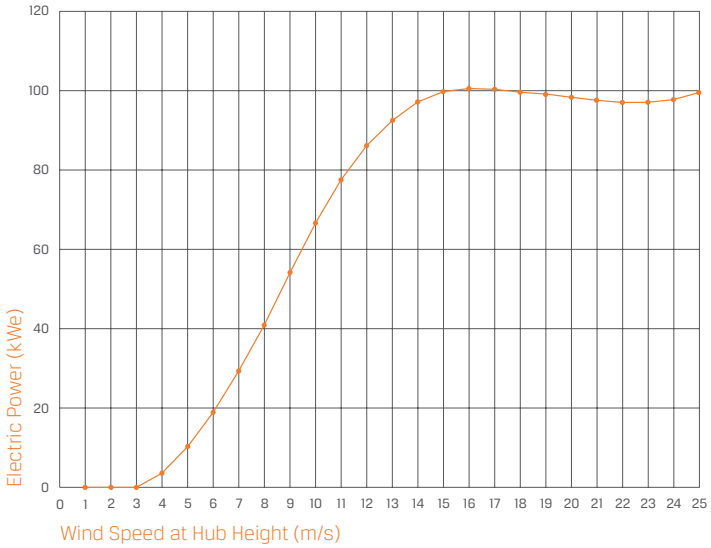
APPENDIX A

Turbine Specifications

Northwind® 100

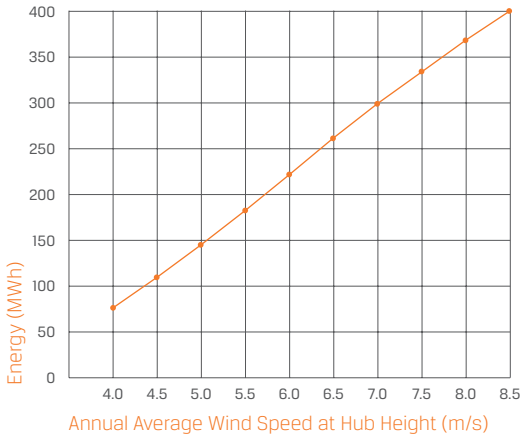
Power Curve: 21-Meter Rotor Standard Air Density (1.225 kg/m³)



Wind Speed (m/s)	Power (kWe)	Wind Speed (m/s)	Power (kWe)
1	0	14	97.3
2	0	15	100.0
3	0	16	100.8
4	3.7	17	100.6
5	10.5	18	99.8
6	19.0	19	99.4
7	29.4	20	98.6
8	41.0	21	97.8
9	54.3	22	97.3
10	66.8	23	97.3
11	77.7	24	98.0
12	86.4	25	99.7
13	92.8		

1 m/s = 2.24 mph

Annual Energy Production*: 21-Meter Rotor Standard Air Density, Rayleigh Wind Speed Distribution



Average Annual Wind Speed (mph)	Average Annual Wind Speed (m/s)	Annual Energy Output (MWh/yr)
8.9	4.0	77
10	4.5	110
11	5.0	145
12	5.5	183
13	6.0	222
15	6.5	260
16	7.0	298
17	7.5	334
18	8.0	368
19	8.5	400

*Annual energy production estimates assume standard conditions, 100% availability and no losses.

Northern POWER SYSTEMS

Specifications

GENERAL CONFIGURATION	DESCRIPTION
Model	Northwind 100
Design Class	IEC IIA (air density 1.225 kg/m^3, average annual wind below 8.5 m/s, 50-yr peak gust below 59.5 m/s)
Design Life	20 years
Hub Height	37 m (121 ft) / 30 m (98 ft)
Tower Type	Tubular steel monopole
Orientation	Upwind
Rotor Diameter	21 m (69 ft)
Power Regulation	Variable speed, stall control
Certifications	UL1741, UL1004-4, CSA C22.2 No.107.1-01, CSA C22.2 No. 100.04, and CE compliant

PERFORMANCE	DESCRIPTION (standard conditions: air density of 1.225 kg/m^3, equivalent to 15°C (59°F) at sea level)
Rated Electrical Power	100 kW, 3 Phase, 480 VAC, 60/50 Hz
Rated Wind Speed	14.5 m/s (32.4 mph)
Maximum Rotation Speed	59 rpm
Cut-In Wind Speed	3.5 m/s (7.8 mph)
Cut-Out Wind Speed	25 m/s (56 mph)
Extreme Wind Speed	59.5 m/s (133 mph)

WEIGHT	DESCRIPTION
Rotor (21-meter)	1,400 kg (3,100 lbs)
Nacelle (standard)	5,800 kg (13,000 lbs)
Tower (37-meter)	13,800 kg (30,000 lbs)

DRIVE TRAIN	DESCRIPTION
Gearbox Type	No gearbox (direct drive)
Generator Type	Permanent magnet, passively cooled

BRAKING SYSTEM	DESCRIPTION
Service Brake Type	Two motor-controlled calipers
Normal Shutdown Brake	Generator dynamic brake and two motor-controlled calipers
Emergency Shutdown Brake	Generator dynamic brake and two spring-applied calipers

YAW SYSTEM	DESCRIPTION
Controls	Active, electromechanically driven with wind direction/speed sensors and automatic cable unwind

CONTROL/ELECTRICAL SYSTEM	DESCRIPTION
Controller Type	DSP-based multiprocessor embedded platform
Converter Type	Pulse-width modulated IGBT frequency converter
Monitoring System	SmartView remote monitoring system, ModBus TCP over ethernet
Power Factor	Set point adjustable between 0.9 lagging and 0.9 leading
Reactive Power	+/- 45 kVAR

NOISE	DESCRIPTION
Apparent Noise Level	Less than 55 dBA at the base of the tower

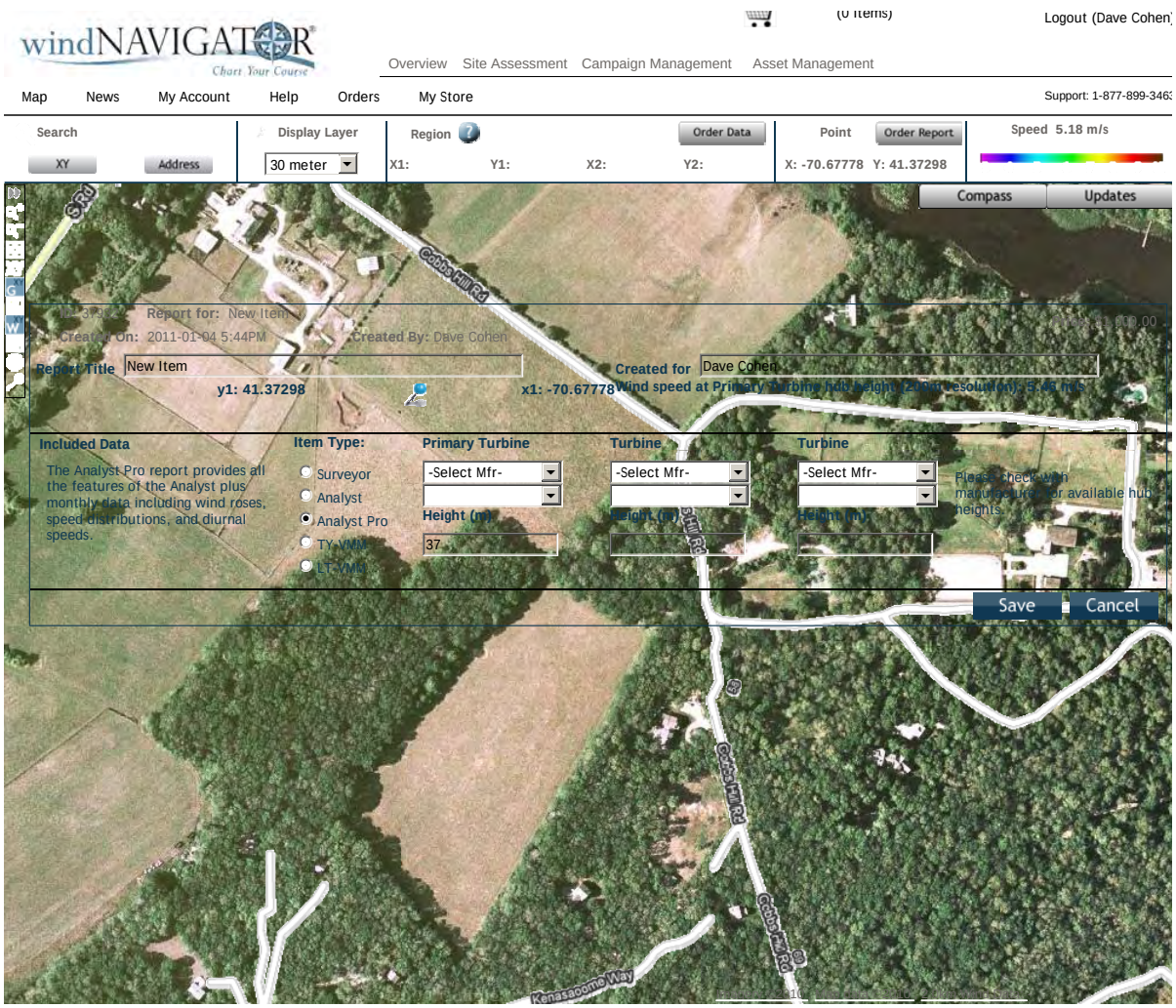
ENVIRONMENTAL SPECIFICATIONS	DESCRIPTION
Temperature Range: Operational	-20°C to 50°C (-4°F to 122°F)
Temperature Range: Storage	-40°C to 55°C (-40°F to 131°F)
IP Class: Generator/Nacelle	IP55/IP54
Lightning Protection	Receptors in blades, nacelle lightning rod and electrical surge protection
Icing Protection	Turbine designed in accordance with Germanischer Lloyd Wind Guidelines Edition 2003

All Specifications subject to change without notice.

SS-090901-01

Northwind is a registered trademark of Northern Power Systems.

Wind Speed Data from WindNavigator


windNAVIGATOR
Chart Your Course
(0 items)
Logout (Dave Cohen)
Overview
Site Assessment
Campaign Management
Asset Management
Map
News
My Account
Help
Orders
My Store
Support: 1-877-899-3463
Search
XY
Address
Display Layer
30 meter
Region
X1:
Y1:
X2:
Y2:
Order Data
Point
Order Report
X: -70.67778 Y: 41.37298
Speed 5.18 m/s
Compass
Updates
Cobbs Hill Rd
Report for: New Item
Created On: 2011-01-04 5:44PM
Created By: Dave Cohen
Report Title
New Item
y1: 41.37298
x1: -70.67778
Created for
Dave Cohen
Included Data
The Analyst Pro report provides all the features of the Analyst plus monthly data including wind roses, speed distributions, and diurnal speeds.
Item Type:
Surveyor
Analyst
Analyst Pro
TY-VMS
LT-VMS
Primary Turbine
-Select Mfr-
Height (m)
37
Turbine
-Select Mfr-
Height (m)
Turbine
-Select Mfr-
Height (m)
Please check with manufacturer for available hub heights.
Save
Cancel
Kenasaoome Way

WindPRO Report (N100 30m)

Project:
Grey Barn Farm Resource Assessment

Description:
Verification of existing wind energy resource calculations

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METEO - Main Result

Calculation: N100 (30m) AEP

Name AWS Meteo

Site Coordinates
UTM NAD 83 Zone: 19 East: 359,676 North: 4,581,533

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.244 kg/m³
Air density relative to standard	101.6 %
Hub altitude above sea level (asl)	30.0 m
Annual mean temperature at hub alt.	9.5 °C
Pressure at WTGs	1,009.6 hPa

Calculation is based on "AWS Meteo", giving the Weibull distribution for the wind speed on the site.
Using the selected power curve, the expected annual energy production is calculated.

Weibull data 30 m above ground level

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]	Wind gradient exponent
0 0	5.85	5.18	2.330	100.0	0.300
All	5.85	5.18	2.330	100.0	

Calculation Results

Key results for height 30.0 m above ground level
Wind energy: 1,261 kWh/m²; Mean wind speed: 5.2 m/s;

Calculated Annual Energy

WTG type						Power curve		Annual Energy			
Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Result [MWh]	Result-13.0% [MWh]	Mean wind speed [m/s]	Capacity factor [%]
No	Northern Power Systems	Northwind 100-100	100	21.0	30.0	USER	N100 Power Curve	154.1	134	5.18	17.6

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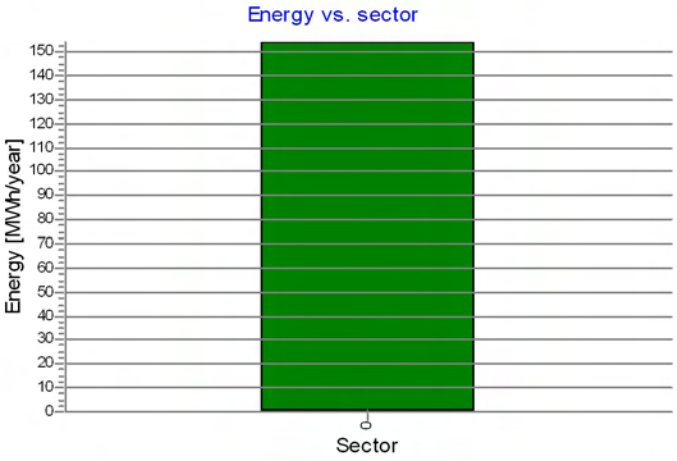
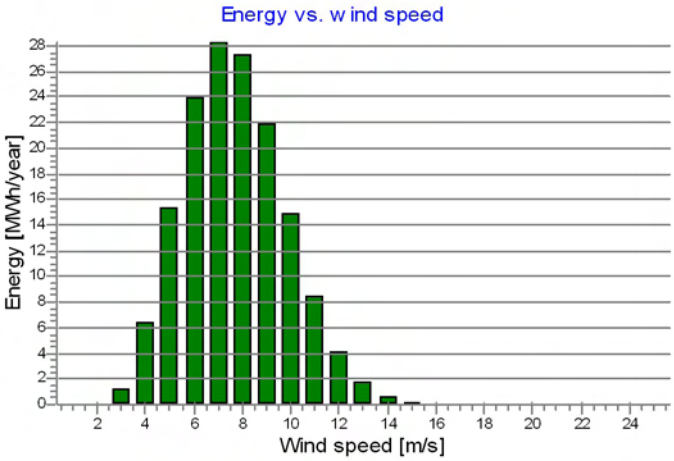
METEO - Production Analysis

Calculation: N100 (30m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O!, Hub height: 30.0 m, Air density: 1.244 kg/m³

Directional Analysis

Sector		0 0	Total
Roughness based energy	[MWh]	154.1	154.1
Resulting energy	**[MWh]**	**154.1**	**154.1**
Specific energy	[kWh/m²]		445
Specific energy	[kWh/kW]		1,541
Directional Distribution	[%]	100.0	100.0
Utilization	[%]	35.3	35.3
Operational	[Hours/year]	7,092	7,092
Full Load Equivalent	[Hours/year]	1,541	1,541
A- parameter	[m/s]	5.8	5.8
Mean wind speed	[m/s]	5.2	5.2
k- parameter		2.33	2.33
Frequency	[%]	100.0	100.0
Power density	[W/m²]		144





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Description:
Verification of existing wind energy resource calculations

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METEO - Power Curve Analysis

Calculation: N100 (30m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve, Hub height: 30.0 m

Name: N100 Power Curve
Source: Northern Power Systems

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
1/1/2011	USER	1/5/2011	1/5/2011	25.0	Stall	Standard stall

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	146	222	306	379	427	493
Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve	[MWh]	147	222	298	369	431	482
Check value	[%]	0	0	2	3	-1	2

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

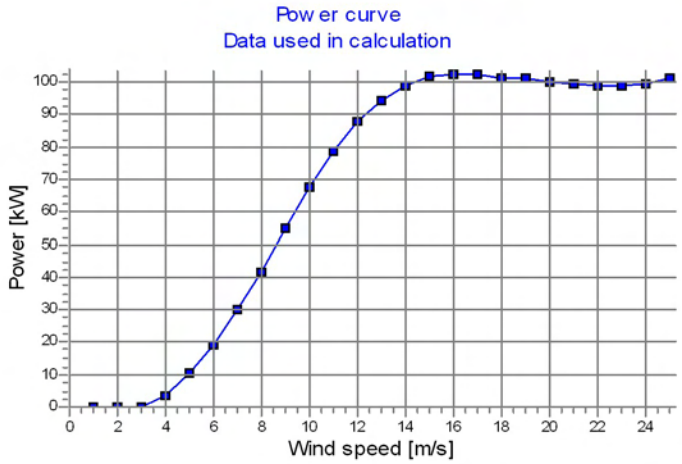
Original data from Windcat, Air density: 1.225 kg/m³

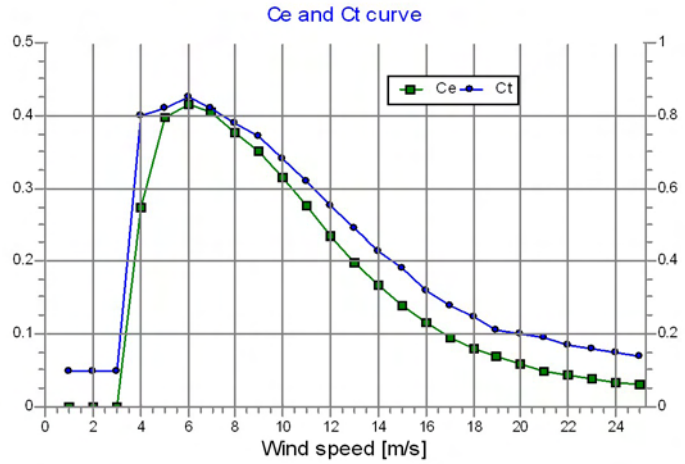
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.10
2.0	0.0	0.00	2.0	0.10
3.0	0.0	0.00	3.0	0.10
4.0	3.7	0.27	4.0	0.80
5.0	10.5	0.40	5.0	0.82
6.0	19.0	0.41	6.0	0.85
7.0	29.4	0.40	7.0	0.82
8.0	41.0	0.38	8.0	0.78
9.0	54.3	0.35	9.0	0.74
10.0	66.8	0.31	10.0	0.68
11.0	77.7	0.28	11.0	0.62
12.0	86.4	0.24	12.0	0.55
13.0	92.8	0.20	13.0	0.49
14.0	97.3	0.17	14.0	0.43
15.0	100.0	0.14	15.0	0.38
16.0	100.8	0.12	16.0	0.32
17.0	100.6	0.10	17.0	0.28
18.0	99.8	0.08	18.0	0.25
19.0	99.4	0.07	19.0	0.21
20.0	98.6	0.06	20.0	0.20
21.0	97.8	0.05	21.0	0.19
22.0	97.3	0.04	22.0	0.17
23.0	97.3	0.04	23.0	0.16
24.0	98.0	0.03	24.0	0.15
25.0	99.7	0.03	25.0	0.14
			26.0	0.13
			27.0	0.12
			28.0	0.11
			29.0	0.10

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.244 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.0	0.00	2.50- 3.50	1.2	1.2	0.8
4.0	3.8	0.27	3.50- 4.50	6.4	7.6	4.9
5.0	10.7	0.40	4.50- 5.50	15.3	22.9	14.9
6.0	19.3	0.41	5.50- 6.50	23.9	46.8	30.4
7.0	29.9	0.40	6.50- 7.50	28.3	75.1	48.7
8.0	41.6	0.38	7.50- 8.50	27.3	102.3	66.4
9.0	55.1	0.35	8.50- 9.50	21.9	124.3	80.7
10.0	67.8	0.31	9.50-10.50	14.8	139.1	90.3
11.0	78.9	0.28	10.50-11.50	8.4	147.5	95.7
12.0	87.7	0.24	11.50-12.50	4.1	151.5	98.4
13.0	94.2	0.20	12.50-13.50	1.7	153.2	99.4
14.0	98.8	0.17	13.50-14.50	0.6	153.8	99.8
15.0	101.6	0.14	14.50-15.50	0.2	154.0	100.0
16.0	102.4	0.12	15.50-16.50	0.0	154.0	100.0
17.0	102.2	0.10	16.50-17.50	0.0	154.1	100.0
18.0	101.4	0.08	17.50-18.50	0.0	154.1	100.0
19.0	101.0	0.07	18.50-19.50	0.0	154.1	100.0
20.0	100.1	0.06	19.50-20.50	0.0	154.1	100.0
21.0	99.3	0.05	20.50-21.50	0.0	154.1	100.0
22.0	98.8	0.04	21.50-22.50	0.0	154.1	100.0
23.0	98.8	0.04	22.50-23.50	0.0	154.1	100.0
24.0	99.5	0.03	23.50-24.50	0.0	154.1	100.0
25.0	101.3	0.03	24.50-25.50	0.0	154.1	100.0





Project:
Grey Barn Farm Resource Assessment

Description:
Verification of existing wind energy resource calculations

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METEO - Wind profile detailed

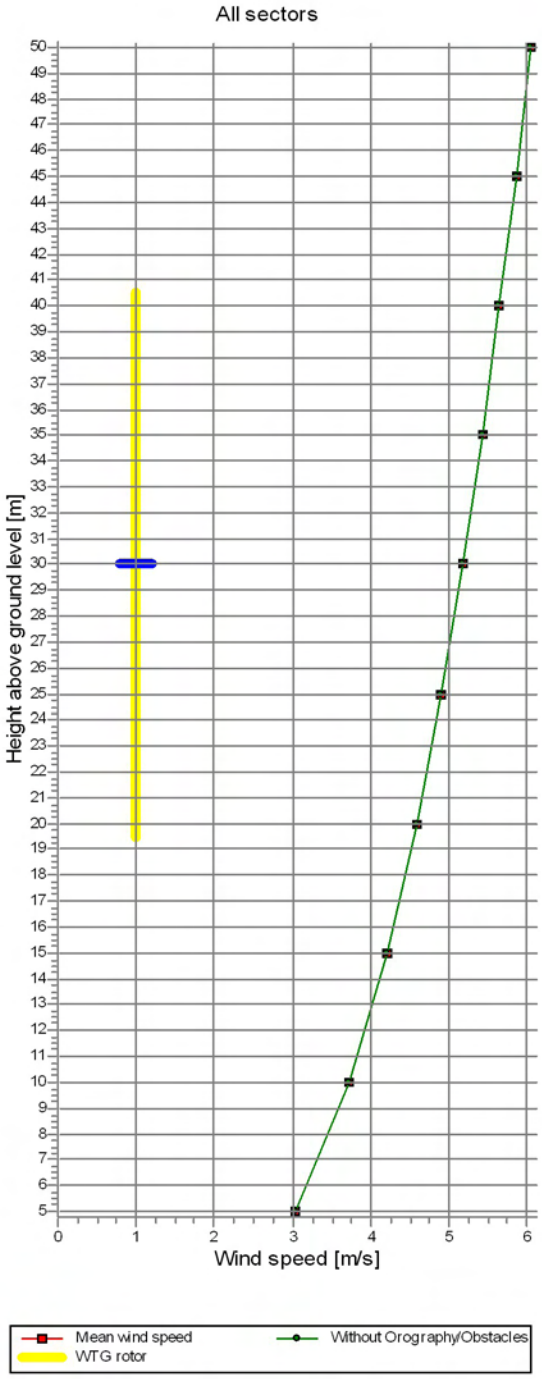
Calculation: N100 (30m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve, Hub height: 30.0 m

Site Data AWS Meteo
Site Coordinates UTM NAD 83 Zone: 19 East: 359,676 North: 4,581,533

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.244 kg/m³
Air density relative to standard	101.6 %
Hub altitude above sea level (asl)	30.0 m
Annual mean temperature at hub alt.	9.5 °C
Pressure at WTGs	1,009.6 hPa

All sectors

Height	Mean wind speed [m/s]	A- parameter [m/s]	k- parameter	Wind energy [kWh/m²]	Yield [MWh]	Yield change [MWh]
5	3.02	3.4	2.13	271	30	-124
10	3.72	4.2	2.17	498	62	-92
15	4.21	4.7	2.21	706	89	-65
20	4.59	5.2	2.25	901	113	-41
25	4.90	5.5	2.29	1,085	134	-20
30	5.18	5.8	2.33	1,261	154	0
35	5.43	6.1	2.37	1,429	172	18
40	5.65	6.4	2.41	1,592	189	35
45	5.86	6.6	2.45	1,749	205	51
50	6.05	6.8	2.49	1,901	219	65



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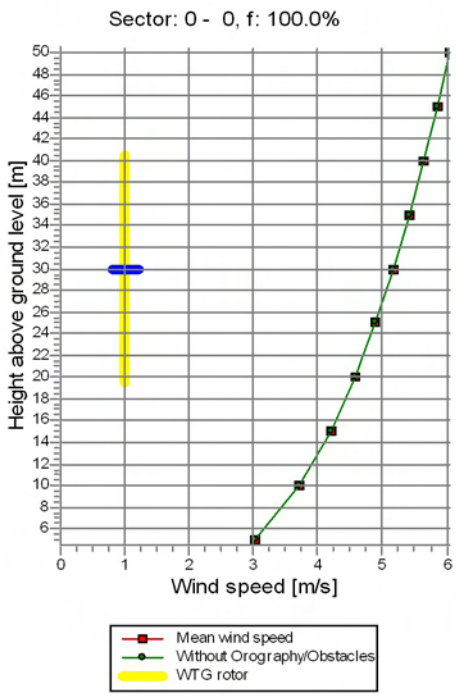
METEO - Wind profile detailed

Calculation: N100 (30m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve, Hub height: 30.0 m



WindPRO Report (N100 37m)

Project:
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Description:
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METEO - Main Result

Calculation: N100 (37m) AEP

Name AWS Meteo

Site Coordinates
UTM NAD 83 Zone: 19 East: 359,676 North: 4,581,533

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.243 kg/m³
Air density relative to standard	101.5 %
Hub altitude above sea level (asl)	37.0 m
Annual mean temperature at hub alt.	9.5 °C
Pressure at WTGs	1,008.7 hPa

Calculation is based on "AWS Meteo", giving the Weibull distribution for the wind speed on the site.
Using the selected power curve, the expected annual energy production is calculated.

Weibull data 37 m above ground level

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]	Wind gradient exponent
0 0	6.16	5.46	2.330	100.0	0.300
All	6.16	5.46	2.330	100.0	

Calculation Results

Key results for height 37.0 m above ground level
Wind energy: 1,476 kWh/m²; Mean wind speed: 5.5 m/s;

Calculated Annual Energy

WTG type						Power curve		Annual Energy			
Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Result [MWh]	Result-13.0% [MWh]	Mean wind speed [m/s]	Capacity factor [%]
No	Northern Power Systems	Northwind 100-100	100	21.0	37.0	USER	N100 Power Curve	175.8	153	5.46	20.1

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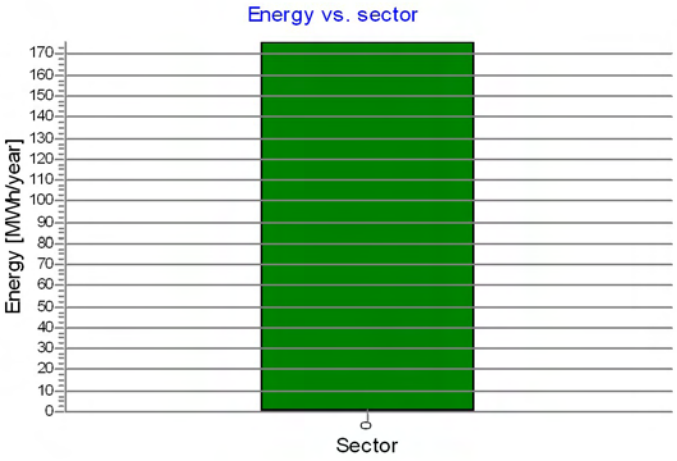
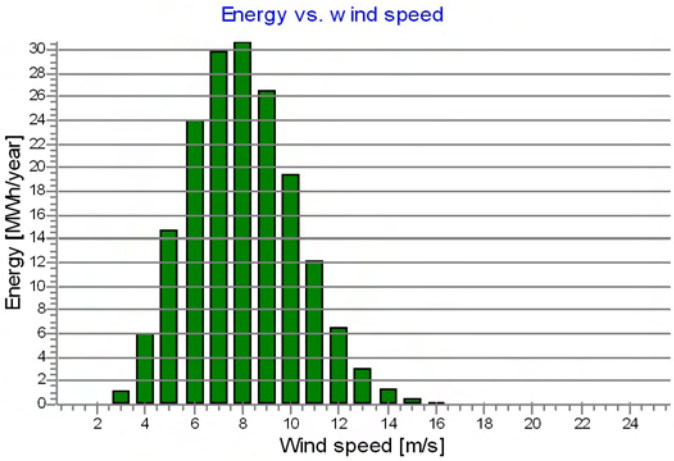
METEO - Production Analysis

Calculation: N100 (37m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O!, Hub height: 37.0 m, Air density: 1.243 kg/m³

Directional Analysis

Sector		0	0	Total
Roughness based energy	[MWh]	175.8		175.8
Resulting energy	**[MWh]**	**175.8**		**175.8**
Specific energy	[kWh/m²]			507
Specific energy	[kWh/kW]			1,758
Directional Distribution	[%]	100.0		100.0
Utilization	[%]	34.4		34.4
Operational	[Hours/year]	7,267		7,267
Full Load Equivalent	[Hours/year]	1,758		1,758
A- parameter	[m/s]	6.2		6.2
Mean wind speed	[m/s]	5.5		5.5
k- parameter		2.33		2.33
Frequency	[%]	100.0		100.0
Power density	[W/m²]			168





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METEO - Power Curve Analysis

Calculation: N100 (37m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve, Hub height: 37.0 m

Name: N100 Power Curve
Source: Northern Power Systems

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
1/1/2011	USER	1/5/2011	1/5/2011	25.0	Stall	Standard stall

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	146	222	306	379	427	493
Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve	[MWh]	147	222	298	369	431	482
Check value	[%]	0	0	2	3	-1	2

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

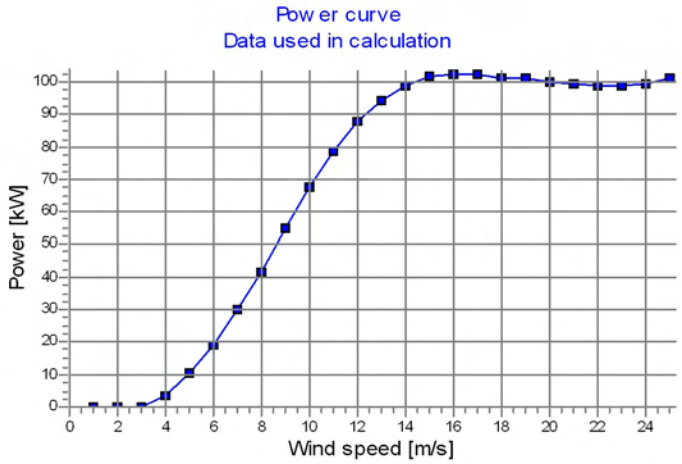
Original data from Windcat, Air density: 1.225 kg/m³

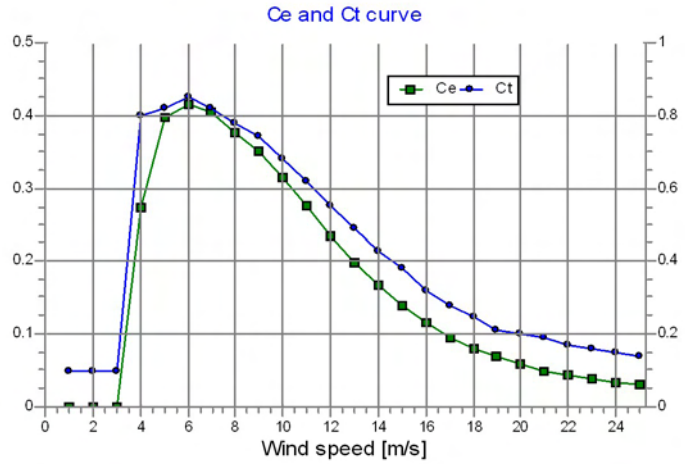
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.10
2.0	0.0	0.00	2.0	0.10
3.0	0.0	0.00	3.0	0.10
4.0	3.7	0.27	4.0	0.80
5.0	10.5	0.40	5.0	0.82
6.0	19.0	0.41	6.0	0.85
7.0	29.4	0.40	7.0	0.82
8.0	41.0	0.38	8.0	0.78
9.0	54.3	0.35	9.0	0.74
10.0	66.8	0.31	10.0	0.68
11.0	77.7	0.28	11.0	0.62
12.0	86.4	0.24	12.0	0.55
13.0	92.8	0.20	13.0	0.49
14.0	97.3	0.17	14.0	0.43
15.0	100.0	0.14	15.0	0.38
16.0	100.8	0.12	16.0	0.32
17.0	100.6	0.10	17.0	0.28
18.0	99.8	0.08	18.0	0.25
19.0	99.4	0.07	19.0	0.21
20.0	98.6	0.06	20.0	0.20
21.0	97.8	0.05	21.0	0.19
22.0	97.3	0.04	22.0	0.17
23.0	97.3	0.04	23.0	0.16
24.0	98.0	0.03	24.0	0.15
25.0	99.7	0.03	25.0	0.14
			26.0	0.13
			27.0	0.12
			28.0	0.11
			29.0	0.10

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.243 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.0	0.00	2.50- 3.50	1.1	1.1	0.6
4.0	3.8	0.27	3.50- 4.50	6.0	7.1	4.0
5.0	10.7	0.40	4.50- 5.50	14.8	21.9	12.4
6.0	19.3	0.41	5.50- 6.50	24.0	45.8	26.1
7.0	29.8	0.40	6.50- 7.50	29.9	75.7	43.1
8.0	41.6	0.38	7.50- 8.50	30.6	106.3	60.5
9.0	55.1	0.35	8.50- 9.50	26.5	132.8	75.6
10.0	67.8	0.31	9.50-10.50	19.4	152.2	86.6
11.0	78.9	0.28	10.50-11.50	12.1	164.3	93.5
12.0	87.7	0.24	11.50-12.50	6.5	170.9	97.2
13.0	94.2	0.20	12.50-13.50	3.0	173.9	98.9
14.0	98.8	0.17	13.50-14.50	1.2	175.1	99.6
15.0	101.5	0.14	14.50-15.50	0.4	175.6	99.9
16.0	102.3	0.12	15.50-16.50	0.1	175.7	100.0
17.0	102.1	0.10	16.50-17.50	0.0	175.8	100.0
18.0	101.3	0.08	17.50-18.50	0.0	175.8	100.0
19.0	100.9	0.07	18.50-19.50	0.0	175.8	100.0
20.0	100.1	0.06	19.50-20.50	0.0	175.8	100.0
21.0	99.3	0.05	20.50-21.50	0.0	175.8	100.0
22.0	98.8	0.04	21.50-22.50	0.0	175.8	100.0
23.0	98.8	0.04	22.50-23.50	0.0	175.8	100.0
24.0	99.5	0.03	23.50-24.50	0.0	175.8	100.0
25.0	101.2	0.03	24.50-25.50	0.0	175.8	100.0





Project:
Grey Barn Farm Resource Assessment

Description:
Verification of existing wind energy resource calculations

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1/18/2011 8:24 AM / 4

Licensed user:
Tighe & Bond, Inc.
53 Southampton Road
US-01085 Westfield, MA
4736
Ellen Ebner / eeebner@tighebond.com

Calculated:
1/18/2011 8:24 AM/2.7.468

METEO - Wind profile detailed

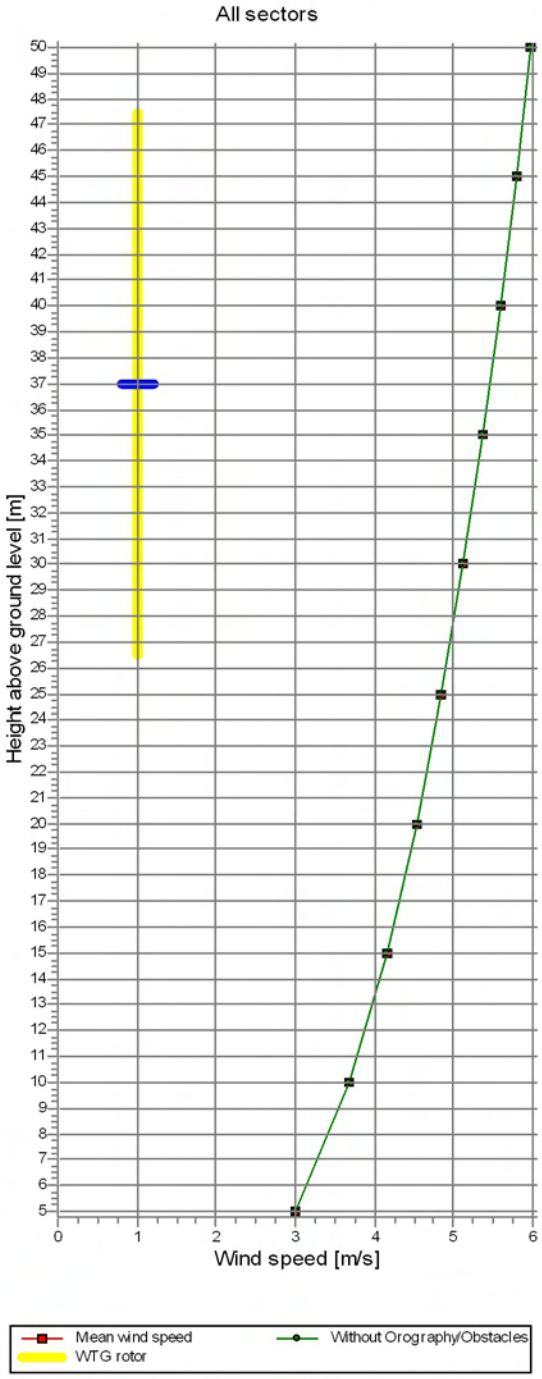
Calculation: N100 (37m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve, Hub height: 37.0 m

Site Data AWS Meteo
Site Coordinates UTM NAD 83 Zone: 19 East: 359,676 North: 4,581,533

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.243 kg/m³
Air density relative to standard	101.5 %
Hub altitude above sea level (asl)	37.0 m
Annual mean temperature at hub alt.	9.5 °C
Pressure at WTGs	1,008.7 hPa

All sectors

Height	Mean wind speed [m/s]	A- parameter [m/s]	k- parameter	Wind energy [kWh/m²]	Yield [MWh]	Yield change [MWh]
5	2.99	3.4	2.07	270	30	-146
10	3.69	4.2	2.11	495	61	-115
15	4.16	4.7	2.15	700	88	-88
20	4.54	5.1	2.19	892	111	-64
25	4.85	5.5	2.23	1,074	132	-43
30	5.13	5.8	2.27	1,246	151	-24
35	5.37	6.1	2.31	1,411	169	-7
40	5.59	6.3	2.35	1,570	185	10
45	5.79	6.5	2.39	1,723	201	25
50	5.98	6.7	2.43	1,872	215	39



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Verification of existing wind energy resource calculations

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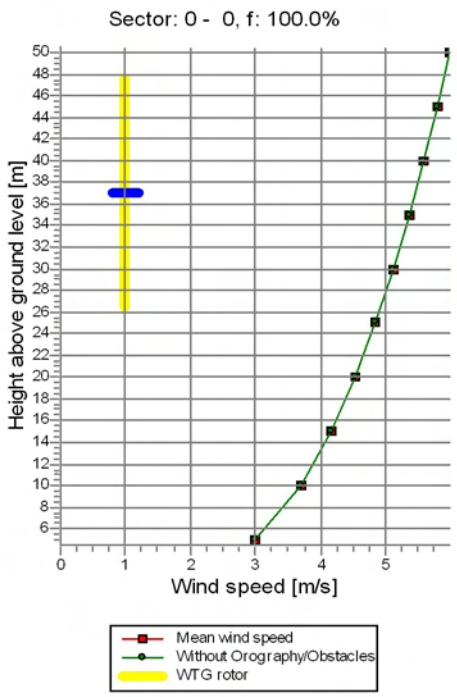
METEO - Wind profile detailed

Calculation: N100 (37m) AEP**WTG:** Northern Power Systems Northwind 100 100 21.0 !O! N100 Power Curve, Hub height: 37.0 m



Grey Barn Farm Master Plan

summary of farm buildings:

exitsing:		proposed:	
fertilizer barn =	1,608 s.f.	dairy barn =	3,900 s.f.
equipment barn =	3,492 s.f.	equipment barn =	4,927 s.f.
utility barn =	2,725 s.f.	utility barn =	1,593 s.f.
calfing barn =	292 s.f.	loafing barn =	3,378 s.f.
loafing barn =	1,418 s.f.		
animal barn =	2,180 s.f.		
total =	20,010 s.f.	total =	13,798 s.f.

summary of farm roadways & parking:

existing:		proposed:	
roadways =	47,625 s.f.	roadways =	28,450 s.f.
parking =	8 spots	employee parking =	8 spots

summary of main barn:

existing:		proposed:	
basement =	2,300 s.f.	basement =	3,000 s.f.
first floor =	3,605 s.f.	first floor =	3,290 s.f.
loft =	2,390 s.f.	loft =	2,700 s.f.
total =	8,295 s.f.	total =	8,990 s.f.
		greenhouse =	200 s.f.
		parking =	8 spots

summary of main house:

proposed:	
basement =	770 s.f.
first floor =	3,500 s.f.
second floor =	2,275 s.f.
total =	6,545 s.f.
garage first floor =	960 s.f.
garage second floor =	460 s.f.
total =	1,420 s.f.
screen porch =	285 s.f.
sauna =	350 s.f.

- 500' roadside district setback
- 50' setback from property line
- main barn (farm office, greenhouse) & main house (garage, screen porch, sauna)
- proposed milking/dairy barn
- proposed utility barn
- proposed equipment barn
- proposed loafing barn
- proposed wind turbine
- proposed farm access paths
- 1 existing fertilizer barn (to be removed)
- 2 existing equipment barn (removed)
- 3 existing utility barn (removed)
- 4 existing calfing barn (to be removed)
- 5 existing loafing barn (to be removed)
- 6 existing animal barn (to be removed)
- 7 existing main barn (to be renovated)

hutker architects

08 JULY 2010

GREY BARN & FARM
MASTER PLAN

SCALE = N.T.S.

Energy Consumption Calculations

Grey Barn Farm
Schedule of Electrical Usage Comparison

Tighe&Bond

Grey Barn Farm Estimate (Data and Comments provided by E. Glasgow)				Tighe & Bond Estimate		
Equipment	**kWh/day**	**Days of Operation/ year**	**Assumptions**	**kWh/day**	**Days of Operation/ year**	**Assumptions/Comments**
DAIRY BARN						
Air Compressor	7		5hp, 2 hours per day	7		Agreed. 5 hp vacuum pump for 2 hours a day is typical for operations.
Vacuum Pump	15		7hp, 3 hours per day	26		Conservative estimate. Vacuum pumps are on during milking and equipment washing. Assume 5 hours per day.
Milking Equipment	2		500W, 4 hours per day	2		Depending on number of workers, 4 hours is reasonable (6.25 cows per hour). 500W seems conservative for milking equipment.
Hot Water Heater	24		150 gallons raised from 115F to 180F assumes preheated solar water as input	27		$Q=mc_p\Delta T$, Assumes: cp = 4.186 j/g C, 150gal = 492 kg, delta T = (82-46 C) = 36, efficiency = 85% --> Q = 100,523,096 J = 27.1 kWh. Performed a heat transfer analysis for the heating with the above assumptions to yield the total heating load.
Bulk Tank cooling	30		200 gallons cooled from 100 to 38	33		$Q=mc_p\Delta T$, Assumes: cp = 3.77 j/g C, 200gal = 778.7 kg, delta T = (3-38 C) = -35, efficiency = 85% --> Q = -102,749 KJ = 32.6 kWh. Performed a heat transfer analysis for the cooling with the above assumptions to yield the total heating load.
Climate Control/Ventilation	50		awaiting confirmation	34		Estimate of annual use received from BTU Control, Inc on 1/13/11. This consultant concluded the annual use for two HVAC zones in Dairy Barn = 12,320 kWh. Equates to about 34 kWh per day assuming the barn is only in operation for 255 days. There will be some HVAC requirement, particularly in office portion, even during the days the cows are in pasture.
Lighting	100		2W per sq. ft, 10 hours per day	78		2W per sq ft typical of industrial /commercial buildings and office space (RS Means 2011), for a dairy barn (food-product equipment) 2W per sq. ft. is appropriate.
Office	1.5		computer, printer, etc.	2		2 kWh/day is reasonable for small office equipment. RE Means 2011 estimates that miscellaneous office equipment would use about 1.2 W/sq. ft., which amounts to 4.6 kWh/day with only 1 hour of use. Since the farm office is not a typical office and is expected to be less energy-intensive, we remain conservative and take 1.5 kWh/day as the estimate.
Cheese vat/pasteurizer	60		30kW run 2 hours daily	108		Conservative. Cheese vat alone is 30 kW, pasteurizer is another 24 kW (eqiupment in purchase order from 4/28/2010, usage is from Manufacturers' specifications). Assume 2 hours operation for heating milk and maintaining at pasteurization temperature.
Other processing equipment	16		2000 watts, 8 hours/day estimate	25		Conservative. Other processing items listed include Electrical Steam Heater = 2,000 W, milk pump = 1.1 kW, milk separator = 1.5 kW, ice accumulator = 19.4 kW, circulation pumps, yogurt pump, temperature monitoring and controls, etc.
Walk-In Refrigeration	23		based on email estimate	18		Based on 1.25 hp at 80% use per day as outlined in purchase order dated 4/28/2010 (use pattern for walk-ins by US Cooler, Quincy, IL). "Emerson Climate Technologies Operating Cost Estimate" seems to be for condenser and evaporator for freezer and refrigeration (8376 kWh/year)
Dairy Barn Total	**328.5**	**255**		**360**	**255**	The Dairy Barn is expected to use only 3.9 W/sq. ft for the entire building. This is low in comparison to standards for manufacturing and food processing facilities (RS Means 2011 estimates 9.6 W/sq ft.) Clearly an effort has been made to remain conservative and only major devices consuming energy were considered. 255 Days is the expected usage of the dairy barn. This is a-typical of dairy practices and is reduced from 365 because the farm will calve all the cows in the spring and they wil only be in the barn and milking from October - May.

Grey Barn Farm
Schedule of Electrical Usage Comparison

Tighe&Bond

Grey Barn Farm Estimate (Data and Comments provided by E. Glasgow)					Tighe & Bond Estimate		
Equipment	**kWh/day**	**Days of Operation/ year**	**Assumptions**		**kWh/day**	**Days of Operation/ year**	**Assumptions/Comments**
UTILITY BARN							
Hot Water Heater	1.75		10 gallons raised from 50F to 120F		2		$Q=mc_p\Delta T$, Assumes: cp = 4.186 j/g C, 10gal = 37.8 kg, delta T = (49-10 C) = 39, eff=85% ---> Q = 7260001 J = 1.96 kWh. Performed a heat transfer analysis for the cooling with the above assumptions to yield the total cooling load.
Workshop	1		1 hour per day on average of power tool use		2		RS Means 2011 estimates 0.5 W/sq. ft. demand for miscellaneous uses associated with a commercial garage, which would have similar machine tool usage. Assume 0.5 W/sq. ft. The barn is 1,593 sq. ft. Assume 3 hours of use per day.
Climate Control/Ventilation	12		Heat/ac in employee break room		6		Assume 4.3 W/sq. ft. demand for an office (RS Means 2011), Assume a 200 sq. ft. room, 8 hrs use.
Lighting	2		1W/ft2, 1 hour per day workshop, 4 hours per day employee room		5		1W per sq ft is demand typical of tools manufacturing and warehouse (RS Means 2011). Assume conservatively 1 W/ft2 for entire building for 1 hr/day.
Laundry	1		Farm laundry (electric dryer)		4		Typ. Electric dryer is about 5 kW (National Electric Code), so 1 kWh is conservative. Assume 5 kW demand at 45min a day.
Utility Barn Total	**17.8**				**19**	**365**	The Utility Barn is expected to use only 0.5 W/sq.ft. of energy per day. This is extrememly conservative and highly dependent on the use pattern (hours per day operational) of the lighting and HVAC systems.
LOAFING BARN							
Lighting	13.20		1/2W per sq. ft . 12hours per day		20		1/2W per sq. ft typical of storage facilities & commercial garages (RS Means 2011), 12 hrs/day
Ventilation fans	24.96		2 fans, 10A/208V. Assume half the usage pattern as lights		67		Most building use-types have an estimated HVAC energy requirement between 3 - 6 W/sq. ft. Assume 4 W/sq. ft. for the loafing barn and that the HVAC system is operating for 5 hours per day. Loafing Barn is 3378 sq. ft.
Livestock water heaters	21.6		6x150W across whole farm		22		150W is similar to heat lamp or other small heating device. Assume six 150W heaters operating 24 hrs per day
Loafing Barn Total	**59.8**	**120**			**109**	**120**	The Loafing Barn uses only 1.3 W/sq.ft. of energy per day. This is extrememly conservative and highly dependent on the use pattern (hours per day operational) of the lighting and HVAC systems. The loafing barn is only used when the dry cows are indoors (November - March)
MAIN BARN							
Walk-In Refrigeration	23		based on forwarded email		18		Based on 1.25 hp at 80% use per day as outlined in purchase order dated 4/28/2010 (use pattern for walk-ins by US Cooler, Quincy, IL). "Emerson Climate Technologies Operating Cost Estimate" seems to be for condenser and evaporator for freezer and refrigeration (8376 kWh/year)
Walk-in Freezer	34		based on forwarded email		21		Based on 1.5 hp at at 80% use per day as outlined in purchase order dated 4/28/2010 (use pattern for walk-ins by US Cooler, Quincy, IL). "Emerson Climate Technologies Operating Cost Estimate" seems to be for condenser and evaporator for freezer and refrigeration (8376 kWh/year)
Cheese Rooms	8		Temperature and humidity controlled rooms. This is an educated guess		8		Based on feeder sizing (condensers run on approximately 2.5 kW) from Allied Consultants (4/26/2010). 8 kWh would be using condensers approximately 3 hrs per day. This is conservative, depending on traffic in/out of cheese rooms and insulation.
Hot Water Heater	8		25 gallons raised from 50F to 180F		9		$Q=mc_p\Delta T$, Assume: cp = 4.186 j/g C, 25gal = 94.5 kg, delta T = (82-10 C) = 72, eff = 85% ---> Q = 33.5 KJ = 9.0 kWh. Performed a heat transfer analysis for the heating with the above assumptions to yield the total heating load.

Grey Barn Farm
Schedule of Electrical Usage Comparison

Tighe&Bond

Grey Barn Farm Estimate (Data and Comments provided by E. Glasgow)					Tighe & Bond Estimate		
Equipment	**kWh/day**	**Days of Operation/ year**	**Assumptions**		**kWh/day**	**Days of Operation/ year**	**Assumptions/Comments**
Climate Control/Ventilation	175		based on engineers estimate		175		Conservative based on Allied Consultants estimate (Avg. 252 kWh/yr). E. Glasgow reduced the estimate based on the fact that he does not anticipate heating/cooling the entire building to the ideal temperature at all times. E. Glasgow reduction of 30% is appropriate. Note that estimate using 4.5 W/sq. ft. (RS Means 2011 for food processing/manufacturing) is approximately 300 kWh/day with 8 hour use.
Bakery Ovens	141		3 Ovens on full power 3 hours per day, 15.7kW each		104		Provided that retail agricultural activities meet the requirements outlined at MGL c. 40A Section 3, baked goods sold to supplement other agricultural products and the ovens used to produce these goods can be considered part of the on-site agricultural activities. 11.6 kW per chamber (Manufacturer's specifications for the Doyon 2T 3 Chamber 480V purchased by E. Glasgow on 4/28/10), 3 hrs per day
Other equipment	18.75		Mixers, proofers, electric range., small appliances, coffee, etc. Based on 125kVA installed circuits operating 15% of the time. Conservative estimate.		11		Restaurant Miscellaneous equipment is 1.7 W/sq. ft (RS Means 2011). Assume the kitchen is 25% of the main floor (820 sq. ft.) and overall daily usage = 8 hrs.
Lighting	100		2W/ft2, 10 hours per day. This is a blended average of retail, storage, processing etc. space. Conservative estimate.		179		2 W/sq. ft. is good for overall, note that kitchen/food prep will typically use more and storage may use less. (RS Means 2011 and National Electric Code)
Office	2		computer, printer, phone system		2		2 kWh/day is reasonable for small office equipment. RE Means 2011 estimates that miscellaneous office equipment would use approx 1.2 W/sq. ft., which amounts to 4.6 kWh/day with only 1 hours of use. Since the farm office is not a typical office and is expected to be less energy-intensive, we remain conservative and take 1.5 kWh/day as the estimate.
Main Barn Total	**509.8**	**300**			**527**	**300**	The Main Barn is expected to use only 2.3 W/sq.ft. of energy per day. This is extrememly conservative (RS Means 2011 estimates 9.6 W/sq ft.) Also, there is a greenhouse on the plans and no usage was taken into account for it. The main barn will be operating, on average about 300 days per year. The barn will be in low use during the winter and calving.
EQUIPMENT BARN							
Lighting	2.50		1/2W per sq. ft . 1 hour per day averaged back to a daily use		3		1/2 W per sq. ft typ of commercial garages and storage (RS Means 2011)
Equipment Barn Total	**2.5**				**3**	**365**	
OTHER							
Well Pump	1		1.5hp, 1 hours		3		Assume pumping time of 3 hrs per day, more reasonable than 1 hour. Assume pumping at at 75% capacity (1.12 hp).
Irrigation Well pump	40		7hp, 24 hours/day for 125 days per annum averaged back to a daily use		30		Q= 60 gpm, head = 80 psi, pump efficiency = 0.6 (Demand 3.5 kW), run time = 24 hours for 125/365 days
Electric Fence Charger	4				1		Electric fences only use kWhs when grounded (sparking something) - heat loss from charge is main energy use. Typical 10W electric fence woul use 7 kWh per month (S. Maryland Electric Coop).
Electric Vehicle	6		Polaris EV run for 1 hour daily		7		Polaris EV is 48V at 110A, 30 hp - for 1 hr use, 6 kWh is conservative. Assume 1 hr per day at 10 hp average use
Other Total	**51.0**	**365**			**41**	**365**	
TOTAL All BARNS/USAGE (kWh/year):		**262,479**			**TOTAL All BARNS/USAGE (kWh/year): 278,006**		

Grey Barn Farm Dairy Barn
Energy Cost Analysis

for

John Early Contractor and Builder
PO Box 336
West tisbury, MA 02575

Elite Software

ENERGY AUDIT

Residential and Light Commercial
Energy Analysis

Prepared By:

TCA
BTU Control,Inc
18 metells way
Edgartown, MA
508-627-3999
Thursday, January 13, 2011

Project Summary

General Project Information

Project Title:	Grey Barn Farm Dairy Barn	Company Name:	BTU Control,Inc
Designed By:	TCA	Company Rep:	TCA
Project Date:	Friday, January 07, 2011	Company Address:	18 metells way
Client Name:	John Early Contractor and Builder	Company City:	Edgartown, MA
Client Address:	PO Box 336	Company Phone:	508-627-3999
Client City:	West tisbury, MA 02575	Company Fax:	508-629-0064
Client Phone:	508-693-6177	Company E-Mail Address:	tom@btucontrol.net

Design Data

Building Area:	1,145 sq.ft.	Cooling Load:	41,228 Btuh
People:	5	Heating Load:	36,491 Btuh
Occupancy:	12	Loads Adj. Factor:	0.77
		AC On Temp.:	70 °F
Actual City:	West Tisbury.MA		
Weather Ref. City:	Boston, Massachusetts		
Summer Outdoor:	88 °F	Winter Outdoor:	9 °F
Summer Indoor:	75 °F	Winter Indoor:	72 °F
Cooling Hours:	816	Degree Days:	5,952

Annual Operating Cost Estimate

System Description	Fuel Rates Set	Total Heating Cost	Total Cooling Cost	Annual Service Charges	Total Oper Cost	Average Monthly Cost
Nordyne IQ Drive ASHP Processing wing	1	$1,072	$130	$0	$1,201	$100
Nordyne IQ Drive ASHP Office Wing	1	$548	$100	$0	$647	$54

Total $1848 @ .15/kwH

Total kw usage = $\frac{\$1848}{.15/\text{kwH}}$ = 12320 kw annual usage

12320 kwH Annual estimated usage

Input Data - System 1 - Nordyne IQ Drive ASHP Processing wing

		Estimated Cost
Cooling		
System Type:	Air Source Heat Pump	
Model:	FT4BI024K	
Efficiency:	22.00 SEER	
Capacity:	23,291 Btuh	
Cooling Load:	23,291 Btuh	
Annual Cost (Spec Cooling Hours Method):		$129.58
Heating		
System Type:	Air Source Heat Pump	
Model:	ft4bi024k	
Efficiency:	10 HSPF	
Capacity:	22,600 Btuh	
Heating Load:	22,157 Btuh	
47° Capacity:	22,600 Btuh	
17° Capacity:	14,000 Btuh	
47° COP:	3.93	
17° COP:	2.729	
Capacity Balance Point:	24 °F	
Cutoff Temperature:	12 °F	
Annual Cost (Bin Data Method):		$1,032.82
Backup		
System Type:	Electric Resistance	
Model:	904409-8kw	
Efficiency:	100.00	
Capacity:	8 kW	
Annual Cost:		$38.86
Total Cost		
Total Annual Operating Cost:		$1,201.26

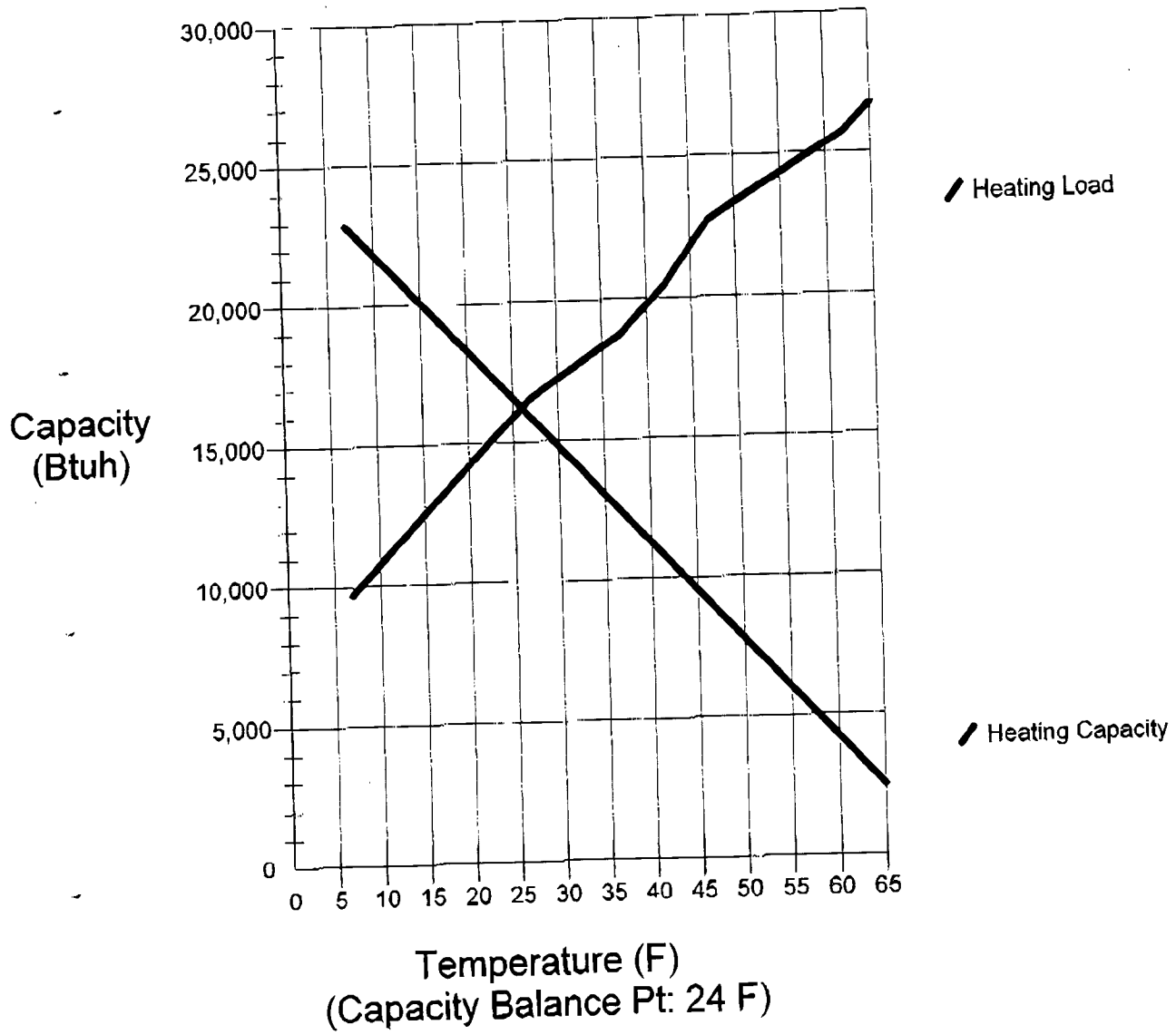
Input Data - System 2 - Nordyne IQ Drive ASHP Office Wing

		Estimated Cost
Cooling		
System Type:	Air Source Heat Pump	
Model:	FT4BI024K	
Efficiency:	22.00 SEER	
Capacity:	17,936 Btuh	
Cooling Load:	17,936 Btuh	
Annual Cost (Spec Cooling Hours Method):		$99.79
Heating		
System Type:	Air Source Heat Pump	
Model:	FT4BI024-K	
Efficiency:	10 HSPF	
Capacity:	22,600 Btuh	
Heating Load:	14,334 Btuh	
47° Capacity:	22,600 Btuh	
17° Capacity:	14,000 Btuh	
47° COP:	3.93	
17° COP:	2.73	
Capacity Balance Point:	15 °F	
Cutoff Temperature:	12 °F	
Annual Cost (Bin Data Method):		$524.98
Backup		
System Type:	Electric Resistance	
Model:	904409-8KW	
Efficiency:	100.00	
Capacity:	8 kW	
Annual Cost:		$22.64
Total Cost		
Total Annual Operating Cost:		$647.41

Bin Analysis Report - System 1 - Nordyne IQ Drive ASHP Processing wing

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x DT7)	Heat Pump Output Btuh	H. Pump Run Time Fraction	Backup Output Btuh	H. Pump Heating Cost	Back up Heating Cost	Total Heating Cost
5 to 10	12	22,860	17,603	0	0.000	17,603	0.00	9.28	9.28
10 to 15	90	21,102	16,248	12,440	0.784	16,248	12.88	25.71	38.59
15 to 20	126	19,343	14,894	14,390	1.000	699	32.64	2.79	35.43
20 to 25	189	17,585	13,540	13,540	0.829	0	59.16	0.00	59.16
25 to 30	453	15,826	12,186	12,186	0.671	0	165.41	0.00	165.41
30 to 35	907	14,068	10,832	10,832	0.555	0	288.97	0.00	288.97
35 to 40	963	12,309	9,478	9,478	0.456	0	235.33	0.00	235.33
40 to 45	794	10,551	8,124	8,124	0.373	0	98.74	0.00	98.74
45 to 50	685	8,792	6,770	6,770	0.297	0	49.01	0.00	49.01
50 to 55	731	7,034	5,416	5,416	0.228	0	32.81	0.00	32.81
55 to 60	824	5,275	4,062	4,062	0.164	0	22.81	0.00	22.81
60 to 65	805	3,517	2,708	2,708	0.105	0	12.62	0.00	12.62
Totals:	6,579						$1,032.82	$38.86	$1,071.68

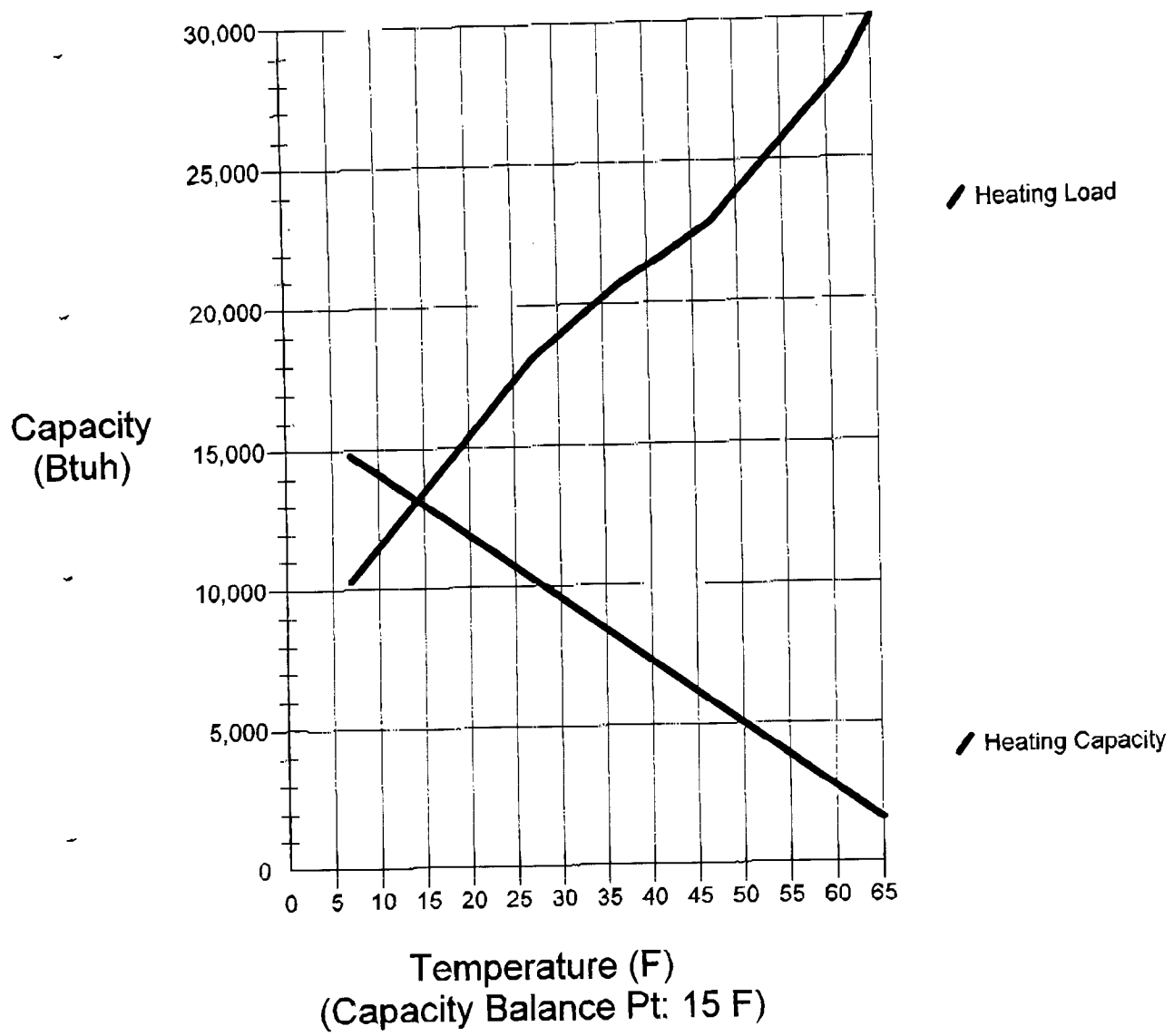
System 1 Heating Performance



Bin Analysis Report - System 2 - Nordyne IQ Drive ASHP Office Wing

Bin Temp Ranges Degree F	Hours Per Bin	Heating Load Btuh	Adjusted Load (x0.77)	Heat Pump Output Btuh	H Pump Run Time Fraction	Backup Output Btuh	H Pump Heating Cost	Backup Heating Cost	Total Heating Cost
				0	0.000	11,388	0.00	6.01	6.01
5 to 10	12	14,789	11,388	10,512	0.507	10,512	9.99	16.63	26.62
10 to 15	90	13,651	10,512	9,636	0.670	0	19.14	0.00	19.14
15 to 20	126	12,514	9,636	8,760	0.536	0	23.73	0.00	23.73
20 to 25	189	11,376	8,760	7,884	0.434	0	49.94	0.00	49.94
25 to 30	453	10,239	7,884	7,008	0.359	0	120.00	0.00	120.00
30 to 35	907	9,101	7,008	6,132	0.295	0	138.85	0.00	138.85
35 to 40	963	7,963	6,132	5,256	0.241	0	61.04	0.00	61.04
40 to 45	794	6,826	5,256	4,380	0.191	0	33.15	0.00	33.15
45 to 50	685	5,688	4,380	3,504	0.142	0	26.73	0.00	26.73
50 to 55	731	4,550	3,504	2,628	0.099	0	21.40	0.00	21.40
55 to 60	824	3,413	2,628	1,752	0.062	0	13.24	0.00	13.24
60 to 65	805	2,275	1,752				$524.98	$22.64	$547.62
Totals:	6,579								

System 2 Heating Performance



REFRIGERATION/FREEZING POWER CONSUMPTION

Emerson Climate Technologies Operating Cost Estimate

1/5/2011

Customer Name: BTU Control Grey Bran project

Model Number	Capacity (Btu/hr)	Power (watts)
CS10K6E-TF5	15523	1634

Evap Temp: 25 °F

Refrig: R404A

Elec Data: 200/230-3-6

Location:	OTIS ANGB, MA
Design Evaporator Load:	15523 Btu/hr
Energy Cost ($/Kw-hr):	$0.15
Design Condenser TD:	10 °F
Minimum Op. Condensing Temp:	70 °F
Compressor used for Mech. Subcooling:	
Evap. Temp for Mech. Subcooling:	0 °F
Design Liquid Refrigerant Temperature:	105 °F
Natural Subcooling:	0 °F
Mechanical Subcooling:	0 °F
Coefficient of Degradation:	0.00
Est Annual Energy Use by Subcooler:	0 Kwh
Est Annual Energy Cost for Subcooling:	$0.00
Est Annual Energy Use by Rack:	8376 Kwh
Est Annual Energy Cost for Rack:	$1,256.35
Est Total Annual Energy Use:	8376 Kwh
Est Total Annual Energy Cost:	$1,256.35
% Subcooling Compressor Utilization:	0.00%

Ambient Temp (F)	Bin Hours	Temperature Cond. (F)	Final Liquid After Subc. (F)	Final Liquid Before TXV (F)	Rack Operating Capacity (Btu/hr)	Rack Operating Power (Watts)	Rack Operating Mass Flow (lb/hr)	Mechanical Subc. Load (Btu/hr)	Mechanical Subc. Power (watts)	Total Op. Pwr. (watts)	Bin Energy (kW-hrs)
92.5	3	102.5	102.5	102.5	15523	1602	287	0	0	1602	5
87.5	29	97.9	97.9	97.9	15523	1478	277	0	0	1478	43
82.5	122	93.3	93.3	93.3	15523	1365	269	0	0	1365	167
77.5	320	88.6	88.6	88.6	15523	1257	261	0	0	1257	402
72.5	665	84.0	84.0	84.0	15523	1157	253	0	0	1157	770
67.5	853	79.4	79.4	79.4	15523	1063	247	0	0	1063	907
62.5	893	74.8	74.8	74.8	15523	975	240	0	0	975	870
57.5	829	70.2	70.2	70.2	15523	891	234	0	0	891	738

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Emerson Climate Technologies Operating Cost Estimate

1/5/2011

Customer Name: BTU Control Grey Bran project

Ambient Tmp.	Bin Hours	Cond Temp	Tmp aft subc.	Tmp bfr. TXV	Oper Cap.	Oper Power	Mass Flow.	Subc. Load	Subc. Power	Total Power	Bin Energy
52.5	833	70.0	70.0	70.0	15523	887	234	0	0	887	739
47.5	862	70.0	70.0	70.0	15523	887	234	0	0	887	765
42.5	882	70.0	70.0	70.0	15523	887	234	0	0	887	782
37.5	799	70.0	70.0	70.0	15523	887	234	0	0	887	709
32.5	687	70.0	70.0	70.0	15523	887	234	0	0	887	609
27.5	439	70.0	70.0	70.0	15523	887	234	0	0	887	389
22.5	260	70.0	70.0	70.0	15523	887	234	0	0	887	231
17.5	158	70.0	70.0	70.0	15523	887	234	0	0	887	140
12.5	78	70.0	70.0	70.0	15523	887	234	0	0	887	69
7.5	35	70.0	70.0	70.0	15523	887	234	0	0	887	31
2.5	9	70.0	70.0	70.0	15523	887	234	0	0	887	8
-2.5	2	70.0	70.0	70.0	15523	887	234	0	0	887	2

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MAIN BARN SERVICE ESTIMATE

1/6/2011
26072

Glasgow Farms, Retail Barn, Chilmark MA

Load Calculations 4/26/2010

1. LIGHTING & RECEPTACLE LOAD

Retail space			2,200 sq ft		=	2,200	sq ft
Storage/corridor			5,020 sq ft		=	5,020	sq ft
Office Space			440 sq ft		=	440	sq ft
Kitchen/food prep			2,500 sq ft		=	2,500	sq ft
Total					=	**10,160**	sq ft
Retail space	6 w/sq ft	x	2,200 sq ft		=	13.20	KVA
Storage/corridor	0.5 w/sq ft	x	5,020 sq ft		=	2.51	KVA
Office space	5 w/sq ft	x	440 sq ft		=	2.20	KVA
Kitchen/food prep	5 w/sq ft	x	2,500 sq ft		=	12.50	KVA
Total Connected Load					=	30.41	KVA
Total Calculated Load *(NEC 220.12)*	30.41 KVA	x	100%		=	**30.41**	**KVA**

2. HVAC Heating & Cooling

Heat pump	32 A	x	1	x	208 V	=	11.51	KVA
Electric duct heater	30 A	x	1	x	208 V	=	10.80	KVA
Electric heaters	12 A	x	5	x	208 V	=	21.59	KVA
Total Calculated Load	44 KVA	x	100%			=	**43.90**	**KVA**

6. Miscellaneous

Sanitary pump (2*1.5HP)	3 kVA	x	100%	=	3	kVA
Lift	5 kVA	x	100%	=	5	kVA
Hot Water Heater (2*6kw)	12 kVA	x	100%	=	12	kVA
Site lighting	5 kVA	x	100%	=	5	kVA
Restaurant equipment	125 kVA	x	65%	=	81.25	kVA
Cooler Condensors	32 kVA	x	100%	=	32	kVA
Atrium Fan	6 kVA	x	100%	=	6	kVA
Kitchen Exhaust heater	30 kVA	x	100%	=	30	kVA
Cheese Cave Condensors	4 kVA	x	100%	=	4	kVA
TOTAL					**178.25**	**kVA**

TOTAL = **252.56** **KVA**

Service Size **400A SERVICE**
480 Three Phase Service Voltage
304 Amps , Connected
400A **Switch Size** ***(confirm 400A when all loads are final)***

MAIN BARN CLIMATE CONTROL

This tabulation of Hours of Occurence by Temperature Bin data is derived from the temperature bin data collected by the U.S. Air Force at the Otis Air Force Base in Falmouth, Massachusetts and is divided into occupied and unoccupied building hours.

Occupied Days per week	6	
Building opens at	7	AM
Building Closes at	5	PM

Temperature	Occupied			Cooling		Heating		
Range	01 - 08	09 - 16	17 - 24	Diversity	KVA	Diversity	KVA	KwHr
95 - 99	0.0	2.6	0.0	100%	11.51			30
90 - 94	0.0	22.3	0.4	100%	11.51			261
85 - 89	0.0	76.3	1.8	100%	11.51			899
80 - 84	0.3	162.9	6.4	100%	11.51			1,952
75 - 79	2.9	213.4	13.8	75%	11.51			1,987
70 - 74	12.8	222.9	22.8	50%	11.51			1,487
65 - 69	23.7	197.1	27.9	50%	11.51			1,431
60 - 64	28.1	190.3	27.1	25%	11.51			706
55 - 59	29.0	186.9	26.5					0
50 - 54	27.2	169.7	24.8					0
45 - 49	25.9	158.6	23.4			25%	43.90	2,281
40 - 44	25.7	203.1	25.5			50%	43.90	5,583
35 - 39	29.4	200.6	29.5			50%	43.90	5,694
30 - 34	33.2	183.4	29.6			75%	43.90	8,107
25 - 29	23.5	126.9	19.8			75%	43.90	5,602
20 - 24	17.3	80.6	13.8			100%	43.90	4,901
15 - 19	11.6	54.0	9.2			100%	43.90	3,283
10 - 14	8.9	27.4	5.8			100%	43.90	1,849
5 - 9	6.9	13.7	3.3			100%	43.90	1,049
0 - 4	3.9	5.1	1.0			100%	43.90	437
-5 - -1	1.4	1.7	0.4			100%	43.90	155
-10 - -6	0.8	0.0	0.1			100%	43.90	38
-15 - -11	0.3	0.0	0.0			100%	43.90	14
-20 - -16	0.1	0.0	0.0			100%	43.90	5
								47,751

Temperature	Unoccupied			Cooling		Heating		
Range	01 - 08	09 - 16	17 - 24	Diversity	KVA	Diversity	KVA	KwHr
95 - 99	0.0	0.4	0.0	25%	11.51			1
90 - 94	0.0	3.7	3.6	25%	11.51			21
85 - 89	0.0	12.7	15.2	25%	11.51			80
80 - 84	2.7	27.1	53.6	25%	11.51			240
75 - 79	24.1	35.6	115.2	20%	11.51			403
70 - 74	106.3	37.1	190.2	15%	11.51			576
65 - 69	197.3	32.9	232.1	15%	11.51			798
60 - 64	233.9	31.7	225.9	0%	11.51			0
55 - 59	242.0	31.1	220.5					0
50 - 54	226.8	28.3	206.3					0
45 - 49	216.1	26.4	194.6			0%	43.90	0
40 - 44	214.3	33.9	212.5			25%	43.90	5,056
35 - 39	244.6	33.4	245.5			25%	43.90	5,747
30 - 34	276.8	30.6	246.4			38%	43.90	9,117
25 - 29	195.5	21.1	165.2			38%	43.90	6,286
20 - 24	143.8	13.4	115.2			50%	43.90	5,978
15 - 19	96.4	9.0	76.8			50%	43.90	4,000
10 - 14	74.1	4.6	48.2			50%	43.90	2,785
5 - 9	57.1	2.3	27.7			50%	43.90	1,912
0 - 4	32.1	0.9	8.0			50%	43.90	901
-5 - -1	11.6	0.3	3.6			50%	43.90	339
-10 - -6	6.3	0.0	0.9			50%	43.90	157
-15 - -11	2.7	0.0	0.0			50%	43.90	59
-20 - -16	0.9	0.0	0.0			50%	43.90	20
								44,475

47,751	
44,475	
92,226	kWhrs/year
÷ 365	days/year
252.67	Avg kWh/day