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An overview of energy balance compared to sustainable energy in United Arab Emirates

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ABSTRACT

This paper summarized an overview of energy balance and greenhouse gas emissions at UAE in order to prompt renewable and sustainable energy practices. Electricity demand has been increasing dramatically in the United Arab Emirates (UAE) in the last decade. Electricity production increased 5.39 TWh each year from 2000 (39.9 TWh) to 2013 (110 TWh), which means an annual increase of more than 13.5%. The electric power consumption has increased 5.14 TWh each year in the same period; which is 13.3% each year. The electricity consumption per capita is an indicator that places UAE in the group of highest consumption countries worldwide; namely, UAE ranks 10th in 2012 with 10.13 MWh per capita. UAE's population and economic growth are the main causes of a sharp increase in energy demand. On the other hand, UAE ranked 25th worldwide for CO_2 emissions. However, UAE is not in the top pollutant countries in the world with respect to CO_2 emissions per capita. More specifically, UAE has dropped from the 2nd position in the period 2000–2004 to 8th in 2010 and in year 2013 occupied again 2nd position among the global most pollutant countries. On the other hand, UAE has huge amount of available solar resources; the active and passive use of solar energy could be an approach to reduce even more the fossil energy consumption and the greenhouse gas emissions. It is essential to define the future role of the different sources of energy and to outline the required steps to move into a sustainable future energy system. These may achieve environmentally sustainable power development.

Contents

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1. Introduction

Energy is a continuous driving force for economic development, social advancement, and improved quality of life [1]. The growing world population combined with the fast depleting reserves of fossil fuels has encouraged researchers in the field of engineering to pursue development [2,3] and use of (RE) resources [4]. Climate change and fossil fuel depletion are the main drivers for the recent focus on finding alternative energy resources. RE is an obvious choice to reduce carbon dioxide and other pollutants contributing to global warming. However, since high cost of RE technologies is the main obstacle facing the diffusion of RE power generation, economical and political interventions are inevitable. These interventions include legislation, incentives to investment, energy generation targets, guidelines for energy conservation, strategies to stimulate the energy industry, and taxation [5]. Economic support policies that encourage investments in new technologies promoting adoption of RE have been implemented in many countries. In particular, a variety of economic support policies for RE has been developed and implemented mainly in Europe and the USA [6]. The development of RE has been supported by the developed countries for many reasons including ensuring security of supply, minimizing the usage of fossil fuels, reducing GHG emissions, improving industrial capabilities and increasing local benefits through creating new jobs and economic development [7,8].

The power industry is one of the few industrial sectors, which affect prosperity of every sphere of economic and social life and exert a direct influence on general technological progress [9]. Due to rapid economic growth, the rising power demand requires many countries to make significant investments in power generation [10], transmission and distribution systems as well as in the development of demand side management strategies [11]. Aging electricity assets, economy growth, changing population distribution, changing consumption patterns and environmental constraints, such as the climate change effect, are all driving the need for upgraded electricity infrastructure and for the use of sustainable power generation technologies [12]. The investment and operating choices made will have significant implications for the consumers, investors, environment and the economy [13]. Much of the world's energy, however, is currently produced and consumed in ways that could not be sustained if technology was to remain constant and if overall quantities were to increase substantially. In order to control greenhouse gas emissions and other primary emissions, such as sulphur dioxide and nitrogen oxide emissions, further developments on efficiency and RE production are required [14]. A sound United Arab Emirates (UAE) energy policy should encourage a clean and diverse portfolio of domestic energy supplies. Such diversity helps to ensure that future generations will have access to the energy they need. Renewable Energy Sources for Power Generation (RES-E) can help providing UAE future needs by harnessing abundant, naturally occurring sources of energy, such as the sun, the wind and biomass. Effectively harnessing these renewable resources requires careful planning and advanced technology. Through improved technology, UAE can ensure that those power systems will make use of clean, natural, renewable sources. RES-E technologies will not only help diversify UAE energy portfolio but they will do so with few adverse environmental impacts [15]. RES-E technologies tap naturally occurring flows of energy to produce electricity. UAE have significant potential for renewable resource development especially from the sun [16,17]. This non-depletable source of energy is domestically abundant and has less impact on the environment than conventional sources.

A known region for the huge resources of hydrocarbons constitutes the six Arab States of the Gulf, including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE. In these states, a large number of oil resources have been found, including some of the largest and even giant fields in the world. This area is one of the highest densities of hydrocarbon discoveries in the world. Looking at the undiscovered petroleum resources in the region, the US Geological Survey (USGS) argued in 2000 [18] that the region has an undiscovered crude potential of some 162 billion barrels (mean, around 17% of the world's total). In addition, Oman and Qatar are nowadays seeking to develop their capacity to export natural gas. In the same hand, the undiscovered resources of natural gas in the region were estimated to be at around 23.3 trillion m^3, or about 16% of the world's total [19]. According to the latest issue of British Petroleum (BP) Statistical Review of World Energy (2014), the region was the largest exporter of oil (crude and products), contributing 35% of total exports, being the oil production in the United Arab Emirates rose 250 kb/d to reach a record high (3.6 Mb/d) the highest since 1979.

Noteworthily, the energy sector in the GCC is the main source of CO_2 emission due to fossil fuel great usage [20]. The fact above is that the major and logical reason behind the development of RE has been relatively low in spite of the large geographical potential for the use of these solutions. Indeed, the impression of the RE community over several years has been that these countries are just not interested. Recently, something seems to have changed. These countries are starting a process of environmental awakening, since they have signed and ratified into the United Nations Framework Convention on Climate Change [17] and almost all of them (except Bahrain) have recently accessed the Kyoto Protocol [19]. However, the ratification of the Kyoto Protocol seems not to be sufficient enough and there is a lot to be done. A variety of constraints or conditions prevent RE investments from occurring. These constraints put renewable at an economic, regulatory or institutional disadvantage relative to other forms of energy supply in the region [19]. As example, Abu Dhabi, one of the world's largest producers of oil has actively attempted to diversify its energy economy in recent years through local and international RE investments as many other countries in the gulf region [21]. The aim is to use all available conventional and non-conventional energy resources for electricity generation for longer term period. The ultimate objective of UAE's policy is to maximize use of indigenous energy resources and minimize energy subsidies [22]. The goal of this paper is to provide an overview of energy balance compared to sustainable energy in UAE.

2. Geographical aspects of UAE

UAE is situated in Southwest Asia, bordering Oman and Saudi Arabia between the Gulf of Oman and the Arabian Gulf. UAE geographically lies between 22°50′26″ North latitude and between 51°56′25″ East longitude. It is in a strategic location along the southern approaches to the Strait of Hormuz, a vital transit point for world crude oil [4]. UAE consists of seven emirates, and each emirate is equivalent to a principality with its own government. The seven emirates are Abu Dhabi, Ajman, Dubai, Fujairah, Ras-Al-Khaimah, Sharjah and Umm Al-Quwain. The country shares borders with Oman and Saudi Arabia, it has a 650 km long coast and a surface area of 83,600 km^2 [23]. Abu Dhabi is the capital and second most populous city in UAE. Abu Dhabi lies on a T-shaped island jutting into the Arabian Gulf from the central western coast. The low latitude of the region along with a climate characterized by very small amount of rain or cloudy skies, permits high radiation levels to reach the ground surface in summer. The weather conditions are very hot and semi-arid during summer days becoming warm and humid at night. During winter, daytime conditions fall within the comfort zone, while the night times are cool and humid. Hence, UAE with its vast land, average sunshine of

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