Potential of Solar Water Distillation for Integrated Renewable Energy Farms

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Importance of Renewable Energy for Fresh Water Production

The availability of potable water is an important problem for the communities who will be lived in arid new regions or especially for people in remote region (Bedouins). These regions are recognised by a high intensity of solar radiation, which makes the direct use of solar energy represents a promising option for these communities to reduce the major operating cost for pumping drinking water. Jordan is one of the countries that face the energy shortage problem also the shortage in fresh water source.

In many regions of the world especially Middle-East, desalination has become a most reliable source of fresh water. The different methods used in desalination are based on thermal or

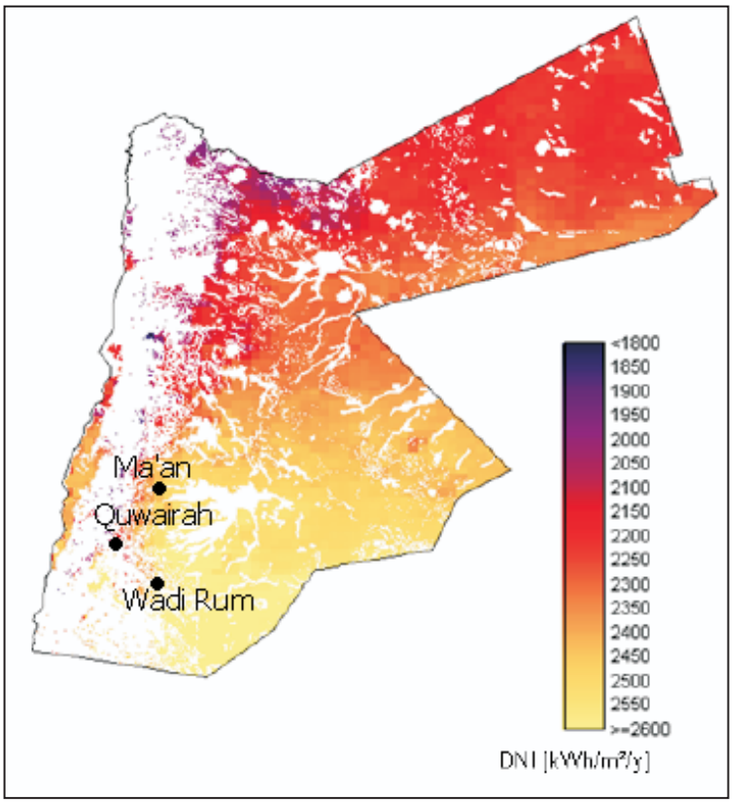

Figure 1: Jordan Solar Map

membrane principles. Among the thermal methods used is solar distillation. Interest in solar distillation stems from the fact that areas of fresh water shortages have plenty of solar energy such as Jordan. Moreover, it's low operating and maintenance costs made it an attractive method in areas away from the electricity grid lines. But most of them suffer from low productivity which put forward an initiative to look for ways to enhance its productivity and efficiency. Solar distillation is one of the available methods for water distillation, and sunlight is one of several forms of heat energy that can be used to power that process. In the present case study different designs of solar stills (i.e. cylindrical parabolic and simple sun tracked solar stills) can be suggested to be used for Integrated Energy Farms (IEF) with an innovative electro-mechanical sun tracking system to enhance the production.

Solar Energy Application in Jordan

Neither gas nor petroleum can be produced in commercial amounts in Jordan, this makes Jordan depends totally on imported oil for producing its required energy. As a consequence, a high petroleum bill is to be paid by the country every year, this forced researchers and establishments in Jordan to think seriously of the Integrated Renewable Energy Farms (IREF) projects to solve this problem totally or partially. Dealing with renewable energy systems, theoretical studies and research started in Jordan in 2004. Some years later, it came to some applications of Renewable energy systems. As part of its policy to reduce dependence on fuel and gas imports, Jordan has developed programs to promote renewable energy. The country is well served for solar energy resources (Figure 1), and the government has set a target of acquiring five per cent of total energy needs from renewable energy by 2015.

Water Desalination Using Solar Energy

One of the most important usages of solar energy is in supplying fresh water especially in water scarce countries such as Arab countries which are poor in fresh water sources but rich in sunshine (Figure 2). Most Arab countries have experimented with solar desalination.

Case Study Concept

The concept of an Integrated Renewable Energy Farm (IREF) which will be implemented in a village in the southern part of Amman, is a farming system model with an optimal energetic autonomy including food production and, if possible, water and energy exports. Energy and fresh water production and consumption at the IREF have to be environmentally friendly, sustainable and ultimately based mainly on renewable energy sources. It includes a combination of different possibilities for non-polluting energy production, such as modern wind and solar electricity and fresh water production, as well as the production of energy from biomass (Figure 3). An integrated energy farming system based largely on renewable energy sources would seek to optimise energetic autonomy and an ecologically semi-closed system while also providing socio-economic viability and giving due consideration to the newest concepts of landscape and biodiversity management of water and energy. Ideally, it will promote the introduction of different renewable energies, promote rural development and contribute to the reduction of greenhouse gas emissions and water scarcity, Figure 3.

Solar distillation application in the IREF for the populations living in arid areas of southern Jordan and Badia is recommended due to the shortage of potable water and due to its simple technology and low cost, which can be easily adopted by local rural people. Solar distillation can be used to convert the available saline or brackish water into potable water economically. Jordan has high solar radiation as far as utilisation of solar energy is concerned. Also Jordan has an excellent mean solar radiation on horizontal surfaces of 5.5-6kWh/m^2/day compared with that of Europe and most of North America, which amounts to 3.5kWh/m^2/day, ie, about 60% of that falling over a square meter in Jordan. Also the solar isolation in Jordan occurs for about 2000-3000 sunshine hours in a year. Recently different designs of solar still have emerged. The single effect solar still is a relatively simple device to construct and operate. However, the low productivity of such solar still leads one to look for ways to improve its productivity, and efficiency. Earlier, it was also found that the sun tracking methods can increase the solar still capability to capture more solar energy to be used later for higher production.

These studies were behind the idea of this case study, and the need for a research work to do more investigation on utilising the solar distillation devices to be used later with the Integrated Energy Farms for arid regions.

Effects of system design and climatic parameters, on the performance of the system are important factors. It has been established that the overall system efficiency in terms of daily distillate output will increase by decreasing the water depth and the use of latent heat of condensation for further distillation. Further, increasing the temperature difference between the evaporating and the condensing surface can increase the daily distillate output of passive solar through the trough pipe. The

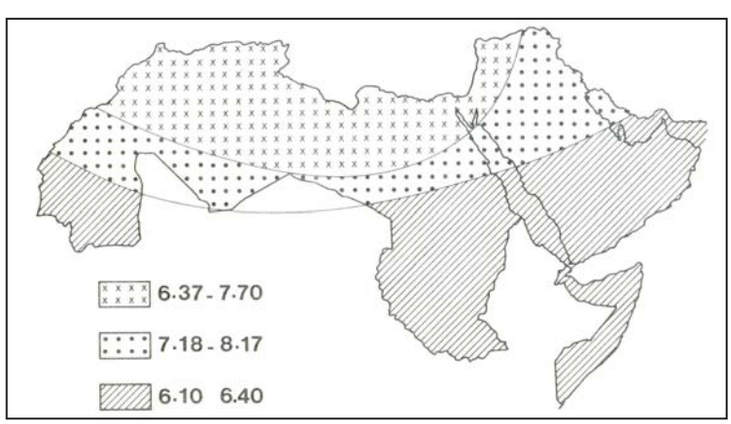

Figure 2: Average Maximum Arab Countries Radiation, kWh/m^2/d

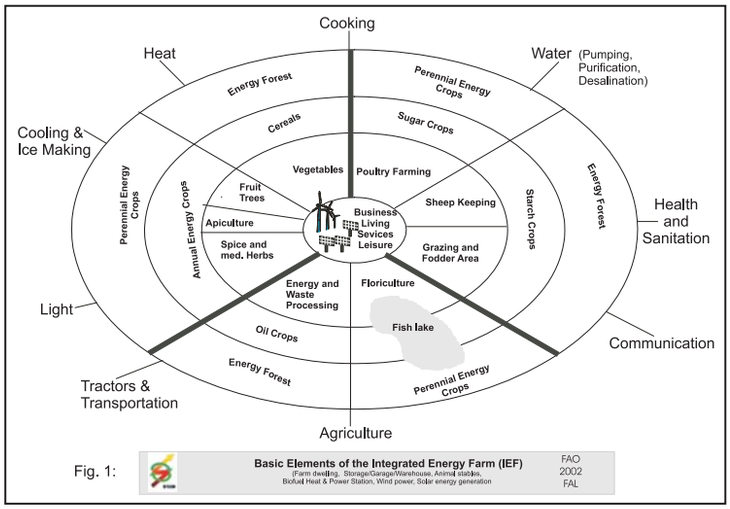

Fig. 1:

Figure 3: Basic Energy Requirements for Rural Communities

condition can be achieved either by increasing the evaporating surface temperature or decreasing the condensing surface temperature or combination of both.

Case Study Implementation

The sources of renewable energy that can be implemented in the farm can be consisted of: solar, wind, wood and waste electric power, solid biomass and animal products, biomass gas and liquids, industrial and municipal wastes. The following points should be taken in the consideration for the implementation of the integrated energy farm:

- Existing Agriculture Farm.
- Production optimisation model.
- Available reserves of production factors (area, capital, main power).
- Analysis of the production factors.
- Integrated Energy Farm: with energy, autonomous food production, and high production level of energy and fresh water.

It is very difficult to determine the exact time schedule of such a project, but a time range between 1-2yrs will be needed to complete such integrated energy farm. The cost of constructing such energy farm will depend mostly on the received funds. The energy farm can be constructed to be very small (a model) or it can be extended to be a real energy farm.

The new approach proposed in this case study is using parabolic collector to concentrate the sun rays reflected on the distiller will be investigated in wide range of results and comparisons with other similar works to be one of the proposed projects in Jordan to face the water crises in long term demand, especially under the continuous increase in population and realising the arduous nature and water scarce resources of Jordan.

The present study aims to develop and enhance the traditional solar distillation method and remark the advantages and ability of the solar energy under the auspices of oil price fluctuation.

It is worth mentioning that distilled water consumption in Jordan will be significantly higher in summer than in winter days during high sunshine period. The distilled water produced by the parabolic still can be used in batteries and in many medical processes as well in the IREF. The solar distillation systems consider the first step to have bootable fresh water for human usage, so the solar distillation has advantage that it is available when it needed to face huge requirement during summer.

Planned Cooperation

The project will be a cooperative work between Al-Balqa` Applied University/ Faculty of Engineering Technology, and International Research Centre for Renewable Energy (Hannover, Germany). Under the leadership of Al-Balqa` Applied University/ Faculty of Engineering Technology, the group of scientists and experts will collaborate to:

- Develop the conceptual framework of the IREF model in Jeza village (belongs to the city of Amman) in the southern part
- Gather the required information
- Elaborate the results into a functional model, and
- Prepare a project proposal for experimental verification of the model

The overall objective is that the IREF concept be successfully introduced into Jordan Badia which have to be completely sustainable and self dependable.

Conclusions

Solar radiation is an integral part of different renewable energy resources. It is the main and continuous input variable from practically inexhaustible sun. Solar energy is expected to play a very significant role in the future especially in developing countries, but it has also potential prospects for developed countries. Extensive fossil fuel consumption in almost all human activities led to some undesirable phenomena such as atmospheric and environmental pollutions, which have not been experienced before in known human history. Consequently, global warming, greenhouse affect, climate change, ozone layer depletion and acid rain terminologies started to appear in the literature frequently. ☞ www.fet.edu.jo

IREF application for the populations living in arid areas of southern Jordan and Badia is recommended due to shortage of potable water and due to its simple technology and low energy cost, which can be easily adopted by local rural people. Solar Energy distillation utilisation in the IREF projects can be used to convert the available saline or brackish water into potable water economically.

Jordan has high solar radiation as far as utilisation of solar energy is concerned. The mean solar insolation falling on horizontal surface in Jordan is about 200-250watt/m^2 with about 1500-3000 sunshine hours in a year. Two plants consisting of 240 stills each with a capacity to clean 6000 gallons of seawater per day can be installed in Badia area.

A number of such schemes can be considered by future projects in southern and Eastern Desert regions in Jordan. Fresh water and energy are the two major commodities that furnish the fundamentals of the project activity for reasonable and good life quality. They are essential ingredients for all human transactions and without them human activities of all kinds will not be progressive. However, newly emerging renewable alternative energy resources are expected to take increasing role in the energy scenarios of the future energy consumptions in developing and developed countries. ☞ www.bau.edu.jo

About the Author

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