGs, respectively.

9. RECOMMENDATIONS

We recommend the following:

1) As soon as possible, IMLD and ISD start to work closely with the MMWEC to secure access to a GE Model 1.5sle WTG at the most preferred pricing and availability.

2) Due to the tight schedule for CREBs availability, Ipswich should initiate detailed project planning within the various boards and town committees and establish the key parameters and requirements of the permitting process.

3) Determine how the Town will be able to incorporate any requirements for project bidding with the desire to work with MMWEC in obtaining a WTG.

4) Because pricing from the recommended suppliers may be high due to market conditions at the time of the bid, we recommend that IMLD also discuss the potential of a bid from Vestas (that supplied two WTGs at Hull, MA) or such other emerging WTG suppliers as Gamesa (from Spain, office in Pennsylvania) and Siemens (formerly Bonus, from Denmark), both of which supply WTGs in the size range discussed above. If Vestas is pursued, we recommend that the town focus on a Vestas Model V82, 1.65-MW WTG, which is reliable and well suited to the Ipswich wind regime.

5) In developing a procurement package, and/or negotiating with MMWEC and GE, the Town should seek a minimum three-year warranty on the WTG, tower and transformer (5 years is a maximum available, in general, and most desirable). The bids should provide an option to IMLD, with an associated price, that allows

IMLD, at the end of the warranty period, to have the supplier train at least three of its employees (or local personnel) to be capable of carrying out all routine (scheduled) O&M activities on the WTG – including carrying out all diagnostics and resets using an on-board SCADA system that reports to an IMLD monitoring center.

Appendix A –
SUMMARY OF WIND DATA MEASURED AT THE IPSWICH SITE BY UMASS

Table A-1: Mean Hourly Wind Speeds
Ipswich, MA

10-M Height agl **Wind Speed (mph)**

June 1, 2003 - May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Mean
----	----	----	----	----	----	---- -	----	---	----	----	----	----	----
1	8.7	6.5	7.5	6.3	5.3	4.1	4.5	4.1	3.3	5.8	6.4	8.5	5.9
2	9	7.1	7.1	6.5	5.2	4	3.8	3.6	3.7	5.6	6.7	8.3	5.9
3	8.4	7.1	6.9	7.1	4.8	3.8	3.9	3.5	3.7	5.6	6	8.4	5.7
4	8	7	6.5	6.7	5.5	3.1	3.6	3.7	3.9	6.1	6.1	8.7	5.7
5	7.5	6.7	6.7	7.2	5.5	3.4	3.7	3.8	4.2	5.7	6.5	8.9	5.8
6	6.9	6.6	6.7	7	5.8	4	4.1	3.9	4.2	6	6.5	9.1	5.9
7	7.1	6	6.8	7.3	5.8	4.5	4.6	4.7	4.3	5.8	6.9	8.4	6
8	7.9	6.8	7.3	7.9	6.9	4.8	5.1	5.2	5.1	6.1	7	8.1	6.5
9	9.2	7.4	8.1	8.3	7.7	5.6	5.7	5.4	5.6	6.9	7.2	8.3	7.1
10	9.5	7.5	8.6	8.7	7.7	5.5	6.2	6.2	6	7.4	7.7	9.5	7.5
11	9.9	8.3	9.8	8.8	8.3	6.6	6.8	6.4	5.8	8.3	8.1	9.5	8
12	10.3	8.4	10.4	9.5	9.2	6.8	7.4	6.5	6.5	8.7	8.3	10	8.5
13	9.9	9.6	10.2	9.6	9.1	6.9	7.9	7	6.4	8.7	8.3	9.4	8.6
14	10.3	9.4	10.7	10.1	8.7	7	8.5	7	6.1	8.6	8.5	10.1	8.7
15	9.9	9.6	10.3	9.5	8.7	6.1	8.3	7	6.6	8.1	7.8	9.9	8.5
16	9.3	9.1	9.9	9.1	7.9	5.9	8	6.1	6	7.8	6.5	9.1	7.9
17	8.1	7.7	8.9	8.1	7.6	5.4	6.8	4.7	4.5	6	6.9	8.9	7
18	8	7.5	8.5	7.1	6.8	4.3	5.9	4.1	3.5	5.8	6.8	9.3	6.5
19	7.7	6.6	8.2	6.9	5.5	4.3	5.2	4.5	3.5	5.8	6.6	9	6.1
20	8.3	7.7	7.8	6.6	4.8	4.7	4.7	4.5	3.5	5.2	6	9.4	6.1
21	8.6	7.9	7.4	6.6	4.6	4.7	4.6	4.3	3.6	5.7	6.6	9.5	6.2
22	8.4	7.5	8	6.2	5.1	4.7	4.7	4.4	3.6	5.7	6.8	9.1	6.2
23	9	7.1	7.5	6.1	5.1	4.6	4.7	3.9	3.4	5.7	6.6	9.1	6.1
24	9.1	6.5	7.5	6.7	5.2	4.3	4.3	4.2	3.7	5.9	7	9	6.1
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
Mean	8.7	7.6	8.2	7.7	6.5	5	5.5	5	4.6	6.5	7	9.1	6.8
Good Hours													
	721	682	743	720	743	720	744	744	720	744	720	721	
Missing Hrs													
	23	14	1	0	1	0	0	0	0	0	0	23	

8722 Hrs of good data 62 Hrs missing data 99.3% Data recovery

Table A-2: Mean Hourly Wind Speeds
Ipswich, MA

30-M Height agl **Wind Speed (mph)**

June 1, 2003 - May 31, 2004

Hour	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
1	12.4	9.9	11.4	10.6	8.4	7.6	7.3	7.4	6.7	10	10.3	13.6	9.6
2	12.7	10.2	11.2	11.2	8.7	7.9	6.8	6.8	7.3	9.7	10.4	12.9	9.6
3	12.1	10.8	10.8	11.7	8.3	7.8	7	6.9	7.4	10.1	9.4	13	9.6
4	11.4	10.5	10.5	11.3	9.3	6.8	6.7	7.1	8	10.8	9.8	13.8	9.6
5	10.8	10.2	10.8	12	9.3	6.9	6.8	7.4	8.4	10.3	10.2	14.1	9.7
6	10.4	9.8	10.8	12	8.9	7.3	6.8	6.9	8.4	10.7	10	14.1	9.7
7	10.5	9.1	10.7	11.8	9.1	7.8	7	7.6	7.5	10.3	10.6	13	9.6
8	10.7	9.7	11.5	12.1	10.3	8.5	7.5	8.2	8.9	9.4	10.5	11.6	9.9
9	12.1	10.2	11.9	12.2	11.3	9.2	7.9	8.5	9.2	10.1	10.3	11.8	10.4
10	12.7	10.4	12.4	12.9	11.3	9.2	8.5	8.9	9.4	10.5	11	13.4	10.9
11	13.3	11	13.7	12.8	12.1	10.3	9.3	9.4	9.1	11.5	11.4	13.3	11.4
12	13.6	11.7	14.4	13.5	12.8	10.6	10	9.7	9.7	11.9	11.4	14.4	12
13	12.8	13	14.2	13.5	12.6	10.2	11.1	0.2	9.7	12.6	11.5	13.6	12.1
14	12.9	12.6	15	14.2	11.8	10.2	12	0.4	9.4	12.2	11.8	14.4	12.2
15	12.9	13	14.4	13.2	12	9.2	12	0.3	9.7	12	11.4	14.3	12
16	12.1	12.6	13.8	12.8	11.3	8.9	11.6	9.2	9	11.7	10.1	13.9	11.4
17	11.2	11.1	12.9	11.8	11	8.2	10.3	7.4	7.7	10	10.6	13.6	10.5
18	11.6	11.3	12.6	10.9	10.2	7.1	9	7.5	7.1	9.7	10.5	13.9	10.1
19	10.8	10.3	12	10.8	8.8	7.3	8.7	7.9	6.9	9.6	10.4	13.6	9.7
20	11.8	11.5	11.6	10.6	8.4	8	8.1	7.9	6.9	9.4	9.9	13.9	9.8
21	12.2	11.5	10.9	10.4	8	8.4	7.9	7.5	6.9	9.8	9.8	14.3	9.8
22	12.4	11.1	11.7	9.9	8	8.2	7.8	7.3	6.9	9.9	10.2	13.9	9.8
23	12.7	10.7	11.2	10.4	8.1	8.1	8.1	7.2	6.9	9.8	10	14.4	9.8
24	13	10	11.7	10.8	8.3	7.8	7.3	7.2	7.1	10.1	10.6	13.6	9.8
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
Mean	12.1	10.9	12.2	11.8	9.9	8.4	8.6	8.1	8.1	10.5	10.5	13.6	10.4
Good Hrs	700	675	737	719	743	720	744	744	720	744	720	718	
Missing Hrs	44	21	7	1	1	0	0	0	0	0	0	26	

8684 Hrs of good data 100 Hrs missing data 98.9% Data recovery

Table A-3: Mean Hourly Wind Speeds
Ipswich, MA

30-M Height agl **Wind Speed (mph)**

June 1, 2003 - May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1	12.3	10.2	11.6	10.6	8.5	7.6	7.3	7.3	6.8	9.7	10.2	13.8	9.6
2	12.6	10.1	11.3	11.3	8.7	7.8	6.8	6.8	7.4	9.6	10.3	13	9.6
3	12.1	10.8	11.1	11.8	8.4	7.6	7	6.8	7.5	9.8	9.4	12.9	9.6
4	11.4	10.5	10.7	11.4	9.4	6.8	6.7	7.1	8.1	10.6	9.8	13.8	9.7
5	10.8	10.2	10.8	12.1	9.4	6.8	6.8	7.3	8.5	10.1	10.2	14	9.7
6	10.4	9.7	10.8	12	9	7.3	6.8	6.9	8.4	10.5	10	13.9	9.6
7	10.4	9.1	10.7	11.8	9.1	7.8	7	7.6	7.6	10.1	10.7	13	9.6
8	10.7	9.6	11.4	12.3	10.3	8.4	7.5	8.2	8.9	9.3	10.5	11.6	9.9
9	12.1	10	11.9	12.3	11.4	9.3	8	8.4	9.3	10	10.3	11.6	10.4
10	12.8	10.3	12.5	13	11.3	9.3	8.6	8.9	9.6	10.4	11	13.2	10.9
11	13.3	10.9	13.9	12.9	12.1	10.4	9.4	9.4	9.3	11.5	11.4	13.2	11.4
12	13.6	11.6	14.7	13.4	12.8	10.6	10	9.7	9.9	11.8	11.4	14.2	12
13	13	12.9	14.4	13.6	12.6	10.2	10.9	0.2	9.7	12.4	11.4	13.4	12.1
14	13	12.5	15	14.2	12	10.2	11.9	0.4	9.5	12.1	11.6	14.2	12.2
15	12.9	12.9	14.4	13.4	12.2	9.4	11.9	0.2	9.7	11.9	11.5	14.2	12
16	12.1	12.5	13.8	12.9	11.5	9	11.4	9.1	9	11.6	9.9	13.8	11.4
17	11.2	11.3	13.1	11.8	11.2	8.2	10.3	7.4	7.6	10	10.5	13.5	10.5
18	11.7	11.4	12.8	10.9	10.4	7.2	9.1	7.6	7.1	9.7	10.3	13.9	10.2
19	10.7	10.3	12.1	11	8.9	7.4	8.9	7.9	6.9	9.5	10.1	13.7	9.8
20	11.8	11.5	12	10.7	8.5	8.1	8.2	7.9	7	9.3	9.7	13.9	9.9
21	12.3	11.4	11.1	10.6	8.1	8.6	8	7.5	6.9	9.7	9.8	14.3	9.8
22	12.4	11	11.9	9.8	8	8.4	7.8	7.4	6.9	9.8	10.2	13.9	9.8
23	12.8	10.7	11.4	10.4	8.1	8.2	8.1	7.2	6.9	9.7	9.9	14.4	9.8
24	13	9.9	11.8	10.9	8.3	7.8	7.4	7.3	7.2	10	10.7	13.6	9.8
Mean	12.1	10.9	12.3	11.9	10	8.4	8.6	8.1	8.2	10.4	10.5	13.5	10.4
Good Hrs	700	674	743	720	742	718	741	743	720	743	719	718	
Missing Hrs	44	22	1	0	2	2	3	1	0	1	1	26	

8681 Hrs of good data 103 Hrs missing data 98.8% Data recovery

Table A-4: Mean Hourly Wind Speeds
Ipswich, MA

39-M Height agl **Wind Speed (mph)**

June 1, 2003 - May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Mean
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
1	13.6	11.6	12.4	11.7	9.4	8.7	8.5	8.5	7.8	11.4	11.5	15.2	10.8
2	13.9	11.3	12.1	12.6	9.7	9	8	7.8	8.6	11.1	11.6	14.1	10.8
3	13.3	12.1	12.2	13.1	9.3	9.1	8.3	8.1	8.7	11.4	10.8	14.3	10.9
4	12.5	11.8	11.8	12.7	10.6	8.1	8	8.4	9.2	12	11.1	15	10.9
5	11.9	11.4	12	13.1	10.6	8.2	7.9	8.6	9.6	11.8	11.4	15.6	11
6	11.5	11.2	12	12.9	9.8	8.3	7.7	7.9	9.5	12.4	11.3	15.5	10.8
7	11.5	10.5	11.9	12.7	10	8.6	7.7	8.3	8.7	11.7	11.7	14.5	10.6
8	11.6	11.1	12.4	13	11.1	9.3	8.1	8.9	9.8	10.5	11.5	12.6	10.8
9	12.7	11.1	12.7	13.1	12.1	9.9	8.6	9.2	10.1	10.9	11.2	12.9	11.2
10	13.3	11.1	13.1	13.9	12.1	10	9	9.6	10.2	11.3	11.9	14.3	11.6
11	13.8	11.4	14.5	13.7	12.9	11.1	9.9	9.9	9.9	12.2	12.2	14.2	12.1
12	14.3	12.7	15.1	14.3	13.6	11.3	10.6	0.4	10.5	12.7	12.1	15.4	12.7
13	13.5	13.9	15.1	14.4	13.3	10.8	11.8	1	10.4	13.4	12.2	14.7	12.9
14	13.8	13.5	15.8	15	12.6	10.8	12.8	1.2	10.2	13.1	12.7	15.5	13.1
15	13.7	13.8	15.1	14.1	12.9	9.9	12.8	1.1	10.4	12.9	12.4	15.3	12.9
16	12.9	13.8	14.7	13.7	12.1	9.5	12.3	9.9	9.6	12.7	10.9	15	12.3
17	12.2	12.1	13.7	12.8	11.9	8.8	11.2	8.2	8.4	11.1	11.7	14.9	11.4
18	12.6	12.5	13.7	12	11.1	7.9	10	8.6	8.1	11	11.5	15.3	11.2
19	11.8	11.6	13.1	11.9	9.8	8.3	9.9	9.1	8.1	10.8	11.4	15	10.9
20	12.9	12.9	12.8	11.7	9.5	9	9.3	9.2	8.1	10.7	11.2	15.6	11
21	13.5	12.9	12.1	11.7	9	9.5	9.3	8.8	8.1	11	11.1	15.6	11
22	13.7	12.4	12.9	10.9	8.8	9.6	9	8.4	8.1	11.1	11.3	15.2	10.9
23	13.9	12.3	12.4	11.7	9.2	9.1	9.3	8.5	8.1	11.2	11.2	15.6	11
24	14.2	11.3	11.8	12.1	9.1	9.1	8.6	8.4	8.1	11.3	11.7	15	10.9
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
Mean	13	12.1	13.1	12.9	10.8	9.3	9.5	9.1	9.1	11.7	11.6	14.8	11.4
Good Hrs	695	677	741	718	743	720	744	743	720	744	720	722	
Missing Hrs	49	19	3	2	1	0	0	1	0	0	0	22	

8687 Hrs of good data 97 Hrs missing data 98.9% Data recovery

Table A-5: Mean Hourly Values

Ipswich, Mass.
10-m Wind Direction

June 1, 2003 - May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Mean
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
1	259	247	225	207	229	209	259	218	224	232	238	260	234
2	263	271	230	218	221	213	245	241	217	241	241	243	237
3	250	277	214	208	215	220	252	231	236	237	255	240	236
4	265	248	221	219	201	216	254	223	222	234	258	242	233
5	267	270	218	198	219	216	245	218	183	240	224	239	228
6	245	288	204	182	197	221	252	230	176	240	227	245	225
7	264	277	203	185	196	209	256	202	176	242	251	221	223
8	270	271	211	178	192	191	230	215	155	243	265	236	221
9	263	262	195	182	206	193	219	207	155	248	249	270	221
10	249	200	187	160	185	179	209	211	158	242	203	258	204
11	281	206	190	163	196	190	213	201	155	232	208	231	206
12	279	215	183	176	191	182	201	215	161	231	229	219	207
13	267	249	187	192	205	182	226	214	162	230	213	241	214
14	276	271	190	189	204	186	222	215	176	219	195	234	215
15	279	272	193	179	198	177	223	214	176	218	206	235	214
16	287	274	199	174	205	197	226	220	188	206	212	232	218
17	296	271	196	190	208	190	225	229	192	236	222	236	224
18	289	270	197	198	202	205	227	218	202	234	218	242	225
19	282	281	208	181	177	208	231	228	216	256	217	243	227
20	285	272	221	180	197	211	229	233	218	233	237	255	231
21	266	286	228	215	192	226	224	241	238	267	256	261	241
22	249	265	234	223	204	240	235	235	229	243	256	257	239
23	272	251	233	218	230	235	238	246	222	234	258	237	239
24	251	227	213	206	221	232	244	251	243	237	257	261	237
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
Mean	269	259	208	193	204	205	233	223	195	237	233	243	225
Good Hrs													
	718	682	743	720	743	720	744	744	720	744	720	719	
Missing Hrs													
	26	14	1	0	1	0	0	0	0	0	0	25	

8717 Hrs of good data   67 Hrs missing data   99.2% Data recovery

Table A-6: Mean Hourly Values

Ipswich, Mass.
30-m Wind Direction

June 1, 2003 - May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Mean
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
1	284	259	229	188	220	217	247	229	203	245	235	268	235
2	279	263	232	186	225	216	238	236	204	247	246	265	236
3	282	259	221	213	187	222	243	192	201	247	259	264	232
4	265	251	217	213	202	204	244	231	206	243	245	259	231
5	288	253	212	202	202	201	244	204	187	243	205	257	224
6	263	256	202	183	189	197	255	207	179	242	238	255	222
7	295	281	200	177	189	195	244	201	179	244	236	241	223
8	311	272	203	179	193	189	217	215	143	244	239	242	220
9	274	253	186	186	207	192	220	200	151	238	196	259	213
10	273	211	200	153	187	177	210	211	157	245	206	253	207
11	273	210	192	166	196	190	214	211	152	233	201	233	206
12	271	206	186	180	192	179	202	216	160	232	208	223	205
13	261	252	189	196	207	182	225	205	159	231	203	243	213
14	279	263	193	191	194	186	222	218	168	219	198	247	215
15	270	264	195	181	200	168	224	215	176	208	209	238	212
16	270	265	201	165	217	185	226	222	190	209	215	224	216
17	293	264	199	206	207	181	227	220	191	227	216	251	223
18	293	252	200	192	192	193	228	220	206	227	203	239	220
19	292	276	212	176	177	206	233	213	217	238	211	252	225
20	279	266	214	180	201	211	233	215	210	227	216	263	226
21	280	290	235	221	204	223	225	248	197	229	231	265	237
22	257	268	240	215	193	237	230	217	213	228	242	266	233
23	288	255	237	209	213	227	242	215	206	241	242	256	236
24	275	229	236	200	227	225	240	225	208	224	227	271	232
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
Mean	279	255	210	190	201	200	231	216	186	234	222	251	222
Good Hrs	700	674	742	720	742	720	744	743	719	744	720	718	
Missing Hrs	44	22	2	0	2	0	0	1	1	0	0	26	

8686 Hrs of good data 98 Hrs missing data 98.9% Data recovery

Table A-7: Mean Hourly Values

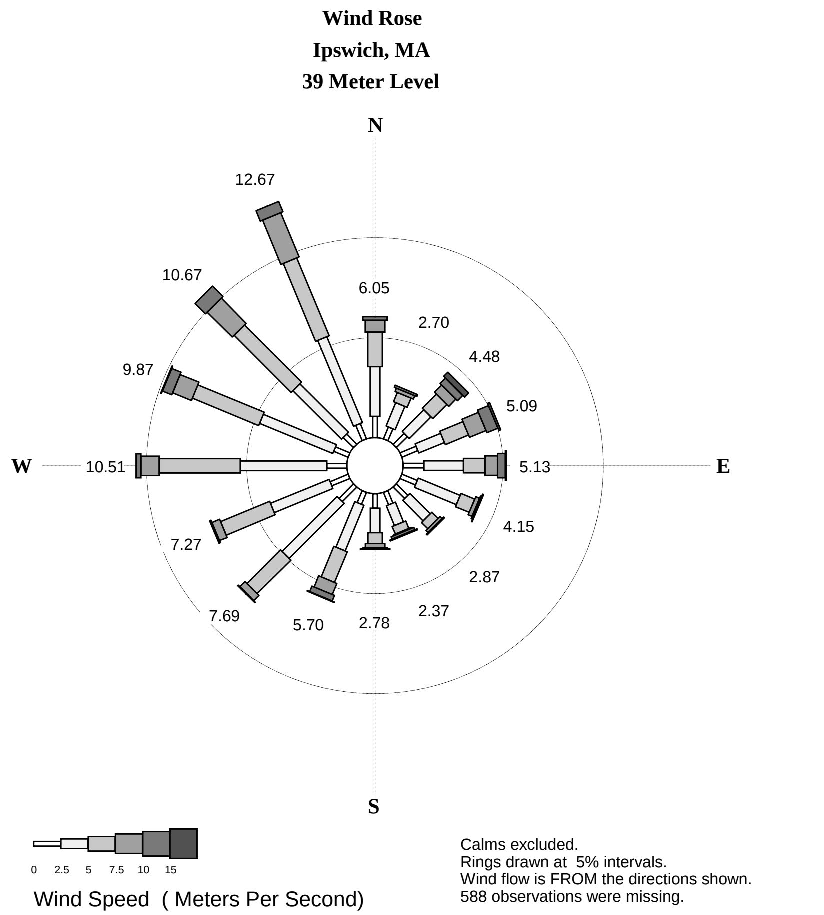
Ipswich, Mass.
39-m Wind Direction

June 1, 2003 - May 31, 2004

Hour	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Mean
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
1	292	270	232	188	227	214	234	222	193	244	222	269	233
2	278	271	223	175	213	205	227	237	189	248	246	266	231
3	281	259	208	214	188	213	241	200	203	247	236	254	228
4	265	263	208	213	198	203	243	208	184	243	233	261	226
5	287	254	212	197	202	201	244	193	176	239	208	249	221
6	262	256	201	190	189	196	254	206	170	243	227	246	219
7	295	281	197	177	190	182	221	205	168	244	214	240	217
8	310	272	202	178	191	176	216	214	142	243	239	253	218
9	261	250	185	186	206	191	218	199	150	236	219	258	213
10	269	207	199	152	186	176	208	209	156	243	205	239	204
11	269	206	190	165	195	189	212	210	156	231	200	232	204
12	268	230	185	179	190	177	212	214	159	231	207	222	206
13	257	251	188	183	206	180	223	204	158	230	202	241	210
14	284	261	192	190	193	185	220	216	166	217	197	246	214
15	280	263	194	180	199	166	222	213	176	206	208	236	212
16	290	264	199	176	204	183	224	220	188	207	211	223	215
17	293	276	198	204	194	178	225	219	195	226	214	249	222
18	292	250	198	191	189	191	225	218	204	226	206	238	219
19	292	275	211	175	185	204	231	213	215	237	211	250	225
20	280	265	213	178	199	209	207	202	208	226	203	264	221
21	280	289	234	209	201	220	211	228	196	228	232	264	232
22	257	267	234	204	192	221	221	221	210	228	243	265	230
23	288	257	232	208	211	222	250	214	218	241	243	255	236
24	274	232	217	201	221	236	237	218	210	225	239	269	232
----	----	----	----	----	----	----	---- -	---	----	----	----	----	----
Mean	279	257	206	188	199	197	226	213	183	233	219	250	220
Good Hrs													
	694	677	744	718	742	720	744	744	719	744	720	722	
Missing Hrs													
	50	19	0	2	2	0	0	0	1	0	0	22	

8688 Hrs of good data 96 Hrs missing data 98.9% Data recovery

Figure A-1:



PERCENT OCCURRENCE: Wind Speed (Meters Per Second)
LOWER BOUND OF CATEGORY

DIR	0	2.5	5	7.5	10	15
N	1.06	2.49	1.74	0.58	0.18	0.00
NNE	0.65	1.27	0.49	0.18	0.10	0.00
NE	0.77	1.52	1.00	0.52	0.36	0.30
ENE	0.86	1.39	1.25	0.89	0.60	0.10
E	1.03	1.97	1.08	0.63	0.39	0.05
ESE	0.83	2.26	0.74	0.22	0.06	0.05
SE	0.81	1.44	0.44	0.13	0.05	0.00
SSE	0.67	1.06	0.41	0.05	0.13	0.05

TOTAL OBS = 52116 MISSING OBS = 588

PERCENT OCCURRENCE: Wind Speed (Meters Per Second)
LOWER BOUND OF CATEGORY

DIR	0	2.5	5	7.5	10	15
S	0.72	1.23	0.55	0.20	0.07	0.02
SSW	0.64	2.47	1.66	0.60	0.31	0.02
SW	1.02	3.88	2.38	0.37	0.03	0.00
WSW	0.97	3.16	2.65	0.41	0.07	0.00
W	0.99	4.32	4.05	0.91	0.23	0.00
WNW	0.79	3.94	3.59	1.00	0.51	0.04
NW	0.72	3.42	4.04	1.77	0.72	0.00
NNW	0.84	4.65	4.22	2.40	0.57	0.00

CALM OBS = 0

Appendix B:
Derived and Other Data Employed in Projecting WTG Production
Table B-1: Logan Airport Wind Speed Measurements
(for correlation and scaling to a long-term average)

Monthly Average Wind Speeds (mph)

Logan Airport

	2000	2001	2002	2003	2004	2005	Average
Jan		10.1	11.7	13.3	13.8	12.3	12.2
Feb	12.1	12.6	11.5	12.3	11.9	10.8	11.9
Mar	12.7	13.5	11.3	11.4	12.7	12.2	12.3
Apr	13.4	10.9	11.8	12.3	12.3	11.3	12.0
May	11.2	11.3	12.1	10	10.6	11.5	11.1
Jun	10.8	10.1	11	9	10.2	9.7	10.1
Jul	10.3	10	10.7	9.7	9.2		10.0
Aug	9.7	9.4	10.2	9.2	9.6		9.6
Sep	10.3	10	10.4	8.8	9.8		9.9
Oct	11.1	12.7	11.4	10.9	11		11.4
Nov	10.9	12	12.5	10.6	11.2		11.4
Dec	13	12.3	12.8	13.6	12.5		12.8
Ann							11.23

Average, June 1, ‘03 - May 31, ‘04: 11.09167

Ratio: Long_term avg/12-mo avg.: 1.012898

....where data in yellow are coincident with UMass, Ipswich measurement period

Adjustment Factor from UMass Avg. to LT Avg. = 1.2%

Table B-2. IMLD On-Peak and Off-Peak Monthly Schedule

Assumptions

(1) Avg. Days per month: 30.42

(2) Average weeks per month: 4.35

Hour	Hrs per Avg. Month in Hr Block	On-Peak Hrs/Month	Off-Peak Hrs/Month	% on-Peak
1	30.42	0.00	30.42	0.0%
2	30.42	0.00	30.42	0.0%
3	30.42	0.00	30.42	0.0%
4	30.42	0.00	30.42	0.0%
5	30.42	0.00	30.42	0.0%
6	30.42	0.00	30.42	0.0%
7	30.42	0.00	30.42	0.0%
8	30.42	21.73	8.69	71.4%
9	30.42	21.73	8.69	71.4%
10	30.42	21.73	8.69	71.4%
11	30.42	21.73	8.69	71.4%
12	30.42	21.73	8.69	71.4%
13	30.42	21.73	8.69	71.4%
14	30.42	21.73	8.69	71.4%
15	30.42	21.73	8.69	71.4%
16	30.42	21.73	8.69	71.4%
17	30.42	21.73	8.69	71.4%
18	30.42	21.73	8.69	71.4%
19	30.42	21.73	8.69	71.4%
20	30.42	21.73	8.69	71.4%
21	30.42	21.73	8.69	71.4%
22	30.42	21.73	8.69	71.4%
23	30.42	21.73	8.69	71.4%
24	30.42	0.00	30.42	0.0%