Renewable Energy Sustainability With Micro Hydro Systems In Fujairah

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Abstract

Water resources in the UAE are very limited. No surface water in the form of rivers or lakes is available. The rainfall is very scarce, random and infrequent. The average rainfall is about 110 mm/year. However, this annual rainfall is mostly encountered in a few events. Rainfall records indicate that the average number of rainfall events per year is five or less. These rainfall events are generally characterized by their short durations and heavy intensities. Such rainfall characteristics are quite consistent with regions classified as drought areas. Fujairah is located in the north-eastern part of the UAE. It is surrounded by small mountainous areas and many valleys, not far from the sea. Many sand barriers and concrete dams were built (Fig. 1) to protect mountainous villages from flash floods due to rainwater, and to support underground storage and prevent soil erosion.

Fig. 1, Fujairah dams.

As water is scarce and because of the rapid increase in Fujairah’s domestic and industrial water demand, many desalination plants were installed. The total annual surface water production from desalination plants is about 120 million m3, most of which comes from seawater from neighboring areas. The total groundwater abstraction is around 1500 million m3. This means that groundwater depletion probably amounts to almost 1500 million m3/year. However, the figure does not consider the possible annual cycle of fluctuations emerging from neighboring areas. In any case, the over-extraction of groundwater resources has led to lowering of the water table by more than one meter on average during the last two decades, which increases the risk of seawater intrusion.

To increase the groundwater recharge, a number of dams have been built at various locations across the country. There are more than 50 dams and embankments of various dimensions having a total storage capacity of over 1000 million m3. While most of these dams are basically built for recharge purposes, they also provide protection against damage caused by flash floods. There are also about 130 dams installed with a total estimated capacity of 5000 million m3/year, while total actual production is 50-70% of it. Furthermore, it is estimated that about 100 million m3/year of wastewater were produced in the urban areas, of which 25% of them were treated and reused.

Total water withdrawal was estimated at 10 billion m3/year. Over 75% of the total water withdrawal was groundwater. Agricultural water withdrawal was over 5 billion m3/year (20% from ground water, while 80% from treated wastewater). Total water withdrawal for domestic and industrial purposes was estimated at 1 billion m3 (25% and 10% of total water withdrawal, respectively), of which 500 million m3 of it consisted of deabstracted water and the remaining part of groundwater.

Renewable Projects Model for Water Sources

Whereas solar energy in Fujairah is highly available with up to 100% rate, the wind regime is unpredictable. In general steady wind energy is unavailable, yet occasional gale and gusty high speed winds blow for days. Fujairah gets both north western winds in winter and tropical winds in summer. There has been no detailed study on the wind energy in Fujairah, which has long open sea sides, as well as many mountainous areas with winds channelled through valleys. There is an opportunity to measure wind and test wind turbine systems, whilst utilizing renewable projects for water resources.

Around 50 small dams were built to establish water reservoirs for irrigation and drinking purposes. In order to accumulate larger water reservoirs in the mountainous areas, it is suggested to connect them with channels of water pipelines, with renewable compressors electricity by both solar and wind renewable systems. These compressors can operate as micro hydro systems for generating electricity when water heads were available.

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Fig. 2, Distribution of rainfall in the UAE.

Fig. 3, Channeling three different sizes of water reservoirs.