Honeywell

Orion Campus

Renewable Energy Study & Development Proposal

Prepared by:

ECOSUSTAINABLE

11-21-2010

Introduction:

During the summer of 2010 Ecosustainable Living Technologies Pvt. Ltd. (ELT) was put on retainer by Honeywell Technology Solutions Pvt. (HTS) of Bangalore, to study and propose novel energy solutions for Orion and Kalyani campus. The scope of the study was to provide renewable energy solutions for Orion and review the retro commission of the Kalyani campus based on the suggestions of the TERI study.

These solutions implemented will make the Orion campus into a renewable energy producer. It would also suggest how to make the Kalyani campus more energy conserving.

Design Objectives:

The overarching design objective was and is to:

- Propose a first-of-its-kind design in India that would help Honeywell to demonstrate to its clients a complete renewable energy solution and building energy management system.

- Demonstrate Honeywell Technology Solutions Pvt. (HTS) leadership position in the green design imperative that the building can also be a renewable energy producer.

- Demonstrate how Honeywell control technologies can monitor, control, and manage active state-of-the-art wind, solar PV, and solar concentrator technologies.

- Incorporate and comply with SEZ Green standards and LEED® certification as developed by the U.S., World, and Indian Green Building Council.
  See: http://www.igbc.in/site/igbc/testigbc.jsp?desc=233674&event=233670

Sequence of Work:

Our sequence of work included the following steps.

- Study the energy consumption of the Orion campus by:
    1. Analyzing monthly power bills for year 2009 and 2010.
    2. Request real-time daily power consumption reports.
    3. Establish the baseline electrical load of the Orion campus.
    4. Study peak-demand charges.
    5. Anticipate future energy demand and growth.
    6. Explore energy conservation measures planned.

- Acquire a renewable energy data base, analyze, and evaluate the performance of various renewable energy alternatives by:
    1. Developing a natural resource data base of the quantity and duration of available sun and wind at the Orion site.
    2. Developing monthly wind and solar distribution charts utilizing wind spectrum analysis through building Weibull and Raleigh wind distribution tables and F-chart analysis of the solar potential.
    3. Selecting proven building mounted Indian solar PV, tracking solar concentrators, and urban wind-turbines (mostly developed in the US).
    4. Simulate the monthly performance of the renewable energy assets and their contribution to the building load utilizing the derived energy density tables.

- Develop the comprehensive Financial Analysis by:
    1. Developing cost estimates of the different proposed technology solutions.
    2. Price out the various hybrid solutions and energy producing options into a menu available to Honeywell management.
    3. Incorporate all available financial incentives and subsidies including; Grid based incentives, Subsidies, CDM Credits, and Demand Charges.
    4. Develop tables that show the return on investment (ROI) for each system proposed.

- Summarize the findings of our study by:
    1. Placing the highlights of the study into a Power point presentation to be shown to management and Honeywell business units.
    2. Include live ELT technical and financial personnel into the presentation
    3. Memorialize the renewable energy study and continue to add to it all future findings and data.

- Review the findings of the TERI study and update progress made to date on implementing their suggestions at the Kalyani campus.

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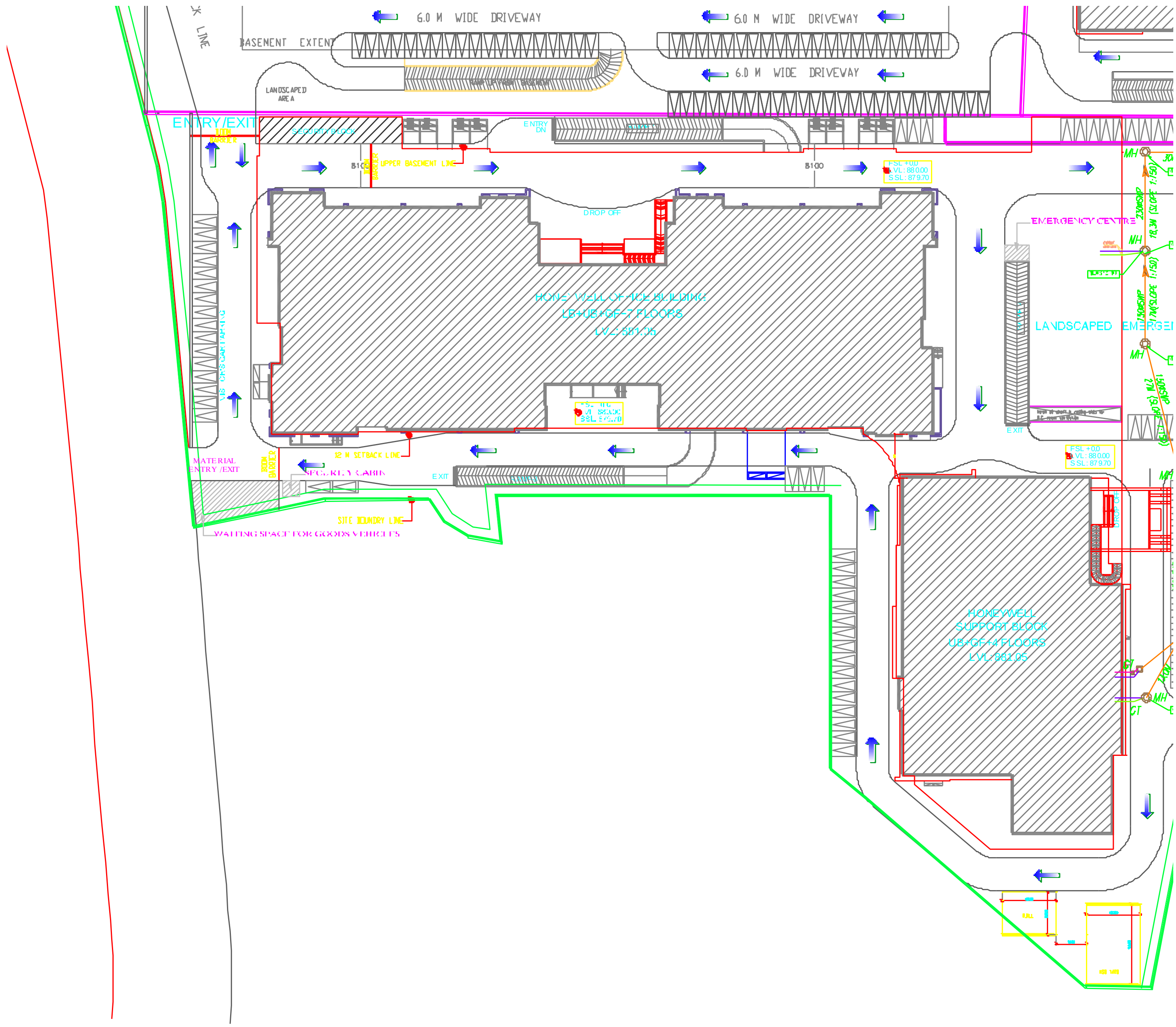
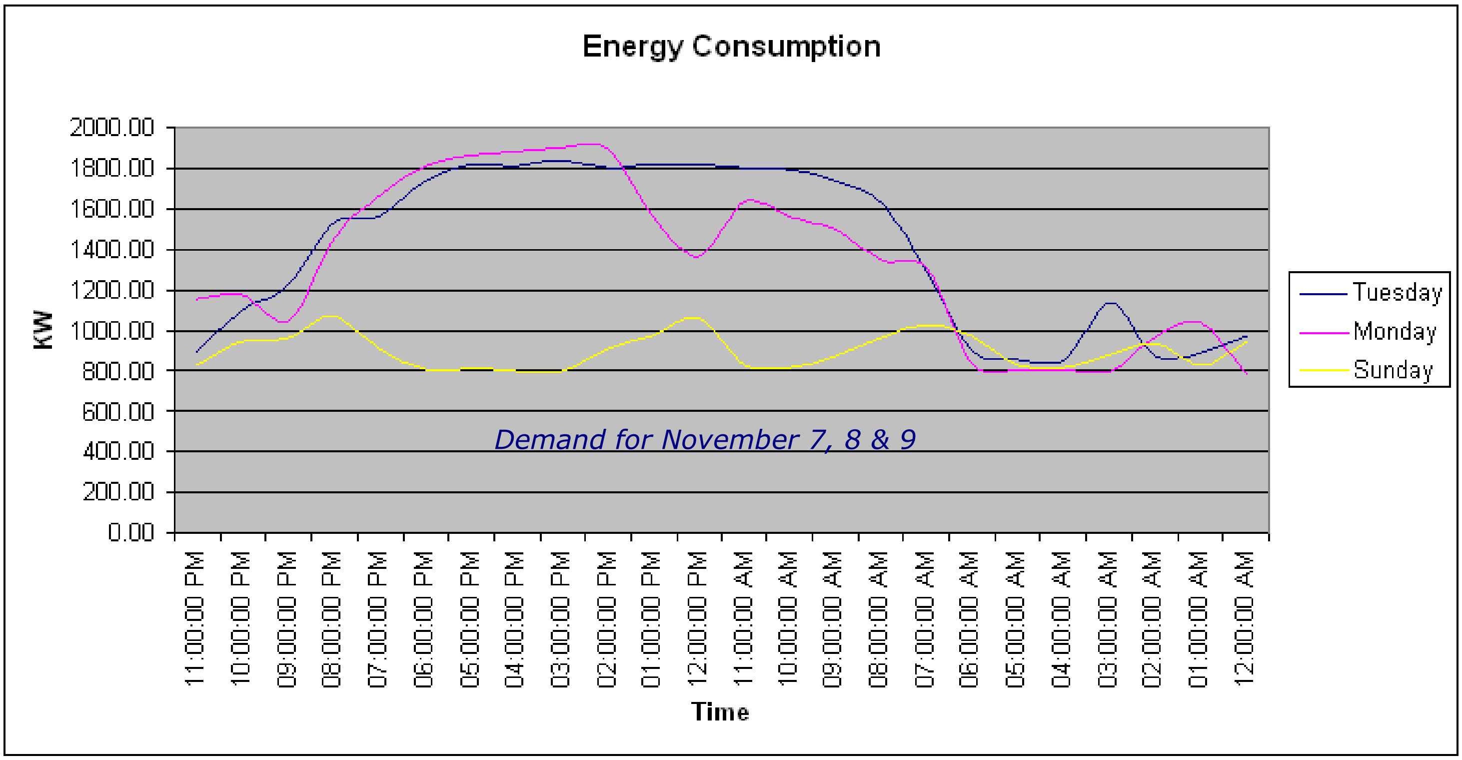
Honeywell Orion Campus:
Honeywell Technology Solutions, Pvt. India





From discussion with the facilities managers and from data loggers we know that the building has a constant base load of 800 KVA 24—7. This load rises during weekdays to 1,900 KVA.

In times of power outages from the Bangalore Grid 3 Cummins diesel generators located in the basement of the Orion complex automatically engage in 15 seconds to provide full power for the building.

There is also an uninterruptable power supply, UPS, whose batteries and inverters can carry the emergency loads of the emergency circuits during the 15 second interval before the distributed generation (DG) can start.

Honeywell Power Demand

We have studied the demand side of power consumption at the Honeywell Orion Campus.

The primary loads include:

1. Power for two chillers and two pumps:
   These consume each 360 Kw or a total of 720 Kw.
   The air-conditioning system is rated at 600 tons for the buildings.

2. SCADA and server:
   120 KW with 200 Kw consumption anticipated by year’s end.
   The air conditioning load for the server alone is 120 tons.

3. Lighting:
   The lighting load has been operating at 200 Kw. With conversion to LED lighting this level will drop to 150 Kw.

There is a constant load on the building of approximately 800 Kw.

Observation:

Since the primary load of the building is a thermal load for air conditioning, the study may want to focus on creating direct solar thermal heat for utilization by absorption chillers.

Honeywell Orion Daily Energy Demand

Base Load = 800 Kw

Honeywell Power Bill Analysis 2009

We have studied the power bills of the HTS for the last 18 months. The following is the tabulation of those costs.

ANALYSIS OF POWER BILLS FOR 2009

Month	Peak demand			Energy Charges - 1			Energy Charges - 2			Tax	Total	Total
	KWH	Rate	`	KWH	Rate	`	KWH	Rate	`	5%	`	KWH
Jan-09	1121	200	224,200	35100	4.85	170,235	0	5.15	0	19,722	414,157	35,100
Feb-09	1463	200	292,600	122580	4.85	594,513	0	5.15	0	44,356	931,469	122,580
Mar-09	1463	200	292,600	200000	4.85	970,000	31320	5.15	161,298	71,195	1,495,093	231,320
Apr-09	1463	200	292,600	200000	4.85	970,000	1300	5.15	6,695	63,465	1,332,760	201,300
May-09	1892	200	378,400	200000	4.85	970,000	126460	5.15	651,269	99,983	2,099,652	326,460
Jun-09	1463	200	292,600	200000	4.85	970,000	20500	5.15	105,575	68,409	1,436,584	220,500
Jul-09	1463	200	292,600	113860	4.85	552,221		5.15	-	42,241	887,062	113,860
Aug-09	1463	200	292,600	136080	4.85	659,988		5.15	-	47,629	1,000,217	136,080
Sep-09	1463	200	292,600	200000	4.85	970,000	445800	5.15	2,295,870	177,924	3,736,394	645,800
Oct-09	1746	200	349,200	200000	4.85	970,000	517260	5.15	2,663,889	199,154	4,182,243	717,260
Nov-09	1682	200	336,400	200000	4.85	970,000	437460	5.15	2,252,919	177,966	3,737,285	637,460
Dec-09	1622	200	324,400	200000	5.6	1,120,000	388800	5.95	2,313,360	187,888	3,945,648	588,800
Total	18304		3,660,800	2,007,620		9,886,957	1,968,900		10,450,875	1,199,932	25,198,564	3,976,520

Honeywell Power Bill Analysis 2010

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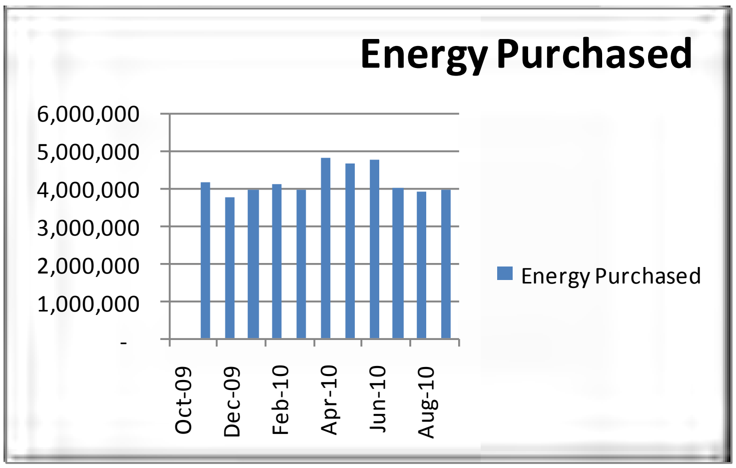
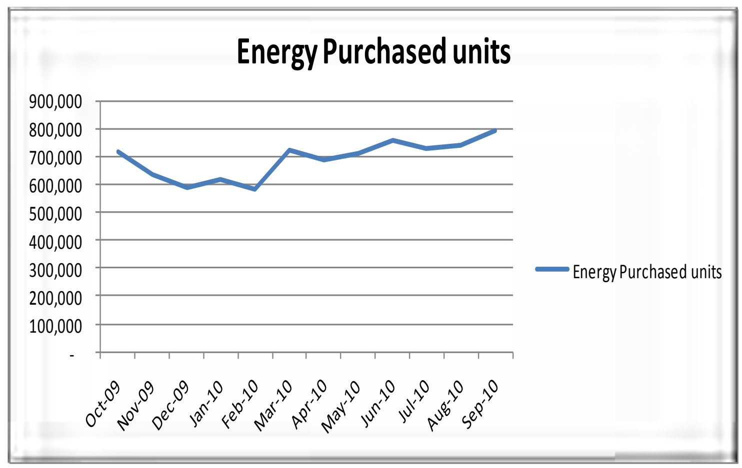
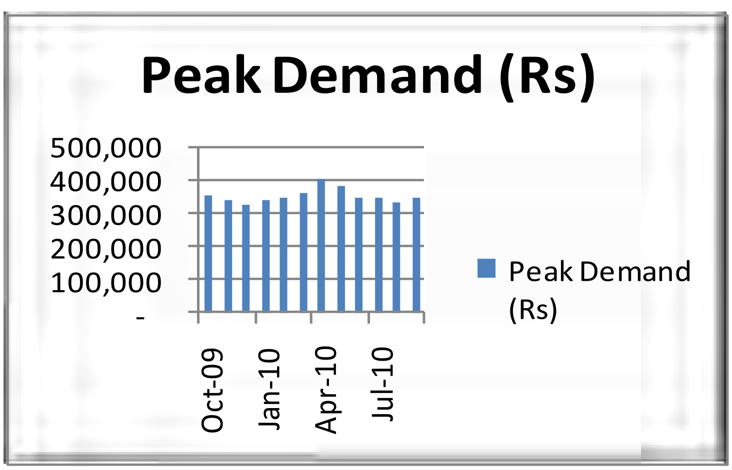
ANALYSIS OF POWER BILLS FOR 2010

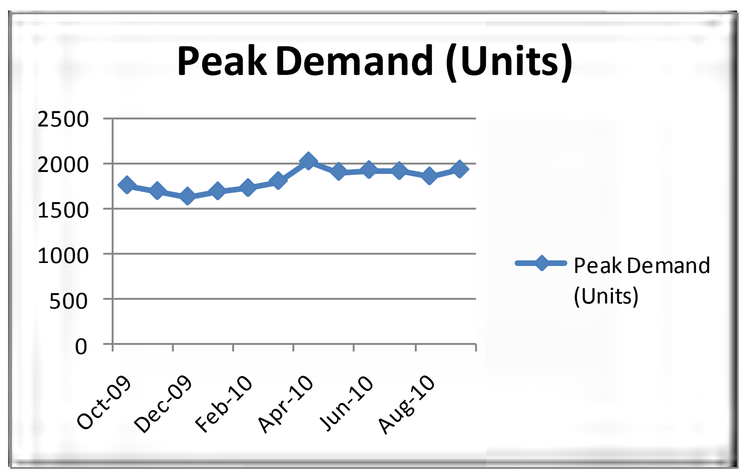
Month	Peak demand			Energy Charges - 1			Energy Charges - 2			Tax	Total	Total
	KWH	Rate	`	KWH	Rate	`	KWH	Rate	`	5%	`	KWH
Jan-10	1680	200	336,000	200000	5.6	1,120,000	415340	5.95	2471273	196,364	4,123,637	615,340
Feb-10	1716	200	343,200	200000	5.6	1,120,000	384780	5.95	2289441	187,632	3,940,273	584,780
Mar-10	1794	200	358,800	200000	5.6	1,120,000	521520	5.95	3,103,044	229,092	4,810,936	721,520
Apr-10	2012	200	402,400	200000	5.6	1,120,000	488760	5.95	2,908,122	221,526	4,665,068	688,760
May-10	1896	200	379,200	200000	5.6	1,120,000	512980	5.95	3,052,231	227,572	4,779,003	712,980
Jun-10	1916	180	344,880	100000	4.3	430,000	655980	4.65	3,050,307	191,259	4,016,446	755,980
Jul-10	1904	180	342,720	100000	4.3	430,000	629680	4.65	2,928,012	185,037	3,885,769	729,680
Aug-10	1846	180	332,280	100000	4.3	430,000	642880	4.65	2,989,392	187,584	3,939,256	742,880
Sep-10	1922	180	345,960	100000	4.3	430,000	694120	4.65	3,227,658	200,181	4,203,799	794,120
Total	16686		3,185,440	1,400,000		7,320,000	4,946,040		26,019,480	1,826,246	38,364,186	6,346,040

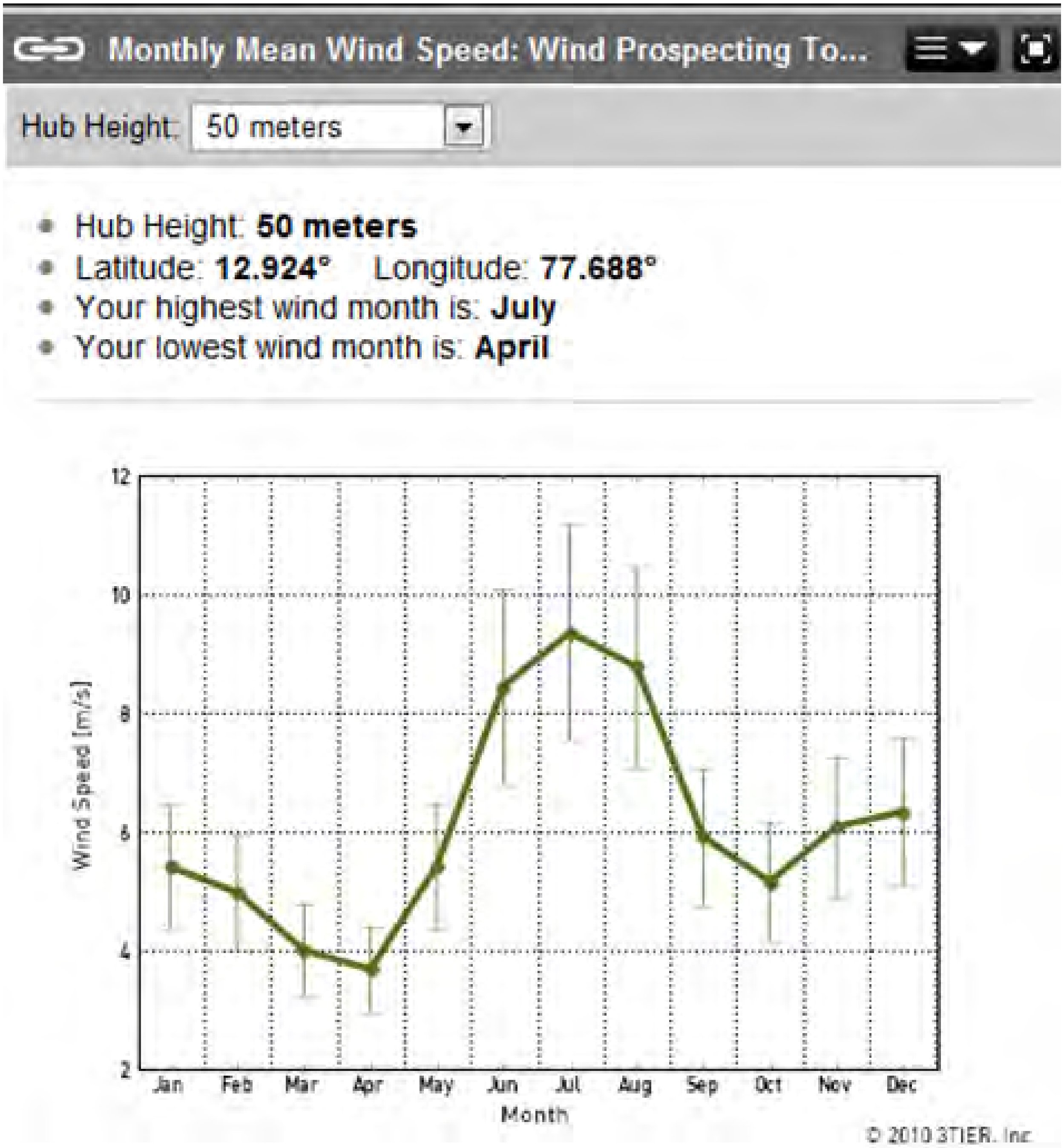
Honeywell Power Bill Charts





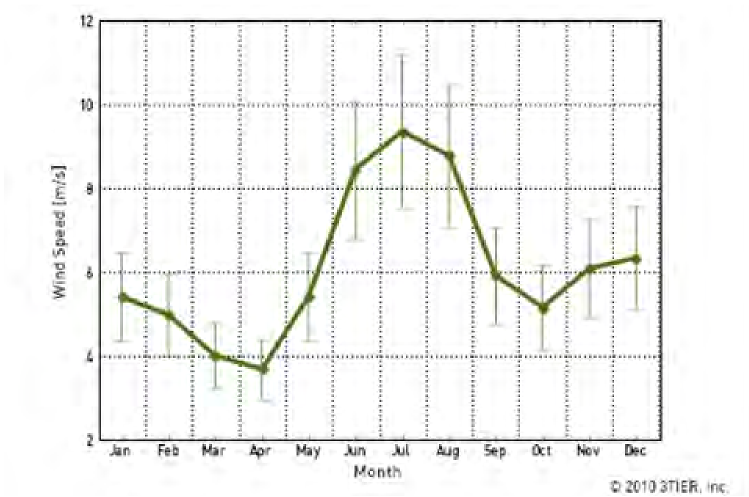






The average yearly wind speed for the site is 6 meters per second or 13.2 miles per hour. The chart above shows the average wind speed on a monthly basis for one year. This data is part of a 40 year collection of wind speed data that we bought for the project from 3-Tier out of Seattle, Washington, for the project. Note that the lowest wind speed occurs in April at 3.5 meters per second and the highest during the monsoons in July at a median wind speed of 9.3 meters per second. The following charts these median data points.

The Wind Resource Monthly Tables



Average wind speeds while useful are not that accurate for predicting the power output from wind turbines. Each wind speed has a specific power density defined in watts/sq meter. The power of the wind varies as the cube of the velocity. A 10 meter per second wind has eight times the energy of 5 meter per second wind. A 15 meter per second wind has 27 times the energy of a 5 meter/second wind.

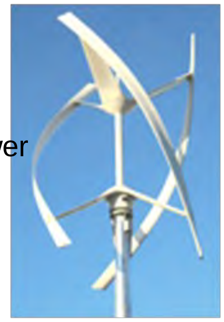
The monthly average wind speeds were unpacked into a monthly wind distribution utilizing a Weibull distribution analysis.

Monthly Wind Averages	Orion Campus	1 UGE 4 KW	18 UGE 4 KW	
Month	Average (m/s)	Kilowatt hrs/ month	Kilowatt hrs/ month	
Jan	5.4	381	6,096	
Feb	5.0	313	5,008	
Mar	4.0	186	2,976	
Apr	3.5	139	2,224	
May	5.4	381	6,096	
June	8.5	1258	20,128	
July	9.3	1668	26,688	
Aug	8.8	1392	22,272	
Sept	6.0	504	8,064	
Oct	5.1	329	5,264	
Nov	6.1	527	8,432	
Dec	6.2	550	8,800	
	Average 6.0	7,628 Kwhr	137,304 Kwhr	TOTALS

The monthly average wind speeds were unpacked into a monthly wind distribution utilizing a Weibull distribution analysis. Utilizing our proposed UGE wind turbine's output, the average-wind speed was broken into velocity bins and the percent of occurance and multiplied by the documented turbine output resulting in true monthly and yearly totals. See the following proprietary spreadsheet calculator.

Estimated Annual Energy Output: Urban Green Energy UGE Turbines

Derived for HONEYWELL, BANGALORE, INDIA By Reinhold Ziegler, ELT 11-1-2010

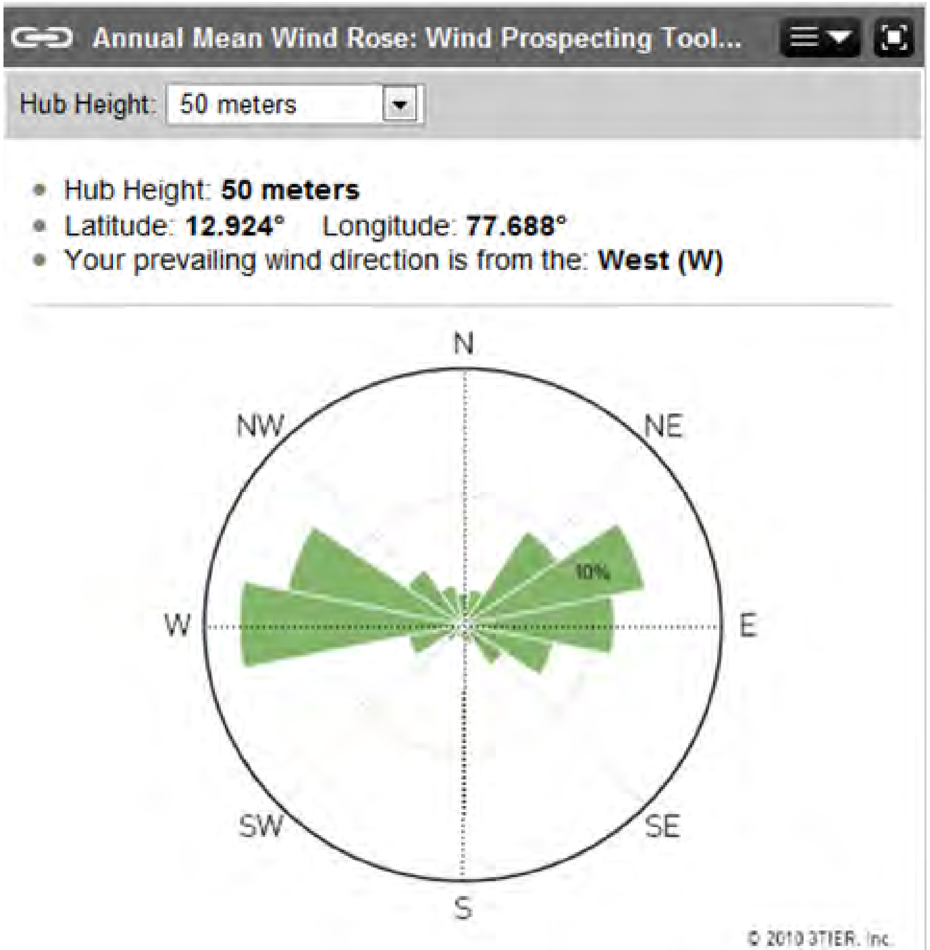


	Swept Area (m^2)	Rated Power (kW)	Peak Power
UGE-4K	11.68	4 Kw	4335

Inputs	Enter below
Rated Power (kW)	4
CP-Efficiency (%) varies	
Swept Area (m^2)	11.68
Avg. Wind Speed (m/s)	6.1
Weibull K Factor	2.75
Altitude (m)	50
Avg. Temp. (C)	20
Anemometer Height (m)	50
Tower Height (m)	50
Wind Shear Exponent	0.24
Avail:	100%
Turbulence Intesity	0
Safety Margin	10%

Output	Click below
Hub Height Avg. Wind Speed (m/s)	6.1
Altitude Correction	1.00
Temperature Correction	1.00
Annual Energy Output (kWh)	6069.72
Avg. Daily Energy (kWh)	16.63
Avg. Monthly Energy (kWh)	505.81
Avg. Power (kW)	0.77
Avg. Conversion Efficiency	0.32
Capacity Factor	0.17
Annual Specific Yield (kWh/m^2/yr)	519.67

Wind Speed Bin (m/s)	Gross Wind Power (kW)	Turbine Power Curve (kW)	Effic. (%)	Turbine Cor-rected Power (kW)	Weibull Freq. Dist.	Turbine Avg. Power (kW)	(h/yr)	Gross Wind Energy (kWh/yr)	Turbine Avg. Energy (kWh/yr)
1	0.00716	0	0	0	0.01375	0	120.45	0.86	0.00
2	0.05724	0	0	0	0.04494	0	393.66	22.53	0.00
3	0.19319	0.14	0.72468	0.14	0.08525	0.01193	746.77	144.27	104.55
4	0.45793	0.25	0.54593	0.25	0.12455	0.03114	1091.04	499.62	272.76
5	0.8944	0.36	0.40251	0.36	0.15179	0.05465	1329.72	1189.30	478.70
6	1.54552	0.525	0.33969	0.525	0.15887	0.08341	1391.74	2150.96	730.67
7	2.45422	0.755	0.30763	0.755	0.14428	0.10893	1263.86	3101.80	954.22
8	3.66345	1.085	0.29617	1.085	0.11389	0.12357	997.66	3654.88	1082.46
9	5.21612	1.56	0.29907	1.56	0.07795	0.12161	682.88	3562.01	1065.30
10	7.15517	2.18	0.30467	2.18	0.04605	0.10038	403.37	2886.19	879.35
11	9.52353	3.08	0.32341	3.08	0.02333	0.07185	204.35	1946.11	629.39
12	12.3641	4	0.32352	4	0.01006	0.04026	88.16	1090.08	352.66
13	15.7199	4.295	0.27322	4.295	0.00367	0.01576	32.15	505.43	138.09
14	19.6338	4.335	0.22079	4.335	0.00112	0.00487	9.83	193.07	42.63
15	24.1487	4.275	0.17703	4.275	0.00029	0.00122	2.50	60.43	10.70
16	29.3076	4.225	0.14416	4.225	6E-05	0.00025	0.53	15.40	2.22
17	35.1533	4.195	0.11933	4.195	1E-05	4.3E-05	0.09	3.17	0.38
18	41.7289	4.195	0.10053	4.195	1.4E-06	6E-06	0.01	0.53	0.05
19	49.0773	4.195	0.08548	4.195	1.6E-07	6.8E-07	0.00	0.07	0.01
20	57.2413	4.195	0.07329	4.195	1.4E-08	6.1E-08	0.00	0.01	0.00
							TOTAL		6,744



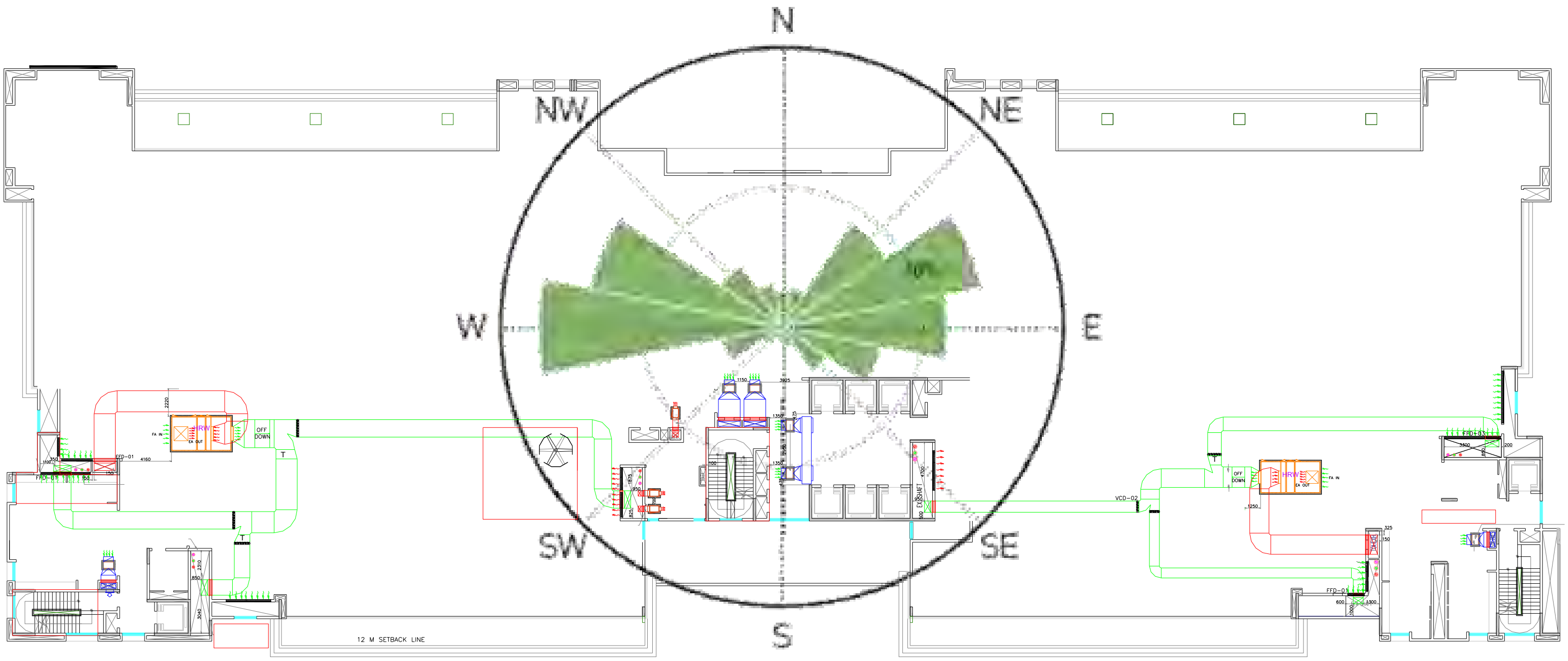
The wind rose determines the predominant direction of the wind.

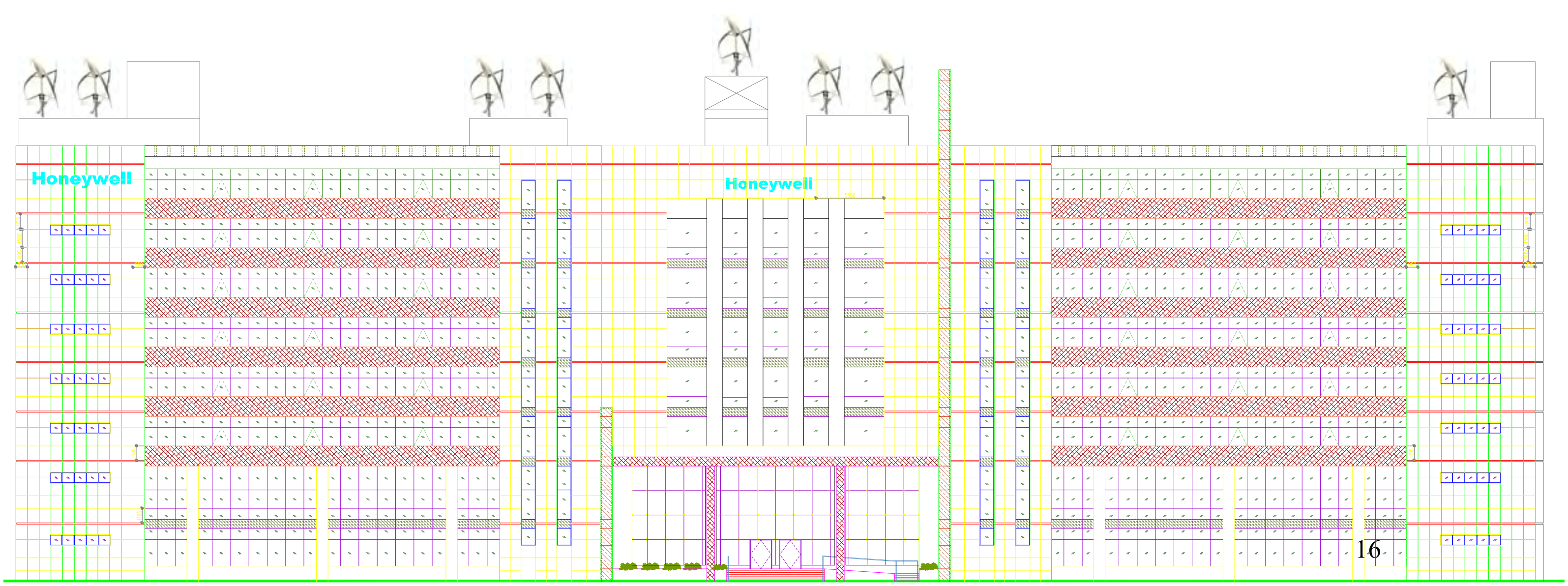
Note that the predominant direction of the wind is from the West and West northwest about 30% of the time. Winds from the East and East North East, North East and south east occur approximately 40 % of the time.

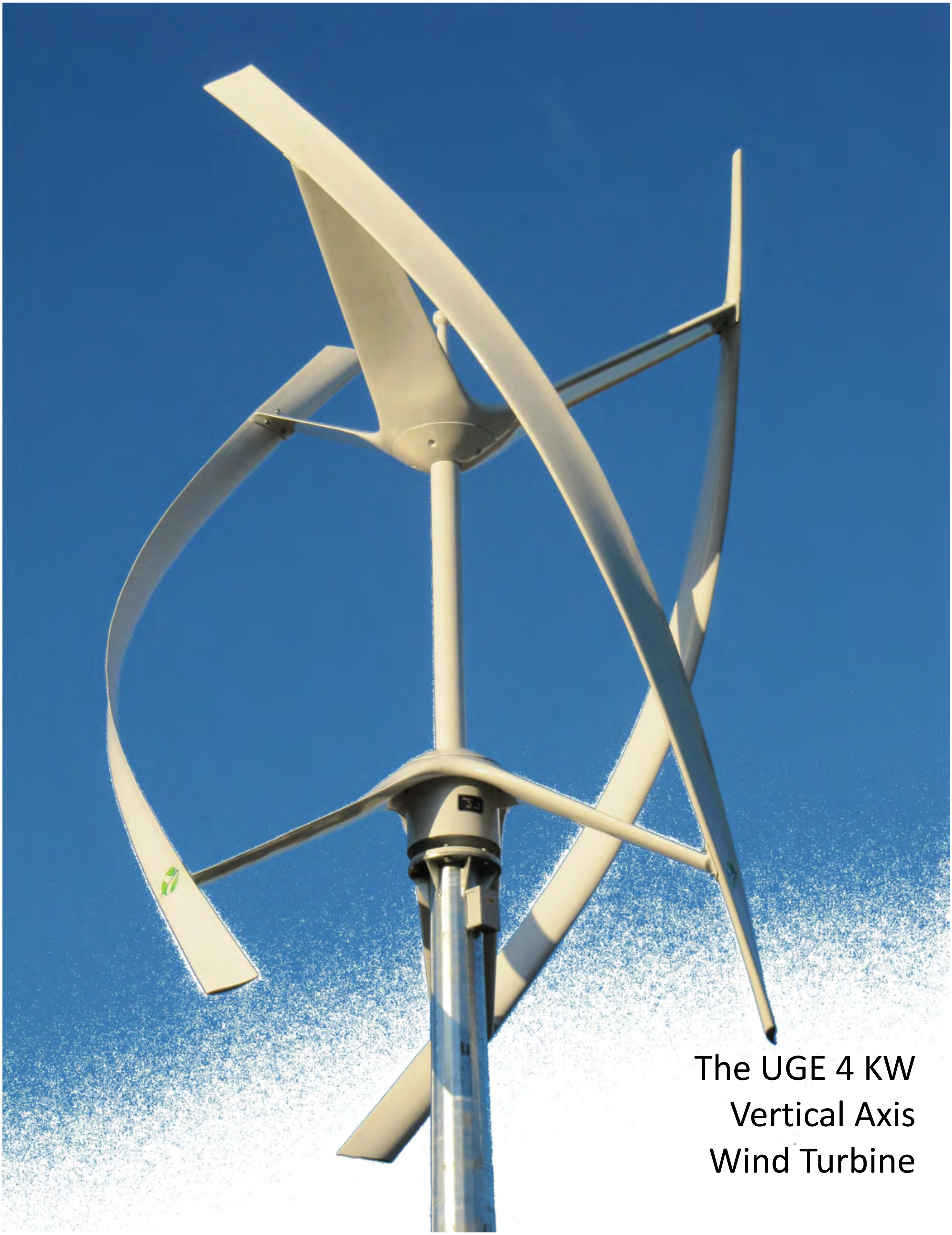
The wind turbines can accept winds from any direction without having to track the wind.

The Wind Rose on the Orion Building

Placing a wind rose over the building helps us place future turbines on the building so that the turbulence created by one machine does not spoil the wind for the other turbines.






The UGE 4 KW
Vertical Axis
Wind Turbine

UGE-4K

4 kW 2nd Generation Vertical Axis Wind Turbine Specifications

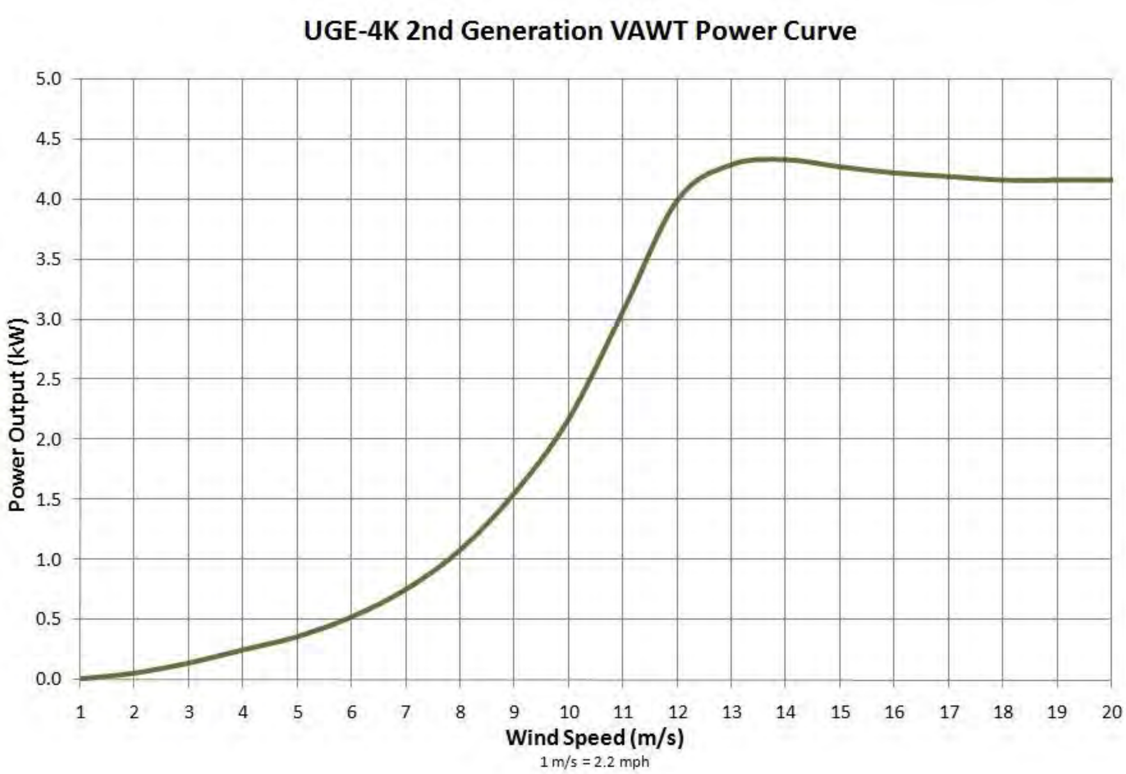
Grid-tie and Off-grid Models

Updated: 08/30/2009

Physical Parameters	
Turbine Diameter (average)	2.75m (108”)
Turbine Height	4.2m (165”)
Tower (standard)	5.5m (18’)
Turbine weight (w/ generator)	190 kg
Tower weight	540 kg
Roof mount weight (steel)	280 kg
Roof mount weight (aluminum)	90 kg
Shipping size	7.4 CBM

Performance Parameters	
Start-up wind speed	2.5m/s (5 mph)
Cut-in wind speed	3.5m/s (7.5 mph)
Cut-out wind speed	25m/s (56 mph)
Rated wind speed	12m/s (27 mph)
Max (survival) wind speed	50m/s (110 mph)
Rated Lifetime	20 Years

	Performance Data
Wind Speed (m/s)	Output (kW)
2	55
3	140
4	250
5	360
6	525
7	755
8	1,085
9	1,560
10	2,180
11	3,080
12	4,000
13	4,295
14	4,335
15	4,275
16	4,225
17	4,195



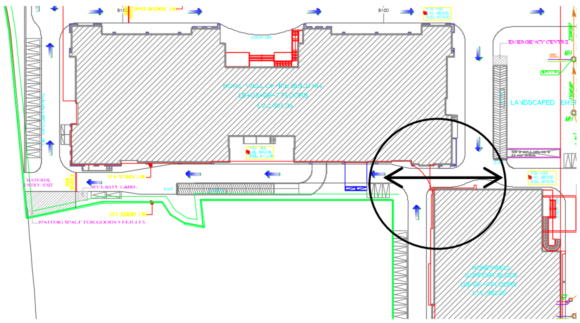
Placement of Wind turbines on the Orion Building

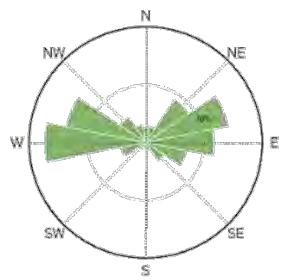
Visual Rendering showing the placement of the wind turbines on the roof of the Orion building.

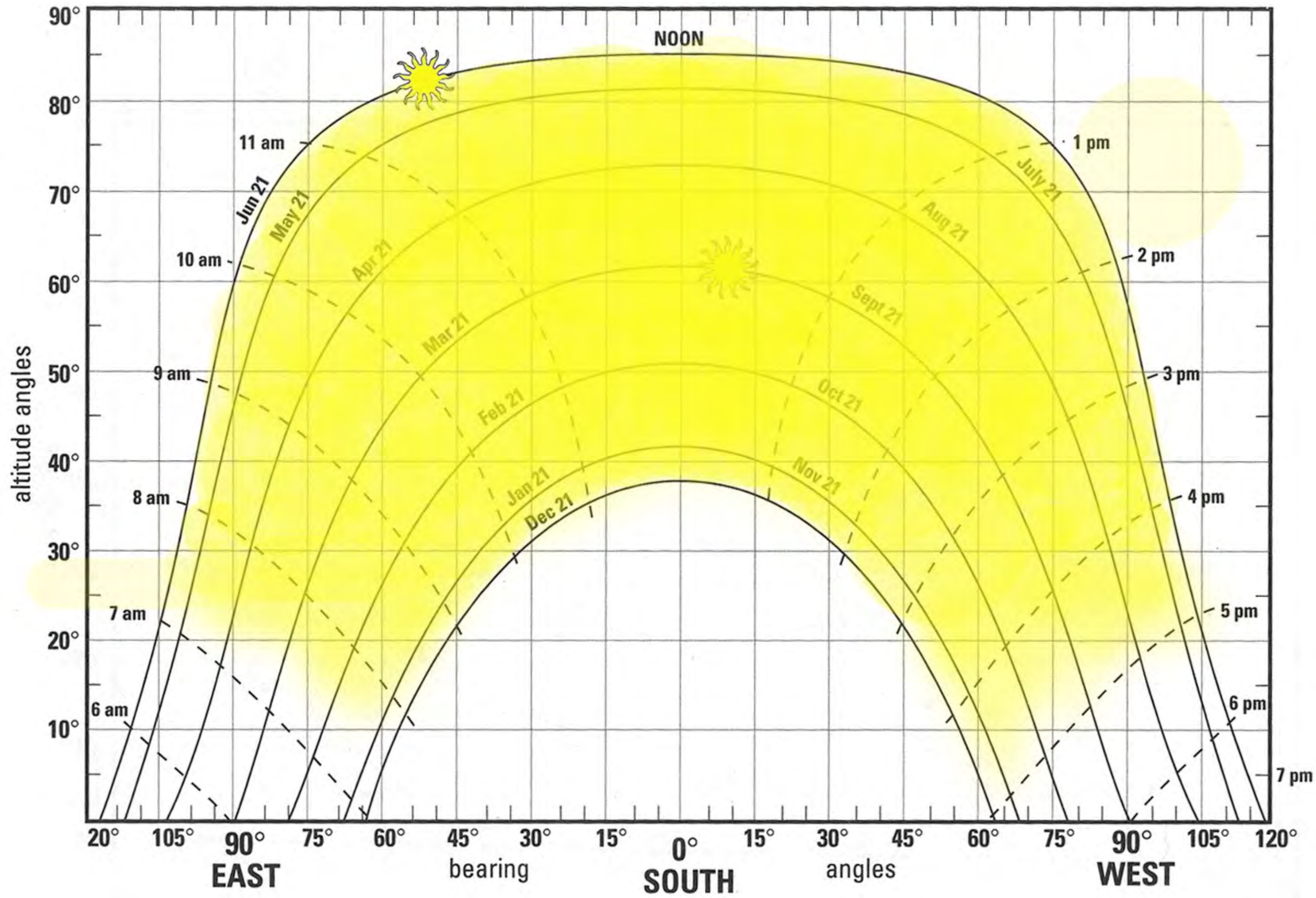
Proposed UGE Vertical Axis Wind turbines on the roof

Mounting of proposed wind turbines will be on 2-3 meter stub towers and stands similar, but more robust, than the telecom parabolic pictured here.

The Honeywell 3 Phase H Wind bridge proposal







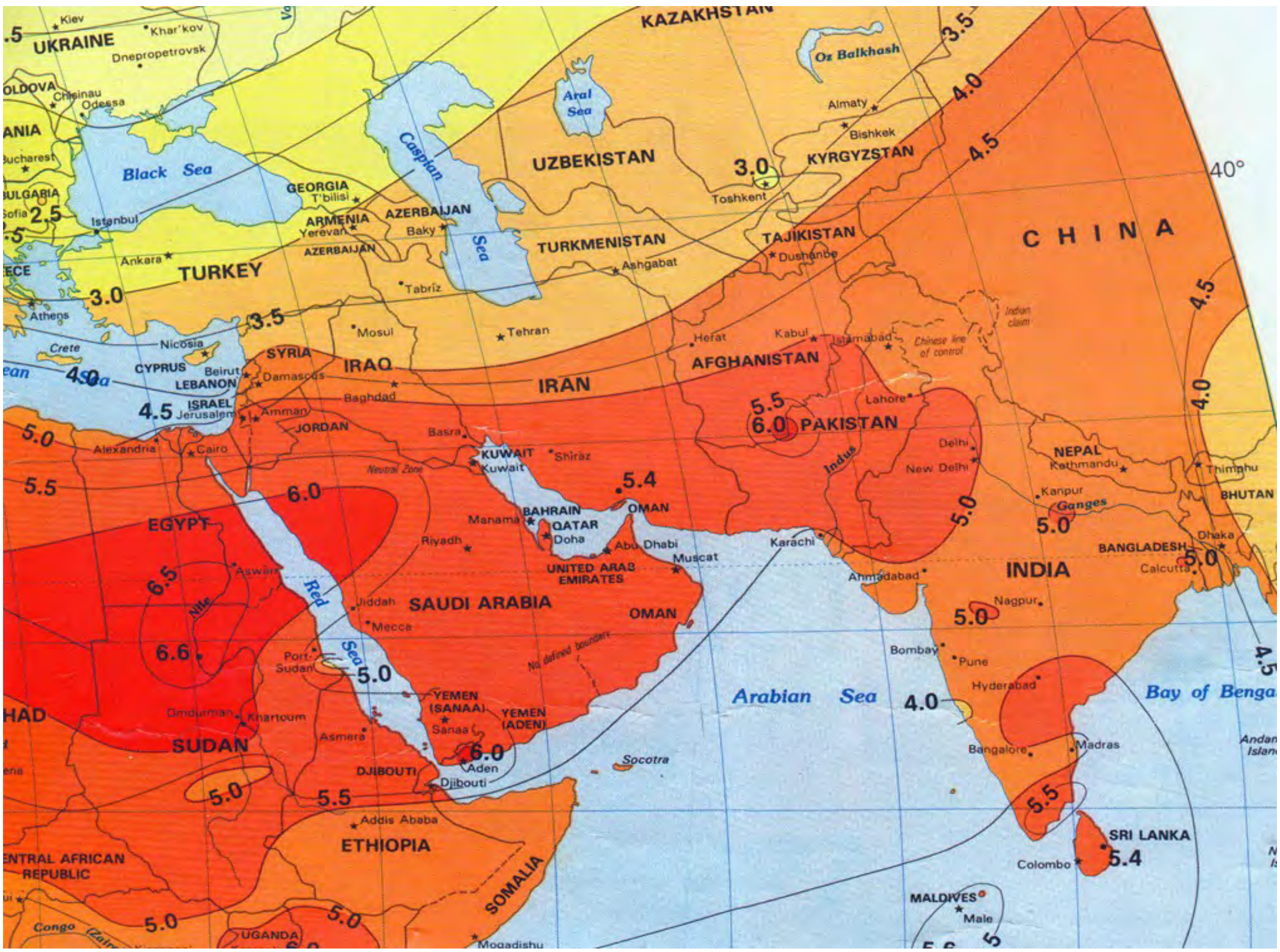
The above chart shows the arc-path of the sun.
Please note:

The sun apparently rises in the east reaching its highest zenith on June 21 at noon
On December 21 the sun rises significantly later at 7 AM reaching its peak at noon

All other dates during the year are indicated and can be viewed.

Regional Solar Potential in Full Sun hours per day.

It can be seen that Bangalore receives 4.5 full sun hours of solar radiation every day. This energy might be obscured by atmospheric haze and cloud cover which has to be anticipated in predicting power output from solar energy collectors.



Orion Campus Solar Potential in watts/sq meter

Latitude: **12.924°** Longitude: **77.688°**

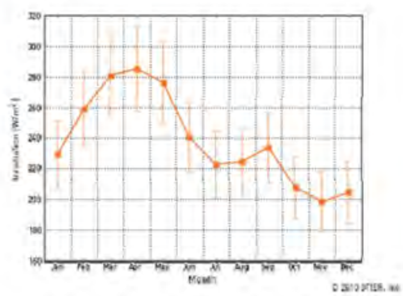
238.2 ± 23.3 W/m²

Latitude: **12.924°** Longitude: **77.688°**

203.2 ± 19.9 W/m²

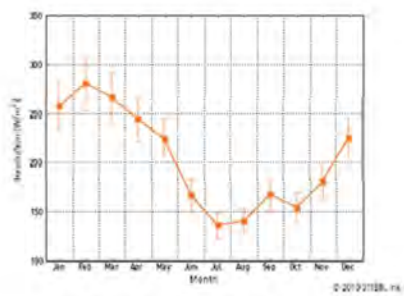
Monthly Mean GHI: Solar Prospecting Tools

Latitude: **12.924°** Longitude: **77.688°**
Your highest GHI month is: **April**
Your lowest GHI month is: **November**



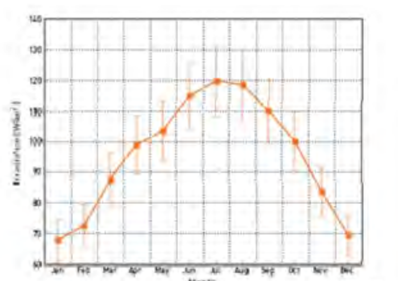
Monthly Mean DNI: Solar Prospecting Tools

Latitude: **12.924°** Longitude: **77.688°**
Your highest DNI month is: **February**
Your lowest DNI month is: **July**



Monthly Mean Diffuse: Solar Prospecting Tool...

Latitude: **12.924°** Longitude: **77.688°**
Your highest Diffuse month is: **July**
Your lowest Diffuse month is: **January**



Annual Mean Diffuse Range: Solar Prospecting...

Latitude: **12.924°** Longitude: **77.688°**

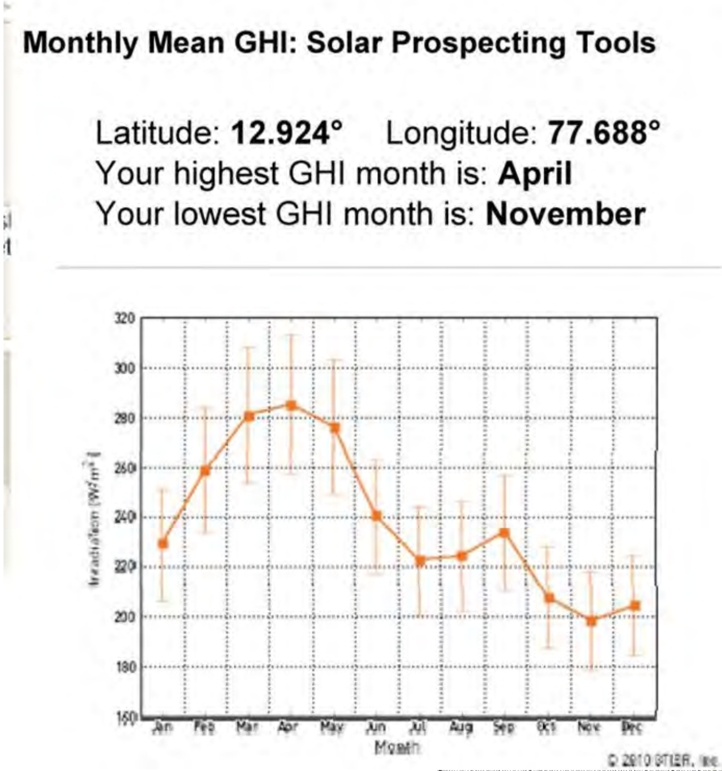
95.5 ± 9.3 W/m²

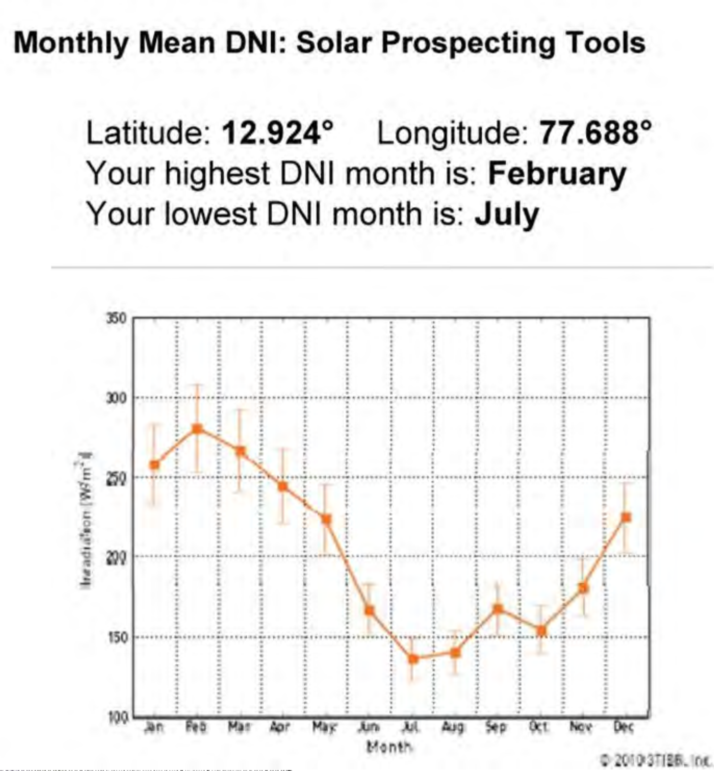
The radiation reaching the earth's surface can be represented in a number of different ways.

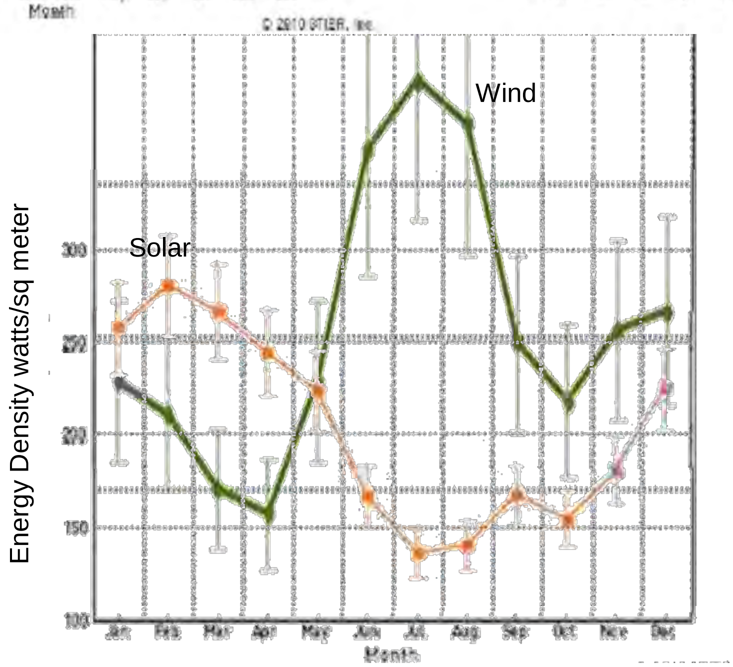
Global Horizontal Irradiance (GHI) is the total amount of shortwave radiation received from above by a surface horizontal to the ground. This value is of particular interest to photovoltaic installations and includes both Direct Normal Irradiance (DNI) and Diffuse Horizontal Irradiance (DIF).

DNI is solar radiation that comes in a straight line from the direction of the sun at its current position in the sky.
DIF is solar radiation that does not arrive on a direct path from the sun, but has been scattered by molecules and particles in the atmosphere and comes equally from all directions.

Monthly Solar and Wind Potential comparison in watts/sq meter







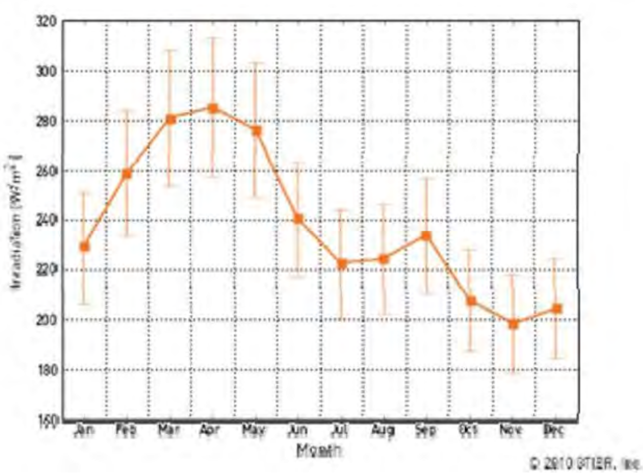
Note that diffuse solar energy is strongest in February (at 275 watts/sq meter) and diminishes to an all year low of 150 watts/sq meter. Wind mimics the solar in loss of energy density and then rapidly reverses into high winds starting at April and peaking into July.

From May until September the energy density available from the wind is substantially higher than the sun. Plus this energy is available during the day and through the night. This is a period of monsoons of strong winds and rain. Solar diminishes in intensity because of the cloud cover.

Monthly Solar PV Power Output for various arrays

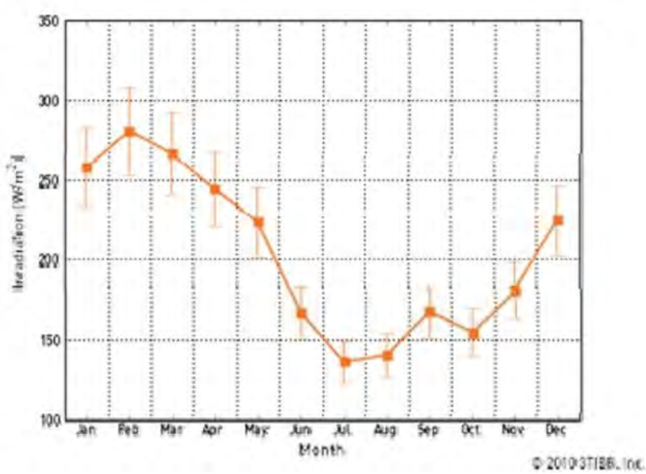
Monthly Mean GHI: Solar Prospecting Tools

Latitude: **12.924°** Longitude: **77.688°**
Your highest GHI month is: **April**
Your lowest GHI month is: **November**

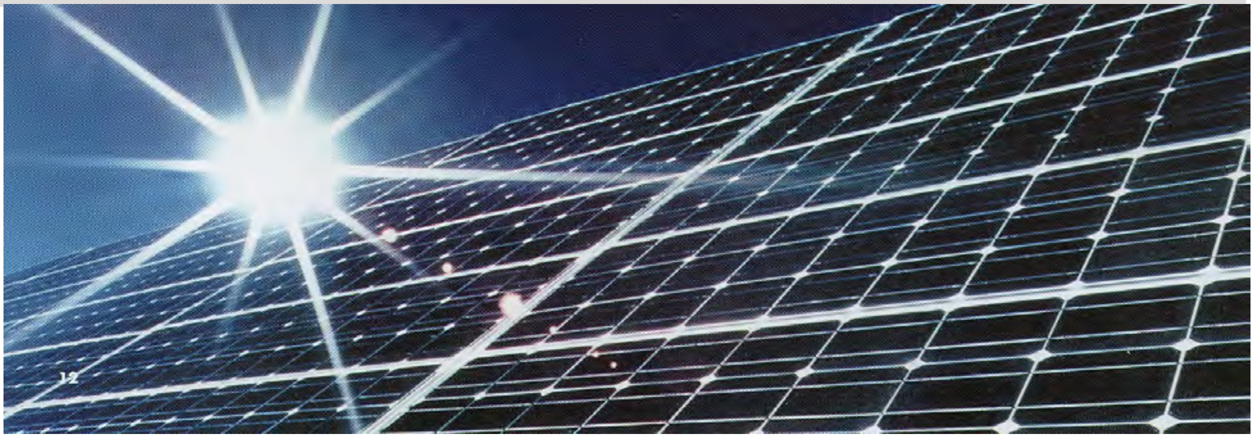


Monthly Mean DNI: Solar Prospecting Tools

Latitude: **12.924°** Longitude: **77.688°**
Your highest DNI month is: **February**
Your lowest DNI month is: **July**

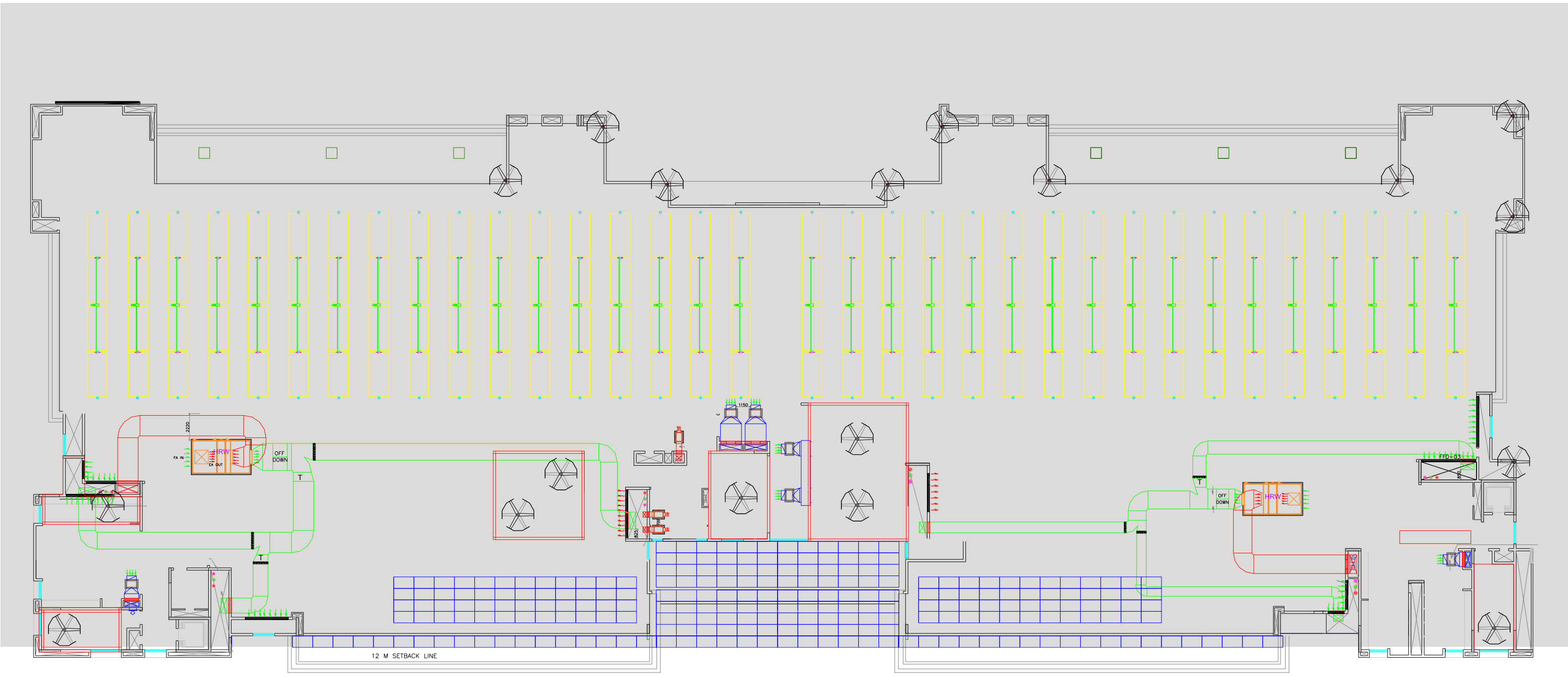


Monthly Diffuse Energy densities	**Irradiation Density**	**11 Kw PV Base Array**	**55 Kw PV Array**	**176 Kw PV Array**
Month	Average (watts/m^2)	Kilowatthrs/ month	Kilowatthrs/ month	Kilowatthrs/ month
Jan	260	1469	7345	23,506
Feb	275	1553	7765	24,848
Mar	265	1497	7485	23,952
Apr	245	1384	6920	22,144
May	225	1271	6355	20,336
June	160	903	4515	14,448
July	140	790	3950	12,640
Aug	143	807	4035	12,912
Sept	165	932	4660	14,912
Oct	152	858	4290	13,728
Nov	175	988	4940	15,808
Dec	225	1271	6355	20,336
	Average 202.5	13,728 Kwhr/yr	68,640 Kwhr/yr	219,656 Kwhr/yr.



- 230 watt PV Panel from India
- **Peak Power watts 230**
- **Peak Power voltage: 29.6**
- **Peak Power Current: 7.76**
- **Open Circuit voltage: 36.9**
- **Max system voltage: 600**

Solution A: The Concentrator, PV, and Wind System Description



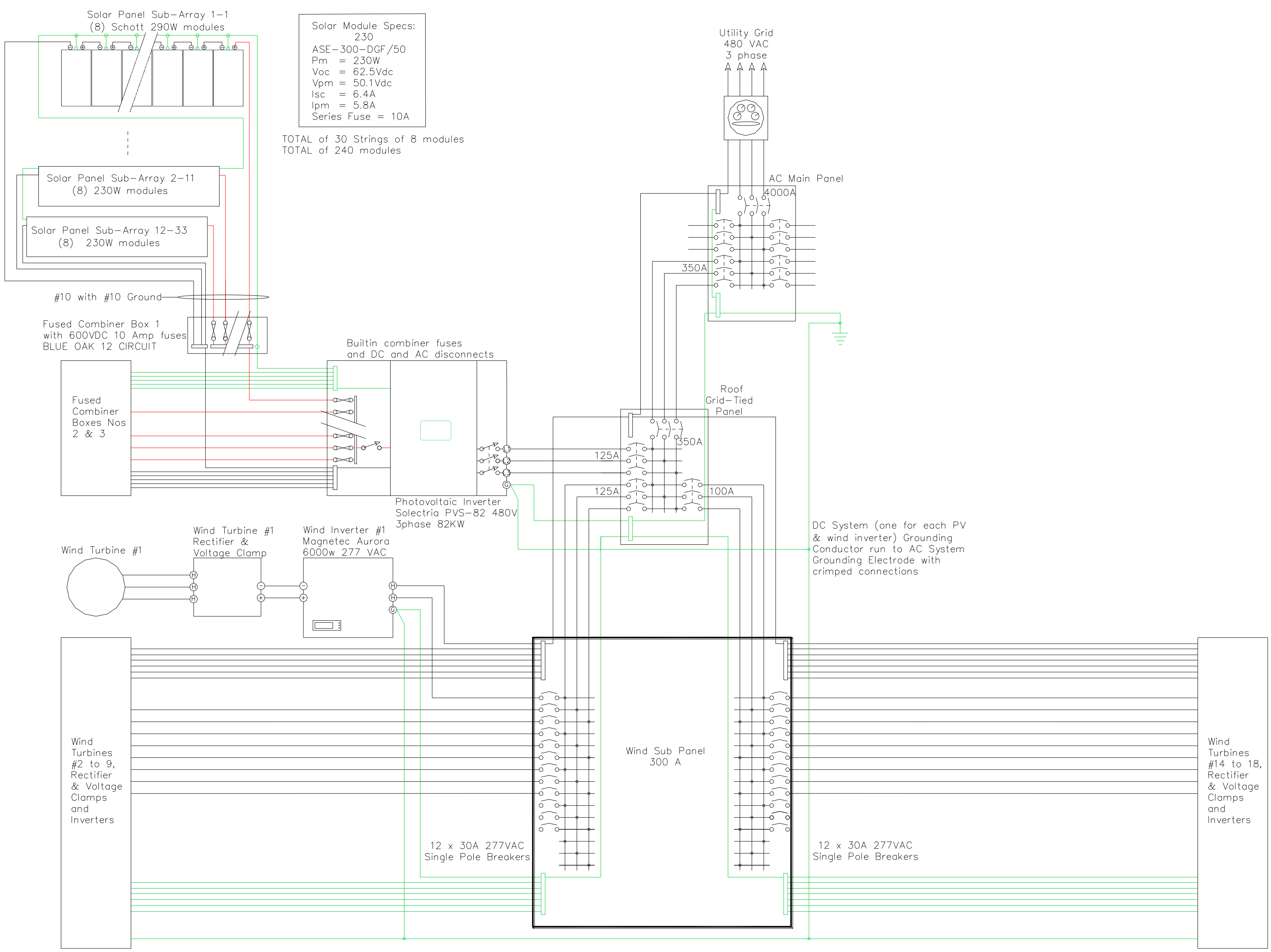
Solution A Specifications:

1. The Thermal Concentrator System:
   136 Concentrators in 34 rows that follow the sun from East to West.
   Systems Efficiency: 58%

2. The PV System:
   Each Photovoltaic panel has the capacity to generate 230 watts .
   Panels are grouped into arrays which have 6 string circuits of 8 panels each. Total: 5
   Each array has a capacity of 11,040 watts or 11 Kw.
   Total charging capacity of 55,000 watts or 55 Kw.
   Systems Efficiency: 12%

3. The Wind Turbine System:
   The vertical axis wind turbines are rated at 4.0 Kw at a wind speed of 12 meters/second.
   There are 15 wind turbines proposed for the top of the Honeywell Orion building.
   There is also a proposal that bridges the Orion building with 3 turbines.
   The capacity of the 18 wind turbines is 72 Kw.
   Systems Efficiency: 20%

Solution A	*Capacity*	*Actual Yearly output Kwhr/yr*
Photovoltaic Power	55.0 Kw	68,640 Kwhr/yr
Wind Power	72.0 Kw	137,304
Solar Concentrator	405.3 Kw	772,180
Total	532.3 Kw	978,124 Kwhr/yr



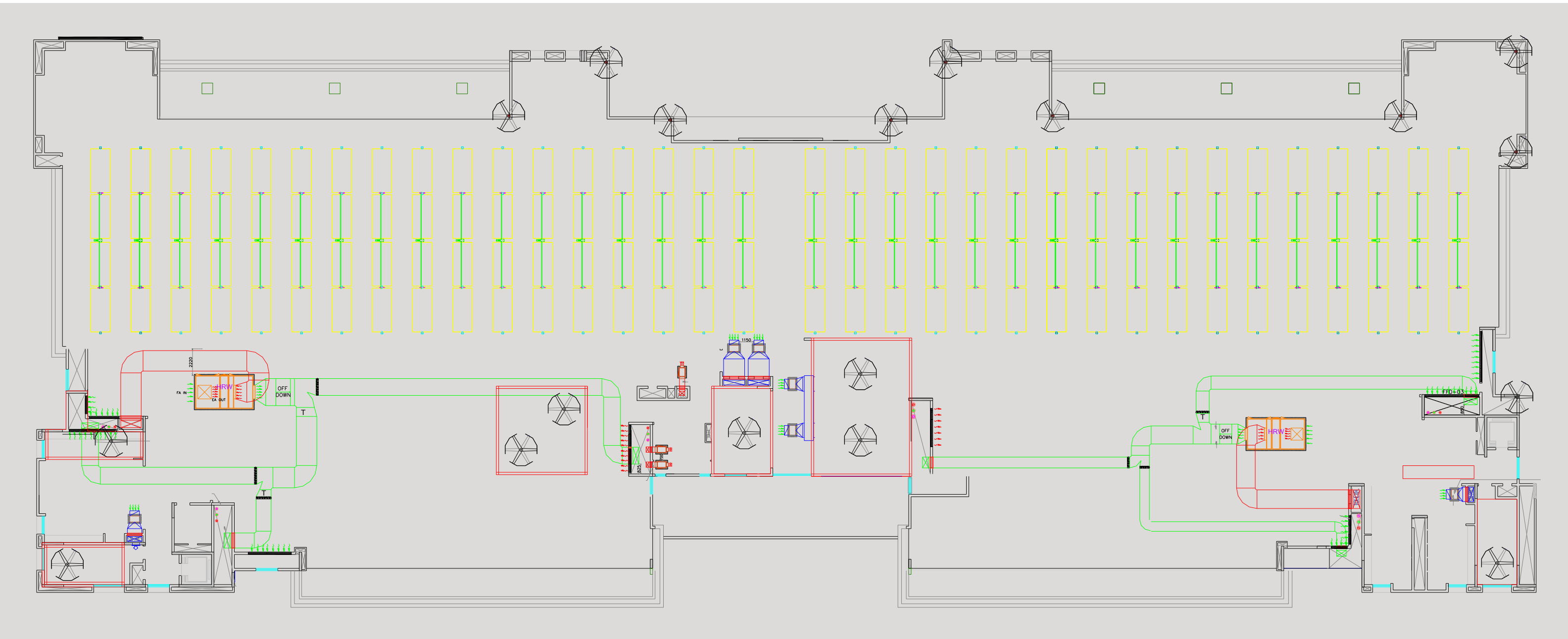
Honeywell Wind and Solar PV Line Diagram

Design: R. Ziegler EcoSustainable LivingSystems Pvt. Ltd.

This circuit diagram shows the photovoltaic panels grouped in series of 8 and routed to combiner boxes. Mains from the combiner boxes run through large 3 phase inverters and into the building mains at 440 or 480 VAC.

Similarly, 18 wind turbines configured groups of 3 generate 6 power groups of 3 Phase power at 440 or 480 VAC.

Solution B: The Concentrator and Wind System Description



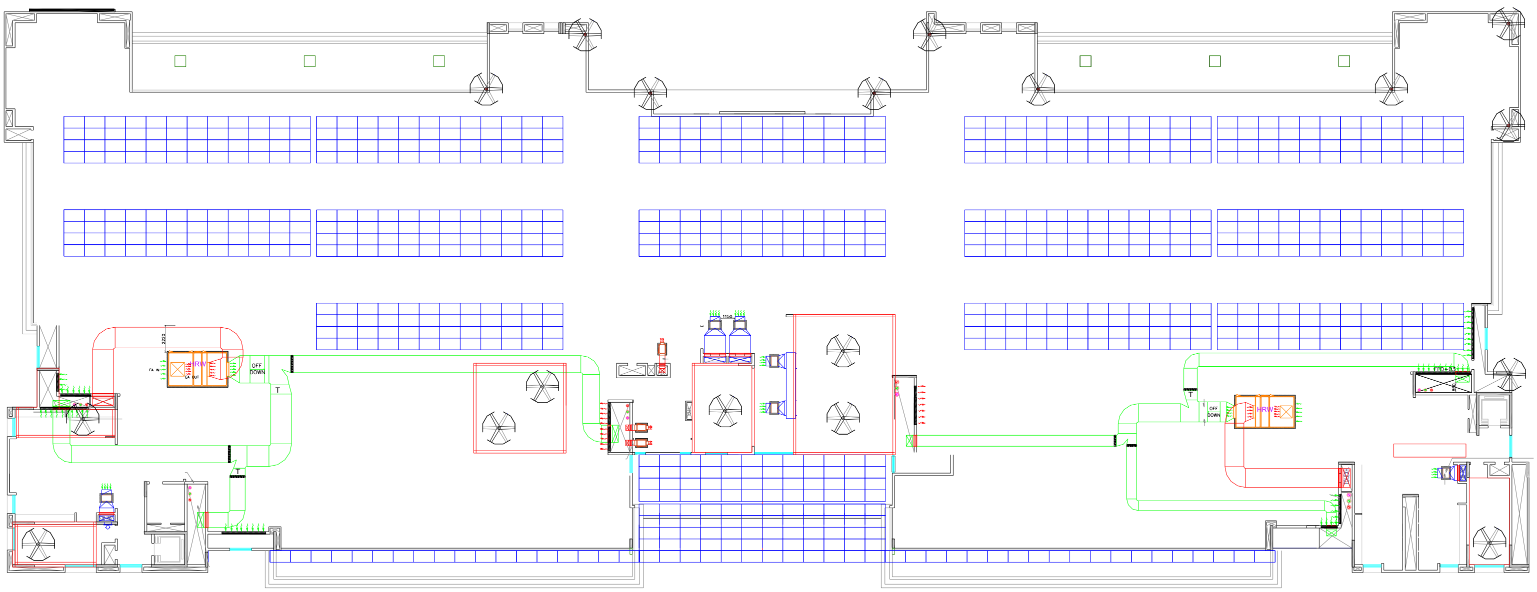
Solution B Specifications:

1. The Thermal Concentrator System:
   136 Concentrators in 34 rows that follow the sun from East to West.
   Systems Efficiency: 58%

2. The Wind Turbine System:
   The vertical axis wind turbines are rated at 4.0 Kw at a wind speed of 12 meters/second.
   There are 15 wind turbines proposed for the top of the Honeywell Orion building.
   There is also a proposal that bridges the Orion building with 3 turbines.
   The capacity of the 18 wind turbines is 72 Kw.
   Systems Efficiency: 20%

Solution B		*Capacity*	*Actual Yearly output Kwhr/yr*
	Wind Power	72.0 Kw	137,304
	Solar Concentrator	405.3 Kw	772,180
	Total	477.3 Kw	909,484 Kwhr/yr

Solution C: The PV and Wind System Description



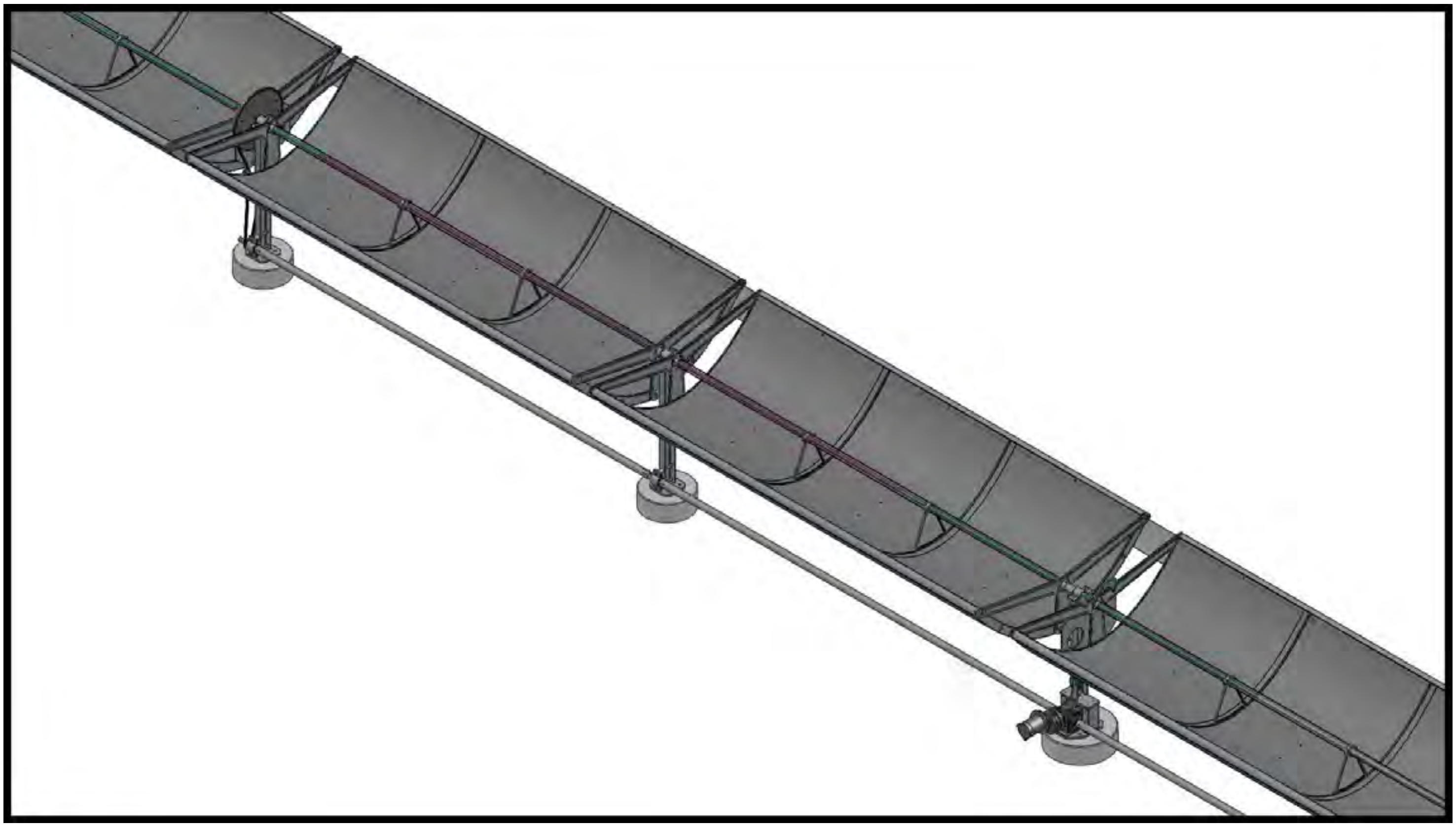
Solution C Specifications

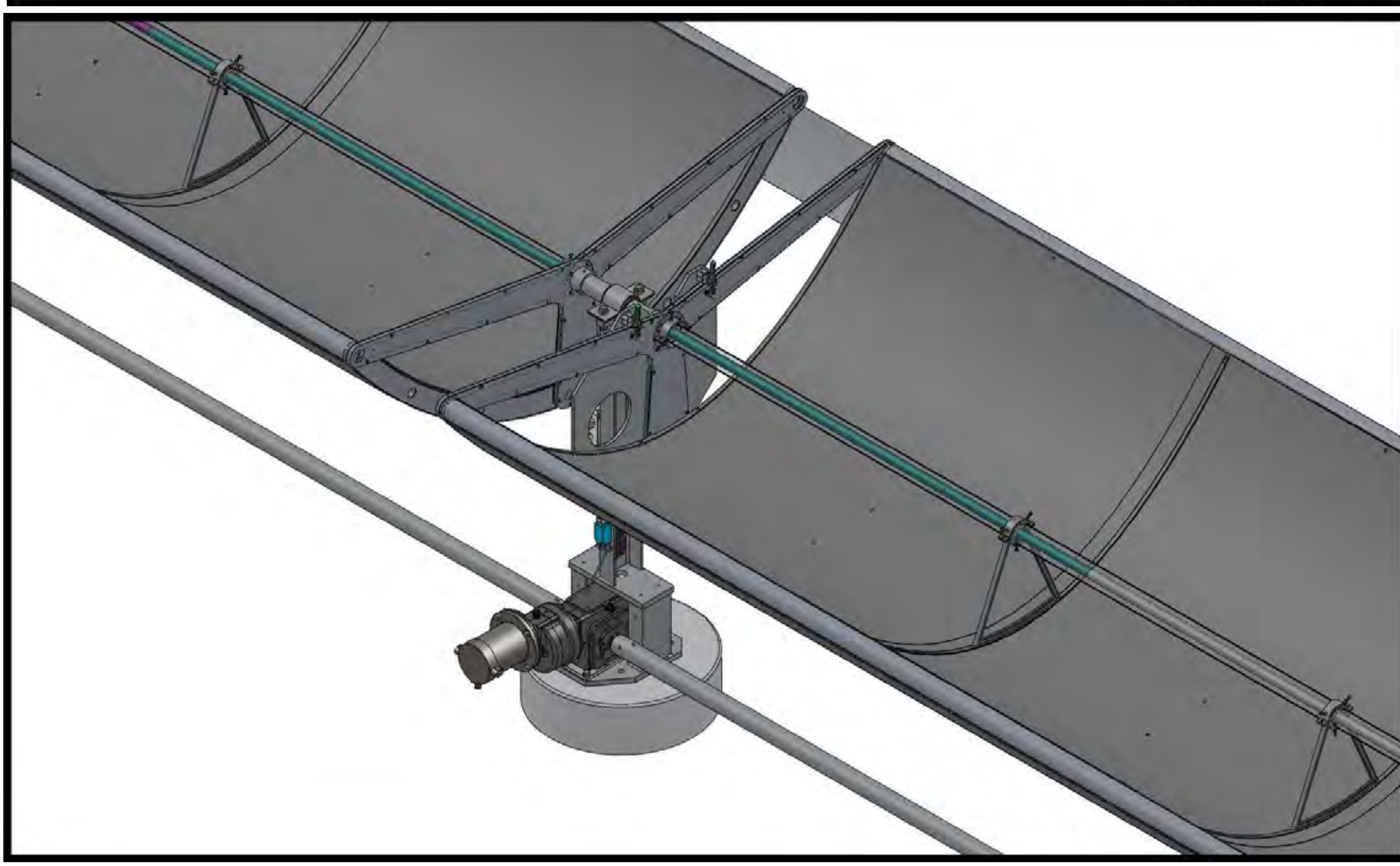
1. The PV System:
   Each Photovoltaic panel has the capacity to generate 230 watts .
   Panels are grouped into arrays which have 6 string circuits of 8 panels each. Total: 48
   Each array has a capacity of 11,040 watts or 11 Kw.
   There are 16 arrays with a total charging capacity of 176,648 watts or 176.7 Kw.

2. The Wind Turbine System:
   The vertical axis wind turbines are rated at 4.0 Kw at a wind speed of 12 meters/second.
   The generators can feed their energy directly into the grid or their power can be stored in batteries for UPS applications.
   There are 15 wind turbines proposed for the top of the Honeywell Orion building. There is also a proposal that bridges the Orion building with 3 wind turbines.
   The capacity of the 18 wind turbines on the roof is equal to 72 Kw.

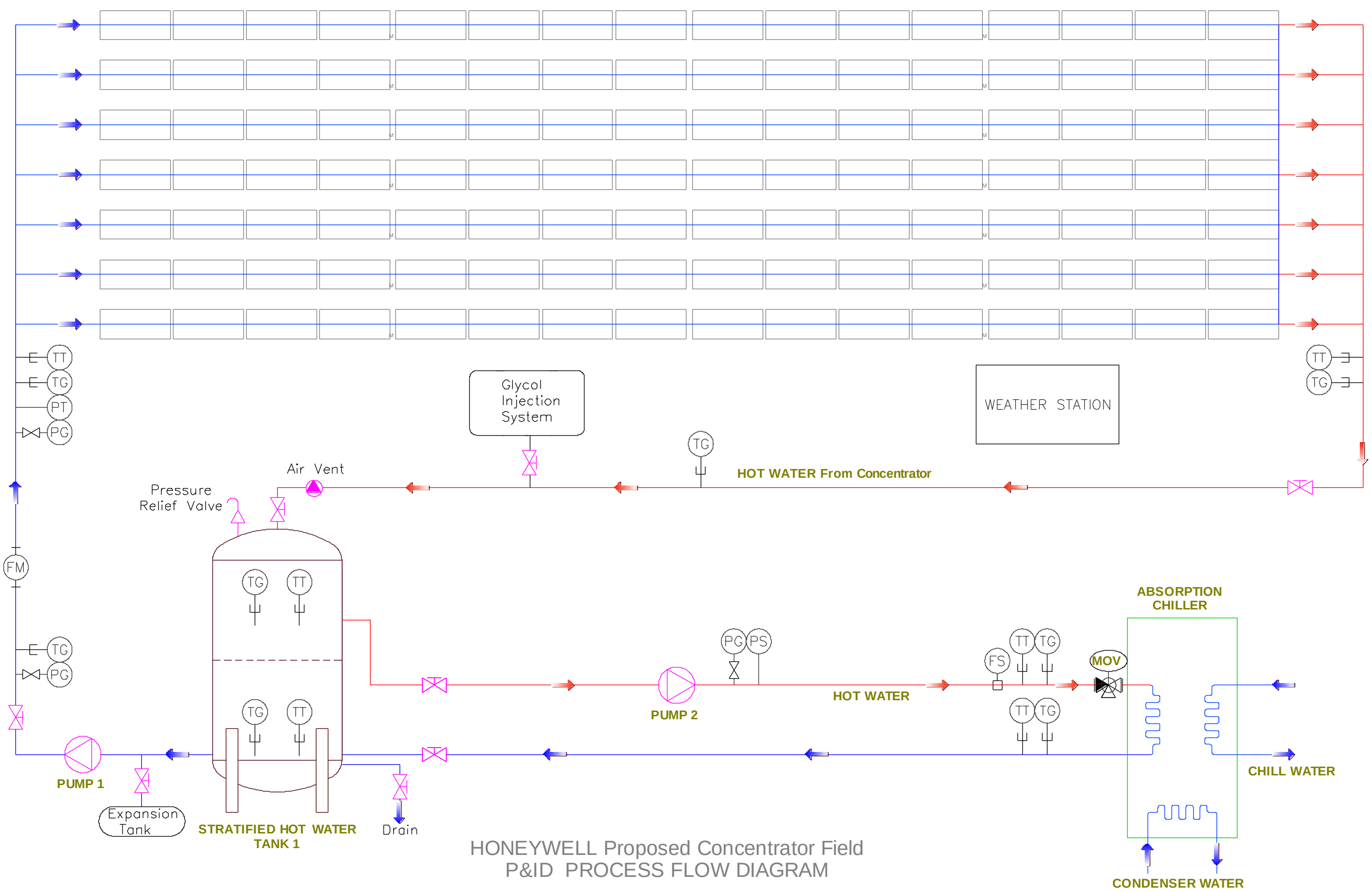
3. Total Renewable energy capacity from the roof:

Solution C		*Capacity*	*Actual Yearly output Kwhr/yr*
	Photovoltaic Power	176.0 Kw	219,656 Kwhr/yr
	Wind Power	72.0 Kw	137,304
	Total	248.0 Kw	356,960 Kwhr/yr





SOPOGY Concentrator Collectors Piping and Instrumentation Diagram



HONEYWELL Proposed Concentrator Field
P&ID PROCESS FLOW DIAGRAM

Financial Analysis

Financial Analysis of 3 Hybrid Solutions—A Snapshot

HONEYWELL TECHNOLOGY SOLUTIONS: - ORION CAMPUS
Solution A : Solar Concentrator, Solar PV and Wind Hybrid System - 532 KWp

	KWp	KWH	Investment	subsidy	pay back (yrs)	pay back cal
Solar Concentrator	405	772,180	16,821,000	4,406,400		
Wind Generator	72	137,304	14,418,000			
Solar PV	55	68,642	9,487,500	2,846,250		
					4.9	DCF
Total	**532**	**978,126**	**40,726,500**	**7,252,650**	**4.1**	**FCF**

HONEYWELL TECHNOLOGY SOLUTIONS: - ORION CAMPUS
Solution B : Solar Concentrator and Wind Hybrid System - 477 KWp

	KWp	KWH	Investment	subsidy	pay back (yrs)	pay back cal
Solar Concentrator	405	772,180	16,821,000	4,406,400		
Wind Generator	72	137,304	14,418,000			
					3.9	DCF
Total	**477**	**909,484**	**31,239,000**	**4,406,400**	**3.4**	**FCF**

HONEYWELL TECHNOLOGY SOLUTIONS: - ORION CAMPUS
Solution C : Solar PV and Wind Hybrid System - 248 KWp

	KWp	KWH	Investment	subsidy	pay back (yrs)	pay back cal
Wind Generator	72	137,304	14,418,000			
Solar PV	176	219,656	30,360,000	-		
					10.7	DCF
Total	**248**	**356,960**	**44,778,000**	**-**	**7**	**FCF**

Solution A provides for maximum energy generation estimated at 978,126 KWh per annum equivalent to 1.4 month's energy requirement. It requires capital investment in excess of ` 40 million and the project can possibly claim Off Grid subsidy from MNRE for both Solar Thermal and Solar PV installations. It offers a pay back period of 4.1 years on the basis of Free Cash Flows and a slightly higher pay back of 4.9 years if cash flows are discounted at 10%. This offers an attractive return for assets that have a useful life of over 25 years (40 years in case of Solar PV). It uses all the three renewable energy options available and thus makes it a complete integrated and unique renewable energy solution.

Solution B provides for little lower energy generation vis-à-vis Solution A, estimated at 909,484 KWh per annum. It however, requires a significantly lower capital investment in excess of ` 31 million and the project can possibly avail Off Grid subsidy from MNRE for the Solar Thermal installations. It offers the best pay back period of 3.4 years on the basis of Free Cash Flows and a marginally higher pay back of 3.9 years if cash flows are discounted at 10%. This offers the most attractive return for assets that have a useful life of over 25 years (40 years in case of Solar PV). It uses the two most efficient renewable energy options available given the availability of renewable energy resources available at the Orion Campus.

Solution C provides for the least energy generation vis-à-vis Solution A and B, estimated at 356,960 KWh per annum. It also requires the highest capital investment in excess of ` 44 million and the project can possibly avail Grid Based Generation Incentive from MNRE for the Hybrid Solution of Solar PV and Wind. It offers the longest pay back period of 7 years on the basis of Free Cash Flows and a significantly higher pay back of 10.7 years if cash flows are discounted at 10%. This offers a conservative return for assets that have a useful life of over 25 years (40 years in case of Solar PV). It predominantly uses solar PV which at present is the most costly and least efficient of all the three renewable energy applications available for deployment at the Orion Campus.

Cash Flow Analysis: Solution A—Solar Thermal, PV and Wind

Year	Output kWh/yr	Demand Charges	CDM Benefit	Power Saving	Green Cess	kWh Rate	Depreciation Tax saving	Saving Net Benefit	Capital Cost post subsidy	Maintenance	Cash Flow Cumulative
1	978,126	767,268	374,329	4,548,286	48,906	4.650	8,896,010	14,634,799	(33,473,850)	(407,265)	(19,246,316)
2	973,235	763,432	372,457	5,204,376	48,662	5.348	1,779,202	8,168,129		(407,265)	(11,485,452)
3	968,369	759,615	370,595	5,333,705	48,418	5.508	355,840	6,868,173		(407,265)	(5,024,544)
4	963,527	755,816	368,742	5,466,247	48,176	5.673	71,168	6,710,150		(407,265)	1,278,342
5	958,710	752,037	366,898	5,602,084	47,935	5.843	14,234	6,783,188		(407,265)	7,654,265
6	953,916	748,277	365,064	5,741,295	47,696	6.019	2,847	6,905,179		(407,265)	14,152,179
7	949,147	744,536	363,238	5,883,967	47,457	6.199	569	7,039,768		(407,265)	20,784,681
8	944,401	740,813	361,422	6,030,183	47,220	6.385	114	7,179,752		(407,265)	27,557,169
9	939,679	737,109	359,615	6,180,033	46,984	6.577	23	7,323,764		(407,265)	34,473,668
10	934,980	733,423	357,817	6,333,607	46,749	6.774	5	7,471,601		(407,265)	41,538,004
11	930,306	729,756	356,028	6,490,997	46,515	6.977	1	7,623,298		(407,265)	48,754,037
12	925,654	726,108	354,248	6,652,299	46,283	7.187	-	7,778,937		(407,265)	56,125,709
13	921,026	722,477	352,477	6,817,608	46,051	7.402	-	7,938,613		(407,265)	63,657,057
14	916,421	718,865	350,714	6,987,026	45,821	7.624	-	8,102,426		(407,265)	71,352,217
15	911,839	715,270	348,961	7,160,653	45,592	7.853	-	8,270,476		(407,265)	79,215,428
16	907,279	711,694	347,216	7,338,596	45,364	8.089	-	8,442,869		(407,265)	87,251,033
17	902,743	708,136	345,480	7,520,960	45,137	8.331	-	8,619,712		(407,265)	95,463,480
18	898,229	704,595	343,752	7,707,856	44,911	8.581	-	8,801,114		(407,265)	103,857,329
19	893,738	701,072	342,034	7,899,396	44,687	8.839	-	8,987,188		(407,265)	112,437,252
20	889,269	697,567	340,323	8,095,696	44,463	9.104	-	9,178,049		(407,265)	121,208,036
21	884,823	694,079	338,622	8,296,874	44,241	9.377		9,373,815		(407,265)	130,174,586
22	880,399	690,608	336,929	8,503,051	44,020	9.658		9,574,608		(407,265)	139,341,929
23	875,997	687,155	335,244	8,714,352	43,800	9.948		9,780,551		(407,265)	148,715,215
24	871,617	683,719	333,568	8,930,904	43,581	10.246		9,991,772		(407,265)	158,299,722
25	867,259	680,301	331,900	9,152,836	43,363	10.554		10,208,400		(407,265)	168,100,857
Total		**18,073,728**	**8,817,672**	**172,592,886**				**211,756,332**			

Cash Flow Analysis: Solution B—Solar Thermal and Wind

Year	Output kWh/yr	Demand Charges	CDM Benefit	Power Saving	Green Cess	kWh Rate	Depreciation Tax Saving	Saving Net Benefit	Capital Cost post subsidy	Maintenance	Cash Flow Cumulative
1	909,484	696,456	348,060	4,229,101	45,474	4.650	7,131,032	12,450,122	(26,832,600)	(312,390)	(14,694,868)
2	904,937	692,974	346,319	4,839,148	45,247	5.348	1,426,206	7,349,894		(312,390)	(7,657,363)
3	900,412	689,509	344,588	4,959,401	45,021	5.508	285,241	6,323,760		(312,390)	(1,645,994)
4	895,910	686,061	342,865	5,082,642	44,795	5.673	57,048	6,213,412		(312,390)	4,255,028
5	891,430	682,631	341,150	5,208,946	44,572	5.843	11,410	6,288,709		(312,390)	10,231,347
6	886,973	679,218	339,445	5,338,388	44,349	6.019	2,282	6,403,681		(312,390)	16,322,638
7	882,538	675,822	337,747	5,471,047	44,127	6.199	456	6,529,200		(312,390)	22,539,448
8	878,126	672,443	336,059	5,607,003	43,906	6.385	91	6,659,502		(312,390)	28,886,559
9	873,735	669,080	334,378	5,746,337	43,687	6.577	18	6,793,501		(312,390)	35,367,670
10	869,366	665,735	332,706	5,889,133	43,468	6.774	4	6,931,047		(312,390)	41,986,327
11	865,019	662,406	331,043	6,035,478	43,251	6.977	1	7,072,179		(312,390)	48,746,116
12	860,694	659,094	329,388	6,185,460	43,035	7.187	-	7,216,977		(312,390)	55,650,703
13	856,391	655,799	327,741	6,339,169	42,820	7.402	-	7,365,528		(312,390)	62,703,840
14	852,109	652,520	326,102	6,496,697	42,605	7.624	-	7,517,924		(312,390)	69,909,374
15	847,848	649,257	324,472	6,658,140	42,392	7.853	-	7,674,261		(312,390)	77,271,245
16	843,609	646,011	322,849	6,823,595	42,180	8.089	-	7,834,635		(312,390)	84,793,491
17	839,391	642,781	321,235	6,993,161	41,970	8.331	-	7,999,146		(312,390)	92,480,247
18	835,194	639,567	319,629	7,166,941	41,760	8.581	-	8,167,896		(312,390)	100,335,753
19	831,018	636,369	318,031	7,345,039	41,551	8.839	-	8,340,990		(312,390)	108,364,354
20	826,863	633,187	316,440	7,527,564	41,343	9.104	-	8,518,535		(312,390)	116,570,498
21	822,729	630,021	314,858	7,714,624	41,136	9.377		8,700,640		(312,390)	124,958,748
22	818,615	626,871	313,284	7,906,332	40,931	9.658		8,887,418		(312,390)	133,533,776
23	814,522	623,737	311,718	8,102,804	40,726	9.948		9,078,985		(312,390)	142,300,371
24	810,449	620,618	310,159	8,304,159	40,522	10.246		9,275,459		(312,390)	151,263,440
25	806,397	617,515	308,608	8,510,517	40,320	10.554		9,476,961		(312,390)	160,428,010
Total		**16,405,684**	**8,198,873**	**160,480,826**				**195,070,360**			

Cash Flow Analysis: Solution C—Solar PV and Wind

Year	Output kWh/yr	Demand Charges	CDM Benefit	Power Saving	Green Cess	kWh Rate	Depreciation Tax saving	Saving Net Benefit	Capital Cost post subsidy	Maintenance	Cash Flow Cumulative
1	356,960	401,712	136,609	5,354,397	17,848	15.000	1,041,268	6,951,834	(44,778,000)	(447,780)	(38,273,946)
2	355,175	399,703	135,925	5,327,625	17,759	15.000	1,041,268	6,922,281		(447,780)	(31,799,446)
3	353,399	397,705	135,246	5,300,987	17,670	15.000	1,041,268	6,892,876		(447,780)	(25,354,350)
4	351,632	395,716	134,570	5,274,482	17,582	15.000	1,041,268	6,863,618		(447,780)	(18,938,512)
5	349,874	393,738	133,897	5,248,110	17,494	15.000	1,041,268	6,834,506		(447,780)	(12,551,786)
6	348,125	391,769	133,227	5,221,869	17,406	15.000	1,041,268	6,805,540		(447,780)	(6,194,027)
7	346,384	389,810	132,561	5,195,760	17,319	15.000	1,041,268	6,776,718		(447,780)	134,912
8	344,652	387,861	131,898	5,169,781	17,233	15.000	1,041,268	6,748,041		(447,780)	6,435,173
9	342,929	385,922	131,239	5,143,932	17,146	15.000	1,041,268	6,719,507		(447,780)	12,706,900
10	341,214	383,992	130,583	5,118,213	17,061	15.000	1,041,268	6,691,116		(447,780)	18,950,236
11	339,508	382,072	129,930	5,092,622	16,975	15.000	197,841	5,819,440		(447,780)	24,321,896
12	337,811	380,162	129,280	5,067,159	16,891	15.000	197,841	5,791,332		(447,780)	29,665,448
13	336,122	378,261	128,634	5,041,823	16,806	15.000	197,841	5,763,365		(447,780)	34,981,033
14	334,441	376,370	127,991	5,016,614	16,722	15.000	197,841	5,735,537		(447,780)	40,268,790
15	332,769	374,488	127,351	4,991,531	16,638	15.000	197,841	5,707,848		(447,780)	45,528,858
16	331,105	372,616	126,714	4,966,573	16,555	15.000	197,841	5,680,298		(447,780)	50,761,377
17	329,449	370,753	126,080	4,941,740	16,472	15.000	197,841	5,652,886		(447,780)	55,966,483
18	327,802	368,899	125,450	4,917,031	16,390	15.000	197,841	5,625,611		(447,780)	61,144,314
19	326,163	367,054	124,823	4,892,446	16,308	15.000	197,841	5,598,472		(447,780)	66,295,006
20	324,532	365,219	124,198	4,867,984	16,227	15.000	197,841	5,571,469		(447,780)	71,418,695
21	322,910	363,393	123,578	4,843,644	16,145	15.000		5,346,760		(447,780)	76,317,675
22	321,295	361,576	122,960	4,819,426	16,065	15.000		5,320,026		(447,780)	81,189,921
23	319,689	359,768	122,345	4,795,329	15,984	15.000		5,293,426		(447,780)	86,035,567
24	318,090	357,969	121,733	4,771,352	15,905	15.000		5,266,959		(447,780)	90,854,746
25	316,500	356,179	121,124	4,747,495	15,825	15.000		5,240,624		(447,780)	95,647,590
	Total	**9,462,708**	**3,217,944**	**126,127,927**				**151,620,090**			

1. The following sources of cash inflow have been considered for financial analysis
   - Saving in Demand Charges @ ` 200 per unit
   - Saving in Energy Charges payable to BESCOM @ ` 4.65 per unit. Energy escalation charges of 15% in year 1 and 3% p.a. for all subsequent years has been assumed.
   - Saving in Income Tax outflow on account of accelerated and normal depreciation.
   - Cash flow generated from Energy Unit Credits available under the CDM
   - Saving in Green Cess of ` 0.05 per unit
   - Subsidy offered by Ministry of New and Renewable Energy (MNRE) and Karnataka Renewable Energy Development Limited (KREDL)

2. The following sources of cash outflow have been considered
   - Capital Investment in Indian Rupees. The conversion rate used is 1 US $ = ` 44.5
   - Annual Maintenance Charges @ 1% p.a. of the Capital Investment

3. The Free Cash Flow's have been discounted at 10% p.a.

4. The financial analysis is subject to the eligibility and availability of financial incentives offered by the MNRE and State Governments for promoting New and renewable Energy Sources from time to time. As such the project would be subject to the conditions applicable at the time of implementation of the project by Honeywell.

5. Cost estimate of 176 KWp Solar PV system:

• PV Panels	` 18,216,000
• Invertors, electrical, mountings, civil works, implementation, etc	` 12,144,000
Total	**` 30,360,000**

6. Cost estimate of 405 KWp Solar Thermal system:

• Solar Concentrator, trackers, etc.	` 9,871,000
• Sensors, Gauges, valves, tanks Pumps, plumbing, intallation etc	` 6,950,000
Total	**` 16,821,000**

6. Cost estimate of 72 KWp Wind Generation system:

• 18 wind turbines includes fitting	` 14,418,000
Total	**` 14,418,000**

Concluding Remarks

The previous completes our study of the Orion campus as outlined in the project summary on page 2. After extensive analysis of the solar and wind potential the alternative solutions have been presented as a menu. The Break Even has been determined under the Financial Analysis. Management can now decide which option to pursue.

Whatever option is chosen Ecosustainable Living Technologies (ELT) will perform due diligence on the sample technologies presented here. We also recommend making this project LEED® certified. This involves hiring a LEED certified building professional familiar with the Indian environment and SEZ Green standards.

Next steps is to complete the design engineering and construction documents of the chosen system. ELT has started this process but the implementation is beyond the scope of this study.

This study is a work in progress. We will continue to add to its refinement and content. Any suggestions or feedback should be directed to the following principals.

Respectfully submitted,

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Honeywell

Kalyani Campus

Energy Audit and Retro Commissioning Study

Prepared by:

ECOSUSTAINABLE

11-30-2010

Introduction

As part of its contract with Honeywell Technology Solutions Lab Pvt. Ltd. (HTSL) - Ecosustainable Living Technologies PVT Ltd. (ELT) was requested to do an Energy Audit and recommend methods for Retro Commissioning the Kalyani campus.

Our standard procedures for doing such a study are outlined in the following pages. This includes extensive walk through site surveys and interviews with facilities managers at the Kalyani campus. Normal procedures involve creating a team to analyze and measure inefficiencies and coming up with a strategy for implementing the least-cost yet highest return on investment. (ROI)

What follows in this report is a description of ELT procedures for doing energy audits and suggestions for retro-commissioning with energy saving measures (EMS).

ELT spent a day talking to the Kalyani facilities mangers to assess what energy conservation programs had been carried out and which ones are in process.
This information is summarized at the end of this document.

EcoSustainable Living Technologies Pvt : Our Retro-commissioning Procedures for Honeywell

Select Honeywell team mates for achieving and maintaining energy savings.

Set goals and objectives:

- Targeted savings, available budgets, time frame for the project.

Gather historical database:

- Utility consumption, occupancy rates, operating hours, floor area, production rates.

Identify specific energy saving measures (ESMs)

- Perform energy audits
- Can be classified into three main categories based on the scope of work or study.

Outcomes & Deliverables

Level 1- Walk through assessment

Determines the building's energy cost and efficiency through the analysis of energy bills Determines the best potential for savings and where further effort and study should be devoted.

Level 2- Energy Survey and Analysis

- Collection of information on facility operations.
- Utility bill analysis.
- End user profile.

Identifies and provides the savings and cost analysis of all practical measures. Involves spot measurements of motor power, space temperature, relative humidity, and airflow rates.

- Determines kWh/ft2 and $/ft2 which may be compared to other buildings.
- Determines where and when energy is being consumed.
- Consumption is grouped into: chillers, boilers, pumps, cooling towers, air handling units, fan coil units, ventilation fans, lighting, conveyor motors, etc.

Level 3 – Detailed energy audits: Investment Grade Audits (IGA)

- Focus on potential optimization and capital intensive projects identified in Level 2 audits.
- Involve more detailed field data gathering and engineering analysis.
- Provide detailed project cost and savings information sufficient for major capital investment decisions.

Provides a benchmark parameter for building.
Lighting w/floor area served (W/ft2)
Cooling load/air-condition floor area (RT/ft2)
Chiller kW/cooling load (kW/RT)
Load factor = total monthly kWh consumption/ maximum kW demand x 24 hours x no. of days in month.

DATA GATHERING

Determine base line of electricity consumption in the total building.
Utilize kW sensors linked to data loggers. Measure 24 hours for 6 days.
Determine electrical motor loads from different systems including loads from mail sorting conveyor equipment.
Sub-metering utilizing clamp-on current sensors multiplexed into data loggers. Measure chiller, fan, pump, motor and hours of use.
Determine electrical lighting loads throughout building.
Determine lighting operating hours, power consumed by light circuits, lighting levels.

Determine base line of gas consumption in the total building.
Read gas volumes consumed for a period of time. (day, week, month)
Determine the parameters for Boilers and Chillers
Supply and return temperatures, flow rates, cooling load profiles, efficiencies (kW/RT)
Steam and hot water systems
Fuel usage, boiler efficiency, etc.

DATA ANALYSIS

Data in raw form need to be refined
Computation of useful parameters
Parameters not directly measured need to be computed using measured data. (Cooling load, chiller efficiency.
Tabulation of data
Comparison of measured data with design data
Plotting of data
Data is plotted to show various operating trends and characteristics.
Comparing performance with specifications
Identifies shortcomings or possible improvements.

ENERGY SAVING METHODS, ESMs

Identification and Concept design

Chillers
Providing design flow rates and temperatures.
Reducing operating hours.
Sequencing chillers.
Resetting chilled water and condenser water temperatures.
Using small chillers for night operations.

Cooling towers
Installing variable speed controls for tower fans
Replacing under performing cooling towers.
Reducing operating hours.

Air handling units and air distribution systems
Reducing fan speed/use of variable speed drives. (VSD)
Converting constant air volume (CAV) systems to variable air volume (VAV) system
Improving controls and control strategies.
Reducing operating hours.
Cleaning/replacement of coils and filters.
Air balancing for distribution systems.

Electric Motor Conveyor Systems
Retrofit current VSD drives
Explore power factor correction

Lighting
Replacing inefficient lamps with high-efficiency lamps.
Using high-efficiency ballasts.
Reducing lighting levels in non-active zones.
Installing timer controls.
Installing occupancy sensors.
Using day lighting and sky lighting.

Steam and hot water systems
Improving boiler operating efficiency.
Heat recovery from flue gas.
Heat recovery from blow down.
Condensate recovery.
Reduction of boiler pressure.
Introduce solar pre-heaters.
Solar concentrators.

Executive Summary

This section presents a summary of the results of the brief walk-through energy audit carried out at Honeywell Technology Solutions Lab, Bangalore during November of 2010. The audit focused on energy conservation measures including performance assessment of vital energy consuming equipment and suggestions for energy conservation.

We believe that what is needed now is an Investment Grade Audit (IGA) that:

- Focus on potential optimization and capital intensive projects identified in previous audits.
- Involve more detailed field data gathering and engineering analysis.
- Provide detailed project cost and savings information sufficient for major capital investment decisions.

In order to carry out the IGA's we need to select Honeywell team mates for achieving and maintaining energy savings. This full time team needs to:

Set goals and objectives:

- Targeted savings, available budgets, time frame for the projects.

Gather a historical database:

- Utility consumption, occupancy rates, operating hours, floor area, production rates.

Identify specific energy saving measures (ESMs)

- Perform <u>continuous</u> energy audits
- Create company incentives that lead to energy conservation.

The exact costs to implement these savings depend on the scale of the retrofit. There are short, medium, and long term solutions. Some of these solutions have been identified by previous studies.

We know that electricity is the major source of energy to the plant. The chillers are the primary users of electricity. HS Diesel is used as fuel in DG sets. The savings that can be achieved with small investments are sizable.

The following charts present potential energy saving measures (ESMs) for Honeywell Kalyani campus. Some of these measures have been implemented, others are being planned. The quantification of the costs of the recommendations was not carried out by ELT as we understood from the facility manager that an earlier study was conducted which had made similar observations and had included detailed cost estimates.

For the time being our cost estimates are labeled (TBD). To be determined.

Kalyani Campus: The Energy Saving Measures

No	ESMs	Annual energy savings Potential, lakh kWh	Annual cost savings Rs Lakh	Cost of implementation Rs. Lakh	Simple payback period years
	SHORT TERM SOLUTIONS				
	ELECTRICAL SYSTEM				
1	Surrendering Contract demand.	**TBD**	**TBD**	**TBD**	**TBD**
	Building Owner will not surrender. Will require a meeting with the owner.				
	AIR CONDITIONING SYSTEMS				
2	Optimizing the cooling water system of the main chiller to improve the overall systems performance.	**TBD**	**TBD**	**TBD**	**TBD** .
	According to facilities management, this proposal is being considered for implementation in 2011				
3	Use of more fresh air for cooling Instead of air conditioning during winter months.	**TBD** .	**TBD** .	**TBD** .	**TBD** .
	This idea is also being considered for implementation in 2011 in Neptune, Saturn, Jupiter, and Earth building.				
4	Shifting the new Trane chiller of 60 TR capacity to Mercury building and separating the Mercury building from the main.	**TBD**	**TBD**	**TBD**	**TBD**
	Requires further analysis.				
5	Improving the performance of the ductable split A/S in Mother Earth.	**TBD**	**TBD**	**TBD**	**TBD**
	Requires further analysis				

Sl	ESMs	Annual energy savings Potential, lakh kWh	Annual cost savings Rs Lakh	Cost of implementation Rs. Lakh	Simple payback period years
	MEDIUM TERM SOLUTIONS				
	LIGHTING SYSTEM				
6	Automatic Light Switches	.10	0.48	Nil	Immediate
	This suggestion has been implemented throughout the campus. ROI is higher than originally predicted				
	ELECTRIC DRIVES:				
8	Replacement of V-belts with Poly V belts	TBD	TBD	TBD	TBD
	Under way by Rajendran, Facility manager.				
9	Replacement of standard motor with energy efficient motor	TBD	TBD	TBD	TBD
	High Priority Suggestion by Rajendran, Facility manager.				
	AIR CONDITIONING SYSTEMS	.	.	.	.
10	Energy savings by introducing a single pump in place of two pumps for secondary chilled water system	TBD	TBD	TBD	TBD
11	Replacing the present York chiller and AHU with D/X type packaged units in the Venus building	TBD	TBD	TBD	TBD
12	Separating the high heat generating equipments from the users of south wing ground Floor LAB of Pluto	TBD	TBD	TBD	TBD
	High Priority Suggestion by Rajendran, Facility manager.				
	LIGHTING SYSTEM				
13	To substitute LED lights in place of compact flourescent.	Must confirm	Must confirm	Must confirm	3.5
	This suggestion can generate up to 30% savings. DC lights have more lumens/watt.	Complete documentation exists	Contact Rajendran, Facility manager.	Two years of data exists	Confirmed ROI 3.5 years
	ELECTRICAL SYSTEM				
14	Peak load loss reduction in transformers by improving power factor	TBD	TBD	TBD	Typically 1.2
	Standard solution utilizing capacitors.				

Sl	ESMs	Annual energy savings Potential, lakh kWh	Annual cost savings Rs Lakh	Cost of implementation Rs. Lakh	Simple payback period years
	LONG TERM MEASURES				
	ELECTRICAL SYSTEM				
15	Replacement of electrical heating with solar water heating system This suggestion has much more merit than shown here. The typical return on investment of a solar hot water system is now about 4 years.	TBD	TBD	TBD	4.0

Conclusions on the Kalyani Campus Site Survey Study

During November 2010 we had a chance to meet with Facilities managers and head management to discover the power loads of the Orion and Kalyani campuses. We also had a chance to see the actual Distributed Generators and witness several power failures and recovery sequences.

The focus of the Kalyani site survey was to corroborate the findings of a previous site survey and to discover what conservation measures had been carried out and their result. The following are bullet statements that stand out.

- The chillers seem to be the largest load for both Orion and Kalyani. Kalyani has 3 300 ton chillers. This represents 70% of the total power load. Any attempt to create heat for absorption chillers will be very cost effective.
- Power disruption is the other main concern from facilities managers. Should the grid fail emergency circuits are backed-up by battery powered UPS. Distributed generators (DG's) automatically respond in 15 seconds. The real cost of DG power is 16 rupees per Kwh.
- This study has indicated many of the suggestions provided by previous energy studies and ELT Energy Saving Methods (EMS) have been carried out, while some are in process.
- The most successful retrofit to date has been the swap out of overhead lights with LED's. It is suggested that you make contact with Rajendran.R at Kalyani and ask him to submit some 1 year of energy bills for lighting and see the substantial savings that have been generated. There are other energy conservation measures underway including Variable frequency drives to improve the efficiency of motors through-out the facility.

Other topics included the discussion of mounting renewable assets on the roof of the facilities. The general reaction was:

- There is very little space to mount collectors on the roof of the main buildings, although we discovered excellent south-facing metal roofs on Mother Earth and two other buildings. We also noticed some high locations for potential wind turbines.
- There were also some issues about adding value to the buildings which are leased. There may have to be discussions with the owners about adding energy hardware to the building.
- We suggested that we could mount solar and wind energy systems that are demountable and that the equipment would be owned by Honeywell.

ELT thanks you for the opportunity to get to know the Honeywell Technology Solutions campus in Bangalore and to work with your excellent staff. We are ready to provide more specifics on our proposals and we welcome your continued feedback.

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