A Concept of a Sustainable productive remote community in Egypt powered by a Hybrid renewable energy system

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***Abstract* - Challenges nowadays go to a more clean planet with low cost of operation and energy saving. From another perspective, balancing the energy trilemma paradigm aspects, which is the economic, the environment, and the security performance is crucial for any effective energy system. Therefore, Hybrid energy systems are considered an effective way to achieve the above goals; however, their cost mainly depends on where it's established especially in remote locations. In order to lower the cost of such systems, in the long run, renewable energy is integrated into the system. Wind and solar energy are complementary on a daily, annual, and regional basis; accordingly, the energy provided by wind turbines and PV has become a major renewable energy resource stand-alone. However, storage resources and diesel generators are also used to overcome the intermittent nature of wind and solar energy. Therefore, the main focus of the research is modeling and management of a sustainable productive environmental Hybrid renewable energy system in a chosen remote community. This sustainable- economic energy model is aligned with the Egyptian government 2030 development plan. Moreover, this sustainable community is considered a promising model in remote communities to be relying on itself in productivity of food and energy which is effect by its role on the Egyptian national economy.**

Keywords: Hybrid Renewable Energy Systems, Sustainability, Energy Consumption, Remote communities.

I. INTRODUCTION

Hybrid Renewable energy systems are considered one of the optimal solutions for energy sources in remote communities that are not connected to the government grid. These remote communities need to be productive in terms of their food and energy or have the capacity for agricultural or animal production and are ready to be inhabited in the near future.

In order for the state to guarantee the eligibility of these places for living and production, it must provide a secure and continuous source of energy and at the same time be economic and reliable. The project mainly aims to reach the optimum sustainable hybrid renewable energy system for remote places. Every place depends on the nature of the wind and the presence of solar energy and the existing energy system in it to design a hybrid system that suits the nature of this place. The choice of location is a very important factor in the perspective of the renewable energy system clean applications to reduce carbon dioxide emissions and at the same time rationalize the energy consumption and exploit every single element.

Fluctuation nature of renewable energy is considered an important factor; therefore, Emilia et al. [1] has been analyzed a hybrid renewable energy system .Community organization and governmental support are found to be the most effected factor in successful of such integrated systems to extend the project life time and achieve its lowest possible cost of energy and production. Specific focus has been given to developing countries in this research. In such remote communities in developing countries, the power supply through this hybrid renewable system is much cheaper and faster than connecting to the national grid, but a number of supportive policies must be existed to facilitate the configuration of these energy systems.

A plan for power generation in economical perspective has been implemented in remote area using hybrid energy system. General framework perspective in designing a small scale HRES has been introduced by Gupta et al. [2]. The plan is demonstrated using a numerical example to give a brief overview of the cost analysis investigation in this rural remote community.

Standalone energy systems in remote communities has been reviewed and analyzed in terms of general energy trends and characteristics by William et al. [3]. These effective sustainability solutions showed better performance in the form of economic and environmental aspect over the traditional sources like diesel oil based systems. About 168 remote communities case study have been investigated and showed that the hybrid PV, wind and batteries, as an energy storage method, is the perfect combination by 80.4%, while the diesel generator as the backup is 61.3%.

A design and optimization of hybrid renewable energy system in chosen remote community is implemented using HOMER software tool by Shadman et al. [4]. The system supplies a community consists of 300 families and it's found that the optimal composition is PV-Diesel-Biomass according to the meteorological data available in the studied location to provide an electricity cost of 0.340 $/kWh.

Finally, we have to continue in supporting any private investments is such mini grid systems for remote communities. So that, the way of thinking in the production community life style quality and dynamics has to be changed to support the Egyptian government plan in giving a potential for new remote cities in industry, education, production and energy.

The main focus of the research is on the hybrid renewable energy systems in Egypt. The meteorological data and resources are collected and studied for the purpose of choosing the appropriate locations of remote communities in the Egyptian land to model a concept of a hybrid renewable energy system. In essence, we ask you to make your paper look exactly like this document. The easiest way to do this is simply to download the template, and replace (copy-paste) the content with your own material. Number the reference items consecutively in square brackets (e.g. [1]).

However the authors name can be used along with the reference number in the running text. The order of reference in the running text should match with the list of references at the end of the paper.

1.1 Objectives

- Design a sustainable - economic energy model in remote communities to be relying on itself in productivity of food and energy
- Monitor the system performance and record the operation for giving solutions to any similar community
- Optimize the performance and cost analysis to reach the optimum configuration related to the nature of the chosen community
- Setting up a new renewable energy concept in modeling the energy in the Egyptian land.

II. Approach and Methodology

We will be one of the first facilities to make a hybrid system with a biogas unit for a steady production of energy throughout the day-month-year and we will be able to measure its direct effect on the agriculture process growing crops, providing organic waste, watering with fish waste …etc. Furthermore, the effect of animal's life as livestock, poultry and the temperature required for the wards, lighting, ventilation...etc. To sum up, the focus is to build a fully sufficient efficient productive active standing alone community. And to give the remote areas a chance to stand in the upcoming challenge of the climate change.

It is worth noting that in the planned place there are all the applications that will need a power system for different productive applications in the form of a residential complex and agricultural and animal production. One of the important environmental factors is exploiting the animal waste; therefore, a biomass gas station is established in the chosen location and will be integrated into the system. Another sustainable factor is using the water out of the fish farming cycle for irrigation of specific crops which is reducing the water consumption.

Wind and solar energy are complementary on a daily, annual, and regional basis; accordingly, the energy provided by wind turbines and PV has become a major renewable energy resource stand-alone. However, storage resources and diesel generators are also used to overcome the intermittent nature of wind and solar energy.

Firstly, a detailed study of the location characteristics in terms of energy data and resources available will be implemented. It's considered a milestone stage since collecting load and demand data and detecting the current resources available is crucial on the subsequent decision making of the research. Current operation and production status needed to be will defined in terms of current operation model, current performance load and efficiency, current cost analysis in terms of energy and community productivity, and peak load demand.

Consequently, a new hybrid renewable system can be design and modeled. The technical specifications and configuration of the hybrid renewable system can be specified. Then, operation the new hybrid system will be monitored for the purpose of optimization using HOMER PRO software.

Finally, the reliability of the system will be checked and detect differences between different operation modes, stand-alone system, Microgrid with another near community, or connected to the governmental grid and set the proposed dispatch strategy taking into considerations the environmental aspects and economic aspects for reaching to the best case scenarios in long term and short term.

It has become noticeable in front of everyone's eyes the political leadership's interest in remote areas such as El Alamein and the Galala plateau and the construction and reconstruction of cities in an unprecedented manner. The main pillar is certainly how to supply these cities and sectors with energy, not only supply, but also to ensure that they are environmentally clean to help in the future transformation to 100% renewable energy and do not contain In addition, harmful carbon emissions must be economically efficient and of course insured throughout the year and available on demand and at peak times. We had no choice but to think about extending a helping hand with what we can do by planning to secure clean and economic energy sources in the remote region of Egypt, which is of course part of the government's future plan.

2.1 Installation, Configuration and Optimization steps

- Study the location characteristics in terms of energy data and resources available
- Collect data and resources
- Current operation model
- Current performance load and efficiency
- Current cost analysis in terms of energy and community productivity
- Peak load demand
- Hybrid renewable system design concept

III. Hybrid Productive System Concept

3.1 Location Description

Farafra City, New Valley Governorate

3.2 Concept

The conceptual system design is consisting of three main units as shown in the figure

- The Hybrid renewable energy system
- Animal and fish production sector
- Water utility supply circulation

The HRES consists of a wind turbine, PV, diesel engine, and biogas units connected and delivered the energy to the power accumulator. The accommodation units are connected to the power source of the hybrid renewable energy system and connected with the other small biogas unit for supplying the gas needed for heating purposes. The waste from the livestock units is the main input to the biogas unit whose output is directed as the main source of our hybrid system. The water supply needed for fish farming is from the underground water supply supported by outsourcing till reaching the sustainability level in the next steps. Exploiting the output water from the fish farming units, which is full of useful gradients and components for the agriculture process, is feeding the greenhouse area.

3.3 Description

Figure 1 show a solar pump with 10 Kw power, the components consists of a solar panel, pump, pump inverter, combiner box and cables as shown in figure 2. Furthermore, the vertical wind turbine with power of 5 Kw. These power sources supported by our hybrid renewable energy system solar, wind with power of 1200 watt power solar and 1000 watt wind energy capacity. This hybrid system consists of Solar Panels, HAWT, Hybrid controller, Inverter, Solar Batteries, 2 batteries each 12v, 190 AH, solar Panels' Chassis, and Cables and other electrical components as shown in figure 3.

Finally, the bio-energy unit, conventional type with capacity of 3 m^3 and industrial with feeding capacity 2 tons of dung added to it 1 ton of water shown in figure 4

Figure 1: Solar pump controller

Figure 2: Solar pump system

Figure 3: Hybrid Energy System

Figure 4: Bio-Energy Unit

IV. RESULTS AND DISCUSSION

The biogas unit production is 60-100 m3 with electricity production: 160 – 200 Kw which is acceptable at the productivity and human capacity of the community. Additionally, the power needed to the production of Six greenhouses for the production of all types of crops such as (zucchini - cucumber - tomato - eggplant - pepper - watermelon .... etc.) will be enough for the four seasons production to secure the main food demand.

4.1 Technical output and Impact

Providing energy for remote area is a big challenge , conserving this energy and storing it is a bigger challenge , providing an efficient hybrid system may help greatly in this regard mainly if the system is Wind-Solar but also if we added to it the Biogas system and we can cross reference according to the geographic nature of the selected area (Wind-Solar / Solar-Biogas / Wind-Biogas) as the bio gas system helps greatly in providing a major type of energy which is gas which can later be used in producing electricity with gas generators (no combustions) all aiming towards one goal A Sufficient Community.

Measurable factors that effects by its role the current and proposed hybrid system are turbine efficiency, turbine output relating with wind speed, Solar system output / efficiency throughout the year, batteries efficiency and lifetime and how it affected merging the biogas unit with either solar / wind on the stability of energy produced.

4.2 Financial feasibility, Socio-economic Impact and Sustainability

A sustainable community that is standing alone in the face of climate change and all challenges depending only on nature and all the natural resources available all around it starting from farming depending on underground water and using all water conserving methodologies that we can to using solar energy, wind energy, biogas energy. There are a lot of people desiring to purchase lands in the new cities but we are taking slow steady steps in order to provide best solutions with latest technologies.

And for the feasibility study, how much would you pay for a Feddan in a green environmental new advanced smart city that provide you with all the facilities that you need to live a better and a sufficient life?

It's shown in table a Gantt chart with a proposed timeline for similar project to reach its maximum efficiency in terms of feasibility, sustainability and Scio economic

IV. CONCLUSION

Such communities are considered one the most influential factors on the national economy and awareness of its people. Therefore, the government must give flexibility in providing laws and regulations to facilitate establishing of such productive integral community with its sustainable and environmental advantages.

IV. FUTURE WORK

Investigate solutions for future energy systems; the goal is to identify and analyze the optimal necessary investment in renewable energy in the Egyptian land and to achieve CO2 reduction giving the focus on the development and optimization tools and algorithms in the energy sector that can be used to create the meaningful scenario; therefore, a comprehensive review has to be made to choose a suitable software tool for management of our proposed system.

- Optimization methods using energy simulation software, HOMER PRO.
- Check the reliability of the system
- Detect differences between different operation modes, (stand-alone system-Microgrid with another near community, connected to the governmental grid
- Proposed dispatch strategy
- Environmental aspects
- Economic aspects
- Best case scenarios in long term and short term

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