

# POLICY BRIEF

## From Irrigated Agriculture to Solar Energy Farming in the Azraq Basin in Jordan

### A Pilot Measure of the Regional GIZ Programme “Adaptation to Climate Change in the Water Sector in the MENA Region (ACCWaM)”

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#### EXECUTIVE STATEMENT

- Jordan is rich in renewable energies (namely solar energy) and (further) incentives should be provided to utilize these resources. The use of fossil fuels for energy generation should be consequently reduced as it accelerates climate change and is a burden to the national budget.
- Solar energy farming (SEF), the substitution of irrigated agriculture with solar energy-based power generation, is an interesting economic alternative for farmers, who run into problems due to water scarcity or salinity. In general, SEF will be particularly attractive for young, educated and/or rich farmers.
- SEF is suitable to mitigate climate change and to adapt to the impacts of climate change. It deserves any political and administrative support, if the technical, socio-economic and environmental pre-conditions for its application are given.
- The major drawbacks of SEF in Jordan are the (for an average farmer) high investment costs and the long pay-back periods. State (or NGO / donor) support (subvention or at least soft loans) can ease this problem.
- A venture like solar energy farming can succeed only, if adequate supporting regulations and laws are available and investments are encouraged. The private sector, namely the banks, will play an important role in the implementation.
- SEF will be a feasible, water-friendly alternative to conventional agriculture, thereby reducing excessive groundwater abstraction while generating renewable energy.

## INTRODUCTION

The centre of the Azraq Basin in the northeastern part of Jordan was covered by vast wetlands until the early 1990s, but both man-made and natural impacts caused a severe depletion of the groundwater resources of this basin. A safe yield of the Azraq aquifer was estimated in 2009 as being 24 MCM/Y only. Currently, the total annual abstraction is around 56 MCM/year (36.7 MCM for agriculture and 15.6 MCM to supply Amman and Zarqa cities); this resulted in 32 mcm/year deficit. Due to over pumping the groundwater level is dropping at a rate of 80- 90 cm/ year.

- In 2010 6.3 MCM/y only were extracted by farmers having a well licence, but the remaining volume was pumped illegally, creating an environmental disaster.
- Since 1992 no well licences were issued anymore and in recent years the number of illegal wells was gradually reduced.
- During the last 2 decades the critical situation was aggravated by a severe drought and a general rise in temperature caused by climate change.



The Azraq Basin is located in the northeastern part of Jordan. Until the early 1990s the centre of this basin was covered by vast wetlands (see photo), but man-made impacts (e.g. groundwater abstraction for irrigation and the capital Amman; and climate change) caused severe depletion of this basin. Many farmers suffer from water supply problems and are interested in alternatives to irrigated agriculture.

The regional GIZ programme '**Adaptation to Climate Change in the Water Sector in the MENA Region (ACCWaM)**' is exploring in the Azraq Basin the option of preventing the extension of irrigated agriculture, and hence reducing groundwater abstraction, by offering an alternative source of income; solar energy. The innovation is called 'solar energy farming'.

The ACCWaM pilot measure in Jordan is targeting three urgent issues: (1) reducing the further lowering of the groundwater table of the Azraq aquifer; (2) offering solar energy farming as a source of income to farmers in that area (a water-friendly alternative to agriculture); (3) generating electricity, which is high in demand in Jordan, by making use of intensive solar radiation in Jordan.

The Jordanian Ministry of Water and Irrigation (MWI) and the Ministry of Energy and Mineral Resources (MEMR) are the main partners in this innovative adaptation measure. The planned activities are part of the Azraq Groundwater Management Action Plan, which was endorsed by the Ministry of Water and Irrigation in February 2014. This Action Plan was developed by the Azraq Basin Committee, a body within the Highland Water Forum. In its role as technical advisor to the Arab Ministerial Water Council, the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) will help scale up the measure within the Arab countries.

## WHAT ARE THE MAIN ARGUMENTS FOR SOLAR ENERGY FARMING AS AN ADAPTION TO CLIMATE CHANGE?

- (1) Presently the demand on electricity in Jordan rises due to population growth, economic development and climate change impacts (e.g. temperature increase, heat waves, droughts). Energy generation in Jordan is based largely on fossil fuels (natural gas and crude oil), emitting more than 17 million Mt of carbon dioxide annually. Solar energy farming is aiming at an increase of the share of renewable energy in the country. It eases Jordan's heavy dependence on fossil fuel and gas imports and hence prevents the emission of large amounts of greenhouse gases (Mitigation measure).
- (2) Solar energy farming shall become an important element of 'Green Economy': Jordan's solar farmers shift from fossil fuel energy consumers (water pumping) to clean energy producers (photovoltaics).
- (3) Solar farming is aiming at a reduction of groundwater abstraction, as it offers another income source outside of irrigated agriculture. Therefore it contributes to a preservation of the country's strategic water reserve for future generations.
- (4) By reducing anthropogenic groundwater exploitation, it contributes to the preservation of wetlands (e.g. in the Azraq Basin) and hence biodiversity.

### RECOMMENDED POLICY RESPONSES

- Promotion of solar energy use e.g.
  - by giving incentives to the implementation of photovoltaic panels on rooftops,
  - by easing (through adequate laws and regulations) the access to the electricity grid when installing photovoltaic plants,
  - by advising the State's Electricity Company to offer attractive purchase prices for solar energy being fed into the grid.
- Enforcing the laws and regulations regarding groundwater extraction, preventing illegal pumping.
- Encouraging the private sector (including the banking system) to invest and to offer loans.

## COURAGE OR HINDER THE UPSCALING OF INDIVIDUAL AND SMALL-SCALE SOLAR ENERGY FARMING ON IRRIGATED FARMLAND.

Solar energy farming is a good example of the water-energy-agriculture nexus and its application is based on a smooth cooperation between the three groups.

Four ministries have their say in regard to solar energy farming in Jordan:

- (1) The main regulatory governmental body for solar energy farming projects is the **Ministry of Energy and Mineral Resources** (MEMR). The MEMR has set a target to obtain 10% of energy from renewable resources by 2020.
- (2) **The Ministry of Water and Irrigation** (MWI) has the responsibility to set regulations related to managing groundwater abstraction by farmers.

- (3) The **Ministry of Agriculture** (MoA) aims at increasing the living standards of farmers without harming the environment. The Ministry of Agriculture (MoA) has awareness programmes that aim to reduce water consumption and increase water use efficiency.
- (4) The **Ministry of Environment** (MoE) decided, that each solar energy farm requires an environmental license to be legally qualified to generate electricity. The environmental license is issued after conducting an Environmental Impact Assessment (EIA) study. The Ministry of Environment (MoE) encourages the implementation of solar energy farms and supports all renewable energy projects.

If those four ministries (or their agencies such as the Electric Power Company or the Electricity Distribution Company) cooperate without frictions, the solar energy farming venture can succeed. If not – as it is apparently the case in the Azraq Basin – the project is retarded or may fail completely.

#### RECOMMENDED POLICY RESPONSES

- A venture like solar energy farming can succeed only, if all actors involved (such as the ministries being responsible for water/irrigation, energy, agriculture and environment and their departments / agencies), banks, NGOs and farmers cooperate smoothly. This is a great challenge.
- Decisions on ministerial level are as essential as the active engagement of liaison officers or specific committees dealing with solar energy farming. Regulations which facilitate cooperation between concerned ministries and agencies are needed.
- The initiative for any joint ministerial action could come from any of the ministries involved, but more likely from national or international NGOs, from farmers' organisations etc. In the latter cases the ministerial staff should maintain good relations with these organisations (and opposite).

#### ARE SMALL-SCALE SOLAR PLANTS ON PRIVATE AGRICULTURAL LAND A VIABLE OPTION?

- In a survey 17 out of 30 farmers in Azraq Basin (in 2012) were willing to change to solar farming, but they lack the technical and financial support. Many members in the Forum said that “the shift from agriculture to other businesses is a difficult and sensitive task because farmers have to give up their lifestyle and lack the necessary knowledge and experience. It is obvious that farmers will require technical assistance and financial facilities to enable them of venturing into new businesses”.
- Any farmer who is willing to invest in solar energy farming in Azraq basin has three options to finance the project, the first option is to finance a photovoltaic system on his own, the second is to take out loans, and the third through local and international donors.
- Getting loans can be done through governmental bodies or the private sector, e.g. from banks. On the governmental sector, the Ministry of Energy and Mineral Resources (MEMR) has established the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) which aims to provide funds in form of soft loans for innovative projects related to energy and energy efficiency.
- The key points of the innovation, based on a feasibility study done in the area, are:

- *Economies of small scale:* A farmer installs a 100 kWp photovoltaic power plant on one Jordanian dunum of farmland. This equals 1000 square meters, one tenth of a hectare
- *Power generation:* 180,000 kWh per year - produced by the 100 kWp solar energy power plant operating on a one dunum-sized plot
- *Gross earnings:* € 24,000 per year, with a feed-in tariff (FIT) of € 0.13 per kWh over 20 years
- *Opportunity cost:* € 250 - average loss per dunum of annual agricultural net profit
- *Investment:* € 150,000 – which is the turnkey cost of the 100 kW photovoltaic plant at today's prices, and includes the costs of connection to the public grid.
- *Net income:* Depending on the project finance terms and assuming 100% project financing at a 5% interest rate over 10 years, net income is at least EUR 1,000 per year over the first 10 years (i.e. the payback period for investments), and many more times higher for the remaining lifetime of the plant.

A larger sized plant can be installed depending on a farmer's energy appetite and the parameters of the respective grid.

- Assuming a high average net income from agriculture in Azraq area of € 250 per dunum x year, the farmer can earn at least four times as much annually when switching from agriculture to solar farming. After the payback period, earnings will go up even more.
- *Drinking water:* The year-round irrigation of annual crops requires on average 1 cubic metre of water per square meter of land. When shifting to solar energy farming, 1000 cubic meters of groundwater per year can be saved on a 1000 m<sup>2</sup> area, a volume which can cover the demand for drinking water of 1000 people per year.
- The above given figures on costs and income are based on sound calculations, but deviations may occur when putting it into execution.
- Most probably wealthy and well educated farmers are most interested in changing to solar energy farming. Most small farmers will be afraid of changing due to the high investment costs and the risk involved.
- Participating farmers shall be obliged to sign a binding agreement with MWI, however, it will be difficult to control the adherence to the agreement.

The implementation of the idea of solar farming in the Azraq basin was not yet feasible mainly due to legal and administrative problems.



*Photovoltaic plant in Jordan  
established on desert land  
©Mustakbal*

## RECOMMENDED POLICY RESPONSES

- As the prevention of a further degradation of the Azraq basin (and its aquifer) is the prime aim of the GIZ-ACCWaM pilot measure, other alternatives than solar energy farming should be explored. Changes in the agricultural system towards other crops (with lower water demand) and cropping techniques (e.g. in greenhouses) might be more efficient than solar energy farming. This new policy has to be developed between MoA, MWI and MoE and the farming community (including the Highland Forum).
- Solar energy farming remains a valuable offer to young, educated and / or wealthy farmers, but also to those farmers, whose wells are being closed down because of illegality. Special support should be given to these farmers, who lack further income from agriculture.

## UPSCALING SOLAR FARMING IN OTHER COUNTRIES OF THE ARAB REGION?

Preconditions for transferability are:

- Contracts between the grid operators and the farmers, fixing an acceptable price for feeding energy into the national power grid;
- Access to loans ( at low interest rates) and financial support;
- Access to technical service for implementation and maintenance;
- Widespread information distribution on pros and cons of ‘energy farming’ and later on training of energy farmers.
- In general, solar energy farming can be a sustainable alternative to agriculture suffering from water shortage in (semi-)arid areas. Farmers can stay on their land, maintaining the installations, and enjoying a secure income.
- However, there are still uncertainties in so far, as the amortization period of the investments runs for 10 years – a long time span in a fragile natural and political environment. An insurance (hopefully backed by an international donor) might reduce the risk.
- Solar energy farming contributes to climate change mitigation and can be regarded as a climate change adaptation measure.
- However, the objective of reducing the further lowering of the groundwater table of the local aquifer can be achieved only if (1) the ‘energy farmers’ really reduce their area under irrigated agriculture; and (2) the water left in the ground is not extracted by somebody else. This calls for strict regulations and their enforcement by authorities.

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## ANNEX

### Stakeholders Role, Interest and Influence

Stakeholder	Role in Projects	Interest	Influence	Remarks
<b>MWI</b>	Project owner	Reduction of water abstraction in Azraq	High	Water resources management
<b>MEMR/EMRC</b>	Energy project approvals / Legislator	Promote and control solar energy projects	High	Issue licenses for renewable energy projects according to laws and bylaws/Development of laws and bylaws in accordance to national strategy and government mandate
<b>NEPCO</b>	Power off-taker	Diversify power generation capacities	Medium	Issue project licenses in coordination with EDCO
<b>EDCO</b>	Feed-in grid operator	Ensure grid stability	High	Approve project and issue required connection permits. It monitors feed-in
<b>GIZ</b>	Facilitator for project implementation	Aligned with MWI interests	medium	GIZ award grant for the project and facilitates coordination of implementation.
<b>Banks/ investors</b>	Project finance	Finance good business opportunities with good return	medium	Banks and investors will finance the pilot project and any future scale ups, only under attractive economic conditions (Feed-in tariffs)
<b>Farmers</b>	Target group	Sustain socio-economic situation	High	Farmers would support project, only in case they see it offers economic benefits

Source: GIZ (2015) Solar Energy Farming in the Azraq Basin of Jordan, Mustakbal Clean Tech, Amman