Recent Trends in Solar PV Systems in Jordan

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Outline

• Jordan Renewable Energy (RE) Policy Targets
• RE Regulatory Framework
• Investment Opportunities - Floated and Planned Renewable Energy Tenders
• Additional RE Tenders
• Direct Proposals Submissions
• Distribution Companies and Energy Net-Metering for Small-scale RE systems (Mainly for PV Rooftop Installations)
• Recent grid connected PV Installations done by NERC
• Testing PV modules and PV inverters at PV Systems Laboratory of NERC
• Conclusions
Jordan Renewable Energy (RE) Policy Targets

- Promoting RE to contribute 7% in the primary energy mix in 2015, and 10% in 2020.
- Main Projects to be developed either through Competitive Bidding, or Direct Proposal Submissions to reach these targets include:
  - 1200 MW Wind Energy
  - 600 MW Solar Energy
  - 50 MW Waste-to-Energy

Source: MEMR
RE Regulatory Framework

➢ **RE and Energy Efficiency (EE) Law:**
The Law was issued in April 2012, allowing Direct Proposal Submissions of projects for generating electricity and connecting to the grid.

➢ **By-laws and Regulations for Investment:**
The by-laws and regulations related to RE projects for electricity generation were also issued, mainly:

- The Reference Price List which includes the indicative prices for each type of Renewable Source.
- Connecting RE Facility to Distribution Grid

Source: MEMR
- **Energy Efficiency (EE) By-law:**
  - Issued on 14 November 2012.
  - SWHs are mandatory as of April 2013 for new buildings.
  - Energy Service Companies (ESCOs) market to be regulated.
  - Labeling is mandatory to all Electrical Appliances.

- **Tax Exemptions By-law:**
  - Under final approval.
  - Exempting all RE and EE Systems and Equipment from Sales Tax and Custom duties.
  - All RE Projects shall enjoy the tax exemptions applicable to Conventional IPP projects.

- **Ongoing Grid Reinforcement Plans by NEPCO**
  The so-called “Green Corridor” transmission line is under development, to be ready by 2015 to absorb new renewable power.

Source: MEMR
<table>
<thead>
<tr>
<th>Tender</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fujeij90MW project wind Basis BOO Maan project wind Basis EPC 65-75MW</td>
<td>Under announced, bidder ranked First 2014 by operational Award, final under are offers closed, Prequalification evaluation</td>
</tr>
<tr>
<td>Azraq Project Solar PV (above 2MW EPC basis)</td>
<td>evaluation under are offers closed, Bid evaluation</td>
</tr>
<tr>
<td>Quweirah PV Solar project (65-75MW EPC basis)</td>
<td>Under planning and development (UAE support- Abu Dhabi Fund)</td>
</tr>
</tbody>
</table>
TendersRE Additional

Direct Proposals Submissions:

- As per the RE Law on Direct Proposals:
  - MEMR received (64) EOI s.
  - (34) shortlisted in April 2012.
  - (30) MOUs signed total capacity of about 850 MW.

- Expected dates for Submission of Direct Proposals:
  - Photovoltaic (PV) Projects; March 2013.
  - Concentrated Solar Power (CSP) Projects; mid 2014
  - Wind Energy Projects; 1st quarter of 2014 (could be earlier).

- The first Wind Direct Proposal submission for 115 MW at Tafila site was submitted by (JWPC), PPA agreement is under final discussion.

- Next round for EOI submissions expected in the second half of 2013.

Source: MEMR
## Direct Proposals Submissions

<table>
<thead>
<tr>
<th>Technology</th>
<th>Received Applications</th>
<th>Qualified Applications</th>
<th>Signed MOUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>24</td>
<td>545</td>
<td>15</td>
</tr>
<tr>
<td>Solar CPV</td>
<td>5</td>
<td>125</td>
<td>2</td>
</tr>
<tr>
<td>Solar CSP</td>
<td>8</td>
<td>370</td>
<td>5</td>
</tr>
<tr>
<td>Wind</td>
<td>22</td>
<td>1,190</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>---</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>2,230</td>
<td>34</td>
</tr>
</tbody>
</table>

Source: MEMR
RE and EE Fund

This Fund was established in accordance with Articles of the RE & EE Law aiming to:

- Provide incentives and financial support for RE and EE measures, studies and projects.
- Promote the use of RE and EE in Jordan.
- Encourage private-sector investment in RE and EE projects and activities.

Source: MEMR
Distribution Companies and Energy Net-Metering for Small-scale RE systems (Mainly for PV Rooftop Installations)

Source: NERC / RSS
Recent Grid Connected PV Installations done by NERC

- 288 kWp PV power plant at RSS in Amman
- PV Evaluation Field in Ma’an (South)
- PV Evaluation Field in Irbid (North)

Source: NERC / RSS
In November 2011, NERC designed and installed through a Japanese grant a 288 kWp grid connected PV system within the campus of the Royal Scientific Society (RSS) where NERC exists.

The utility operator at that time was not obliged to receive any electricity from the system as the connection and feed-in instructions were not issued yet by the Electricity Regulatory Commission (ERC), so the system was equipped with a utility reverse power protection.

Source: NERC / RSS
288 kWp PV System at RSS

Site Photo

GUI, monitoring system

Source: NERC / RSS
Site Analysis
## Site Evaluation Criteria

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Land geography of the site</td>
<td></td>
<td>The site is not influenced by natural disaster like a flooding, strong wind, sand storm, etc. ○</td>
</tr>
<tr>
<td>2 Direction (South)</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>3 Situation of around site (Obstruction etc.)</td>
<td></td>
<td>No shadow by building, trees, poles and so on △ The direction of the slope is up to South (Recovered by Land leveling) ○</td>
</tr>
<tr>
<td>4 Power consumption of the site facility.</td>
<td>○</td>
<td>Consumed by EHSC</td>
</tr>
<tr>
<td>5 Visibility of PV system</td>
<td>○</td>
<td></td>
</tr>
</tbody>
</table>

Source: NERC / RSS
Existing grid system (Before Project) & Protection system for the grid system

Source: NERC / RSS
PV system (After Project)
& Protection system for the grid system

Source: NERC / RSS
DC Connection Boxes for PV Strings and Arrays

Source: NERC / RSS
Control Room for Inverters and Monitoring System

Source: NERC / RSS
Net electricity consumption = Building electricity consumption - PV electricity production

Year 2012

Source: NERC / RSS
PV Evaluation Field in Ma’an (South)

• In year 2011, NERC signed an agreement with a Jordanian company, aiming to invest in solar electricity generation, to install different PV systems with different cell technologies and evaluate the technical performance of them under the climatic conditions of a site located in the southern part of Jordan. The nominal capacity for each PV system is around 1 kWp or more.

• 8 systems are installed in the evaluation field till the moment.

Source: NERC / RSS
Site Photos

A Photo during Installation

A Photo after Installation

Source: NERC / RSS
PV Evaluation Field in Irbid (North)

• In October 2012, NERC installed 5 grid connected PV systems on the rooftop of one of the buildings located within the campus of a University in the northern part of Jordan. The nominal capacity for each PV system is around 1 kWp or more.

• This project was funded by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) as a research project.

• A central monitoring system was installed. Data is accessible offline and online via the internet.

Source: NERC / RSS
Site Photos

A Photo during Installation

A Photo after Installation

Source: NERC / RSS
Testing PV modules and PV inverters at PV Systems Laboratory of NERC

• **Outdoor Testing of PV Modules and Arrays:**
  – Testing up to 100 kWp PV arrays (NERC received recently a new IV curve tracer, the only one in Jordan)
  – Testing according to IEC 60904-1 entitled “Photovoltaic devices-Part 1: Measurements of PV current-voltage characteristics”
  – Correction according to IEC 60891 standard entitled “Procedures for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic (PV) devices”

• **Measurement of PV inverter efficiency:**
  – Testing up to 10 kVA
  – Testing according to IEC 61683 standard entitled “Photovoltaic systems-Power conditioners-Procedure for measuring efficiency”

Source: NERC / RSS