Solar Energy Farming
in the Azraq Basin of Jordan
Imprint

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1. Background

The Highland Groundwater Aquifers, in particular the Amman-Zarqa Basin and the Azraq Basin, are heavily over-pumped to a level of some 200% of the renewable water quantity not to mention an increase in salinity. Irrigated agriculture uses almost half of the abstracted groundwater. In the light of increasing water scarcity in Jordan and, thus, growing competition for water resources, the pressure to reduce water consumption of agriculture is growing.

In order to ensure socially compatible solutions, the Ministry of Water and Irrigation (MWI) established the Highland Water Forum (HWF). The Forum includes a Stakeholder Dialogue, which enables water users from various sectors and decision-makers to meet at regular intervals in order to discuss and agree on policy recommendations for more sustainable groundwater management in the Highlands. The Dialogue hence offers decision-makers insights on the specific needs, living conditions and livelihoods of the affected population. The Highland Water Forum has started work on the Stakeholder Dialogue in 2010 by forming the first Basin Committee in Al-Azaq Groundwater basin as a pilot area. The Azraq Basin Committee consists of 60 representatives from the water user community (local community, farmers, etc), governmental institutions, civil society, the private sector and academia.

Over the past 4 years, the Azraq basin Committee worked on developing the first participatory action plan namely “Azraq groundwater Management Action Plan”. This Action Plan was finalized in 2013, reviewed by the HWF Steering Committee and officially endorsed by MWI in February 2014. The Azraq Groundwater Management Action Plan complements the Jordanian Water Strategy 2008-2022 and includes a number of activities and measures that ultimately will reduce the over-abstraction of groundwater in Al-Azaq Groundwater Basin.

In the context of the “Azraq groundwater Management Action Plan” and in the framework of German-Jordanian Program "Water Resources Management" initiatives were developed towards the sustainable recovery of the Azraq groundwater aquifer include:

- Increased awareness and dialogue between public and private sector influencers with the objective of motivating change,
- Increase investment for increasing efficiency in irrigation methods among farmers,
- Improvement in enforcement of legal wells and farms,
- Identification of other income generating activities to reduce the water pumping from the basin, mainly for irrigation for being the largest consumer; such as solar energy farming.
One of the activities that were requested from the Azraq Basin Committee and mentioned in the Action Plan is the Solar Energy Farming as one of the potential non-water consuming alternatives for farmers in order to reduce groundwater over-abstraction as while maintaining their social and economic situation.

Such Kind of projects is advantageous circumstances that attract investments from the agricultural sector (a heavily fresh water-dependent activity) to other activities in different sectors, which are economically feasible and less water consuming. Because most of the agricultural lands in the highlands are dependent on the already over-exploited groundwater resources, creating new business and investment opportunities will enhance and revive the economy of the rural communities and reduce their reliance on agriculture.

2. Introduction

2.1 Azraq Basin

Azraq basin is considered one of the most important water sources in Jordan groundwater. Azraq Oasis forms the heart of the Azraq basin and it is located around the mudflats at the southern downstream borders of the basin. In 1977 the oasis received the status of a RAMSAR site. This was at the time that the Oasis was still naturally fed by springs and a very shallow ground water table until years ago, where the surface springs have been disappeared because of the over pumping of ground water, which was resulted in a rapid decline of the ground water table. Subsequently, a strong reduction of the spring water flow has been occurred, the almost disappearance of the lakes and as a consequence the oasis disappeared almost entirely at the end of 1992. This was further aggravated by a decline in rainfall, which resulted in desertification and drought with serious impacts on water resources and agriculture.

Most of the pumped water is from the shallow aquifer system, which is over exploited. The basin has developed rapidly in the last ten years where significant parts of grazing lands are used for agriculture. The safe yield of Azraq basin ranges from 24 mcm/year. 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 the over pumping from the basin, water elevation dropped significantly. The static water level is dropping at a rate of 80-90 cm/year occurs in the basin.

The over abstraction of irrigation water in the highlands area has been identified by the Ministry of Water and Irrigation (MWI) a key challenge which has been exasperated by the refugee situation and
the increasing requirements for drinking water. Water levels of aquifers are decreasing year on year, as the salinity of that water is increasing.

2.2 Solar Energy Farming

The “Azraq groundwater Management Action Plan” encompasses a measure called “solar energy farming” that is based on creating non-water consuming economic alternative, here decentralized grid-tied solar energy plants, to replace agricultural activities in the region. This is done in order to ease pressure on the single water resource and sustain the socio-economic structure of the region.

To this effect – and with a focus on creating other income generating activities – the MWI, with the support of GIZ, investigated and sanctioned a demonstration project to assess the viability of solar energy as an alternative economic activity that would lead to the reduction of farming activities and water use in the Highlands area.

Because most of the agricultural lands in the highlands are dependent on the already over-exploited groundwater resources, creating new business and investment opportunities will enhance and revive the economy of the rural communities and reduce their reliance on agriculture.

The energy farming offers an alternative water-friendly income opportunity to replace conventional farming, thereby reduce excessive groundwater abstraction by the agricultural sector. Energy farming will only be considered as an option if farmers give up unsustainable irrigation.

Selling electricity to the electrical grid is not new. It has been common practice in many countries like Germany for many years, but has only recently been introduced in Jordan in the framework of the Renewable Energy Law of 2012. The novelty of Energy Farming in this context is the act of substituting irrigated agriculture activities by solar energy based power generation as an economic activity aims ultimately at reducing groundwater abstraction. In other words, a Photovoltaic (PV) power plant will be built to produce electric power that would feed into the electricity grid. Meanwhile, the beneficiary (farmers) interested in this program stops irrigating parts of their lands (hence reduce groundwater abstraction). The generated electric power will be sold at the price specified by the Ministry of Energy and Mineral Resources (MEMR) and this income will generate a profit compensating the farmers for not farming these lands.

Implemented under the right conditions, this initiative would have a direct impact on reducing groundwater over-pumping on the long run. This measure shall allow the recharge of the water basin and hence bring its water level gradually to an acceptable and sustainable level. It is also expected to
contribute to securing a reliable income for farmers and diversifying their income sources, rendering their livelihoods more resilient. In the wake of the energy crisis, domestic economic difficulties, and the challenging geopolitical situation, the fossil fuel bill has increased many times’ fold. Converting traditional farming to “solar energy farming” is foreseen to reduce the financial burdens of the National Electric Power Company (NEPCO).

2.3 Pilot project concept and objectives

The envisioned “solar farming” pilot project, implemented by MWI and supported by GIZ regional funding project “Adaptation to climate change in the water sector in the MENA region”, aims at motivating farmers to invest in a solar project on their property, in an effort to demonstrate the viability of solar farming as an alternative source of income. The photovoltaic systems that would generate electricity that would be sold to the electricity utility, resulting in an alternative income stream for the farmers.

The envisioned pilot project would be supported by a grant (of some $120,000) whereby MWI intends to identify a farmer or a group of farmers that would co-invest or co-finance the project, which would serve as a show case, and support the case for replication and scale-up.

To summarize, the following were some of the key objectives of the pilot project:

- Offer farmers in targeted region an economic alternative to generate income instead of practicing irrigated agriculture or at least avoiding the expansion of the irrigated land
- Identify the possible impact of solar farming to reduce water abstraction, and methods to monitor and evaluate reduction in water abstraction.
- Demonstrate and examine the Jordanian legal framework and economics pertaining to solar farms.
- Showcase the solar farm for scale up potential and adoption by other farmers.

The long-term vision – if the pilot project was proved successful – would be to provide farmers an opportunity to invest in solar energy and to develop solar farms, in exchange for reduction of their water consumption. It is also recognized that the farming activities comprise of investors and subsistence-type farming, and that there is no “one size fits all” philosophy in this respect.
2.4 Project Approach

Whether or not PV plants function in Jordan is not the question. What is interesting is to walk through the system by establishing a “pilot” under real legal and institutional conditions, all the while testing the procedures of contracting, debt terms, applications, approvals, and developing partnerships with private financiers (e.g. banks). It is also necessary to draw agreements with the beneficiaries (farmers) to guarantee that they keep their end of the bargain by not irrigating parts of their lands.

In early stages before project starts, the GIZ carried out a feasibility study for solar energy farming in the current framework conditions with the title “Photovoltaic based energy farming in Jordan: Sample plant and system design for grid-connected PV systems”. This study proved that, financially speaking, a 100kWp grid-connected PV plant is attractive for investors at the current Feed-In-Tariff (FIT) of 0.120 JOD/kWh as stipulated in the current Renewable Energy Law. From a technical point of view (e.g. the capacity of the grid), the study states that there are no technical obstacles for implementation. The remaining challenge is the framework conditions, i.e. the institutional environment that enables the successful implementation of the idea to reach reduced groundwater abstraction.

Following the mentioned feasibility study, the GIZ played a leading role to establish a project team made out mainly of MWI and GIZ experts in order to facilitate the realization of a pilot project of 200 kWp at a selected land in Azraq, preferably with the involvement of several farmers as project owners. Furthermore, contacts were established with key stakeholders including the Ministry of Energy and Mineral Resources (MEMR), the Mineral and Energy Regulatory Commission (MERC), Electric Distribution Company (EDCO), National Electric Power Company (NEPCO), farmers and others to create suitable legal environment for the project implementation. This encountered several challenges to be addressed in following sections in this report.

3. Implementing partners and involved stakeholders

Unlike typical solar energy projects, solar energy farming project involves wider spectrum of key stakeholders, who are essential for its implementation. The pilot project has an energy-water interdisciplinary nature in the so-called nexus. Furthermore, it is first of kind in the country. Hence, the development of this project should engage partners from various sectors, i.e. energy, water and legislative sectors to ensure its success. Key stakeholders are demonstrated in Figure 1 below and the
role, interest and influence of each stakeholder are listed together with other key data in Table 1 below.

**Main Stakeholders of the Solar Energy Farming Project**

- **MWI**: Ministry of Water and Irrigation
- **MEMR**: Ministry of Energy & Mineral Resources
- **Banks/Investors**: to finance the project
- **EDCO**: Electricity Distribution Company
- **NEPCO**: National Electric Power Company
- **Farmers**: Farmers’ community in Azraq
- **GIZ**: German International Cooperation

![Figure 1: Main Solar Farming Project stakeholders](image)

**Table 1: Stakeholders Role, interest and influence**

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

1. First and foremost, the Ministry of Water and Irrigation (MWI), is responsible for regulating water use in the area, coordinating and implementing water reduction policies in the highlands, coordinator for the fund disbursement, approval of shareholders in the company, and follow up on commitments of farmers to reduce water consumption.

MWI aims to safeguard and manage water resources, recognizing that there is significant depletion of resources in the highland and a more pressing need for drinking water. There is also a realization that irrigation and farming is not sustainable under current regime of water and electricity tariff structures. Hence, all means are being exhausted to identify measures that would reduce non-sustainable farming activities by offering alternative income generation for farmers.

While the pilot project impact on water conservation is minuscule, the potential of scale up can be critical and can provide the MWI an instrument to reduce abstraction to some extent and among the legal farming community. The MWI must however depend on energy experts and the support of the MEMR in order to create the enabling environment and the kick-start of the pilot project and to prioritize future scale up.

2. The Ministry of Energy and Mineral Resources (MEMR), is responsible for policies regarding Renewable as well as administering the law, and receiving direct proposals. After the passing of the unsolicited proposals bylaw in mid-2015, MEMR is in a much strong position to support MWI in the development of the project that must be done in partnership with the distribution company, EDCO, whereby a power purchase agreement between the solar farm project and EDCO will need to be developed.

The possibility of a special committee (under MEMR) for the issuance of the call for proposals could result in a healthy number of applicants and resulting projects, provided there are clear and agreed guidelines between all the involved parties including MWI, MEMR, EDCO and GIZ, and a strong mechanism in place to monitor water use.

3. The Farmer Community is comprised of a variety of individuals, those that use the farm as a source of daily livelihood, while others are savvy investors and exporters of agricultural produce. It is likely that the first round of call for proposals would attract the well informed farmers that have been following the solar industry for some time now, and are well prepared to finance the project; while the less capable farmers are unlikely to submit unless they are supported by...
technical assistance. The pilot project, in all cases, aims to highlight that solar farming is attainable to all members of the community. Accordingly, the grant may be allocated to more than one project or to selected projects based on the need of the applicants.

4. The Electricity Distribution Company (EDCO) is receptive to connecting PV projects under the unsolicited proposals mechanism (with the approval of MEMR), and as per the regulations of the Mineral and Energy Regulatory Commission (MERC), however, the key challenges embedded in this first-of-a-kind project will pertain to:
   - Formulating a power purchase agreement that is bankable and with a fixed kWh price.
   - Prioritizing the pilot project location and site to minimize grid connection costs.
   - Addressing administrative issues pertaining to accounting the electricity balance with the National Electric Power Company (NEPCO).

5. Furthermore, a key stakeholder is the banking community and financiers. A variety of financing options were identified, however, it was found that the most appropriate source of financing for debt is the Central Bank of Jordan facility through local banks. Depending on the farmer(s), arranging the loan is to be with the support of the GIZ, which is typically granted by the banks to clients with good credit history and the ability to put up collateral. The collateral can be lands as well as the assignment of the proceeds from the EDCO, and various loan guarantees schemes could be employed to reduce collateral requirements, noting however, that the PV plant itself could be the collateral.

6. The donor community, particularly GIZ, aims to direct its support in the most effective manner to assist the MWI attain the project objectives, particularly to realizing a pilot project in the short term. To this effect, and given the economics of the project, GIZ grant funds that were initially considered to co-fund the pilot project could go to several activities, such as:
   1. increasing the size of the project,
   2. funding loan guarantees for a larger number of projects,
   3. provide additional technical assistance to the farmers in proposals development, and/or
   4. conduct a grid impact assessment to assess the scale up potential of the program.

Furthermore, cooperation with other donors and donor-funded programs could be considered including the Jordan Renewable and Energy Efficiency Fund (JREEF) role in supporting farmers with net-metering projects, particularly if farmers are allowed to exceed 100% of their electricity consumption figures. JREEF aims at supporting the development of RE and EE measures by
facilitating access to finance and grant support to key initiatives, such as PV projects, particularly in sectors that require support due to subsidies.

4. Overview of legal framework and options

4.1 Laws, by-laws, regulations and directives

Jordan was first in the region to release a renewable energy and energy efficiency law aiming at:

1. Exploitation and development of renewable energy resources to increase its share in the national energy mix and to encourage investment,
2. Contribute in protecting the environment and achieving sustainable development, and
3. Conserve energy use and increase its efficiency in various sectors.

The temporary Renewable Energy and Energy Efficiency Law passed in 2010 and its final form was issued in 2012 with an amendment approved in 2014. Figure 2: demonstrates the evolution of the Jordanian Renewable Energy and Energy Efficiency Law.

Evolution of the Jordanian Renewable Energy and Energy Efficiency Laws

- Temporary Renewable Energy and Energy Efficiency Law (3) 2010
- Amendment of Renewable Energy and Energy Efficiency Law (33) 2014

**Figure 2: Evolution of the Jordanian Renewable Energy and Energy Efficiency Law**

The Renewable Energy Law No. 13 (2012) including its amendment together with the relevant by-laws and directives are the legal basis for all renewable energy projects in Jordan. These are binding for the National Electric Power Company (NEPCO) and all electricity Distribution Companies.

The law and regulations allow for several windows for developing a solar power plant. Those include, unsolicited proposals, net-metering regulations and wheeling regulations (described below), all of which
are underpinned by a “benchmark” electricity selling price of 0.10 JD/kWh\(^1\). This “benchmark” selling price may be subject to change and can be set based on the directives of the Mineral and Energy Regulatory Commission (MERC) and subject to negotiation with the utilities. The following further elaborates the three schemes for developing renewable energy systems:

4.2 Legal framework and options

Figure 3 illustrates most relevant bylaws, directives and regulation to the Renewable Energy and Energy Efficiency Law (13) 2012.

**Figure 3: REEE law most relevant by-laws and regulations**

1. **Direct or unsolicited Proposals** may be submitted to the MEMR based on a call for proposal from MEMR. Since the inception of the Renewable Energy (RE) law, MEMR issued several rounds of calls for RE proposals (round 1 solar and wind, and round 2 solar) under strict tender procedures, however, they were focused on large scale utility applications and not applicable for the scale of projects envisioned under the MWI/ GIZ pilot project.

Subsequent, and most recently in 2015, a bylaw no. (50) 2015 for the management of unsolicited proposals was approved by the Council of Ministers regulating the management process for Unsolicited Proposals by MEMR and partner organizations, and providing a framework and flexibility for launching calls for proposals for all types of Renewable Energy projects. Under such scheme, the electricity transmission or distribution companies would be the purchaser of electricity under a form of Power Purchase Agreement (PPA).

\(^1\) with the possibility of 15% increase in the selling price in the event that the solar system is of Jordanian origin
It must be noted that the unsolicited proposals bylaw no. (50) 2015 makes an exception for all projects that are sponsored or co-sponsored by the government. The rational is that the proposals should be on commercial and competitive basis/merit. Accordingly, an exception would be required to use the unsolicited proposal method if grants are provided to farmers, particularly if they are not equitable grants and support.

Among the other key challenges related to the unsolicited proposals, is that the cap on the selling tariff is adjusted annually by the Mineral and Energy Regulatory Commission (MERC). This also can be linked to the increasing competition in the local market, the thing that certainly will drive the current baseline tariff of 0.10 JOD/kWh downward thus affecting the economics of solar farming.

2. **Net-Metering Regulations** allow any consumer of electricity to generate power in order to reduce their electricity consumption and export electricity to the grid (which would be credited to the consumer) without exceeding 100% of their historical annual consumption, with the exception of grant-funded projects that would be allowed to generate more than 100% of the historical consumption of the consumer. Excess electricity, at the end of the fiscal year, would be sold at the base-line electricity selling price of 0.10 JD/kWh. Based on this exemption in the law, MERC was consulted to discuss scenarios to implement the project through the net-metering scheme. [Annex 1: MoM with MERC](#). As a result of this consultation, it was concluded that implementing this project through the net-metering scheme is against the laws and regulations of MERC for the following reasons:

   a. Net-metering scheme is designed only to generate power for own consumption for already established entity and not for income generation.
   
   b. According to the regulations, the size of the Photovoltaic system must be determined by MERC in a way that power generation should not exceed the consumption and therefore no revenues can be made out of the system.
   
   c. Other legal constrains related to the ownership of the company, which will be established and thus the ownership of the power meter.

Based on the above, the project team concluded that Net-metering scheme is not a compatible legal framework given the solar farming project objectives.

3. **Wheeling Regulations** allows all consumers of electricity to generate power for their own consumption – as in the case of Net-metering – however, from another location. The consumer of electricity would be required to pay wheeling fees and incur wheeling losses in
accordance with MERC regulations. The wheeling fees and losses depend on the connection type, if it is at the distribution company or the transmission company and varies from 6 to 8.3% losses, and 7 fils to 11.5 fils / kWh.

After a review of the three frameworks list above, it was determined that submitting an unsolicited proposal to the MEMR was seen as best avenue for implementing the project. The new bylaw for unsolicited proposals was approved by the council of ministers in June 2015. However, as stated before, this by-law does not allow the development of the intended solar farming project because of the government involvement. Nevertheless, MEMR indicated that it would be willing to grant an exception for the pilot project, particularly for the project objectives and background.

At present, discussions are made with MEMR to approve the pilot plant with an exception under the unsolicited proposals by-law no. (50) 2015. If such an approval is awarded to the project, MEMR will cooperate with MWI for inviting farmers to apply for selling of electricity to the electricity distribution company, particularly those farmers that meet the requirements of MWI and are willing to abide by project objectives of reducing water abstraction at licensed wells. Two challenges need to be addressed however, first, the involvement of grant funding for the projects, and second having a healthy tariff to allow farmers to develop projects. These two challenges are further elaborated in the key challenges section.

5. Summary of project achievement, timeline and progress

In order to develop the pilot project and since the launching of the project in 2013, a series of meeting with all key stakeholders (MWI, MEMR, MERC and EDCO) have conducted, and a lot of correspondences have taken place between the relevant institutions in order to find a proper legal and administrative framework to implement the project.

While much of the assignment-related tasks were completed, the project has not materialized within the anticipated time frame due to a number of complicating factors and challenges described in this
report, thus providing some important lessons learned for future piloting, scale up or replication in Jordan or abroad.

The project achievements can be summarized in the following points:

- Identifying the legal context and parameters of the project, and determine the optimum development approach. Three project development schemes introduced by regulatory body of the government were analyzed thoroughly and were discussed with decision makers. As a result, none of the existing scheme was found to be adequate for the solar farming project as discussed in the legal framework and options section. However, the option of obtaining an exception for the project under the unsolicited proposal scheme was seen the only feasible solution because of project business model and its objectives.

- Identifying interested farmers willing to provide the land, and to implement the PV power plant. Meetings were conducted with farmers identified by the Highland Water Initiative in order to raise their awareness about solar farming, and to identify potential grant recipients to establish the pilot. As a result, several farmers showed interest in the project and have the will to establish such a business on their farms.

- Draft MOU or a grant agreement to show the sponsor interest and level of commitment of farmers. Annex 2: Grant Agreement draft copy.

- A survey to select proper sites for the project was concluded highlighting site selection and evaluation method. Annex 3: PV sites selection presentation. One site was selected as the preferred site due to potential for expandability, in addition to security, cost of grid connection and land preparation costs.

- Review the viability of Photovoltaic (PV) plants on the sites identified by farmers in coordination with the Electricity Distribution Company (EDCO). Results are illustrated below in the “Economics of the solar farming project” section. It worth mentioning here that a meeting with EDCO took place on 13.08.2015 to clarify the confusion in roles and responsibilities between EDCO and MEMR on the implementation of the pilot project. Annex 4: MoM with EDCO.

- Develop a project techno-economic feasibility study as a basis for discussion with farmers and banks. Results are shown in the below section “economics of solar farming”

- Assess available and optimal financing schemes from local banks and financing institutions. Discussions with at least one bank took place that is the Housing Bank, primarily due to their presence in the Azraq Area. However, other banks are more aggressive in the financing of PV
projects that include Cairo Amman Bank, Etihad Bank and Capital bank that will be approached for an offer. It must be noted that other financing options were investigated, namely the Agricultural Credit Corporation from the government of Jordan that were deemed to be too expensive. As of the date of the report, no feedback beyond what is presented above is provided. However, as the project proceeds to applications, then negotiations will progress together with the bank and the project owners as facilitated by the project advisor.

- Development of documents to support the financing and tendering of the project. These are listed below in Table 2 and serve the financial close of the project.

Table 2: project documents

<table>
<thead>
<tr>
<th>Document</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company information bylaws and registration papers</td>
<td>Draft available, to be finalized upon registration and with feedback from MWI and MEMR (Annex 5).</td>
</tr>
<tr>
<td>Executed purchase agreement with utility company</td>
<td>To be provided by EDCO upon MEMR approval.</td>
</tr>
<tr>
<td>Tender Documents</td>
<td>See Annex 6</td>
</tr>
<tr>
<td>Land lease agreement with land owner</td>
<td>Will use standard template from legal firm</td>
</tr>
<tr>
<td>Grant agreement from MWI</td>
<td>See Annex 2</td>
</tr>
<tr>
<td>Personal guarantees from shareholders and/or mortgage agreement on the land</td>
<td>Per bank forms.</td>
</tr>
<tr>
<td>Assignment of project proceeds to the bank.</td>
<td>Per bank forms/letter.</td>
</tr>
<tr>
<td>Project business plan, feasibility study and cash flow.</td>
<td>See Annex 7</td>
</tr>
<tr>
<td>EPC offers and draft contract for project execution.</td>
<td>Ministry of Public Works / Fidic Contract will be used.</td>
</tr>
</tbody>
</table>
6. Economics of the solar farming project

The calculation of economics for the solar farming project was done based on the following tangible factors:

- The selling price of electricity, which has been set according to the benchmark in bylaws to 0.10 JD/kWh, or 0.115 JD/kWh for projects that meet local content requirements, the economics of solar farming can be quite favorable.
- The solar radiation at the site, whereby a safe assumption of plant yield of 1800 kWh/kWp\(^2\) was assumed, and subject to the operator’s effectiveness in cleaning. At 0.10 JD/kWh, the pre-tax net income of a 200kWp would be on the order of 36,000 JOD per year.
- The capital cost of the PV plant, at a conservative 1 JD/Watt would be 200,000 JOD for a 200kWp projects, noting that market prices can vary from 0.8 – 1 JD/Watt. It worth mentioning here that the capital cost is also influenced by various factors:
  a. The quality of components and the design of the plant.
  b. The cost of connection to the grid, and the availability of existing capacity at nearby transformers.
  c. The site-specific requirements for security, fencing, and land preparation.
- The cost of finance, whereby the lowest cost and most flexible terms were determined to be through commercial banks extending the preferential facility provided by the Central Bank of Jordan for renewable energy projects.
- The amount of grant and support offered to the project that is $120,000 offered by the GIZ.

During the course of the study, several potential locations were visited and a conservative budget was developed for the 200 kWp project, and updated for the purposes of this report to be on the order of 1,000 JOD per kWp.

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\(^2\) This number indicates a conservative value of how much 1 kWp of a PV system could produce at the specific site.
Table 3: Project cost breakdown

<table>
<thead>
<tr>
<th>PV plant components</th>
<th>JOD/Watt</th>
<th>JOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modules</td>
<td>0.42</td>
<td>84,960</td>
</tr>
<tr>
<td>Inverters</td>
<td>0.11</td>
<td>21,240</td>
</tr>
<tr>
<td>Mounting</td>
<td>0.11</td>
<td>21,240</td>
</tr>
<tr>
<td>Cables and balance of system</td>
<td>0.04</td>
<td>7,080</td>
</tr>
<tr>
<td>Transformer</td>
<td>0.07</td>
<td>14,160</td>
</tr>
<tr>
<td>Fencing</td>
<td>0.04</td>
<td>7,080</td>
</tr>
<tr>
<td>Installation and transport cost</td>
<td>0.11</td>
<td>21,240</td>
</tr>
<tr>
<td><strong>Subtotal cost</strong></td>
<td><strong>0.89</strong></td>
<td><strong>177,000</strong></td>
</tr>
<tr>
<td>Contractor’s Profit and contingency</td>
<td>0.11</td>
<td>21,240</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.99</strong></td>
<td><strong>198,240</strong></td>
</tr>
</tbody>
</table>

Furthermore, the cost of operation is expected to include the following elements, at an assumed annual cost of 6,000 JOD per year:

- Security personnel (if needed)
- Cleaning personnel (if needed – with an annual wet cleaning, and regular dry cleaning),
- Plant insurance,
- Loan interest.

The following are some of the main conclusions on economic viability of a 200kWp project:

- It is estimated that a 200kWp PV plant could generate an annual pre-tax net income of 36,000 JOD, and payback period of 7 years, without grants or without any debt incurred by farmers. This results in an Internal Rate of Return (IRR) of 15%, and would be deemed as a very attractive investment.
- In case the project is 70% financed by a Jordanian bank with an interest of 5.5% for a period of 10 years, then the IRR on equity would be 23% with a payback period under 7 years, and an annual income of approximately 12,000 JOD until the loan is paid after the tenth year, and 36,000 JOD subsequently.
- The 36,000 JOD of income amounts to some 10,000 JOD per dunum\(^3\) (assuming the 200kWp is installed over three dunums), while the income from farming can vary by as much as 10-1000 JOD per dunum per year depending on the crop (all be it for a lower capital investment)\(^4\).

- In the case where the farmer does not invest in the solar farm, rather is provided a PV system at a zero-interest loan for 10 years, a net-income of 10,000 JOD per farm may be derived, which can be considered as a healthy income for some farmers, which is significantly higher than the minimum wage in Jordan.

Therefore, the conclusion can be drawn that solar farming is economically viable without grant support.

With grant contributions, the attractiveness can be further enhanced.

### 7. Scale Up Possibility

The potential to scale-up solar farms as a mean to incentivize farmers to reduce or stop abstraction would depend on the grid constraints, as well as the MWI ability to regulate water use.

The technical viability of the scale up is constrained by the availability of grid capacity at the location. Grid capacity is defined as the grid ability to absorb the electrical power of the PV plant at all times. The study location in Azraq area on one of the 34 Km feeders that supply the agricultural lands has limited capacity and a maximum load of 3.8 MWp.

The carrying capacity\(^5\) of the Medium Voltage (MV) line is up to 33MWp, however, this would result in reverse current at the NEPCO substation in Azraq area and subject of a grid impact study. Therefore, and if proved viable, and assuming a 200 kWp plant is sufficient income per farm, the total possible farmers that can contribute to the program would be approximately 160 - the result of dividing the maximum carrying capacity (33MWp) by the PV plant size (200kWp).)

It is recommended that a grid impact assessment be conducted to ascertain the maximum PV plant capacities that can be installed on this feeder, and the impact made on technical losses.

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\(^3\) 1 Dunum equals to 1000m\(^2\)

\(^4\) Based on a study carried out by GIZ “farming in the system to identify the farming systems in the project area.

\(^5\) Technically, carrying capacity is the point at which the addition of variable RE produces a system that cannot reliably be operated due to technical challenges or, more simply stated, the point at which the addition of variable RE breaks the grid. (Source: NREL).
On the other hand there are other factors that are intangible and do not contribute to the economic viability of the project, however, they are costs incurred by the government and motivate action to support solar farming project. These factors are the following hidden costs (or saving):

- The cost of water to farmers that is heavily subsidized.
- The cost of electricity used for irrigation that is also subsidized.
- Technical losses in the electricity feeders to the farms\(^6\).

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\(^6\) At time of this report, the amount of technical losses is unknown.
8. **Key challenges analysis**

As the project concept developed and after reviewing the laws, by-laws, regulations and directives and went through deep discussions with the involved parties, the following challenges can be identified:

8.1. **Renewable Energy Legal framework and procedures**

The project was initiated prior to the launch of the unsolicited proposals bylaw (50) 2015. While there was an initial approval from the MEMR to proceed in developing the project as an exception, MEMR had valid concerns that it would open itself up to liabilities.

It is noteworthy that this did not delay the development of the project. The new bylaw now provides the legal context and the procedure for issuing a call for proposals from the farmer community. Noting however that the Unsolicited Proposals committee at MEMR can work in close cooperation with MWI and GIZ representative for the purpose of developing the call for proposals for this specific solar farming program, or at least the pilot project.

For the time being an exception is required by MEMR or the Prime Ministry under the unsolicited proposal scheme in relation to the involvement of GIZ grant and the tariff structure to facilitate the implementation of the project. However, until the moment of writing this report no exception has been given.

8.2. **Water sector legal framework and procedures**

For the process of selecting farmers, MWI aims at insuring that the awarded farmers (for the purpose of the pilot project) were all legal in terms of land ownership, water well licenses, and payment records for water. To this end, an eligibility criteria was developed by MWI to select eligible farmers.

While there are many illegal practices by farmers, MWI sees that the involvement of those illegal farmers in the project as if MWI reward their illegal investments. Thus all illegal farmers are not eligible to benefit from the project though they are the most water consuming group. On the long run and if this project would be implemented and scaled up, MWI can control the illegal activities by eliminating illegal farming activities completely and closing illegal wells in exchange for a license for solar farming. This is only a suggestion from the project team.

In the first round of meetings with farmers, many of farmers who were interested in the project visited the Water Authority of Jordan to check on their eligibility to participate in the project. At that time, only
one farmer fulfilled the criteria of MWI. Recently, some more could legalize their wells and hence became eligible.

There was no clear and binding mechanism to enforce a reduction in water abstraction in return to energy farming. Thus, an internal by-law for the company, which will be established by the selected farmers shall be developed among the relevant parties, here, the MWI is a key player. A binding agreement between the MWI and participating farmers should be signed to enforce water abstraction reduction. Also MWI has to find a tool to monitor farmers’ practices after the termination of the project. For instance, to how extent the farmers are committed to comply with the signed agreement with MWI, how much water is saved before and after the implementation. This should be discussed once the project started.

In order to avoid corruption suspicions, MWI decided to have a transparent process to reach all farmers in the project area. This can be done by first, developing the eligible criteria for participation and invite farmers to participate in the project through the different media channels (newspapers and the relevant directorates in Azraq area). The challenge here is that according to MWI mandate, it is not allowed that MWI invites the farmers; it should be then MEMR, the thing that is not discussed yet with MEMR as the exception is not obtained yet. This concern was clear in the meeting with MWI. Annex 8: MOM with MWI.

8.3. Inter-ministerial cooperation and communication

As a result of the involvement of many key stakeholders in the implementation of this project, close inter-ministerial cooperation is needed and a smooth decision-making process should be in place to facilitate the implementation of such a project within the designed time frame. Unfortunately, this was not the case. Each institution has its own strategy, policies, mandate, laws and regulations. Lack of harmonization and coordination exist unless there is an urgent need to have a joint strategy among the relevant institutions. For example, Ministry of Agriculture has engaged MWI in the process of updating their strategy through forming a joint committee due to the urgent need to control the water use in the agricultural sector.

The uniqueness and innovation of this project is not yet digested by both ministries, especially that such a project needs a special treatment as mentioned before.

Since the launching of the project, the project team has been working in close consultation with both ministries; however, the unexpected frequent cabinet reshuffle makes the mission even harder. Over
the past three years the Minister of Energy changed twice which in turn means internal reshuffling in the same institution. For each time, the project team had to again start the process of the introducing the idea to MEMR and meet the SG and the Director of the Renewable Energy.

Another aspect could be considered here is the small size of the project, which was not enough to encourage MEMR to give it a priority.

The existence of a water-energy task force between the ministry together with related electricity distribution companies, technical assistance agencies and donors, could be an option or tool to focus on joint initiatives and that such a project could be given a fast track and prioritized approach targeting the intersection areas and the main challenges facing both institutions. Such a solution needs to raise this issue to the SGs of both institutions to make sure that this project and other similar initiative could be given a priority to be discussed in the task force meeting.

8.4. Project scalability and grid absorption

The importance of the pilot project is derived from the possibility of scalability, and to this date, the impact of up-scaling the project, up to 10’s of MW in the highlands area, and then replicated to other farming communities is not yet fully understood. This would be informed by a grid impact study or further discussions with MEMR and the distribution companies. Noting however that there is competition for grid access from other RE schemes. Once the scale-up potential and its value for safeguarding water and fiscal resources is assessed, the stakeholders are more included to support the pilot project(s) further.

8.5. Providing an enabling environment for farmers

The ability of farmers to respond to a call of proposals and to act as solar developers is limited, although there are several farmers that are quite business oriented and can identify suitable PV companies and financing sources to implement the project.

However, if the impact is to be spread among a large number of farmers, consideration may be given to a cookie-cutter approach or a pre-qualification of PV contractors and co-developers that can assist farmers in implementing the project.

Furthermore, the ability of farmers to invest in a solar project must also be assessed, whereby many farmers may not have the capital to invest in the project, and where grant support may be required. In such a case, and in the case of scale up, a criterion must be established for donor support and donor
funding may need to be allocated to such farmers, particularly if it means that farming activities are ceased. The donation or soft loan must be substantiated with a saving in water or electricity subsidies.

Furthermore, MWI must also determine what farmers are more important to focus on. The large farmers, that have high water consumption, but perhaps highly efficient operation and access to international markets; or those farmers that have more economic hardship, less access to international markets, and inefficient irrigation techniques. It would appear to be the less effective farmers that should be given the opportunity, whereby they would require more support.

9. Opportunities and Project Impact Potential

As demonstrated by the economics of solar power, the impact of solar farming (at an attractive electricity selling price) could be significant for Jordanian farmers allowing them to participate in the energy revolution and contribute to the sustainable energy mix in Jordan. Such schemes can build social and community cohesion provided they are equal opportunity projects, and that grant support is directed to those farmers that need it most.

At present, we must highlight that there is significant donor interest in Renewable Energy projects that impacts various sectors including water, agriculture, and energy. If those programs are well designed, there could be significant impact and many MW’s of energy derived from community-based projects.

The proliferation of PV farms on the property of legally licensed wells would have the following impact:

- Motivate farmers to dedicate part of their land to solar projects,
- Allow for alternative sustainable income for farmers,
- Assist the electricity distribution companies in having distributed energy sources that would contribute to reducing losses in the network,
- Create a stronger sense of community between government agencies and the local communities.

While the impact of reducing water consumption is not easily monitored, and would be the main byproduct of such activities, it may be possible to offer some farmers the opportunity to depend solely on solar energy as a source of income (all be it gradually), in exchange for closing their wells.

All in all, it may be suggested that a market-driven approach could also work, whereby Net-metering schemes can be encouraged without setting a limit on the cap of the system size. By doing so, farmers can select what is more economical for them, and it would attract partnerships with pure solar
developers and investors on farmland. Such a scheme may result in fewer, yet larger solar plant sizes (perhaps limited to a size of MW), which would need to be conditional on minimizing farming activities on that farm or at least to stop their expansion.

10. Project long term adoption and recommendations for implementation

While the pilot project has not been realized to date, and since the initiation of project activities in 2013, the efforts to date have not gone in vain and only reinforce the need for additional and concerted efforts to develop a program designed to address Jordan’s energy and water challenges through public and private sector cooperation. New technology paradigms resulting in an improvement in the cost of solar energy provide an excellent opportunity for addressing Jordan’s water challenges and the government have some very viable policy and regulatory tools to help motivate investment and change in the farming sector.

The implementation of such a program with farmers as investors needs the full commitment and coordination between MWI and MEMR. Having this project as a pilot, our recommendations would be the following:

1) Strengthen the cooperation between the relevant stakeholders with more focus on the intersection area. This can be done through conducting lessons learned and brainstorming sessions on the scale up potential, the role of the pilot project in creating common understanding for the partners’ roles in implementation; and agree on a development framework and milestones for future project implementation. This will increase the acceptance for the project and ensure a smooth implementation of the project.

2) Design the first round of call for proposals for solar farmers, in order to test the market for unsolicited proposals from farmers by launching a call of proposals for legal farms, limiting the first round to 200kWp, and identifying those interested in a larger project size such that larger project sizes would be tied to curbing the over-abstraction of groundwater for irrigation. Consideration for implementing more than one pilot project should be given depending on the appetite of farmers.

3) Assess the features and eligibility criteria for farmers and what regulatory schemes could be implemented, which may be more than one including:
   a. Net-metering not limited to 100% with support from JREEF
b. Direct/unsolicited proposal, for 200kWp or a specific size

c. Direct/unsolicited proposal, capped to a certain size with conditions for stopping irrigation

4) Identification of additional criteria for which to provide farmers grant support or interest free loans for project implementation, and identify other donor partners and NGOs that are positioned to assist farmers in developing projects. Ideally, these criteria would also be included in the call for proposals.

5) Conduct a pre-screening and qualification of PV Engineering Procurement and Construction (EPC) contractors to insure that the resulting PV pilot project would have the desired impact. The criteria would relate to the capabilities and prior experience of the contractor’s or suppliers to support similar project scale as those proposed by the applicant farmer.

6) Assess the grid impact of various farming locations, taking the Azraq Area or any other area that is of value to the distribution companies in order to conduct the pilot project(s) and simplify the permitting time and challenges related to the project.

7) Develop the Power Purchase Agreement (PPA) template and support program for the implementation of the solar farming project through specialized and dedicated committee or group of implementing organizations.

8) Continue to engage with farmers regarding the pilot and scale up project design, for their value added input and their understanding in the inherent challenges related to program implementation.

On the long run and in case that such projects are initiated more frequently, the tendency to host such projects will be increased especially that in general the economics of PV systems are improving, the openness and awareness of farmers towards the ideas of solar farming is increasing and the legal framework of the renewable energy is subjected to continuous changes more than before.

A key factor for the success of the project is the MWI’s political will to build on the past efforts and get engaged actively to achieve the project’s objectives.
11. Annexes

1. Minutes of meeting with MERC
2. Draft agreement draft
3. PV Sites selection presentation
4. Minutes of meeting with EDCO
5. Company information bylaws and registration papers
6. Tender documents
7. Project business plan, feasibility study and cash flow
8. Minutes of meeting with MWI