Mini Solar and Sea Current Power Generation System

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Abstract. The power demand in United Arab Emirates is increased so that there is a consistent power cut in our region. This is because of high power consumption by factories and also due to less availability of conventional energy resources. Electricity is most needed facility for the human being. All the conventional energy resources are depleting day by day. So we have to shift from conventional to non-conventional energy resources. In this the combination of two energy resources is takes place i.e. wind and solar energy. This process reviles the sustainable energy resources without damaging the nature. We can give uninterrupted power by using hybrid energy system. Basically this system involves the integration of two energy system that will give continuous power. Solar panels are used for converting solar energy and wind turbines are used for converting wind energy into electricity. This electrical power can utilize for various purpose. Generation of electricity will be takes place at affordable cost. This paper deals with the generation of electricity by using two sources combine which leads to generate electricity with affordable cost without damaging the nature balance. The purpose of this project was to design a portable and low cost power system that combines both sea current electric turbine and solar electric technologies. This system will be designed in efforts to develop a power solution for remote locations or use it as another source of green power.

1. Introduction

Since the invention of first engine in 17th century, energy Consumption has been used due to many causes in many different ways. Persistent increase in the energy demand has caused to seek, new energy resources in the world; new alternative energy. Resources have been also utilized to minimize the energy deficit [1-3].

Figure 1 shows a chart of the difference between early consumption and now with different types of resources weather its renewable or non-renewable energy.
Figure 1. History of energy consumption in the United States (1776-2012)
In the early age, people didn’t use too much energy but as time passes, energy demand had increase and the world is now searching for energy resources. Non-renewable energy sources are highly used in caparison with renewable energy and that will cause in environmental problems such as global warming. Electricity is most needed for our day to day life. There are two ways of electricity generation either renewable or non-renewable. Electrical energy demand increases in word so to fulfill demand we have to generate electrical energy. Now a day’s most of electrical energy is generated by the non-renewable energy resources like coal, diesel, and nuclear. The main cons of these sources are pollution and green house effects where it contributes in global warming and the nuclear waste is very harmful to living organism. The non-renewable energy resources are depleting day by day. Soon it will be completely vanishes from the earth so we have to find another way to generate electricity. The new source should be reliable, pollution free and economical. The renewable energy resources should be good alternative energy resources for the non-renewable energy resources. There are many renewable energy resources like geothermal, tidal, wind, solar. Solar energy has drawback that it could not produce electrical energy in rainy and cloudy season so we need to overcome this drawback we can use two energy resources so that any one of source fails other source will keep generating the electricity. And in good weather condition we can use both sources combine. In the United Arab Emirates, solar energy is the best renewable energy we have but one source is never enough. Combing another source with solar energy will give us more power and more reliability in extracting power without burning fossil fuel or damaging the environment. So the best option beside solar is wind but we don’t have too much space to make Huge wind farms, so we thought of sea current power generation which have the same concept of wind energy but under the sea. The turbines area will be much smaller due to the density of the water which is thousand times larger than the wind density. Other renewable source is not as great as sea current energy due to limitations such as the surrounding environment like geothermal. We have few places that are suitable for generation but the places are already occupied with other things such as swimming pools and other facilities. The sea is vast and we can place the turbines any place we want [4-7].
The mechanism of the working of solar panels is depicted in figure 2.
As shown in figure 2. The sunlight is directed to the silicon material, then the n-type and p-type material react upon this energy, resulting in moving of charge carriers. Mainly hole-electron movement. Finally, electrical current is induced. Next we will talk briefly about wind power. Figure 3 shows the Wind turbines. Wind turbines are used to convert the wind power into Electric power. Electric generator inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available ranging from 50W to 2-3 MW. The energy Production by wind turbines depends on the wind velocity acting on the turbine. Wind power is used to feed both energy production and consumption demand, and transmission lines in the rural areas. We have two types of turbines in general, horizontal and vertical turbines, each one of them is used in different areal conditions. Here is a figure that will show the structure of wind turbine.
be used to create the turbines to make them reliable under water and won’t be affected easily by the salt and rust.

2. Site characteristics
United Arab Emirates is located in the gulf region United Arab Emirates’ latitude and longitude is 24° 00' N and 54° 00' E. The United Arab Emirates Climate features extreme heat, UAE weather is sunny all the year round, This can be easily seen in figure 4.

![Figure 4](image)

**Figure 4.** The temperatures soar up to 45°C in summer and in winter it goes down to 20°C

2.1. Solar Energy Potential
Direct normal irradiation:
The estimated direct normal irradiation is plotted with respect to the month for six stations. Figure 5 demonstrates different cities lines in UAE, namely, Masdar, Jabal Haffed, Al aradh, AL wagan, Madinat Zayed and Al sweihan.

![Figure 5](image)

**Figure 5.** How the values are highly variable throughout the different months of the year and that the month of July has the lowest values.

2.2. Peak sun hour
Figure 6 displays the average peak sun hours per day in the UAE for each month. The yearly average peak sun hours/day used in calculations in the UAE is 5.84
2.3. Sea current energy potential
United Arab Emirates have many islands and water surrounding the country, we can use the sea
current to generate energy, the water has at least 1000 density and salty water have even more. So even
a speed of 1 m/s is enough to generate clean power.
Figure (7) shows the potential of wind energy, as long as there is small wind energy to move the sea
current, we can generate energy.

3. Conceptual design
The system will use sea current turbines and solar panels to extract energy. It will let the two sources
extract independently and it would be connected to a hybrid wind solar charge controller, which will
store the produced energy in a battery bank. The charge controller to maintain everything and to store
the energy safely. Then from the battery to the inverter to convert DC to AC, then from the inverter to
the AC load.
In this project we are going to use 6 major processes to complete the system as shown in figure (8).

- **AC load**: we need to put a maximum load so we can design a system based on our maximum load.
- **Inverter**: Inverter is needed to convert DC power into AC power.
- **Battery bank**: the system needs a battery bank size per the load requirement so that it should fulfill the requirement of load.
- **Hybrid solar sea current controller**: Charge controller has basic function is that it control the source which is to be active or inactive. It stores the power that were extracted from the sources to the batteries and take power from the battery to the inverter. The controller has over-charge protection and short-circuit protection. This will increase the battery lifespan.
- **Solar panels (PV)**: Solar panel Solar panel is used to convert solar radiation to the electrical energy.
- **Sea current turbines**: Sea current turbine is that system which extracts energy from sea current by rotation of the blades.

## 4. Modelling

**Modeling of PV System**

The required size of pv panel

\[
\text{Total demanded power} = 80 \times 1.3 = 104 \text{w}
\]

(where 1.3 is the energy loss in the system)

Size of the pv panel

\[
\text{Pv size} = \frac{\text{Total demanded power}}{\text{power generation factor}} = \frac{104}{5.84} = 17 \text{ w}
\]

(5.84 is the power generation factor for UAE).

17 is the panel size, so we would take 20 watt as panel size.

Requirements = 20 watt 12v pv Polycrystalline panel

### 4.1. Modeling of inverter

The size of the inverter should never be smaller than the demanded load, it should be 25 – 30 % bigger than the load.

\[
inverter \_size = 80 \times 1.3 = 104 \text{w}
\]
The calculation of the battery size for one day of autonomy

\[
Battery _{Size} = \frac{AC _{Energy}}{Batt _{eff} \times depth _{discharge} \times nominal _{voltage}} = 13
\] (0.2)

where
- System voltage = 12
- Depth discharge = 0.6
- Battery eff = 0.85
- Days = 1 day without power

So, We need 13 Ah 12v battery (we may change it due to the controller specification)

4.2. Modeling of Wind System

Power available in wind at a specific site depends on three things: air density, area of rotor and wind speed. Wind power can be calculated using this formula. We want to produce at least 80 watt.

\[
P = 0.5 \times \rho \times AW \times v^2 \times \eta
\] (0.3)

- \( P \) = power from the water
- \( \rho \) = density of water 1000 kg/m3
- \( AW = w \) is the cross sectional area of water flow across turbines
- \( v = \) velocity of water (1.5 m/s) (as an average)
- \( \eta = \) efficiencies (25%) (0.7 generator eff * 0.35 turbine eff)

Since we know all the all the parameters accept the Aw, we can get it to help us to design the blades.

\[Aw= 0.28m2\]
\[R =0.3m\]

4.3. Controller size

We can also choose the size depending on the maximum produces watt on both sources.

The system needs a controller which will withstand 20 watt from solar panels and 80 watt from current turbine. It won’t be easy to find one because hybrid controllers always need more watt to operate. We may have to use a bigger controller because the smallest charge controller can withstand 300 watt from water generation and 150 watt from solar generation [8-9].

5. Conclusion

Hybrid power generation system is good and effective solution for power generation than nonrenewable energy resources. It has greater efficiency. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. Cost reduction can be done by increasing the production of the equipment. People should motivate to use the renewable energy resources not only for the personal good but for the global and environment good too. It is highly safe for the environment as it doesn’t produce any emission and harmful waste product like conventional energy resources. It is cost effective solution for generation. It only need initial investment. It has also long life span, it only needs little, uncostly maintenance after a certain periods of time Overall it good, reliable and affordable
solution for electricity generation. People and countries should focus on using renewable energy sources as much as possible to save our global.

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