ALPHA-OMEGA

SOLAR – WIND PROJECT BRIEF FOR ROMBO DISTRICT TANZANIA PILOT PROJECT

ALPHA OMEGA ECOLOGICAL SOLUTIONS

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2. INTRODUCTION

In association with **"Tanzanian NGO - TRANS REGIONAL ENVIROMNMENT TECHNOLOGY ORGANIZATION (TRETA**)**"**, **Alpha Omega Ecological Solutions** and **Urban Green Energy Inc.** have prepared a comprehensive **"Solar –Wind Electrical Power Pilot Project Brief"** that will accommodate and supply electricity for a pilot project town **in Rombo District, Leto- Usseri Town.**

With a town population of **5254**, containing **1200** households, a clinic, one secondary school, and three primary schools, and a church, the **"Solar –Wind Electrical Power Pilot Project Brief"** will supply not only their immediate electrical power needs, (off – grid), but will also address the projects ability to meet their respective future needs as the town grows and develops.

The aims and scope of the **"Solar –Wind Electrical Power Pilot Project Brief"** are as follows:

AIMS

1) To provide the organizational and structural means that exemplifies the need for structured financial requirements to fund the complete "Engineering and Pilot Project Feasibility Study" as "Stage # 1".

SCOPE

1) To provide the depth of analytical material in library that defines the project feasibility based upon technology and need, along with site examination, that will define user requirements and extent of technologies needed to be installed.

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3. ENERGY CONSUMPTION – TANZANIA (IN BRIEF)

Electricity (Billion Kilowatthours)

Net Generation	1.7	2.4	2.3	2.4	2.8	2.8	2.6	2.4	1.9	NA	NA
YEAR	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Net Consumption	1.5	2.2	1.8	1.9	2.1	2.2	2.0	2.0	1.2	NA	NA
Installed Capacity (GWe)	0.6	0.6	0.6	0.8	0.9	0.9	0.9	0.9	0.9	NA	NA

Total Primary Energy (Quadrillion Btu)

Production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA
Consumption	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	NA	NA
Energy Intensity (Btu per (2000) U.S. Dollars)	3292.0	3629.5	3668.5	3497.7	3899.4	4027.9	3861.4	3667.8	3217.3	NA	NA

Carbon Dioxide Emissions (Million Metric Tons of CO_2)

Total from Consumption of Fossil Fuels	2.4	2.5	2.7	2.7	3.1	3.5	3.6	3.9	4.0	NA	NA

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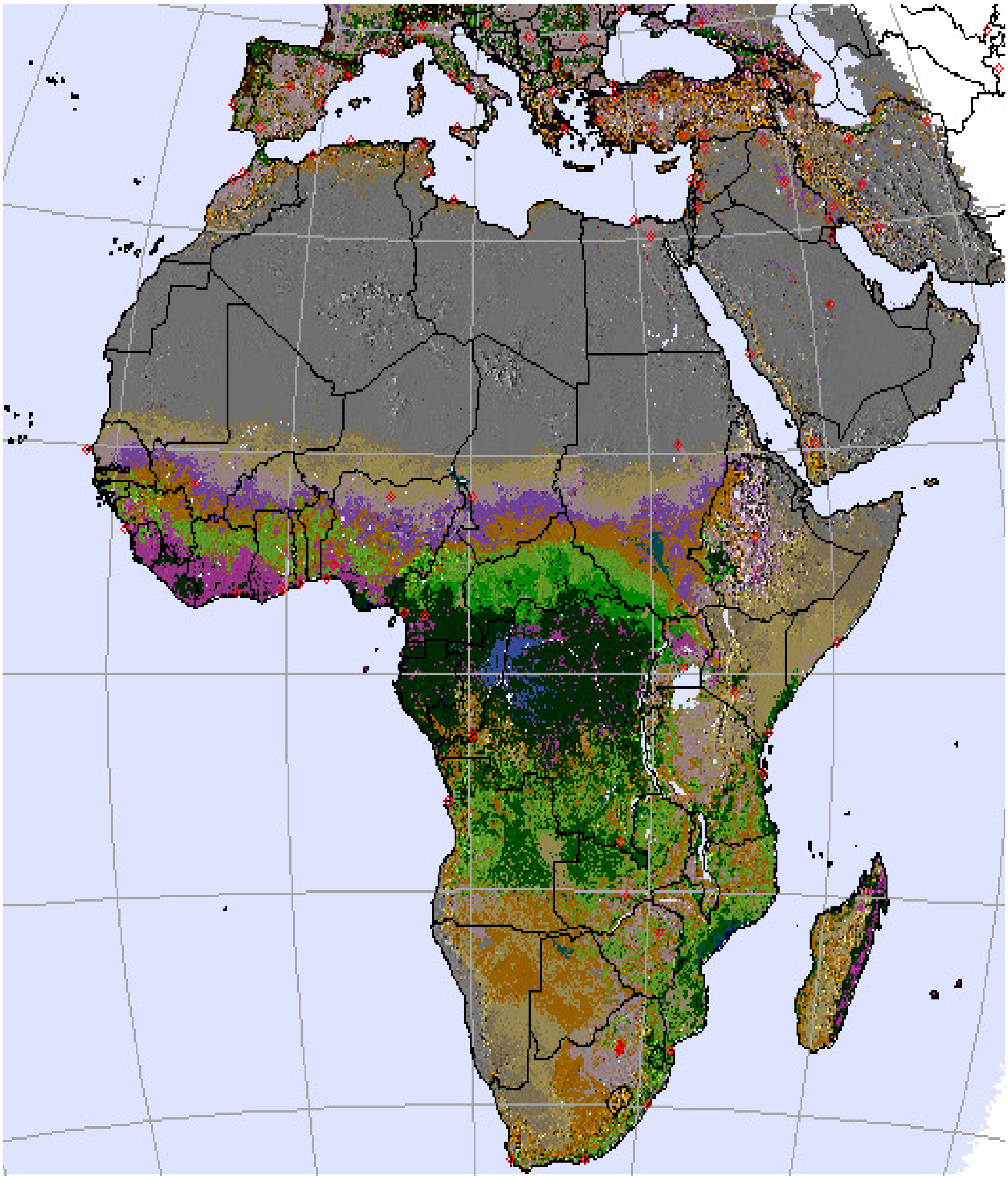
4. LAND COVER MAP AFRICA



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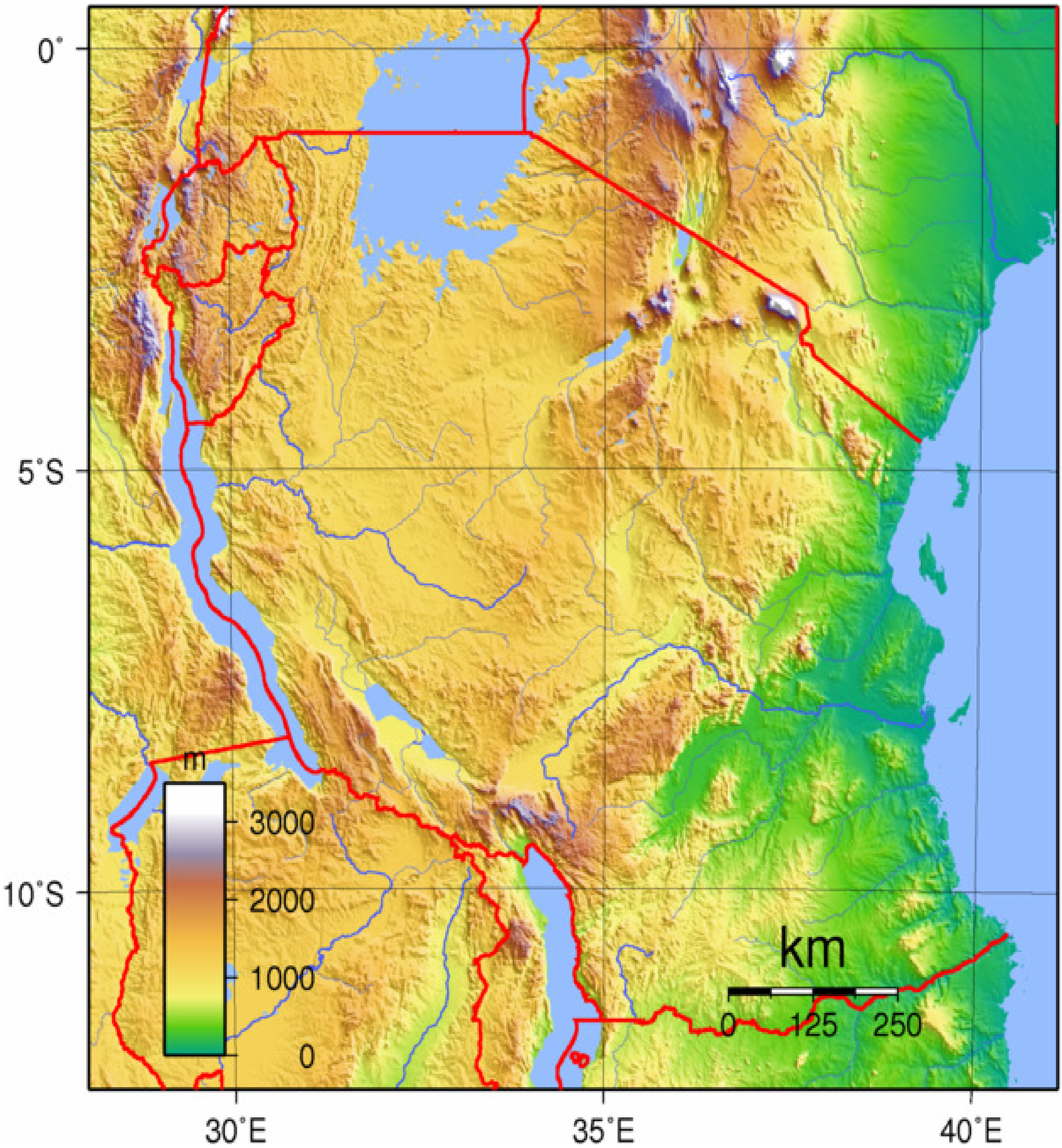
5. ELEVATION MAP OF TANZANIA



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6. GENERAL WEATHER CONDITIONS FOR TANZANIA

Tanzania is the largest country in East Africa. It is situated south of the equator between 1° and 12°S. It has a long coastline on the Indian Ocean. It is bordered by Kenya and Uganda on the north, by Mozambique, Malawi, and Zambia on the south and by the Democratic Republic of Congo on the west.

There is a fairly narrow coastal plain in the east, but most of the interior consists of a plateau 900-1,500 m/3,000-5,000 ft above sea level. There are a number of mountain ranges which rise to between 2,100-3,000 m/7,000-10,000 ft. In the north of the country the isolated peak of Mount Kilimanjaro, the highest mountain in Africa, rises to nearly 6,000 m/20,000 ft. It has a permanent snow-cap and small glaciers.

The whole country, except the higher mountains, has a tropical climate, but above 3,000 ft this is modified by a significant reduction of temperature, particularly at night. Compare the higher temperatures recorded on the coast at **Dar es Salaam** with those for **Dodoma** in the central plateau. Minimum temperatures and daytime humidity are much lower at **Dodoma** and cause the climate to be less enervating.

The coastal regions, including the large offshore islands of Pemba and Zanzibar, have heavier and more reliable rainfall than most of the inland areas. Average annual rainfall is almost everywhere above 1,000 mm/40 in on the coast and up to 1,500 mm/60 in in the wetter places. This compares with an annual fall of between 500-1,000 mm /20-40in over most of the interior. Only the higher mountain areas receive more rain than the coastal region.

The annual rainfall inland is notoriously unreliable and much of it is very sporadic in both time and place. Rainfall increases a little, and also becomes more reliable, towards the west and around the shores of the three great lakes which are partly included within the boundaries of Tanzania: lakes Victoria, Tanganyika, and Malawi.

Over most of the country there is a single rainy season with the heaviest falls between November and April; the period May to October is dry and sunny. The coastal region is rather an exception in that it gets some rain in all months, with the main rain falling between March and May. The southern coastal district is occasionally affected by heavy rain and strong winds associated with tropical cyclones in the south Indian Ocean.

Although weather on the coast is often rather oppressive because of the higher temperatures, particularly at night, and the high humidity, conditions here are not persistently uncomfortable thanks to regular daily sea breezes.

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Inland, the lower humidity and cooler night temperatures mean that heat stress is rare although daytime temperatures are quite high and sunshine abundant.

Much of Tanzania has a very sunny climate with many places averaging from seven to ten hours of sunshine a day with fewer hours during the rainy season. As in most other tropical countries the year is usually divided into the rainy and dry seasons, since the terms winter and summer have little meaning in respect of temperature.

6.1 WIND SPEEDS – FOR THE INSTALLATION OF WIND POWER

Tanzania depends heavily on hydropower for her electricity demand and experiences power shortage during the dry seasons. Wind energy is proposed as an alternative source of electricity to the fossil fuel generators during the dry season, the latter are normally used to supplement the shortfall in hydro-electricity generation.

Fossil fuel generators produce emissions that are toxic and as such degrade the environment. The windy season, which is from July to November, coincides with the dry season. The annual average wind speed is 8.3 m/s, a value that is sufficient to generate electricity. Wind energy that can be harvested from this annual average wind speed is $2.30X10^3$ kwh per year.

UNEP/GRID Legend for Data Set: Mean Annual Wind Velocity (Africa; FAO/Agrymet)

Class #	Windspeed in meters/second		
-------			-------------------------
1	0.0	-	0.5
2	0.5	-	1.0
3	1.0	-	1.5
4	1.5	-	2.0
5	2.0	-	2.5
6	2.5	-	3.0
7	3.0	-	3.5
8	3.5	-	4.0
9	4.0	-	4.5
10	4.5	-	5.0
11	5.0	-	5.5
12	5.5	-	6.0
13			> 6.0

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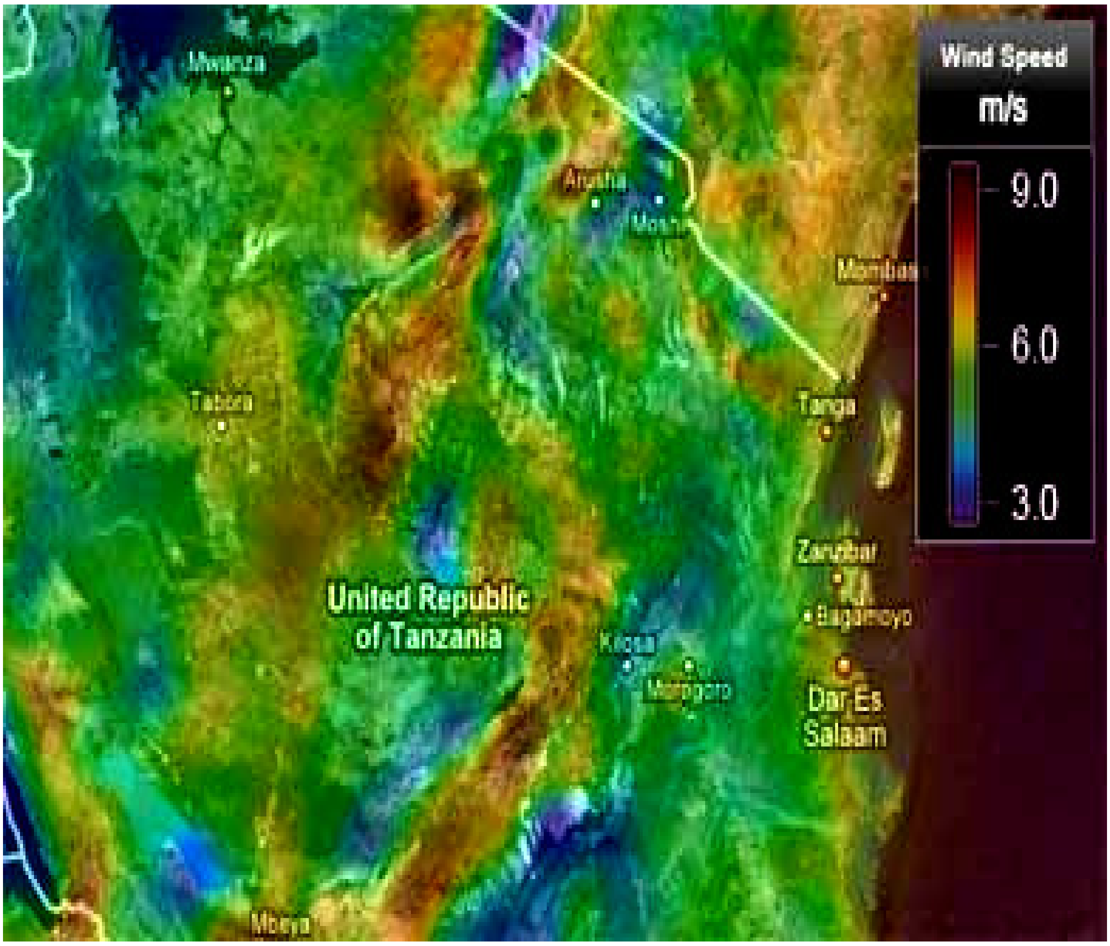

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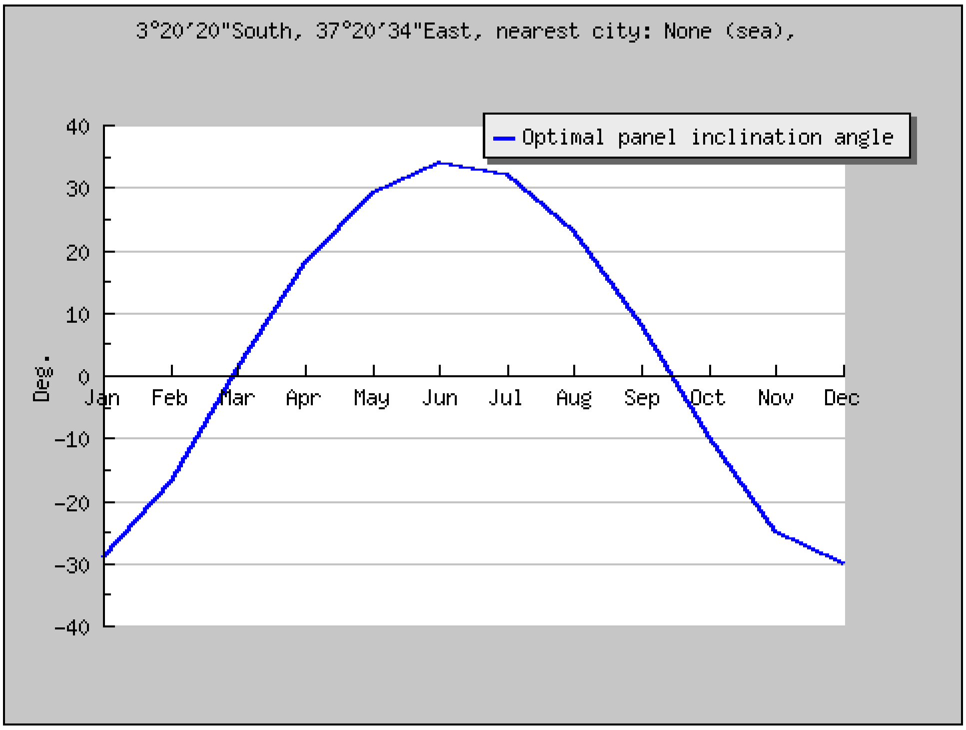
7. SOLAR DATA FOR USSERI TOWN – ROMBO DISTRICT

OPTIMUM SOLAR PANEL ANGLE FOR LETO- USSERI TOWN – ROMBO DISTRICT.(The data shows that a 2-axle tracking system will be required for the solar installation)

Annual irradiation deficit due to shadowing (horizontal): 0.8 %

Month	Optimal inclination (deg.)
Jan	-29
Feb	-17
Mar	1
Apr	18
May	29
Jun	34
Jul	32
Aug	23
Sep	8
Oct	-10
Nov	-25
Dec	-30
Year	**-0**



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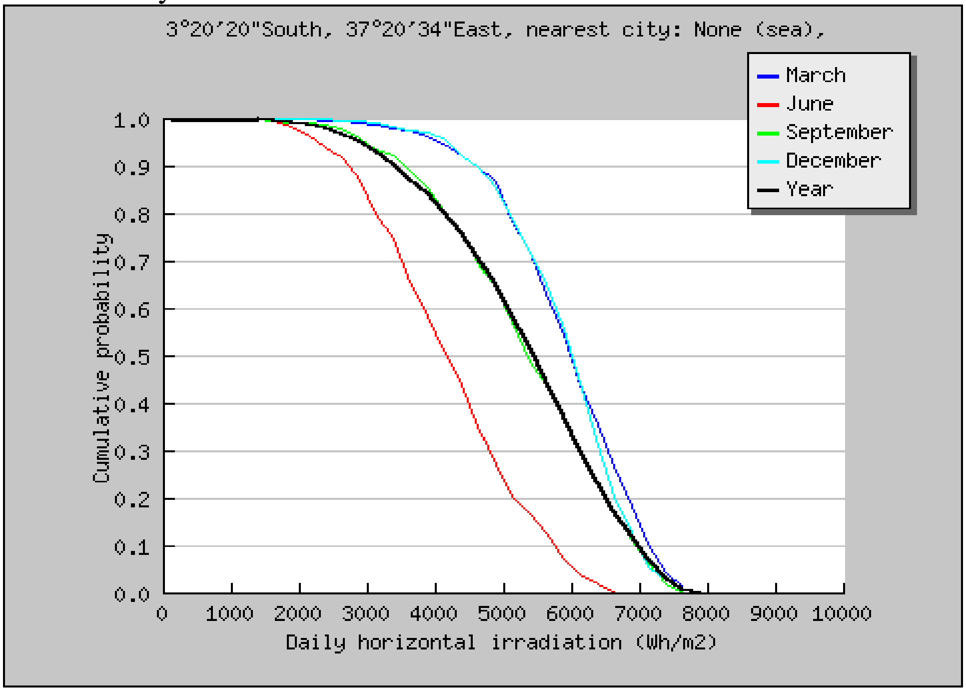

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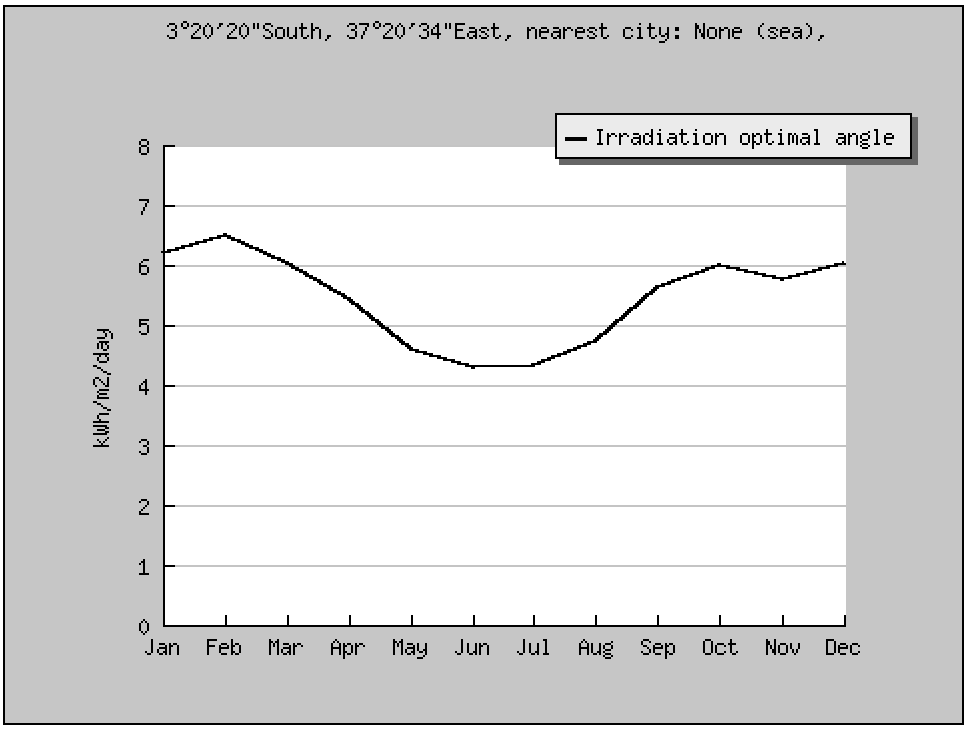
Irradation At Optimal Angle

Annual irradiation deficit due to shadowing (horizontal): 0.8 %

Month	Irradiation at inclination: (Wh/m2/day) Opt. angle
Jan	6185
Feb	6514
Mar	6039
Apr	5421
May	4602
Jun	4312
Jul	4321
Aug	4729
Sep	5633
Oct	6008
Nov	5783
Dec	6046
Year	**5459**



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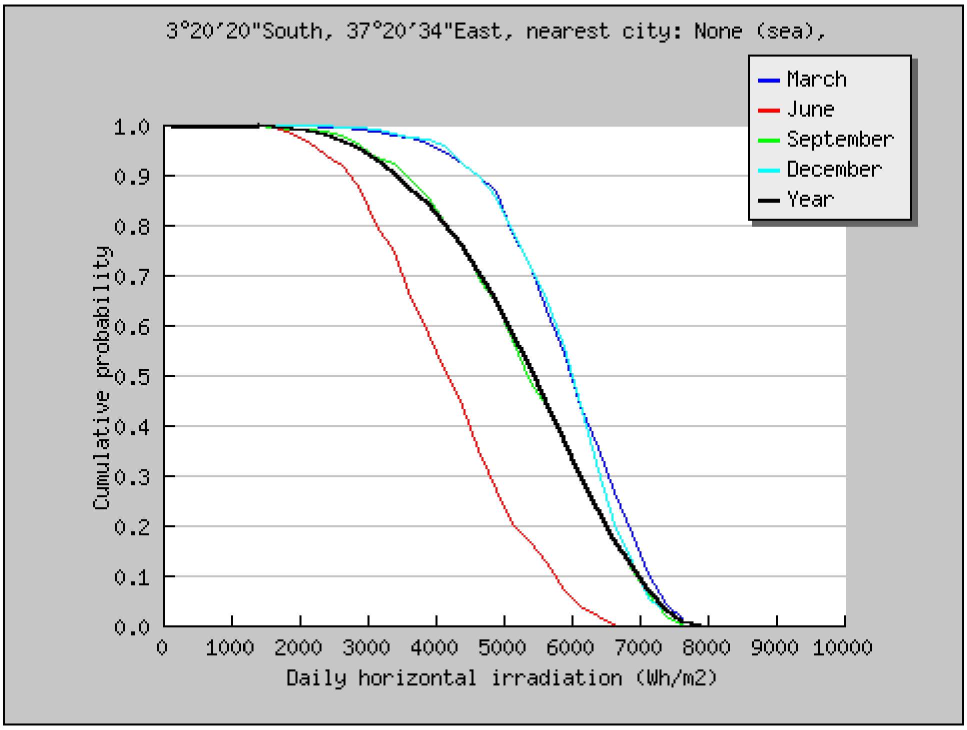
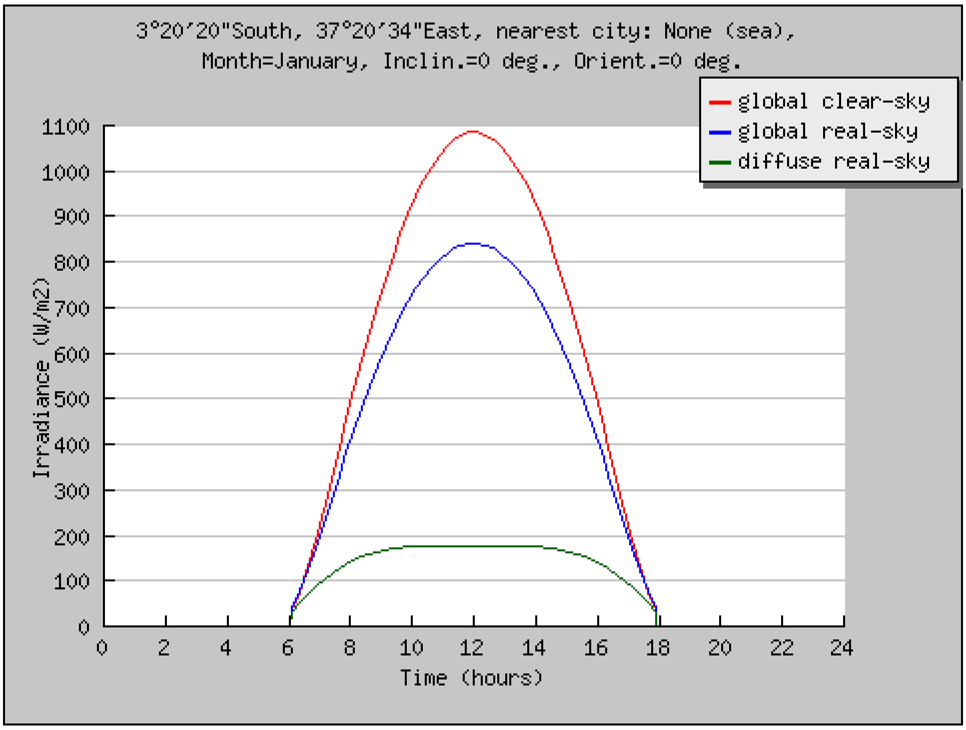


Average daily irradiance variation

Location: 3°20'20" South, 37°20'34" East, Elevation: 924 m a.s.l,



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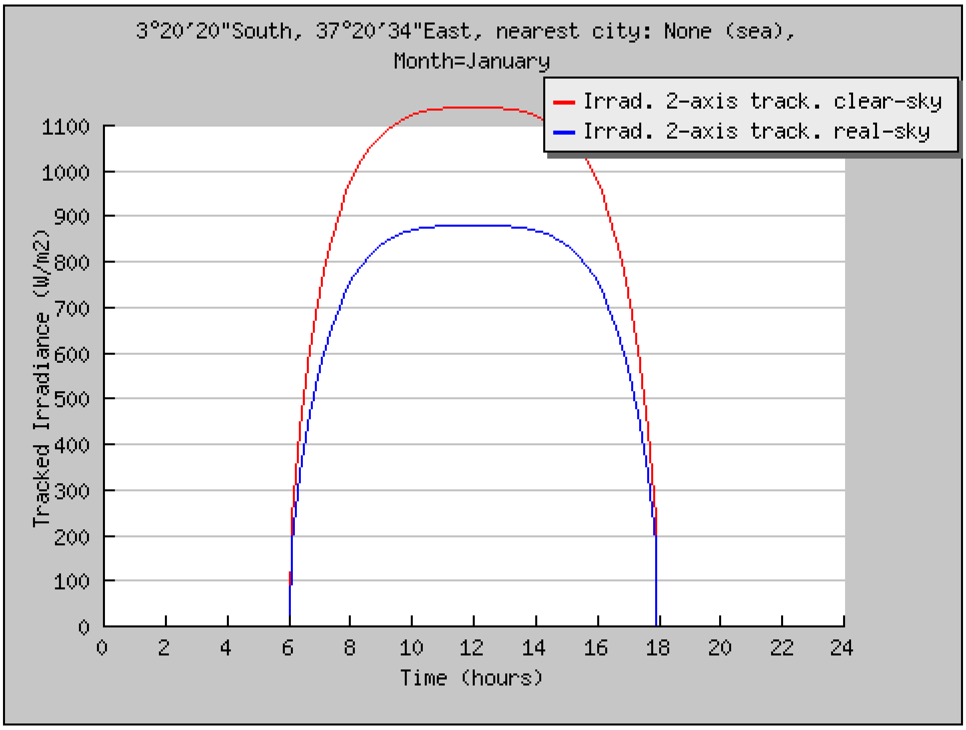

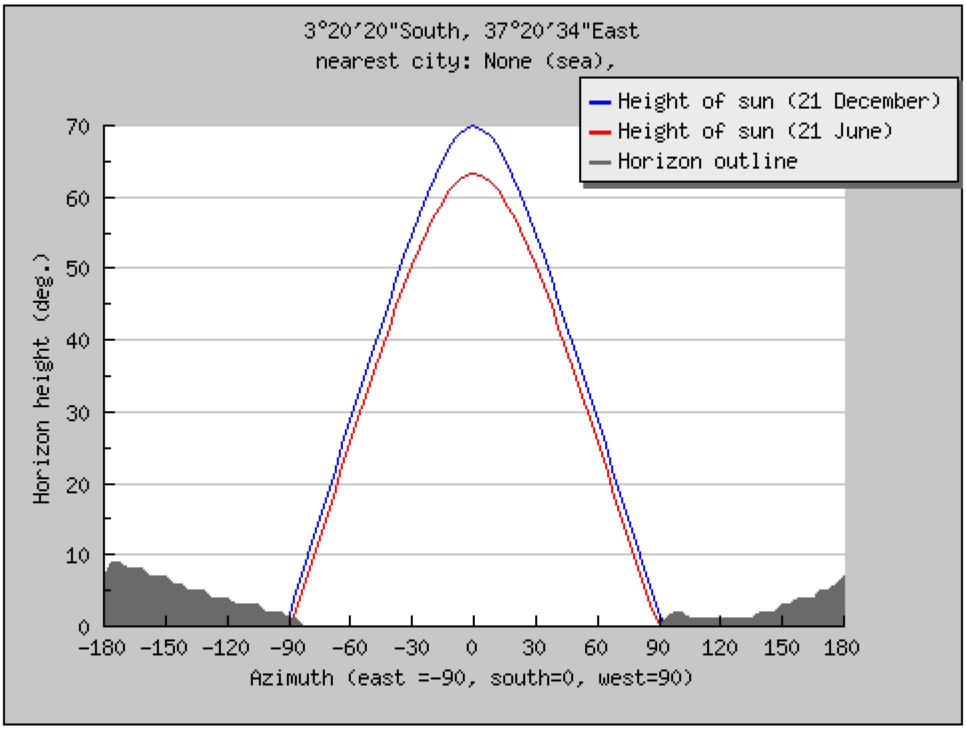

This table shows the global irradiance estimated for every 15 minutes during a typical day in the chosen month, considering the given inclination and orientation of the PV module. The shadowing by local terrain features can affect values during a day. The graph above displays the same results.

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Time	Global Irr. clear sky (W/m2)	Global Irradiance (W/m2)	Beam Irradiance (W/m2)	Diffuse Irradiance (W/m2)	Reflected Irradiance (W/m2)	Global 2-axis real-sky (W/m2)	Global 2-axis clear-sky (W/m2)
6.13	35	39	7	33	0	181	236
6.38	76	77	25	52	0	335	433
6.63	130	123	53	70	0	444	576
6.88	191	173	87	86	0	530	688
7.13	255	225	124	101	0	599	777
7.38	322	278	164	114	0	655	848
7.63	390	331	205	126	0	701	906
7.88	457	382	246	136	0	738	954
8.13	523	432	288	145	0	769	992
8.38	587	481	329	152	0	794	1024
8.63	648	527	368	158	0	814	1049
8.88	707	570	407	163	0	830	1070
9.13	762	611	443	167	0	843	1087
9.38	814	648	478	171	0	854	1100
9.63	862	683	510	173	0	862	1111
9.88	905	714	539	175	0	867	1119
10.13	945	742	566	176	0	872	1125
10.38	979	766	590	176	0	875	1130
10.63	1009	788	611	177	0	877	1133
10.88	1034	805	628	177	0	879	1136
11.13	1054	819	642	177	0	880	1138
11.38	1070	830	653	177	0	880	1139
11.63	1080	837	660	177	0	881	1140
11.88	1085	841	664	177	0	881	1140
12.13	1085	841	664	177	0	881	1140
12.38	1080	837	660	177	0	881	1140
12.63	1070	830	653	177	0	880	1139
12.88	1054	819	642	177	0	880	1138
13.13	1034	805	628	177	0	879	1136
13.38	1009	788	611	177	0	877	1133
13.63	979	766	590	176	0	875	1130
13.88	945	742	566	176	0	872	1125
14.13	905	714	539	175	0	867	1119
14.38	862	683	510	173	0	862	1111
14.63	814	648	478	171	0	854	1100
14.88	762	611	443	167	0	843	1087
15.13	707	570	407	163	0	830	1070
15.38	648	527	368	158	0	814	1049
15.63	587	481	329	152	0	794	1024
15.88	523	432	288	145	0	769	992
16.13	457	382	246	136	0	738	954
16.38	390	331	205	126	0	701	906
16.63	322	278	164	114	0	655	848
16.88	255	225	124	101	0	599	777
17.13	191	173	87	86	0	530	688
17.38	130	123	53	70	0	444	576
17.63	76	77	25	52	0	335	433
17.88	35	39	7	33	0	181	236

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8. PROPOSED TECHNOLOGY FOR THE PILOT PROJECT

8.1 SOLAR

WHERE CAN PHOTOVOLTAIC SYSTEMS BE INSTALLED

Photovoltaic systems can be installed:

a) on roofs of existing buildings
b) in any open or enclosed field
c) in open parking lots as awnings
d) as constructive materials of new building structures according to the existing and very rich architectural experience
e) as architectural interventions in stadiums, parks, squares, streets etc

The PV panels have a size from 10-20 m^2 for each installed KW of power accordingly to our advanced panel technology that would be used. Also the distance between the panel gangs for visit ability and the avoidance of shading can easily be adapted to most physical environments. For the space of the PV panels only consideration is avoidance of areas that would have shading from trees, vicinal buildings, north orientation of inclined roofs, and distance of transmission in an "off-grid" system.

WHAT DOES THE COST OF A COMPLETE TURN KEY INSTALLATION OF A PHOTO VOLTAIC SYSTEM?

The cost of a complete Photo Voltaic is calculated in Euro per installed KW and depends upon the following:

a) The technology of the panels to be used (ex. The technology of amorphous silicon cost less, but need almost double the

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space to mono crystalline silicon) and our technology is mono crystalline.

b) The origination of the panels and the rest of the materials of the equipment. (as an example European origination are more expensive than Asian origination panels and equipment). Our manufacturer is in China.
c) The size of the PV system (the smaller the production size the more expensive per KW of power). In the case of this project we will be potentially examining a system of 300- 500 Kw/hr.
d) The difficulty of the installation (inaccessible areas or installations with increased technical difficulty cost more)

The costs for PV Systems are currently calculated **beginning Euro 4,200 to Euro 7,200 per KW power**, with the costs variable being in the inclusion of tracking systems, and other automated systems to enhance the overall PV production from a single system. Indicatively for the initial feasibility and licensing applications,engineering work ups, environmental approvals, and obtaining the respective grants for the project, the project owner will be paying an average price **Euro 150 per KW power for the study.**

The efficiency of a Photovoltaic System will depend upon

a) the solar climatologic of the area
b) on the latitude of the area
c) on the inclination of the PV panels to the horizontal ground.
d) On the age of the PV panels (it is calculated that the panels have 80% efficiency for the first 20 years and they can operate for 20-30 years)

Of course the most important factor is how many kilowatt-hours the system will perform annually and eventually how much will each produced kilowatt-hour cost. The production of electrical power from a PV system is predictable. For this project in Rombo, we consider that a PV system with optimal inclination and optimal orientation produces in average per year **1200 – 1450 kilowatt hours per kilowatt** installed, making the energy produced at an average cost of **Euro 0.0860 per Kilo Watt Hour**.

Choosing the right solar panel configuration for your needs is important, as a larger solar panel will collect more energy in less time. Therefore the right size of panel will depend on the variables such as your power requirements either by your household appliance use, your daily business power needs, the length of time

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you use all your electrical devices, and how much sunshine you get in your area, averaged over the annual period.

Therefore there are three main considerations when choosing a solar panel and creating your solar power system.

- You need to know what your daily power consumption will be based upon a kilo watt hour usage, then calculated for a 24 hour period,
- Which solar panel configuration will meet your 24-hour demand by charging your battery system in the average sunlight period in your area?
- Your battery storage configuration that not only meets your non – sunlight periods needs, but also will be able to maintain the power needs for extended periods of cloudy days.

As a simple example the power consumption of electrical appliances is given in watts. To calculate the energy you will use over time, you would multiply the power consumption by the hours of use. (see attached appliance calculator to do a total power usage)

To calculate battery capacity, we see that the battery capacity is measured in Amp Hours (eg. 17 Ah). Therefore you need to convert this to watt-hours by multiplying the Amp Hour rate of the battery by the battery voltage. (eg. A 12 volt battery which is a 17 amp hour battery would convert to watt hours by multiplying 12 x 17 = 204 Watt hour). This would mean that the battery could supply a 13-watt florescent light for 15 ½ hours as an example.

To calculate the power generation rating of a solar panel we look at the watt rating of the panel. Therefore to calculate the energy it can supply to the battery, multiply the panel's watt rating by the number of hours that the panel is exposed to sunlight, and then multiplying that by .85 to compensate for natural system losses.

As an example a 10-watt solar panel exposed to 4 hours of sunshine will produce 40 watts of power x .85 (natural system losses)= 34 watts of actual power to the battery system.

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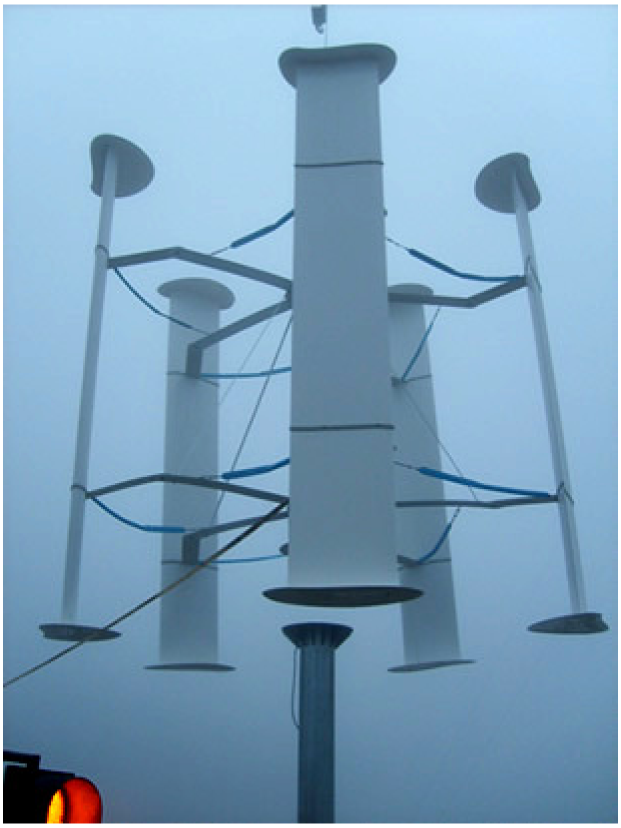
8.2 WIND TECHNOLOGY



Vertical axis wind turbines are different from traditional wind turbines in that their main axis is perpendicular to the ground as opposed to horizontal. Their operation somewhat resembles a water wheel on it's side, but uses the power of the wind rather than the flow of water. The nature of VAWTs makes them ideal for both rural and urban settings. These turbines offer the individual or organization an opportunity to offset the rising cost of electricity and to have an impact on the environment around them.

There are many advantages to using a vertical axis turbine (VAWT):

- VAWTs are not influenced by wind direction, which is useful in areas where an inconsistent wind direction is found. Unlike traditional horizontal axis turbines, a yaw mechanism is not needed to turn the turbine into the wind.
- Efficiency is not reduced by turbulent air flow often found around buildings and other tall structures.
- Ideal for rural, isolated and urban applications, including roof top installations. In fact, depending on the shape of the roof,

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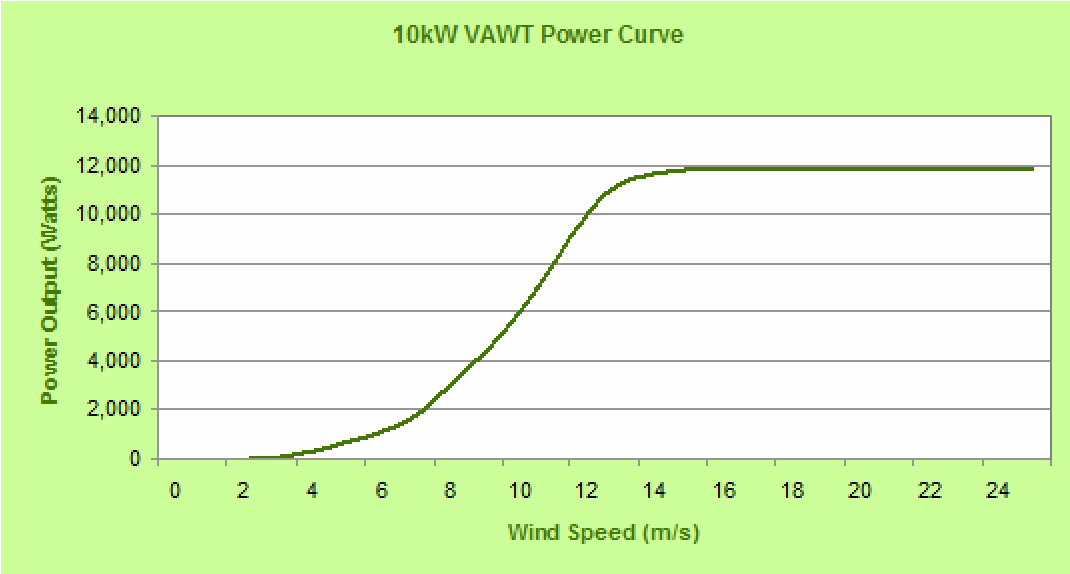
the turbine wind flow over the roof can increase the power output.

- Simple to install and maintain.
- Operation is quiet.
- They are not needed to be placed high in the air, which helps in staying within building codes.



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9. BUDGET FOR THE ENGINEERING AND FEASIBILITY STUDY

To complete the Stage #1 "Engineering and Feasibility Study" which would detail the pilot project in is entirety with all aspects of technical, engineering and project costs, an initial funding of Euro **One Hundred Fifty Thousand (150,000.00 Euro)** is required, which would be finalized in contract form between **Alpha Omega Ecological Solutions** and the Pilot Project Owner.

10. PROJECT ESTIMATED ECONOMICS USING RETSCREEN SOFTWARE

Project name	ROMBO VILLAGE ELECTRIFICATION
Project location	ROMBO- TANZANIA
Prepared for	PROJECT BRIEFING
Prepared by	Dale Simpson - Director R&D Alpha Omega Ecological Solutions
Project type	Power - multiple technologies
Grid type	Isolated-grid & internal load
Analysis type	Method 1
Heating value reference	Higher heating value (HHV)
Language - Langue	English - Anglais
User manual	English - Anglais
Currency	Euro
Units	Metric units

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	Unit	Climate data location	Project location
Latitude	?N	-3,3	-3,3
Longitude	?E	37,3	37,3
Elevation	m	1.082	1.082
Heating design temperature	°C	14,8	
Cooling design temperature	°C	27,9	
Earth temperature amplitude	°C	12,8	

Month		Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
		°C	%	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January		22,2	62,8%	6,20	89,3	3,7	24,6	0	378
February		22,7	59,4%	6,55	89,3	3,6	25,3	0	356
March		22,3	67,2%	6,02	89,3	3,4	25,0	0	381
April		21,3	73,6%	5,24	89,4	3,7	23,8	0	340
May		21,0	67,3%	4,56	89,5	3,9	23,8	0	340
June		20,4	60,1%	4,26	89,7	4,1	23,8	0	311
July		19,9	58,6%	4,44	89,7	4,3	23,7	0	306
August		20,2	58,5%	4,89	89,7	4,6	24,7	0	315
September		21,2	57,3%	5,79	89,6	4,6	26,6	0	335
October		21,6	61,9%	5,98	89,5	4,5	26,8	0	361
November		21,4	70,2%	5,58	89,4	3,9	25,2	0	341
December		21,5	70,2%	5,74	89,4	3,5	24,1	0	357
Annual		21,3	63,9%	5,43	89,5	4,0	24,8	0	4.121
Measured at	m					10,0	0,0		

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Power project	Unit	
Base case power system		
Grid type		Isolated-grid & internal load
Peak load - isolated-grid	kW	40.000
Minimum load - isolated-grid	kW	30.000

Base case load characteristics

Month		Power gross average load kW
January		992
February		896
March		910
April		1.116
May		1.110
June		1.140
July		1.194
August		1.193
September		1.095
October		1.100
November		1.050
December		996
System peak electricity load over max monthly		
Peak load - annual		1.194
Electricity	MWh	9.365
Electricity rate - base case	€/kWh	0,450
Total electricity cost		€ 4.214.361

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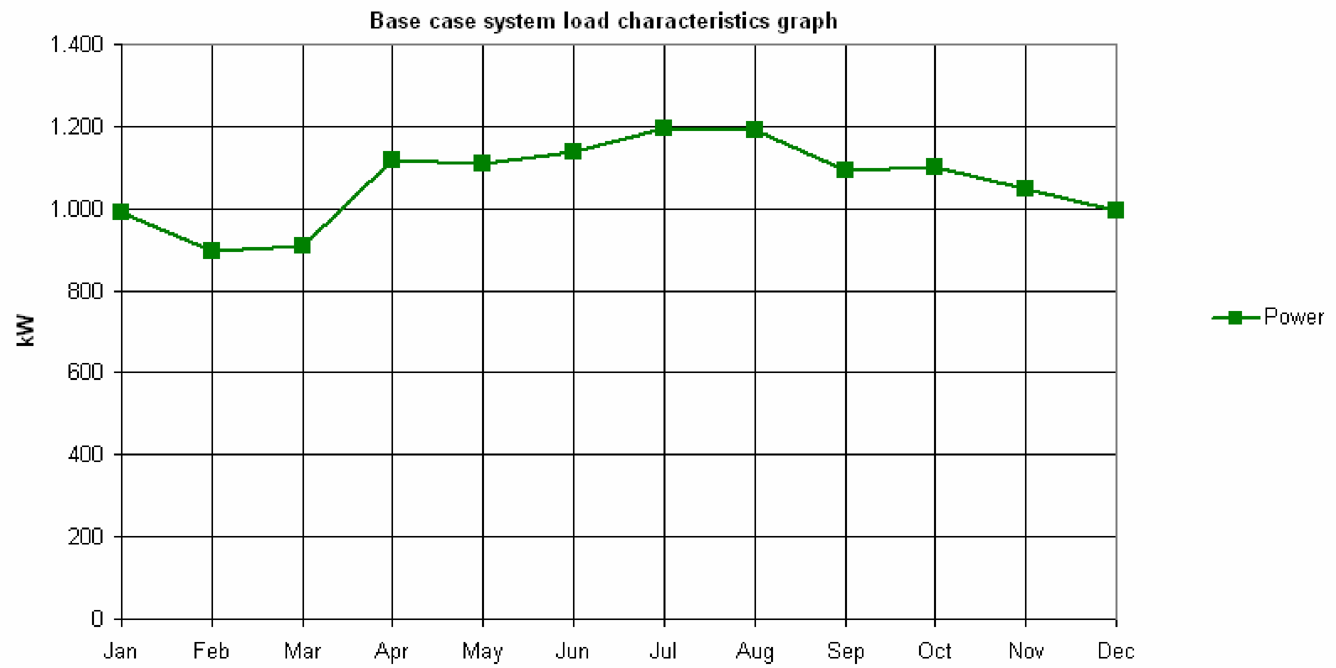

Proposed case energy efficiency measures

End-use energy efficiency measures	%	85%
Net peak electricity load	kW	179
Net electricity	MWh	1.405

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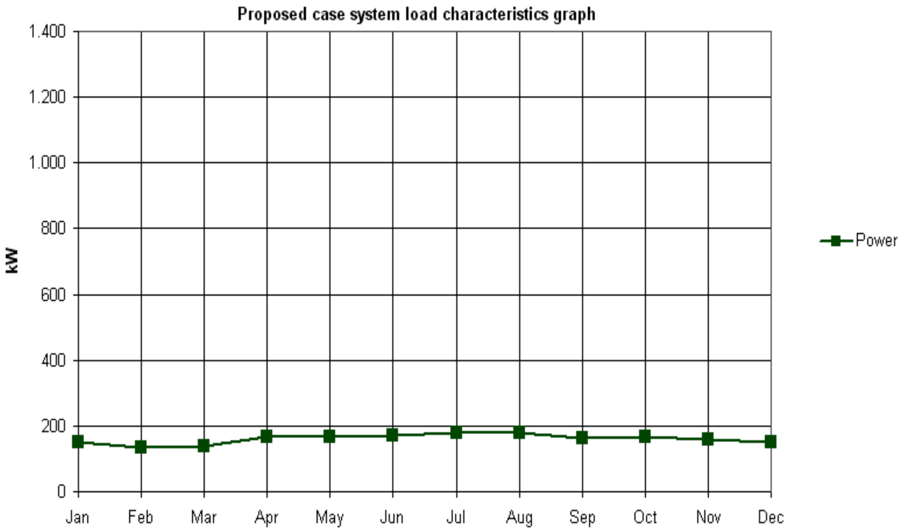
Proposed case load characteristics	
Month	Power net average load kW
January	149
February	134
March	137
April	167
May	167
June	171
July	179
August	179
September	164
October	165
November	158
December	149
Peak load - annual	179



Proposed case load and energy		Power
System peak load	kW	179
System energy	MWh	1.405

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Proposed case power system

Base load power system				
Technology		Wind turbine		
Analysis type		Method 1 (selected)		
		Method 2		
		Method 3		
Wind turbine #1				
Power capacity	kW	100	55,8%	
Manufacturer		AO_UGH		
Model		AO 2000H		1 unit(s)
Capacity factor	%	90,0%		
Electricity delivered to load	MWh	788	56,1%	
Electricity exported to grid	MWh	0		
Intermediate load power system				
Technology		Photovoltaic		
Photovoltaic #2				
Power capacity	kW	80,00	44,7%	
Manufacturer		AO-HIMIN		
Model		AO 300		1 unit(s)
Capacity factor	%	50,0%		
Electricity delivered to load	MWh	350	24,9%	
Electricity exported to grid	MWh	0	0,0%	
Fuel rate - proposed case power system	€/MWh	0,00		
Electricity export rate	€/MWh	850,00		
Electricity rate - proposed case	€/MWh	450,00		

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Proposed case system characteristics	Unit	Estimate	%
Power			
Base load power system			
Technology		Wind turbine	
Operating strategy		Full power capacity output	
Capacity	kW	100	55,8%
Electricity delivered to load	MWh	788	56,1%
Electricity exported to grid	MWh	0	
Intermediate load power system			
Technology		Photovoltaic	
Operating strategy		Full power capacity output	
Capacity	kW	80	44,7%
Electricity delivered to load	MWh	350	24,9%
Electricity exported to grid	MWh	0	
Peak load power system			
Technology		Grid electricity	
Suggested capacity	kW	179,1	
Capacity	kW	180	100,5%
Electricity delivered to load	MWh	266	18,9%
Back-up power system (optional)			
Technology			
Capacity	kW	0	

Proposed case system summary	Fuel type	Fuel consumption - unit	Fuel consumption	Capacity (kW)	Energy delivered (MWh)
Power					
Base load	Wind			100	788
Intermediate load	Solar			80	350
Peak load	Electricity	MWh	266	180	266
			Total	360	1.405

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Emission Analysis

Base case electricity system (Baseline)		GHG emission factor (excl. T&D)	T&D losses	GHG emission factor	
Country - region	**Fuel type**	**tCO2/MWh**	%	**tCO2/MWh**	
Tanzania, United Rep. of	Oil (#6)	1,495		1,495	
Electricity exported to grid	MWh	0	T&D losses	2,0%	
GHG emission					
Base case	tCO2	14.001			
Proposed case	tCO2	398			
Gross annual GHG emission reduction	tCO2	13.603			
GHG credits transaction fee	%	1,0%			
Net annual GHG emission reduction	tCO2	13.467	is equivalent to	2.738	Cars & light trucks not used
GHG reduction income					
GHG reduction credit rate	€/tCO2	35,00			
GHG reduction credit duration	yr	15			
GHG reduction credit escalation rate	%	7,0%			

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Financial Analysis

Financial parameters			
Inflation rate	%	3,5%	
Project life	yr	20	
Debt ratio	%	2%	
Debt interest rate	%	8,00%	
Debt term	yr	15	
Initial costs			
Power system	€	0	0,0%
Other	€	25.000.000	100,0%
Total initial costs	€	25.000.000	100,0%
Incentives and grants	€		0,0%
Annual costs and debt payments			**Cumulative cash flows (€)**
O&M (savings) costs	€	10.000	
Fuel cost - proposed case	€	119.694	
Debt payments - 15 yrs	€	43.811	
	€		
Total annual costs	€	173.505	
Annual savings and income			
Fuel cost - base case	€	4.214.361	
GHG reduction income - 15 yrs	€	471.358	
	€		
Total annual savings and income	€	4.685.718	
Financial viability			

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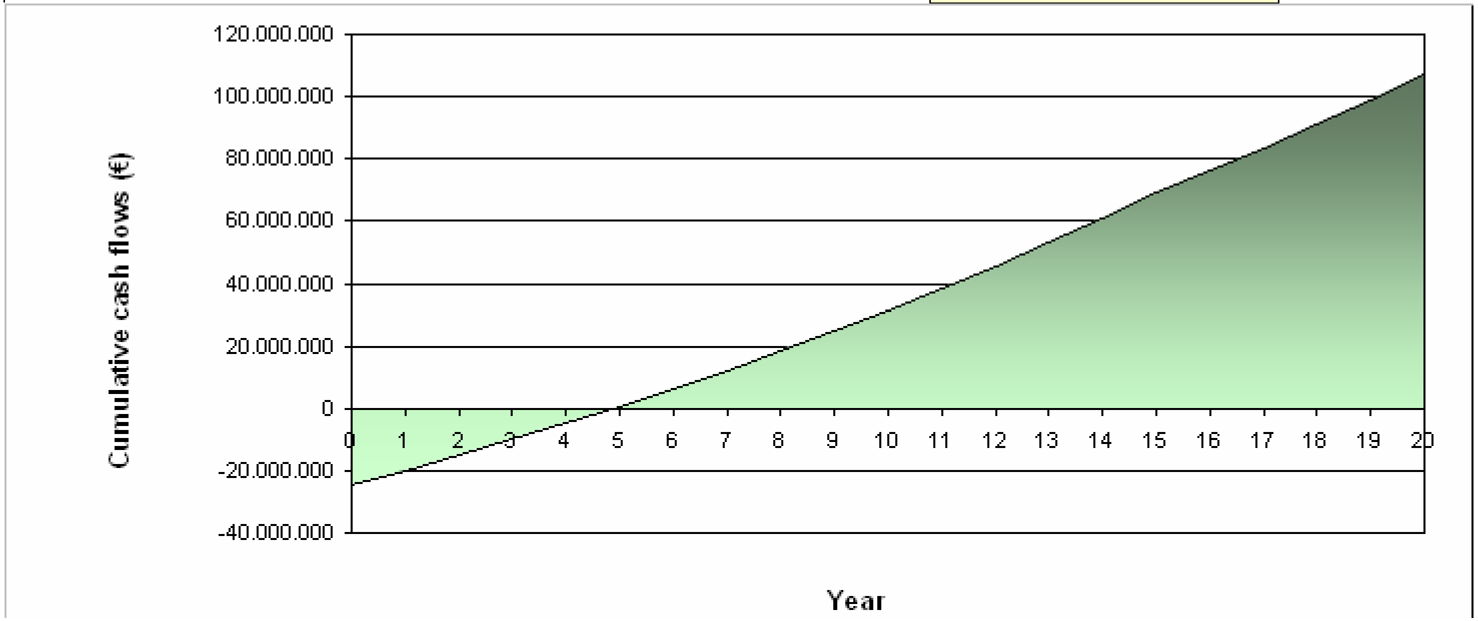
Pre-tax IRR - equity	%	22,1%
Pre-tax IRR - assets	%	21,8%
Simple payback	yr	5,5
Equity payback	yr	4,9



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11. CONCLUSION

It is the intent of **Alpha Omega Ecological Solutions** to provide not only a professional study and finalization, but to provide to the people of Rombo, the most advanced technology for the production of electrical power from Renewable Sources i.e. wind and solar, in the market today. This advanced technology will not only provide for their respective present needs, but also address their needs in the years to come.

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