30 Years Supplying Wind Power for Remote Telecom Sites

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Bergey Windpower

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BERGEY WINDPOWER



Bergey Windpower Co.

The World Leader in Small Wind

- 37 year old, U.S. based, manufacturer of small high-reliability wind turbines
- Over 9,000 installations, in over 100 countries
- Pioneered “sophisticated simplicity” turbine architecture and numerous component technologies
- Turbines have only 4 moving parts, require no scheduled maintenance, and have demonstrated 20+ years with 100% availability and zero O&M costs – unique in wind industry
- Longest warranties in industry
- Financial strength and stability





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Bergey Products



1 kW
2.5m Dia.



6 kW
6m Dia.



10 kW
7m Dia.



Towers: Multiple styles, 60 – 160 ft.





Custom Inverters & battery chargers

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10 kW Bergey Excel 10

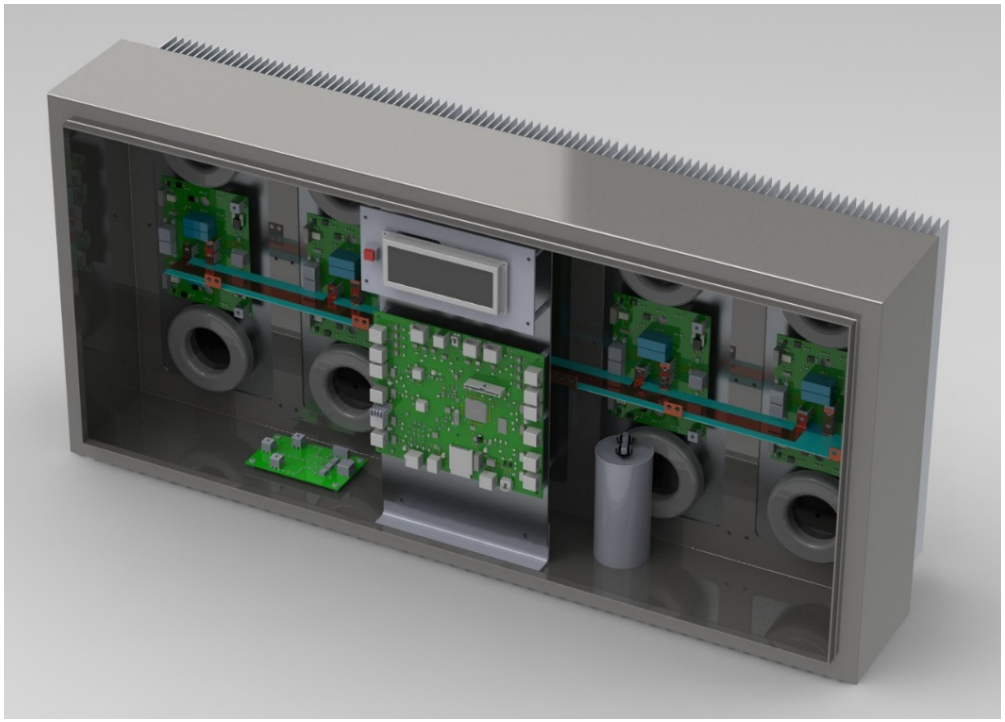
- Well sized for 1 – 3 kW telecom loads
- Over 2,500 Installed
- Leading Worldwide Product in the 5 – 15 kW Size Range
- Certified in US, UK, and Japan
- 10 year turbine warranty

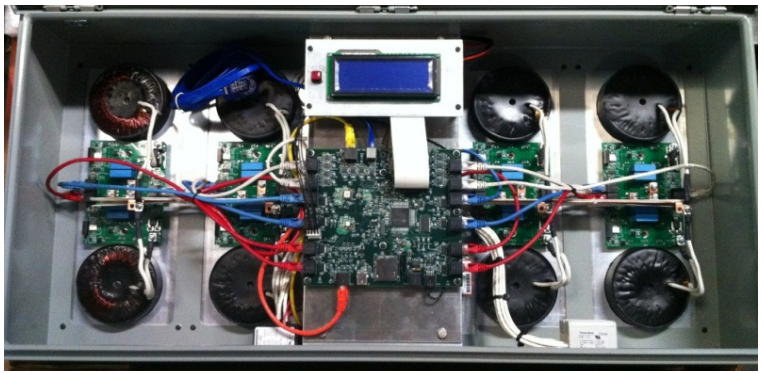


BERGEY WINDPOWER

VCS II - Advanced Battery Charger

- Unique Buck-type, 200A, 48 VDC battery charge controller
- 8 Interleaved DC-DC converters– very low ripple current
- Lowers cut-in wind speed from 4.5 m/s to 2.2 m/s and increases peak power from 7.5 kW to 11 kW
- Increases energy by > 20%
- CAN bus communications, remote monitoring and control; integrated DAS





BERGEY WINDPOWER

WindCAD

- Internet-based Turbine Performance & Financial Modeling
- Worldwide wind resource database by 3Tier
- Efficient site evaluation and input to HOMER model
- Free to Bergey dealers & partners

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Bergey WindCad Performance & Economics Evaluation Tool

Powered by New Roots Energy

Bergey Windpower Co. | (405) 364-4212 | 2200 Industrial Blvd, Norman OK 73069

Turbine Production:



Turbine Selection	Bergey Excel 10kW
Nameplate Capacity [kW]	10.0
Rotor Diameter [m]	7.0
Site Location:	
36.9557° latitude -76.317353° longitude	
Average Wind Speed [mph]	10.07
Tower Height [ft]	100.0
Altitude [ft]	100.0
Weibull K	2.0
Wind Shear	0.18
Turbulence Factor [%]	5.0
Average Output Power [kW]	1.0
Daily Energy Output [kWh]	24.7
Monthly Energy Output [kWh]	752.7
Annual Energy Output [kWh]	9,032.9
Hub Average Wind Speed [mph]	10.1
Air Density Coefficient	1.0
Operating Time [%]	78.5

Telecom Experience Since 1984

Gem State Utilities, Duncan Mountain, Idaho

- **Equipment:** BWC 7.5 kW Wind Turbine, 2 kW Solar, ~ 60 kWh Battery Bank, 15 kW Diesel
- **Performance:** ~ 40 kWh / Day at 120 VDC
- **Customer:** PP&L / OnSite Energy
- **Installation:** October 1984
- **Results:** PP&L initially installed three brands of wind turbines. After a 5-year test period, in which the BWC turbine was 100% available without maintenance, the other two brands were removed. The BWC turbine still powers the site.



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Bergey Wind/Diesel Powered Cell Sites

Haiti





Chile

South Africa



> 50 Sites in Kenya

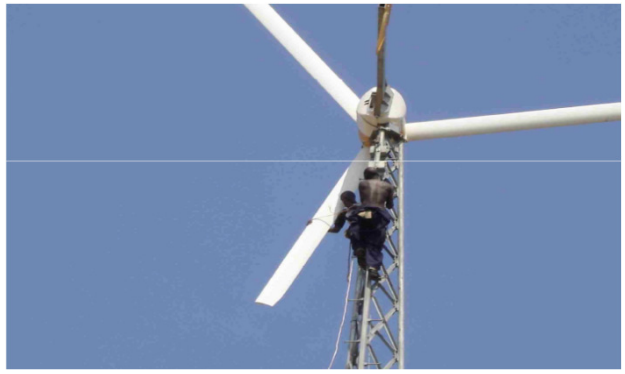












Cabo-Ledo Site, Angola





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Award Winning Projects

- Bergey turbines used in leading, award winning, Green Telecom projects
  - Smart Communications, Philippines, 78 sites
    2009 GSMA Green Telecom Award
  - Winafrique Technologies, vendor for Safaricom & Orange, Kenya, 52 sites
    2009 AfricaCom Green Telecom Award

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GLOBAL MOBILE AWARDS 2009
WINNER

AWARDS
AfricaCom
Winner
Green Telecoms Award
2009
Cape Town Convention Centre, South Africa

Wind for Telecom

- Good broadcast sites often have good wind resources due to their elevation and exposure
- Wind energy costs sensitive to wind resource
- Not all sites will have sufficient wind resources
- Reliability of wind products varies widely
- Need tall towers, 24 – 37m

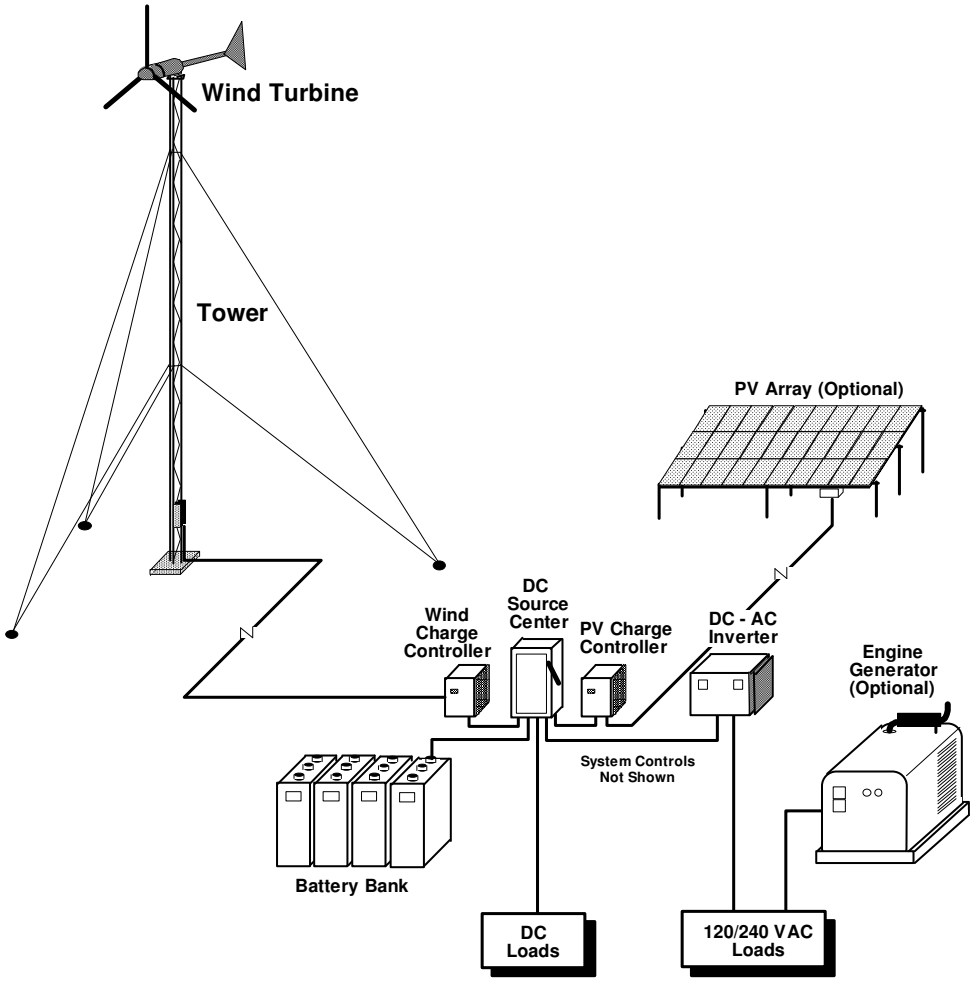


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Wind/Solar/Diesel Hybrid Systems

The Green Way to Power BTS

- **Provides 24/7 Power with Diesel Run Times Reduced to ~ 10 - 25%**
- **Renewables Typically Supply 50 - 90% of Energy**
- **"DC-Bus" Architecture is same as "Cycle-Charge Diesel" Systems, but with Renewables Added**

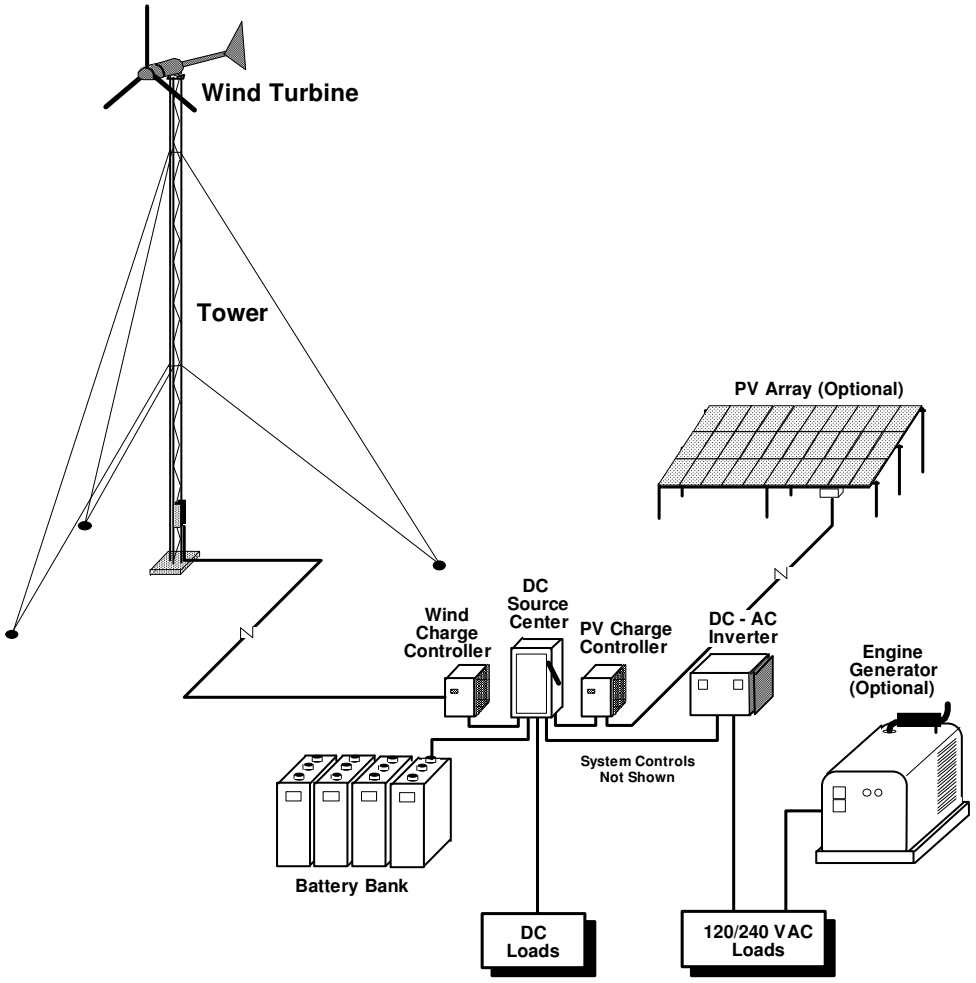


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Wind/Solar/Diesel Hybrid Systems

The Green Way to Power BTS

- One or More DC Wind Turbines & Solar Arrays
- 1 - 3 Days of Battery Storage
- Back-up Diesel Generator for Low Wind / Solar Periods
- Advanced “Consumer” Inverters for AC, Diesel Starting, and Diesel Battery Charging



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Typical Project Metrics

- **Equipment:** BWC 7.5 kW Wind Turbine, 2 kW Solar, ~ 60 kWh Battery Bank, 15 kW Diesel, Controls, & Monitoring
- **Load:** 1.5 kW BTS, plus DC Aircons
- **Performance:** 80% Annual Fuel Savings
- **Cost:** $110,000
- **OPEX Savings:** ~ $25,000/year, fuel & diesel O&M
- **Green Attributes:** Saves 600 tons of greenhouse gases and 3.6 tones of air pollutants over 30 year life



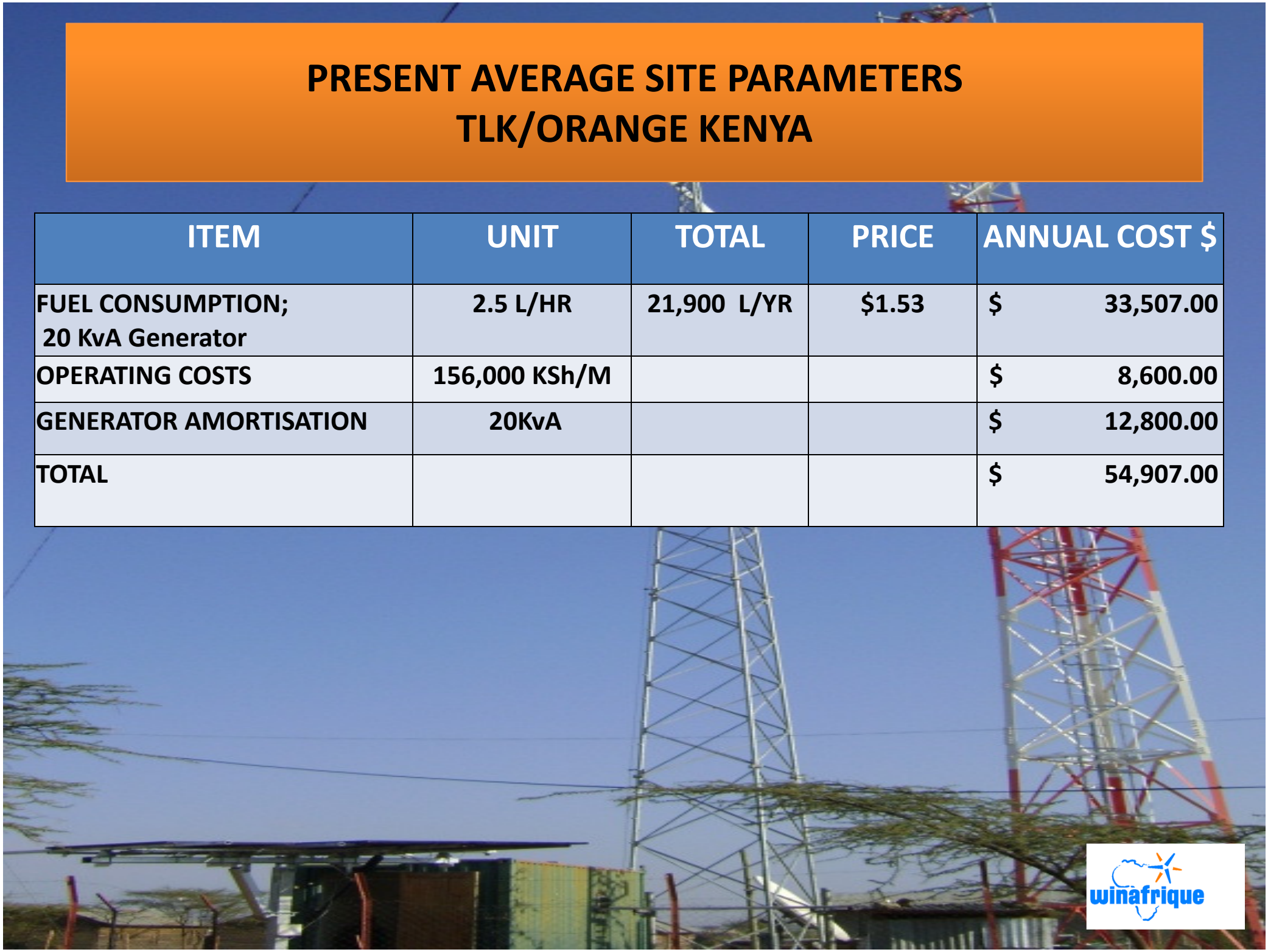
Safaricom
Masai Mara Game Reserve
Kenya



Remote BTS Power OPEX Reduction
with
Wind Solar Diesel Hybrid Power Systems
May, 2010

PRESENT AVERAGE SITE PARAMETERS
TLK/ORANGE KENYA

ITEM	UNIT	TOTAL	PRICE	ANNUAL COST $
FUEL CONSUMPTION; 20 KvA Generator	2.5 L/HR	21,900 L/YR	$1.53	$ 33,507.00
OPERATING COSTS	156,000 KSh/M			$ 8,600.00
GENERATOR AMORTISATION	20KvA			$ 12,800.00
TOTAL				$ 54,907.00



ORANGE TKL TRAIL RESULTS

		Before Hybrid System				
		Generator Run		Diesel OPEX for TKL Two DEG (KShs/Hr); DEG consumes 2.5ltrs per hrs @KShs 112.50 per litre at site		
Orange TKL-WTL Wind Solar Hybrid Site	Trial Days	Hrs in Trial Days	Hrs Per Day in Trial Days	Diesel OPEX PER DAY for TKL Generator Site - Diesel Only (KShs.)	Diesel OPEX for TKL Generator - Diesel Only Trial Sites (KShs.)	Diesel Consumed @ 2.5ltrs per hrs (L)
Mt. Kulal	391.0	9,384	24	6,750.00	2,639,250.00	23,460.00
Pelekech	244.0	5,856	24	6,750.00	1,647,000.00	14,640.00
*Kakuma	230.0	5,520	24	6,750.00	1,552,500.00	13,800.00
Nakobothan	240.0	5,760	24	6,750.00	1,620,000.00	14,400.00
Lokichoggio	267.0	6,408	24	6,750.00	1,802,250.00	16,020.00
Maparasha	385.0	9,240	24	6,750.00	2,598,750.00	23,100.00
*Wind Turbine and Tower decommissioned and re-depoled to Lutarere				Total	11,859,750.00	105,420.00

ORANGE TKL TRAIL RESULTS; Total Diesel OPEX Savings(KShs)

		After Installation and Commissioning of Wind Solar Diesel Hybrid				
		Generator Run		WTL Wind Solar Diesel OPEX ; DEG consumes 3ltrs per hrs @KShs. 112.50 per liter at site		
Orange TKL-WTL Wind Solar Hybrid Site	Trial Days	Hrs in Trial Days	Hrs Per Day in Trial Days	Wind Solar Diesel OPEX PER DAY for TKL Trial Sites (KShs.)	Wind Solar Diesel OPEX for TKL Trial Sites (KShs.)	Wind Solar Diesel OPEX Savings (KShs)
Mt. Kulal	391.0	14.8	0.04	12.77	4,995.00	2,634,255.00
Pelekech	244.0	635.7	2.61	879.30	214,548.75	1,432,451.25
*Kakuma	230.0	245.9	1.07	360.83	82,991.25	1,469,508.75
Nakobothan	240.0	733.0	3.05	1,030.78	247,387.50	1,372,612.50
Lokichoggio	267.0	1348.1	5.05	1,704.06	454,983.75	1,347,266.25
Maparasha	385.0	350.0	0.91	306.82	118,125.00	2,480,625.00
				Total Wind Solar Diesel OPEX	1,123,031.25	
					Total Diesel OPEX Savings(KShs)	10,736,718.75

ORANGE TKL TRAIL RESULTS; Total Diesel Savings(Liters)

Orange TKL-WTL Wind Solar Hybrid Site	Trial Days	Wind Solar Diesel Saved (L)
Mt. Kulal	391.0	23,421.68
Pelekech	244.0	12,002.11
*Kakuma	230.0	12,717.51
Nakobothan	240.0	11,307.66
Lokichoggio	267.0	10,907.82
Maparasha	385.0	22,179.55
Total Wind Solar Diesel Savings(L)		92,536.31

Wind Solar Hybrid Trial On 6 TKL Orange Sites

KPI

Daily Generator Run Hrs Average 4hrs per day







Lessons Learned

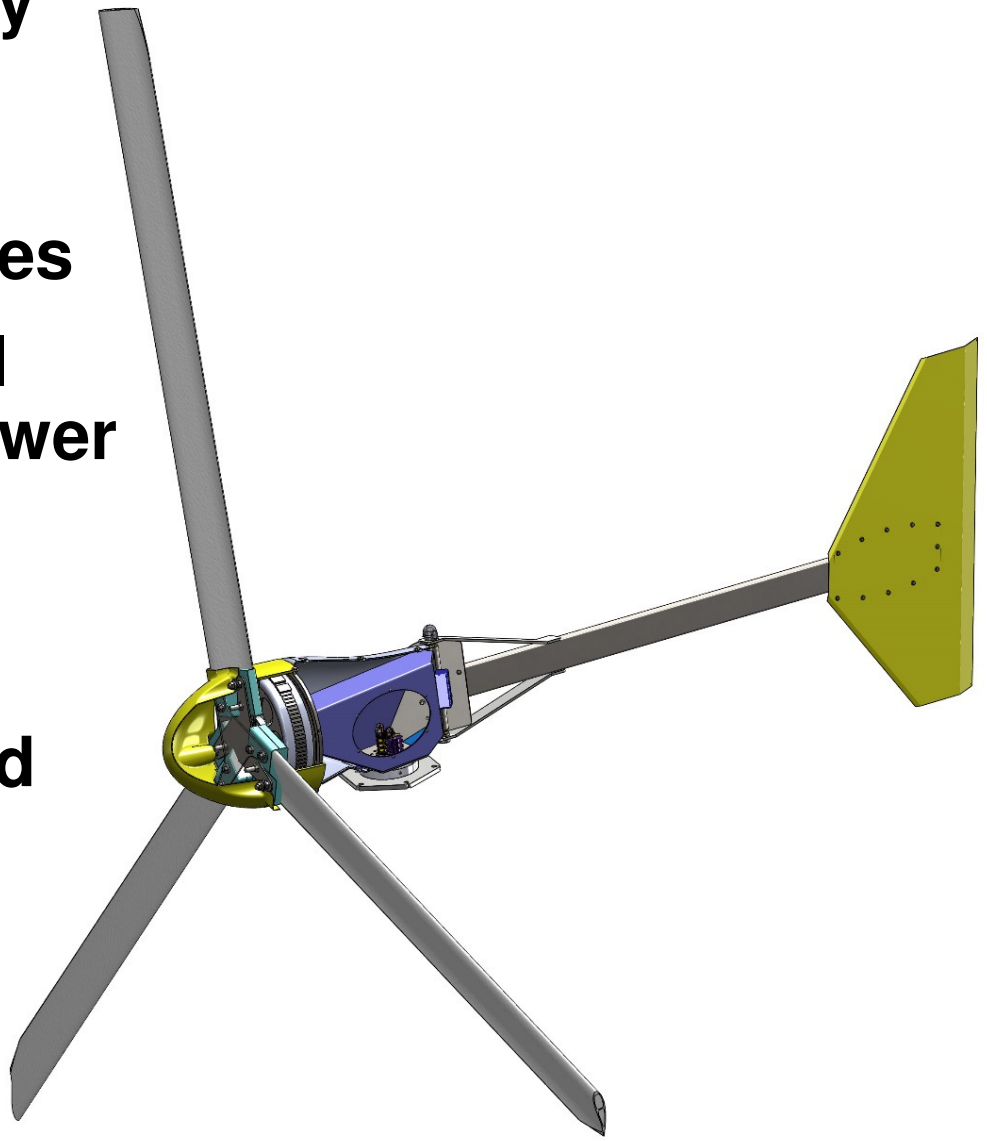
- Wind pilots were successful in 2006-2011 period, but green momentum was lost in recession … oil prices and APRU
- Showing 2-3 year payback is tough
- Wind extends battery life – fewer deep cycles, variable charging rates & regular full charging
- Wind has footprint and equipment theft advantage over solar, but has lost cost advantage except in windy areas and higher latitudes
- Very few existing towers can hold wind turbine sized for load
- Importance of financial stability of turbine manufacturer and local reseller
- Low towers, vertical-axis turbines, and cheap wind turbines (mostly Chinese) should be avoided



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Technology Path – Wind Turbine

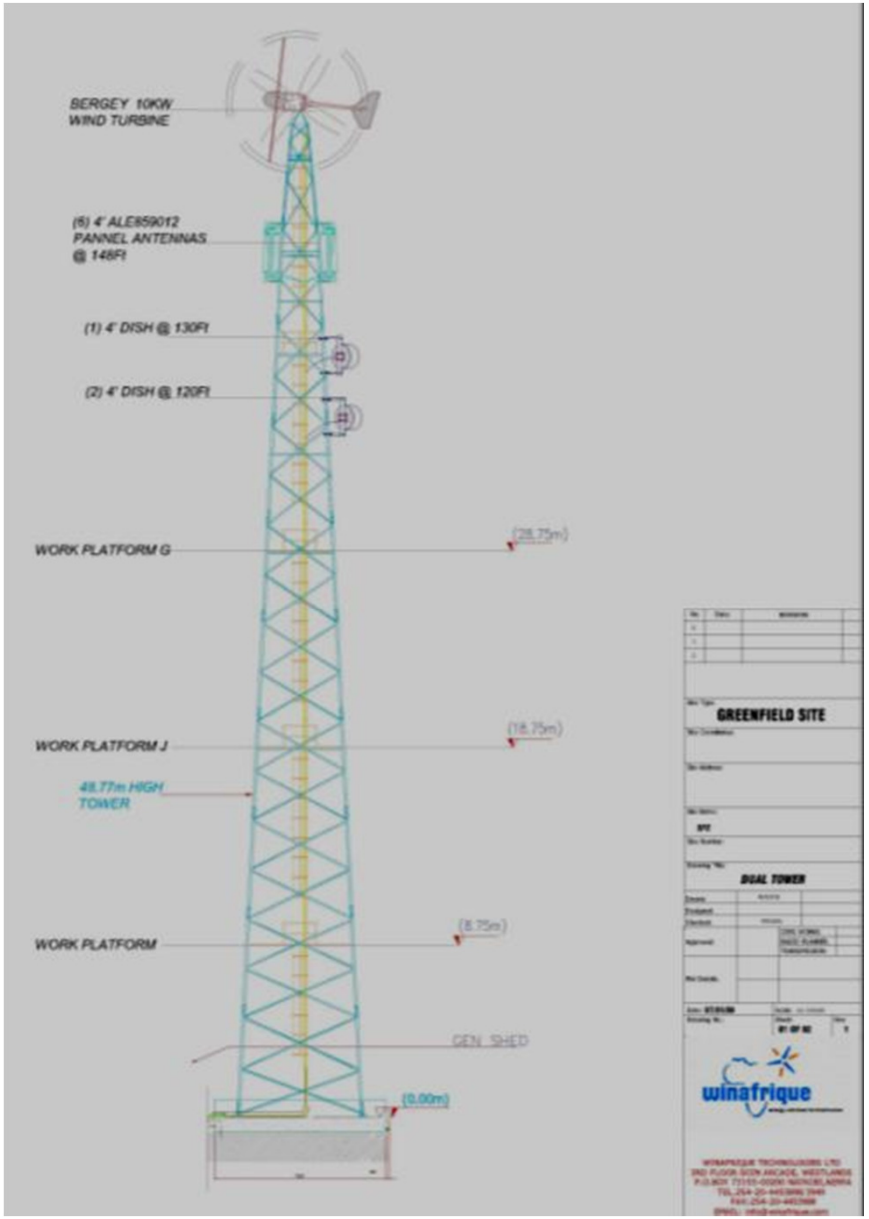
- Plunge in solar prices is a real challenge to wind industry
- LCEC must be reduced ~50% to regain cost advantage at low wind sites
- Larger rotors with control over speed, power and tower loading … advanced aerodynamic design
- Maintain mechanical simplicity, robustness and very low operating costs
- MPPT-like chargers



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Technology Path - System

- Single tower for turbine and antennas
  - saves ~ $30,000 with 43m tower and provides better performance
- Tall guyed towers – extra energy for community services
- Standardized, “value engineered”, electricals
- Export finance



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EXPORT-IMPORT BANK of the UNITED STATES

“Affordable Green Site” Program

- Technical: In-house project in cooperation with telco electronics & battery companies
- Standard kit … including high value electrification / water supply services
- Business: Aimed at retrofits for BTS and community power – BTS as anchor load under PPA
  - Partner with donor aid programs
- Business: For rollouts, green site at same CAPEX as dual-diesel



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Standardized Kit for Rural Services

- Focus on composing a package of energy systems to support vital community infrastructure
- Collaborative effort between Bergey Windpower and University of Oklahoma Health Sciences Center **College of Public Health** with formal end user survey/input
- End user involvement is most critical facet of project development

Example Elements May Include

Structural Components:

- Enhancing telecommunication infrastructure
- **Standard health services kit** design to meet energy requirements for remote locations, including but not limited to:
  - Dental
  - Medical services
  - Neonatal
  - Nutrition
  - Potable water
- School
- Lighting
  - Street lamps

Support and Logistical Components:

- Systems staffing and training
- Geographical radius served
- Minimum and maximum per capita sizing

Need Government and Donor Agency Contacts to Aid in Needs Prioritization and Kit Design

Implementing Wind Energy

- **<u>Buy energy efficient equipment & cut thermal loads – Saves CAPEX!</u>**
- **Provide loads definition & locations to potential vendor(s)**
- **Budgetary estimates to determine feasibility, then formal quotations**
- **Trials Programs for Confidence Building and Staff Training**



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Your Green Power for Mobile Partner

BERGEY WINDPOWER

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