Harvesting Wind and Solar Energy for Off-Grid Applications in the UAE

Mohammad Tauseef - 42312 Talha Khwaja - 40346 Yousuf Altaf - 41065

Situation

UAE has become one of the most famous countries in the world due to its major achievements and growing tourism industry. While cities such as Dubai are undergoing tremendous growth and increase in living standards, there are still parts of the country which have not been able to keep up. One of the major problems in these places is the lack of electricity. In order to combat the lack of electricity, many people have turned to diesel generators to meet their power demands.

Problems

- The quality of life is drastically decreased for people without access to electricity.
- The conventional systems for off-grid electricity such as diesel generators have high running costs which add up over long periods of time. Most residents cannot sustain the cost of owning a generator for personal use.
- The expansion of the country's electrical grid is expensive and will take a long period of time to accomplish.
- Some emirates such as Ajman and Sharjah are not able to meet their power demands; leaving residential buildings without electricity from the grid [1].

Solution

To solve these problems, we propose a system which combines wind and solar energy to provide off-grid electricity. Research has shown that UAE has the potential for wind [2] and solar [3] energy harvesting. Figure 1 shows a schematic of our proposed system.

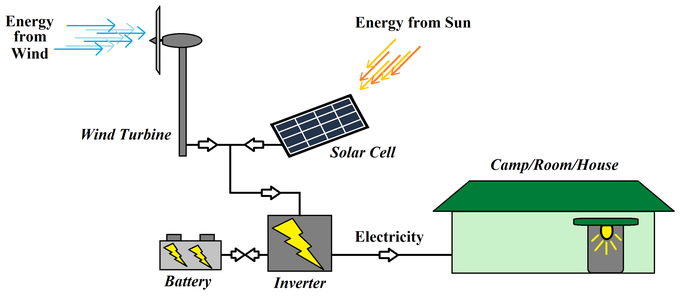

Figure 1: System Schematic

To generate electricity, the following steps will occur in the system:

1) The Solar Panels and Wind Turbine will generate electricity by harnessing energy from sunlight and wind respectively.
2) The generated electricity will pass through an inverter and be supplied to the Camp/House/Room.
3) Any excess electricity which is not supplied will be stored in batteries.
4) The energy in the batteries will be utilized when the system is not producing enough electricity. For example, at night when the solar panels cannot work.

To analyze our proposed system and compare it with a conventional solution, we first designed the power requirements of a space which would use off-grid electricity. The table below shows the basis of our design.

Table 1: Designed Power Requirement

Appliance	Unit Power (W)	Quantity	Hours/Day	KWh/day
CFL Bulbs	25	4	7	0.7
Ceiling Fan	100	2	12	2.4
TV	130	1	3	0.39
Laptop	50	1	3	0.15
			Total KWh/day = 3.64	

Selection of Wind Turbine

For our system, we selected a horizontal axis wind turbine (HAWT); since wind enters perpendicularly in a HAWT, it converts most of the wind energy into electrical energy.

Selection of Solar Panels

For our system, we selected polycrystalline solar panels because they are the most commonly used types of panels for domestic applications.

For analysis, we have selected the following commercial wind turbine and solar panel:

Table 2: Properties of the selected Wind Turbine and Solar Cell

	Aleko WG450A Wind turbine	Renogy Polycrystalline Solar Panel
Power Rating	100 W @5.5 m/s	100 W
Unit Cost	$400	$150
Power Generated	1.8 KWh/Day (18 hrs/day wind)	1 KWh/Day (10 hrs/day sunlight)

Selection of Batteries

To store the generated electricity, we selected lead acid deep cycle batteries. Deep cycle batteries have the following advantages:

. Able to provide steady levels of power for long periods of time.
. Very common for renewable energy applications. Some batteries are marketed as "Solar Batteries."
. Relatively cheaper than other types of batteries.

For analysis, we have selected the following commercial deep cycle battery:

Table 3: Properties of the selected Battery

UPG 85980/D5722 Sealed Lead Acid Battery	
Current Rating	35 Ah
Unit Cost	$64
Power Rating (@ 12 volts)	420 Wh

Total Cost of System

After all the components of our system were selected, the total cost and power generation capacity was calculated. Table 4 lists the costs and power generation of each component of the system.

Table 4: Cost and Power Generation

Component	Unit cost	Qty.	Power Generated	Cost
Wind Turbine	$400	1	1.8 KWh/Day	$400
Solar Panel	$150	2	2 KWh/Day	$300
Battery	$64	8	-	$512
Other	$300	1	-	$300

From table 4, we find that the power generation capacity of our system is 3.8 KWh per day which is suitable for our designed power requirement (3.64 KWh per day), and the total cost is $1512.

Evaluation

To compare our solution to a conventional system, we selected a diesel generator with suitable power generation for our designed power requirement. The selected generator costs $520, has a 1850 W power rating and consumes 0.2 gallons per hour.

The figure below shows the comparison of cost between the diesel generator and our system. The following observations are made:

- The implementation cost of our system is higher than the generator. However, the running cost is lower.
- Running a generator becomes considerably more expensive over the long run.

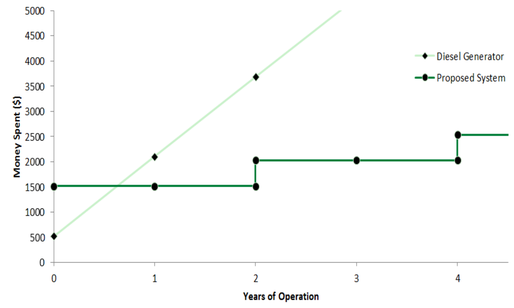

Figure 2: Money Spent vs. Years of Operation

References

[1] Electricity Shortage to Hit GCC Real Estate. (n.d.). Real Estate UAE News. Retrieved from http://www.era-uae.com/Pages/NewsDetails.aspx?NewsID=1866

[2] Abu Dhabi perfect for wind farming. (n.d.). Retrieved November 25, 2013, from http://gulfnews.com/news/gulf/uae/environment/abu-dhabi-perfect-for-wind-farming-1.491002

[3] Islam, M. D., Alili, A. A., Kubo, I., & Ohadi, M. (2010). Measurement of solar-energy (direct beam radiation) in Abu Dhabi, UAE. Renewable Energy, 35(2), 515–519. doi:10.1016/j.renene.2009.07.019

Further references can be furnished upon request.