

# Comparison between hybrid renewable energy systems in Saudi Arabia

Hisham El Khashab<sup>a,\*</sup>, Mohammed Al Ghamedi<sup>b</sup>

<sup>a</sup> Electronics Research Institute, National Research Center, Cairo Egypt

<sup>b</sup> Yanbu Industrial college, Yanbu Al Siniayah, Saudi Arabia

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## Abstract

The continuous rise of energy demand worldwide combined with the decrease of natural resources such as fossil fuel represents a huge energy problem which facing humanity. Industry as well as consumers must rethink how to produce and use energy at low cost price. Renewable Energy (RE) applications and energy savings are keys to meet this challenge in a sustainable way. In the hot and sunny areas of the Arab countries, renewable sources like solar energy can play a key role, besides their help to reduce the percentage of carbon dioxide (CO<sub>2</sub>) emission to environment, which reduces the global warming. According to, that the renewable energy sources such as photovoltaic, wind, biomass have an important role especially when the high new technologies will interfere.

This paper investigates RE sources applications at Yanbu, Saudi Arabia, besides a simulation using HOMER software to three proposed systems newly erected in Yanbu Industrial College Renewable Energy (RE) lab. The lab represents a hybrid system, composed of PV, wind turbine, and Fuel cell systems. The cost of energy is compared in the three systems to have an actual estimation for RE in developing countries. The climatic variations at Yanbu that is located on the west coast of Saudi Arabia are considered.

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**Keywords:** Renewable energy; PV; Wind; Fuel cell; HOMER

## 1. Introduction

Solar and wind energy are the most important sources of renewable energy available in Saudi Arabia. The availability of sun shine all over the year with solar radiation varies from 4 to 7.5 kWh/m<sup>2</sup>/day which represents more than five times its value in Europe (1 kWh/m<sup>2</sup>/day) and (1.7 kWh/m<sup>2</sup>/day in Greece). To get reasonable wind energy sources, a 4–8 m/s wind speed is needed which is available in KSA in some sites, such as Yanbu and Dhalm.

Some references (Nassif, 2012; Shaahid and Elhadidy, 2005; Rehman et al., 2003; Alabbadi, 2005; Alawaji, 2001) discussed the feasibility of using renewable energy in different areas of KSA, considering different system

\* Corresponding author.

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configurations and environmental conditions. Our study will be on Yanbu, which is located on the west coast of Saudi Arabia. Yanbu has a latitude of 23 59' and a longitude of 38 13'.

Until 2011, most of electricity in Saudi Arabia was produced by burning oil due to governmental subsidies to maintain oil price at low cost. The Saudi agency in charge of developing the nations renewable energy sector, KA-CARE (King Abdalla City for Atomic and Renewable Energy), KAUST (King Abdalla University for Science and Technology), announced in May 2012 that the nation would install 41 GW of solar capacity by 2032. It is projected to be composed of 25 GW of solar thermal, and 16 GW of photovoltaics (Nassif, 2012). At the time of this announcement, Saudi Arabia had only 0.003 GW of installed solar energy capacity. Saudi Arabia's first solar power plant was commissioned on October 2, 2011, on Farasan Island, Farasan located southeast of the Red Sea. It is a 500 kW photovoltaic plant and is expected to generate 864,000 kWh/year. 1100 mW of photovoltaics and 900 mW of solar thermal, concentrated solar power (CSP) is expected to be completed by 2013 (Wikipedia, 2015).

Solar thermal applications is one of the main useful applications of RE. Water heating during winter exhausts a huge amount of electrical energy, consequently solar water heater must interfere via governmental laws to superimpose this technique to be utilized.

This paper investigates the life cycle cost analysis for RE hybrid lab of Yanbu Industrial College (YIC). It can be a model suitable to supply small residential units. If the RE system is near to National electricity grid, grid connected systems may be used to reduce storage system cost.

## 2. Energy demand in Saudi Arabia

The objective of this study is to investigate the ability of utilizing renewable energy systems to provide the chosen community with its needs of electricity. These systems will help the community to have better energy efficiency along with environmental benefits by reducing emissions. At this time, the capacity of generating power in Saudi Arabia is 46,000 MW. Power demand is growing every year by 3000 MW. This annual growth is very big comparing to other countries. The investments in power demand for the years between 2009 and 2018 as the experts indicated is about 1125 billion dollars. In terms of oil usage, Saudi Arabia has used 100 million barrels of oil in 2009 to produce electricity. More than one quarter of the oil production in Saudi Arabia is consumed by the country itself (Alaidroos et al., 2012). 53% of the consumed power in Saudi Arabia is by households and most of the power consumption is used for cooling. This demand of electricity will increase from today's 46,000 MW to 120,000 MW within 20 years. At this rate of growth in electricity consumption, the country's energy and oil consumption will be doubled in a decade. This will affect the economy in Saudi Arabia very badly in the future because the economy in this country is depending on oil export revenues. The growth of local consumption will decrease the ability of exporting to the international markets. In fact, this rate of local energy consumption growth is not a sign of economic development; actually it is a sign of inefficient use of energy (Alaidroos et al., 2012; Lahn and Stevens, December 2011). The current cost of conventional electricity production is \$0.10/kWh, while the average electricity price is about 0.03 \$/kWh (Alaidroos et al., 2012), which is considered actually low prices. The difference between prices and cost are paid in the form of government resources. This subsidies is costing Saudi Arabia about \$188 billions. However, these low prices are preventing investments in renewable energy generation and efficiency improvements. Some of RE energy projects in Saudi Arabia are summarized:

- KACST (King Abdulaziz City for Science and Technology) is building a 30,000 m<sup>3</sup>/day solar-powered seawater desalination plant in Al-Kharfji.
- PTC (Polysilicon Technology Company) is building a 7500 tons per year high-quality polysilicon plant in Jubail.
- IDEA Polysilicon Company project in Yanbu to produce 10,000 tons/year polysilicon, 20 million wafers and 19 million solar cells per year.
- Saudi Aramco is building a 10 MW photovoltaic solar carport system in the Dhahran office complex.
- Hydrogen gas network to capture hydrogen from industrial processes and purify to yield a 19.4% energy savings for industrial users.

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