COMPARATIVE ANALYSIS OF SAVINGS GENERATED BY THE USE OF 3KVA STAND-ALONE OR BACK-UP RENEWABLE ENERGY SYSTEMS VERSUS THE USE OF 5KVA DIESEL GENERATOR TO POWER A CAMPUS NETWORK CENTER

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Study Outline

- This analysis is done using a 5KVA Yamaha diesel generator to compare with an equivalent 3KVA Outback sine wave inverter as back up power supply, a 3KVA Solar-powered system and also a Skystream 3.7 Wind-powered system.
- First the *Pay back Period* is derived using Diesel generator in comparison with the solar-powered system, then with the wind-powered system and finally with the Back-up power system.

- 5KVA Yamaha silenced generator consumption running at 1800 rpm - 1.5litres/hr.
- Daily consumption = 1.5 litres/hr x 24 hr
  = 36 litres
- Daily Expenditure on diesel fuel purchase
  = 36 litres x N90/litre
  = N3,240.00 per day

Monthly & Annual Consumption

- Monthly Consumption = 36 litres/day x 30 days
- = 1080 litres
- Monthly Expenditure on diesel fuel purchase =
- 1080 litres x N90/litre
- = N97,200.00 per month
- Annual Consumption = 1080 litres/month x 12 months
- = 12,960 litres
- Annual Expenditure on diesel fuel purchase =
- 12,960 litres x N90/litre

= N1,166,400.00 per annum

- An equivalent Solar-powered Renewable Energy power supply system will cost N13,145,000.00, while a Wind-powered system will cost N4,042,000.00
- ***See details in next frame:***

TYPICAL QUOTATION FOR THE INSTALATIONS OF A SOLAR-POWERED 3.0 KW STAND-ALONE RE POWER SYSTEM

- ***A.*** ***Inverter System***
- **1.** 3.0 KW VFX3024 Outback Power inverter- N450,000.00
- **2.** 8 Nos. 200 Ah; 12 VDC VRLA (Valve
  - Regulated Lead Acid) Heavy duty solar
  - batteries @ N75,000 each N600,000.00
- **3.** 250A Xantrex DC Disconnect N100,000.00
- **4.** Installation Materials N70,000.00
- **5.** Installation Charge N 50,000.00

TOTAL **N1,270,000.00**

- ***B. <u>Photo-voltaic Modules:</u>***
- Our design is based on ***24Vdc***. At 5ESH provided by the PV's in the Anambra area, the nominal current of the 123W; 17V Sharp solar module is 7.1A. Therefore with an actual load value of 3KVA, and for the PV providing all of the required power there will be

PV Nos. Calculations

- 3000VA x 12H = 36KWH of load for the PV
- For a 24V system this requires

$$\frac{3000VA \times 12H}{24V \times 5H} = 300A$$

- Using 120W PV's there will be

$$\frac{300A}{7.1A} = 42.25 \text{ or } 43 \text{ streams of } 24VDC$$

PV's = 86nos. panels

- Thus for a 36KWH load (3KVA average load running at 12 hours per day) we require **86*nos. of the 123W panels***

PV QUOTATION

- 86 nos. 123 Wp 17A; 7.1A Sharp photo-voltaic modules @ N115,000.00 ea. N9,890,000.00
- 5nos. MX60 Outback Charge Controllers @ N125,000.00 ea. N 625,000.00
- 400A, 60 way Combiner box N 280,000.00
- 11 nos. Steel mounting poles for Zomeworks plus concrete base civil works @ N100,000.00 ea. N1,100,000.00
- Design, Installation and professional fee N 250,000.00

  SUB TOTAL **N12,145,000.00**
- **GRAND TOTAL FOR A 3KVA LOAD STAND-ALONE SOLAR-POWERED SYSTEM: N1,270,000.00 + N12,145,000.00**
- **= N13,145,000.00**

TYPICAL QUOTATION FOR THE INSTALATIONS OF A WIND-POWERED 3.0 KW STAND-ALONE RE POWER SYSTEM

A. Inverter System	
3.0 KW VFX3024 Outback Power inverter-	N450,000.00
8 Nos. 200 Ah; 12 VDC VRLA (Valve Regulated Lead Acid) Heavy duty solar batteries @ N75,000 each	N600,000.00
250A Xantrex DC Disconnect	N100,000.00
Installation Materials	N 70,000.00
Installation Charge	N 50,000.00
TOTAL	**N1,270,000.00**

Typical Wind generator quotation:

- ***B. <u>Skystream 3.7 wind generator quotation:</u>***
- Skystream 3.7 Land 2400 Watts peak power wind generator with Battery Sensor for battery charging N1,012,000.00
- Wireless Remote Battery Sensor 916Mz. N 55,000.00
  70ft. Guyed Tower Kit N 325,000.00
- 2 rolls 3-core #2 AWG installation cables @ N100,000.00 ea. N 200,000.00
- 70' Tower for mounting Skystream 3.7 wind gen. N 900,000.00
- System Earthing N 80,000.00
- Design, Installation transportation and professional fee <u>N 200,000.00</u>

TOTAL **<u>N2,772,000.00</u>**

WIND QUOTATION

- **GRAND TOTAL FOR A 3KVA LOAD STAND-ALONE WIND-POWERED SYSTEM: N1,270,000.00 + N2,772,000.00**
- **= N4,042,000.00**

PAY BACK PERIOD

- Excluding the maintenance cost of the generator, the ***Pay-Back Period*** =

  Renewable Energy Installation Cost/

  Annual Cost of Providing Supply using Diesel Generator

For Solar-powered system

Payback Period = Renewable Energy Installation Cost/

Annual Cost of Providing Supply using Diesel Generator

=N13,145,000/

N1,166,400 (gen. running cost) + N150,000 (gen. cost)

- = $\frac{\text{N13,145.000}}{\text{N1,316,400}}$

- = 9.98 or 10 years

For Wind-powered system

Payback Period = Renewable Energy Installation Cost/

Annual Cost of Providing Supply using Diesel Generator

= N4,042,000/

- N1,166,400 (gen. running cost) + N150,000 (gen. cost)
- = $\frac{\text{N4,042.000}}{\text{N1,316,400}}$

- = 3.07 or 3 years

Comments and Conclusion

- In reality it will take much less time when we input the maintenance cost and the cost of procurement of at least 2nos. of the Yamaha generators to run them alternately.
- It is obvious that the major cost of power supply using stand-by generators is not the capital cost of procurement of the generators but rather the cost of fuelling and maintenance of the generators.

- Judging by the way that diesel fuel price had been increased over the past recent years, it will be unrealistic to expect that the price of diesel will remain at N90.00 per litre over the next 10 years. There will definitely be price increases over this period.
- This will mean a shorter Pay Back Period for the Renewable Energy system proposed. In practice, the Renewable Energy system will pay for itself faster for wind-powered systems than for solar-powered systems. The lifespan of the PV of the solar-powered RE system however is 40 years while the expected life span of the wind system is 25 years.

RE vs Diesel Generators

- What this means is that the total capital cost of setting up the Solar-powered system (N13.145m) will be spent in less than 10 years if diesel fuel generators are used in preference while the total capital cost of setting up the Wind-powered system (N4.042m) will be spent in less than 3 years if diesel fuel generators are used in preference.

Using SOLAR POWER

- If Solar-powered RE power system is used, power supply procured at the same cost of N13.145m will last for 40 years instead of only 10 years.
- At present costs, diesel generators will provide the required power at the cost of

$$\frac{40 \quad x \quad N13.145}{10} = \textbf{N52.58m}$$

- This translates to a saving of N52.58m - N13.145m
  = N39.435m
  if Solar-powered RE system is used instead.

Using WIND POWER

- But if Wind-powered RE power system is used, power supply procured at the same cost of N4.042m will last for 25 years instead of only 3 years. At present costs, diesel generators will provide the required power at the cost of

$$\frac{25 \times N4.042}{3} = \textbf{N33.68m}$$

- This translates to a saving of N33.68m - N4.042m
  = N29.641m
  if Wind-powered RE system is used instead.

Comments and Conclusion

- In reality, this is much more since the RE expenditure is made once and at present costs but the generator expenditure begins at present costs and continues at an ever-increasing rate over the next 25 or 40 years. Who knows how much diesel fuel will sell at per liter twenty years from now?

PAYBACK PERIOD FOR BACK-UP POWER SYSTEMS

- There are basically 2 types of RE systems – either Back-up or Stand-alone. Having done the analysis for Stand-alone systems, we now present the analysis for Back-up systems used in areas where there is available grid supply for battery charging.
- Next frames are a Payback Period study done for back-up's.

Basic Assumptions

- 1.5 litres of diesel fuel per hour consumption rate for your 5KVA stand-by generator at 30% capacity utilization.
- N90 per litre cost of diesel fuel.
- 20%, 50% and 80% average grid power outage rates per annum are used for the calculations.
- Total cost for the installation of the proposed back-up power is assumed at N1,270,000.00.
- Grid power, Stand-by generator and the proposed Outback back-up power are the three power sources available in each site.

Payback Period (PBP) Calculations- 20% grid power outages

- Based on 20% average grid power outage rate per annum (19hrs 12 min. of average available grid power everyday of the year)
- Annual cost of diesel consumption per site

  = 20% x 365 days x 24 hrs x 1.5 litres/hr x N90/litre

  = N236,520.00
- PBP = N1,270,000.00 / N236,520.00

  = 5.37 years.

50% grid power outages

- Based on 50% average grid power outage rate per annum (12hrs of average available grid power everyday of the year)
- Annual cost of diesel consumption per site

  = 50% x 365 days x 24 hrs x 1.5 litres/hr x N90/litre

  = N591,300.00
- PBP = N1,270,000.00 / N591,300.00

  = 2.15 years

80% grid power outages

- Based on 80% average grid power outage rate per annum (4hrs 48 min. of average available grid power everyday of the year)
- Annual cost of diesel consumption per site

  = 80% x 365 days x 24 hrs x 1.5 litres/hr x N90/litre

  = N946,080.00
- PBP = N1,270,000.00 / N946,080.00

  = 1.34 years

Comments and Conclusion

- A larger rate of diesel fuel consumption than the 1.5 litres/hr assumed above will result in a shorter Payback Period than that deduced above (You know what your actual diesel consumption rate is).
- Considering the high rate of power outages in Nigeria generally, the above deductions represent the worst case scenario. We believe that in actual practice the savings that will be generated in most of the locations where the proposed back-up power system is installed will pay back the full cost of the installation in less than **2 years.**